



Understanding Human Life

Daniel Courgeau

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Understanding Human Life

A methodological and interdisciplinary
approach

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To my beloved wife, Hella

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General introduction

Chapter 1

Understanding and misunderstanding human life:

This book addresses the challenge of understanding human life. We compare our life experience with the attempts to grasp it by astrologers, eugenicists, psychologists, social scientists, and philosophers. How have these various disciplines sought to give substance to an experience at once so intimate and so universal?

The main opposition in the list above lies between *understanding* and *misunderstanding*. For example, the astrologers' and eugenicists' approach, fully accepted in their day, is now largely viewed as a form of misunderstanding. To show why this is so, we examine their methodology. For practitioners of the other disciplines, their understanding may be limited by various methodological problems they encounter but are trying to overcome. We shall explore these issues as well.

1.1. Varieties of understanding or misunderstanding

The word “understanding” has many meanings (see, for example, Baumberger et al., 2016), as no consensus about its definition has emerged. For our purpose, it will be helpful to narrow our focus in order to better understand the aim of this work.

Let us begin by looking at the meaning of the term “to grasp,” previously used to characterize the attempts made by different approaches to understand human life, and very often adopted by epistemologists (Hannon, 2021, p. 19). The definition of *grasping* comprises two main meanings, which are totally interconnected. The first is physical: to hold someone or something firmly. The second is figurative and applies more specifically to ideas: a person is said to grasp an idea if (s)he understands it fully, i.e., comprehends it perfectly. This work therefore examines the intimate comprehension that we can have of our own life and that of others. Is it possible that we can grasp the essence of this life even before it unfolds—as claimed by astrologers and, later, Galton’s eugenics or the theory of inheritability? We shall also examine other approaches. For example, when analyzing memory, psychologists adopt another perspective and seek to share with us a more general view of the life of an individual, a group of individuals, or even an entire people. Scientists use methods approved by their community in order to gain a deeper understanding of life. Social scientists explore ways of going beyond the personal approach in order to provide a more complex picture of the social world in which we live. Psychologists focus on autobiographical memory, trying to see how people develop and use it. Conversely, philosophers will seek a more precise meaning of the nature of this comprehension, of the various approaches to it, of the notion of causality that can be attached to it, and so on.

Another important distinction is found in Wilhelm Dilthey’s hermeneutic approach (1883) between *comprehension* (German: *Verstehen*) and *explanation* (German: *Erklären*). A detailed discussion of his work lies outside the scope of our book, but we refer the reader to the excellent study by Mesure (1990) on the establishment of historical science, which includes a detailed presentation of Dilthey’s work and the critical reactions to it.

For our purposes here, suffice it to say that *comprehension*, initially viewed in the context of psychic life, was defined as literally reliving another person’s lived experience. The definition was then substantially revised in the attempt to establish the sciences of the mind. As Mesure (1990, p. 231) clearly states:

[. . .] comprehension indeed consists in taking lived experiences and building the *whole* that brings them together, and, from what was a mere sequence, achieving the emergence of a *life* in the proper sense of the word, i.e., a totality oriented toward an end that gives meaning to every one of its stages. In this sense as well, autobiography provides the model for history, for [. . .] its task will always be to overcome the heterogeneity of events or stages and bring to light—in their succession—the continuity of an unfolding, *as if this were a life*.¹

We can see here how *comprehension* is essential for autobiography and, at the same time, allows a reconstruction of history.

While used in the natural sciences, *explanation* is not excluded from the social sciences. First, the physical and biological constitution of man must legitimately be subjected to this form of reasoning. Second, as Dilthey recognized, there was the possibility of a descriptive and analytical psychology that did not set out to *comprehend* lived experiences.

All these ways of understanding life, however, come up against the *elusiveness* of life. The notion of elusiveness embraces all that is hard to understand—in all the meanings of the verb identified above. Clearly, we lack complete information on our own life. Entire facets of our existence elude us today, because we have either forgotten them or, on the contrary, deliberately erased them from memory. How will psychologists explain this forgetfulness to make it credible, and how will they deal with the possibility of recalling lost events? For scientists as well, this mechanism poses many problems. Social scientists search for the reasons that can drive a community to forget certain traumatic facts and the ways in which it manages to do so. Biologists grapple with the difficulty of

¹ French text: ... la compréhension consiste bien, en partant des expériences vécues, à construire l'*ensemble* qui les réunit et, de ce qui n'était qu'une simple succession, fait émerger proprement une *vie*, c'est-à-dire une totalité orientée vers une fin qui donne sa signification à chacune des étapes : en ce sens aussi l'autobiographie fournit le modèle de l'histoire, dans la mesure où, ..., sa tâche consistera à surmonter l'hétérogénéité des événements et à faire paraître dans leur succession la continuité d'un déplacement, *comme s'il s'agissait du cours d'une vie*.

defining life and grasping its emergence and development. Philosophers ask: how can one explain the significance of this act of forgetting events that are trivial or, on the contrary, traumatic?

Moreover, the term “human life” can take on different meanings. The first encompasses all the events that mark our existence, events whose significance may partly or totally elude us. The second, more general meaning covers our biological life, connected to our environment and the other species living in it alongside us. The third meaning, which is more philosophical, concerns the spiritual life of human beings and their comprehension of it.

Alongside the verb “to understand,” another term is key for defining the core argument of our book: the verb “to predict.” If we can grasp something correctly, we should be able to predict it. But it is important to understand how this prediction will operate.

Let us begin by taking a closer look at the etymology and definition of the verb: *praedicere* in Latin is literally “to say beforehand,” but its meaning can be multiple and varies across different periods and languages.

In French, the *Dictionnaire de l'Académie française* (2019) tells us that in the twelfth century the verb *prédire* signified “to issue an order,” and that it did not acquire its current meaning until the fifteenth century. The word now has two definitions:

1. To reveal what will happen, under the effect of a divine inspiration or through an alleged divination, by resorting to magical practices or occult procedures. *Les prophètes ont prédit la venue de Jésus-Christ. L'oracle de Delphes prédit à Œdipe qu'il tuerait son père puis épouserait sa mère. Les voyantes, les diseuses de bonne aventure font métier de prédire l'avenir.* (“The prophets predicted the coming of Jesus Christ. The oracle of Delphi predicted to Oedipus that he would slay his father and marry his mother. The business of psychics and soothsayers is to predict the future.”)
2. To announce what must happen on the basis of reasoning or conjecture. *Les économistes n'avaient pas prédit l'arrivée de la crise. D'aucuns prédisent que son mariage ne durera pas.*

(“Economists had not predicted the onset of the crisis. Some predict that his marriage will not last.”)

As we can see, the first definition is totally suited for examining the various forms of divination (mantic methods), while the second seems more appropriate to the examination of eugenics, which relies on conjectures that we shall show to be fallacies.

The second definition, however, is more general, for in this case the prediction will be able to rely on reasoning, which can lead to a far more accurate science than divination or an approach based on erroneous premises. That is how astronomy—initially indistinct from astrology in ancient times—came into its own as a full-fledged science thanks to the work of Galileo, Kepler, and Newton. The second definition also leads us to Part 2 of our book, which addresses the question: “What can one capture of a human life and how?” Prediction will provide us with an answer to the question of “how?”

In English, the *Oxford Learner’s Dictionary* (9th edition, 2015) tells us that the verb *to predict* appeared in the early seventeenth century with the same etymology. The dictionary, however, gives only one meaning:

To say, expect or suggest that a particular thing will happen in the future or will be the result of something.

It provides various examples of the verb’s use, but without clearly distinguishing between them: *the factors that predict outcome in acute illness in the very old require further explorations*; *the good genes hypothesis predicts that females will prefer to mate with the healthiest males*; and so on. Curiously, these examples do not specify how one can predict the future, and at no point do they envisage divination, which lost much of its impact in the twentieth century. Several other English-language dictionaries searched online (e.g. Cambridge and Collins) offer definitions very similar to Oxford’s and just as vague.

The fuller versions of these dictionaries give us more details on the different meanings of the verb. The *Oxford English*

Dictionary (OED) (2009), for example, offers four distinct definitions, of which only three are of interest to us here:

1. to say beforehand, foretell, give notice of, advise, charge.
2. a. to foretell, prophesy, announce beforehand (an event, etc.). b. to have as a deducible or inferable consequence; to imply.
3. to utter prediction; to prophesy.
4. to direct fire at with the aid of a predictor.

We can disregard the fourth meaning, as it is clearly not relevant to our purpose. Definitions 2a and 3 correspond to the mantic methods examined in Chapter 2, most notably astrology, discussed in greater detail in Chapter 3. Definition 1 fits eugenics, “which will say beforehand that it is possible to predict the future of a lineage.” Definition 2b covers the issues analyzed in Part 2 of our book.

In sum, while the *Oxford English Dictionary* definitions overlap some of those given by the *Académie Française*, they do not enable us to draw clear distinctions. We shall give precedence here to the two *Académie Française* definitions.

Having defined the subject of our work, we must now see which methods will make it possible to objectivate life stories, and how and why they were developed. Next, and most important, we must see if these methods allow a truly scientific approach for analyzing life stories.

1.2. A multi-perspective methodological view

Life stories are by nature multidisciplinary. With their varying degrees of completeness, they serve as the basic tools in all social sciences and also in hermeneutics. We must therefore assess the different methods and approaches for studying them.

Some methods regard biographies as partly predetermined by external factors.

One example is astrology—not only the sort practiced by ancient civilizations, but also the kind practiced today by many pseudo-savants. Its adherents claim that its specific methods are wholly logical and can even be axiomatized (Vetter, 2000), but we need to examine their foundations and, above all, their scientific validity. It is also important to look at the concept of the scientificity of divination in Roman antiquity (Cicero, 44 B.C.E.), and to see which social groups subscribe to astrology today (Bauer, Durant, 1997). Lastly, we turn to astronomy, which was born at the same time as astrology but took a different path in the Renaissance, in order to become a scientific endeavor that led to the discoveries of Johannes Kepler and Isaac Newton.

Another, more recent approach regarded human life as predetermined by genes: eugenics. The methods used by eugenics, which totally negate individual freedom, were introduced by men whose scientific status was undisputed in their time, such as Francis Galton and Raphael Weldon. These “Ancestrians,” as they were then known, were the complete opposites of the “Mendelians” (Mendel, Bateson, and others), most notably for the methods each side used to justify its findings. Fisher tried to reconcile the two camps in 1918, but—here as well—we need to examine whether the axioms he defined for his demonstration were verified?

The end of World War II spelled the end of the preeminent status of eugenics, which tried to dominate the social sciences not only under the Nazi and fascist regimes of the first half of the twentieth century, but also in many countries around the globe—for the stated purpose of improving humanity. However, the notion of human predestination continued to inspire political regimes of the “developed” world under the name of “hereditarianism.” For example, the introduction of behavior genetics was based on Fisher’s 1918 axiomatics, and sought to predict individual behaviors entailed by the presence of certain genes. We must assess such claims with caution and see whether human behaviors obey such rules.

Apart from these attempts to treat life stories as if they were predetermined, it is important to recall how the stories were generated by humanity. They have existed since earliest times, and

they were initially produced as imaginary narratives before becoming more realistic. The methods used to craft them have varied across time, as we shall discuss.

The earliest known life story is that of Gilgamesh, the fifth ruler of the city of Uruk in Mesopotamia, who reigned nearly 2,500 years before our era. The text was discovered on Assyrian tablets in the mid-nineteenth century. It offers a fascinating and highly revealing insight into Mesopotamian culture, totally different from ours yet emotionally so close, in particular in its attitude to death. In Greek antiquity, Plato and Aristotle addressed the issue of *Poetics*, i.e., epic, tragedy, and comedy, which were, at the time, different ways of narrating one or more human lives. For Plato, art could only be the opposite of philosophy. In contrast, Aristotle saw art as an activity that helps us to understand the human mind.

In more recent times, different methodological approaches were developed for dealing with life stories.

The first consisted of population science, founded by Graunt in 1662. It began to analyze several important phenomena of human lives: first deaths, then births, union formations, mobility, and so on. This approach allowed an “*explanatory*” vision of human behavior. For this purpose, however, the persons studied had to be anonymized. Population science can never predict the behavior of a given *individual*; it can only study a *population*. This did not prevent it from making its analysis ever more detailed by introducing a growing number of characteristics of individuals and an ever more complex time frame. Its progress was marked by paradigms such as cross-sectional analysis, longitudinal analysis, biographical analysis, and multilevel analysis. Each of these various methods successively took population science to a new level of complexity, without erasing most of the results obtained with previous methods.

The second, more modern approach was philosophical hermeneutics, introduced in the early twentieth century. Unlike population science, it gave precedence to the study of a specific biography—applicable to one or more *individuals*—in all its dimensions. It allowed the analysis of imaginary as well as real lives. This approach thus endorsed a “*comprehensive*” vision of the

different forms of literature that present life stories in varying degrees of completeness, such as epic, tragedy, and the novel. It is, of course, possible and even necessary to analyze the actual lives of men and women using this approach in order to fully understand their complexity. From real-life narratives, the analysis aims to construct the complex that brings them together: from a simple succession of facts, it must produce a totality directed toward a purpose. In assessing the method's relevance, we shall see whether the results obtained from a very small number of cases studied can apply in a general way.

The third approach seeks to understand how our memory works. It has been followed by successive schools of psychology (chiefly structuralism, functionalism, behaviorism, cognitive psychology, and evolutionary psychology), neuroscience, psychoanalysis and other disciplines since the late nineteenth century. We shall concentrate on the memory of our own life story—our autobiography.

These specialties have used very different methods to analyze human memory. One method consists in analyzing how human memory works by focusing on a single individual—very often the researcher himself—or on a very small set of individuals. In 1879, the functionalist psychologist Francis Galton tried to recall the dates of events that he had memorized, and he compiled a typology of the different kinds of memory. In 1884, the neurologist John Hughlings Jackson used the clinical examination of a few patients to deduce a concept of mental processes and the unconscious. In 1895, from a detailed study of the case of Anna O., Sigmund Freud and Joseph Breuer drew the foundations of psychoanalysis. This method was still followed by later practitioners. In 1986, the cognitive psychologist Marigold Linton recorded the daily events of her life for twelve years, then tried to recall them freely in order to study her memory lapses. In 1991, the neurologists Goodale et al. identified an unconscious behavior of Mrs. D.F., suffering from “aperceptive visual agnosia”—a behavior that contradicted Freud's concept of the unconscious. In 2015, in a study involving only three patients, Naselaris et al. showed that they could memorize information received in visual as well as

propositional form. We shall therefore examine this method as applied to the various cases described above and assess the underlying theories that could justify it.

A second method uses larger samples to verify these theories. In 1880, the functionalist psychologist Galton studied 100 adults' visual memory of their morning breakfast table. His results were therefore conditional upon his having observed a non-representative sample of the English population of his time. Indeed, psychologists very often use such samples, which can produce totally erroneous results. Moreover, these studies are often not replicated in order to validate their findings. This has led to the *replication crisis*, which has always been an underlying issue for psychological studies but climaxed in around 2015. We shall therefore need to examine these studies with great care.

Lastly, two methodological approaches emerged in the second half of the twentieth century and now seem to be the most robust for properly researching human life. The first is the general systemic approach, initially proposed by Ludwig von Bertalanffy (1969), but which has developed toward an autonomy approach for the biological and social sciences promoted by Humberto Maturana and Francisco Varela (1973). The second is the mechanistic approach, first proposed for biological studies (see, for example, the book by William Bechtel and Robert Richardson (1993), but which has now flourished across the social sciences (see the book by Stuart Glennan and Phyllis Illari (2018)). These methodological approaches will be discussed in greater detail later, but we offer a brief presentation here.

The systemic approach was born of the dissatisfaction on the part of biologists, social scientists, and ecologists with the reductionism prevailing in the physical sciences. The concept of system is a new paradigm, which views the world as a complex organization that needs to be analyzed as a whole. If we cannot fully understand a phenomenon simply by decomposing it into more elementary units, we must apply an overall vision in order to understand how it works. This approach covers a vast field of research with different conceptualizations. For example, von

Bertalanffy (1969, p. 31) shows how it can apply to psychology and the social sciences that we discuss here:

While classical association psychology attempted to resolve mental phenomena into elementary units—psychological-atoms as it were—such as elementary sensations and the like, gestalt psychology showed the existence and primacy of psychological wholes which are not a summation of elementary units and are governed by dynamic laws. Finally, in the social sciences the concept of society as a sum of individuals as social atoms, e.g., the model of Economic Man, was replaced by the tendency to consider society, economy, nation as a whole superordinated to its parts.

Few methods were initially available for systemic analysis. The main one is simulation-based modeling. One example is the model applied by Dennis and Donella Meadows' team (1972, 1992, 2004) to predict the future evolution of humanity. We shall examine its validity.

In the life sciences, particularly those concerning human life, the systemic approach was also applied by Varela (1991). It treats human intelligence and memory as a whole that cannot be broken down into parts.

We discuss the systemic approach more fully in Chapter 9. Here, we shall simply mention the notion of *autonomy*, which serves as the link to the mechanistic approach, discussed later. Kepa Ruiz-Mirazo and Alvaro Moreno (2004, p. 240) define autonomy as:

[...] the capacity of a system to *manage* the flow of matter and energy through it so that it can, at the same time, regulate, modify, and control: (i) internal self-constitutive processes and (ii) processes of exchange with the environment. Thus this system must be able to generate and regenerate all the constraints—including part of its boundary conditions—that define it as such, together with its own particular way of interacting with the environment.

The methods proposed to reveal *autonomy* fall into two broad groups. The first is based on “first-person data,” i.e., collected from personal experiences. We may regard them, quite legitimately, as

allowing the *comprehension* of a lived experience in hermeneutic terms. Indeed, Varela et al. (1993, p. 149) clearly state:

The term *hermeneutics* originally referred to the discipline of interpreting ancient texts, but it had been extended to denote the entire phenomenon of interpretation, understood as the *enactment* or *bringing forth* of meaning for a background of understanding.

While admitting that many authors challenge the basic assumptions of this non-objectivist approach, they believe it is necessary to link the study of human experience—as put into practice in a given culture—with the study of human cognition in neuroscience, linguistics, and cognitive psychology. They contrast first-person data with “third-person data,” which allow the use of scientific methods such as encephalograms in order to access these physiological processes. We will see if this can provide a connection between hermeneutic *comprehension* and scientific *explanation* of human facts.

The approach described above was embodied in *Dynamical systems theory* and *Systems biology* in the late 1990s, broadening its scope from the study of a simple neuron to the most complex social systems. It has become highly mathematized but also highly diversified. Some authors argue that it leads to the emergence of a new explanatory paradigm differing from that of the mechanistic approach, discussed below. In their 2008 article “After the philosophy of mind: replacing scholasticism with science,” Anthony Chemero and Michael Silberstein, while recommending a holistic approach to cognitive science, point out the problems this raises (p. 24):

However, the biggest pragmatic or practical problem with developing holistic science is obvious: explanatory and predictive successes are hard to come by when dealing with complex problems. The principle worry here is that too much holism makes science impossible.

They thus show the difficulty of defining a holistic science. We shall therefore argue, as Robert Franck did in 1995, for the need to

transcend the opposition between holism and methodological individualism.

In contrast, the mechanistic approach does not regard the totality of human life as a unit that cannot be broken down. Rather, it focuses on a specific phenomenon in order to analyze its parts and see how they are organized for the purpose of producing the observed phenomenon. The method uses two strategies. The first, *decomposition*, allows the subdivision of the explanatory work so as to make it feasible and to make the system studied intelligible. As we can easily see, this strategy is contrary to the systemic approach. The second strategy consists in *localization*, which assigns responsibility for specific functions to particular structures. Bechtel and Richardson set out these strategies in their seminal work, *Discovering complexity: decomposition and strategies in scientific research* (1993).

The mechanistic approach is completely different from the *covering law* model proposed by Carl Hempel in 1942 in his article on “The function of general law in history” and by Hempel and Paul Oppenheim in 1946 in their article on “Studies in the logic of explanation.” The two authors adopt David Hume’s empirical view (1748), according to which causal mechanisms are not observable, and they use his notion of induction as an empirical generalization of the facts. Hempel (1962, p. 10) explains what he means by the *covering law explanation*:

This explanatory account may be regarded as an argument to the effect that the event to be explained (let me call it the explanandum event) was to be expected by reason of certain explanatory facts. These may be divided into two groups: (i) particular facts and (ii) uniformities expressed by general laws. [...] If we imagine these various presuppositions explicitly spelled out, the idea suggests itself of construing the explanation as a deductive argument of this form:

$$\begin{array}{c} C_1, C_2, \dots, C_k \\ L_1, L_2, \dots, L_r \\ \hline E \end{array}$$

Here, C_1, C_2, \dots, C_k are statements describing the particular facts invoked; L_1, L_2, \dots, L_r are the general laws; jointly, these statements will be said to form the explanans. The conclusion E is a statement describing the explanandum statement [. . .]

Later on, he clearly states that he is talking about empirical generalizations, thus signaling his support for Hume's argument.

Conversely, the mechanistic approach concurs with the views of Francis Bacon (1620), who restored the deductive conception of induction (Franck, 2002, p. 290). We elaborate on Bacon's position throughout our book.

From the outset, in Chapter 5 of their work on *Discovering complexity: The rejection of mechanisms*, Bechtel and Richardson describe the oppositions to the mechanistic approach encountered in the history of science. These include the holistic position of vitalists in physiology (p. 95):

They thus affirm a version of holism according to which the properties of life are treated as properties of the whole that cannot be refined into the properties of the parts, even when relations are taken into account.

However, neither in that chapter nor in the rest of their book do they discuss systemic and holistic studies such as those by Maturana and Varela, despite the fact that Varela's *Principles of biological autonomy* was published in 1979. As we shall see, Bechtel did not recognize the importance of these studies until 2007.

The methods used by the mechanistic approach can be summarized by the term *models*, as Bechtel and Abrahamson (2005, p. 425) explicitly state:

Generically, one can refer to these internal and external representations as *models* of the mechanisms. A model of a mechanism describes or portrays what are taken to be its relevant component parts and operations, the organization of the parts and operations into a system, and the means by which operations are orchestrated so as to produce the phenomenon.

The authors present various forms of these representations, which differ greatly from the standard nomological scientific explanations: they provide diagrams to characterize them, and simulations to reflect on them. The *models* of mechanisms are developed for individual cases and are not represented in terms of universal formulations, as in the covering-law approach.

The power of models, however, is not unlimited. Agent-based models, which “pre-suppose rules of behavior and verify whether these micro-based rules can explain macroscopic regularities” (Billari and Prskawetz, 2003, p. 2), operate only at individual level and so do not avoid *ad hoc* and arbitrary explanations—as shown later.

In 2007, in a chapter on “Biological mechanisms: organized to maintain autonomy” published in a volume on *Systems biology*, Bechtel began a *rapprochement* with the advocates of the systemic approach. He wrote (p. 297):

Vitalists and holists play an important function when they remind mechanists of the shortfalls of the mechanistic accounts on offer. Ideas such as negative feedback, self-organizing positive feedback, and cyclic organization are critical for explaining the phenomena exhibited by living organisms. [...] These critical features are nicely captured in Moreno’s conception of basic autonomy in which we reorganize living systems as so organized to metabolize inputs to extract matter and energy and direct these to building and repairing themselves.

As it happens, this chapter follows the one entitled “A systemic approach to the origin of biological organization” by Alfredo Moreno in the same book, in which he defends the holistic views of Maturana and Varela (1973) from thirty years earlier—without mentioning the mechanistic approach. Yet all these authors agree on the notion of *autonomy*, which we defined earlier.

The notion of *level* lies at the root of many disagreements between the systemic and mechanistic approaches. Comparing the two, Chemero and Silberstein (2008, pp. 22-23) write:

There are of course many gradations of both positions, ultimately shading off into one another. Individualists can be more or less holistic, for example. Even having decided that good cognitive and neuroscience must confine itself to the boundaries of the head, there still remains the question of which scale of cognitive or brain activity to pitch the explanation at. At what “level” should we explain cognitive systems? Those explanations involving the more basic elements of a system (such as a single neuron) and the purportedly intrinsic or local properties of these elements are the more deeply individualistic in kind. Individualist explanations that focus on large scale and inherently relational features of cognitive systems such as functional features or large scale neural dynamics are the least individualistic.

Surely this amounts to a recognition of the need to go beyond *holism* and *individualism*, as Franck proposed in 1995. We return to this question in Chapter 9.

What is certain is that the mechanistic and systemic approaches must converge, as both traditions—which developed largely along independent paths—provide crucial insights for understanding human life (Bich and Bechtel, 2021).

1.3. Book outline

We now turn to a brief presentation of the parts and chapters of this book.

After this introductory chapter, Part 1 looks at how certain approaches may lead to misunderstanding human life before it unfolds.

Chapter 2 presents an overview of the approaches, some of whose more specific aspects are addressed in greater detail in the following chapters. We begin by noting the widespread practice of the divination arts in both past and present, pointing out their prevalence around the world. We distinguish between the “-logies” and the “mancies,” the former making greater use of techniques closer to those of modern science than the latter. We go on to give

the reasons for the closer examination of astrology in Chapter 3. Next, we discuss the history of eugenics, from its ancient roots such as texts by Plato and Aristotle, to the Enlightenment and the writings of early nineteenth-century French physicians. This introduces Chapter 3 on eugenics. Lastly, we examine the various meanings of “freedom,” a concept that Chapter 4 addresses only in its current meaning. The notion emerged in Greece in the eighth century B.C.E. and later in Rome. Its definition at the time was very different from the one assigned to it by the monotheistic religions of the early modern age, i.e., *free will*. The scientific revolution that developed in the sixteenth century further modified the concept. Descartes gave it a philosophical dimension, while classical liberalism and the industrial revolution gave it a political dimension.

Chapter 3 takes a closer look at how astrology and astronomy, once indistinguishable, were deemed capable of predicting future events or the future of a human life. The two disciplines emerged in remote antiquity, most notably in Mesopotamia but also in ancient Egypt. By observing celestial phenomena such as the paths of planets and stars, it was believed that one could foretell future events both in human societies and in individual lives. The disciplines spread to the Greek world in later centuries in the form of horoscopes predicting the fate of a given person. However, the scientific revolution that took hold in the sixteenth century introduced a clear distinction between astrology as a divination art and astronomy as a science describing the movements of celestial bodies. Astronomy became a leading science, achieving major discoveries such as those of Kepler and Newton, whereas astrology was increasingly rejected. Yet, in the twentieth century and especially since the 1950s, there have been ever more attempts at a scientific demonstration of the validity or invalidity of astrology, and we examine their findings. We also try to identify the reasons why astrology, despite its rejection on scientific grounds, retains a strong worldwide appeal.

Chapter 4 focuses on a more recent period, from the late nineteenth century to the first half of the twentieth, when Galton’s eugenics was increasingly recognized and practiced not only by specialized organizations but also by extreme political regimes. The

new discipline sought to predict our future life from our genetic endowment at birth. As with astrology versus astronomy, eugenics came to compete with genetics—a product of Mendel’s laws—and we examine how the two disciplines evolved in the early twentieth century. Eugenics became a formidable concept with the advent of fascist and Nazi regimes, which sought to impose the supremacy of certain “races” by eliminating other ethnic groups. World War II ended these regimes, making the promotion of eugenics impossible. However, many former eugenicists such as Osborn continued to pursue the same goals under another label: hereditarianism. We describe the different forms of this theory and show the reasons for their scientific and political failure.

Chapter 5 takes a broader view, showing first how these approaches—which regard individual lives as predestined—are not truly scientific but are “idols,” to use Bacon’s term for such investigations. At the same time, we verify that astronomy and genetics qualify as genuine sciences, again in the Baconian sense, and that we can state their main axioms. However, as the “idols” still enjoy widespread acceptance, we must explore why so many people continue to believe in them. We move on to a more general view of religious practices, which facilitate these beliefs in supernatural forces. Cicero’s analysis, produced in a context of polytheistic religion, gives us a better insight into the motives for such beliefs. In more recent periods, monotheistic religions have prevailed, and psychology, bio-cultural anthropology, and cognitive sciences have tried to identify the factors driving these faiths. But the detailed examination of the findings does little to explain the complexity of these phenomena—and even less to account for atheism, whose prevalence is far from negligible. We conclude the chapter with a discussion of the current concept of freedom, which—some argue—offers people a way out of these beliefs, and an ethical discussion on the different approaches presented in this first part.

Part 2 looks at whether one can attempt to understand a human life, and at how different social sciences can do so despite some failures.

Chapter 6 looks at the earliest forms of life stories, dating from the invention of writing in the third millennium B.C.E. We

then follow the evolution of these stories over time. We may qualify them as imaginary, although they originate in what are often real lives but magnified into epics, myths, novels, and other narratives that nourish our minds. First, we discuss the notion of genre, which aims to define more precisely the different ways of inventing or transforming lives so as to express deeper reflections on the society and culture in which they take shape. We begin with the Greek philosophers, Plato and Aristotle, who defined epic, tragedy, and comedy by their characteristics. The Middle Ages saw the appearance of a new genre: the novel. In our time, the focus has shifted away from the formal characteristics of genres to their underlying mental processes and the devices they use to bring readers to reflect on and live in their society. Here, we encounter the notion of “comprehension” proposed by hermeneutic philosophy as the opposite of “explanation.” To better understand this approach, we take a closer look at how three examples of the genres were introduced and used. First, the *Epic of Gilgamesh*, which enables us to understand Mesopotamian civilization; second, Sophocles’ tragedy *Oedipus Tyrannus*, which give us an understanding of divine causality and human freedom among the Greeks; third, the romances on the life of Henri de Joyeuse, which give us an insight into Christian thought in seventeenth-century France. The chapter concludes with a fuller discussion of the notion of “comprehension.”

In Chapter 7, we turn to real biographies of famous figures, trying to identify which aspects of their lives are highlighted and which are left out, depending on the period in which the events occurred. The aspects on which ancient biographers focused were clearly very different from those recorded today. Another crucial issue is the veracity of the facts gathered. Ancient biographies were often written long after the person’s death, when the memory of that life had faded considerably and was influenced by external events. For biographies written during a person’s lifetime, the biographer’s interests are more important to keep in mind than those of the subject. These interests intermingle with the story told, turning the account into a view reflected by a distorted mirror. In the case of autobiography, we must pay critical attention to the aspects most frequently emphasized by the writer. The more recent interest in the life stories of more ordinary people should also be examined. The

biography by Thomas and Znaniecki (1919) of Polish peasants who migrated to the United States offers a perfect example, followed by many other similar studies. At the same time as the “comprehensive” approach, another more “explanatory” approach to life stories emerged with the recourse to population sciences. We extensively describe the evolution of the paradigms adopted by these sciences and the relevance of the “explanatory” approach, which we compare with the “comprehensive” approach. We then discuss the methods used by the social sciences to analyze the outline of a human life recorded in one or more interviews and depending on whether the survey is retrospective or prospective. While the approaches to event histories may differ substantially from one science to another, the basic material is the same: the collection, in an interview, of a very small portion of the life of one or more persons. We describe these different methods in detail, including the statistical tools used for the analysis and the scientific foundations of the methods.

Chapter 8 looks at the problems relating to memory and its transmission, which are crucial in the collection of life histories. We focus on the results of psychological and psychoanalytical studies on human autobiographical memory since their beginnings in the late nineteenth century. Over time, psychology and psychoanalysis developed different schools, which placed varying emphasis on the importance of studying memory. They include structuralism, functionalism, psychoanalysis, behaviorism, cognitive psychology, and evolutionary psychology. We deal separately with psychoanalysis, whose connections to neuroscience—discussed in greater detail in Chapter 9—are significant. The structuralist school, which used introspection, makes no contribution to the study of autobiographical memory, but it does offer interesting findings on the memorization of syllables alone, not of life stories. The functionalist school is barely interested in biographical memory. Its only representative, Galton, provided some elements—some important, others debatable—which we analyze. The behaviorist school, which enjoyed great success in the United States in the first half of the twentieth century, totally rejected the study of mental imagery. In the end, it was the cognitive school that made memory the focus of its study in 1950. We show its many contributions to this field, with the use of data from official registers to verify major

life events, and the use of neuroimaging. While evolutionary psychology contributes little to the study of memory, psychoanalysis takes us into new territory. This discipline, introduced by Freud in 1895, relied on Cajal's discovery of neurons in 1888 as possible storehouses of memory. We describe and critique the way in which Freud incorporated this notion into psychoanalysis with the aid of the unconscious, and compare this with the picture provided by today's neuroscience. The chapter's conclusion looks at the challenges to the psychological approach generated by the *replication crisis* and to the broader notion of "statistical significance."

Chapter 9 offers a general conclusion to the whole volume. We return to the various topics discussed and propose a synthesis. The first obvious conclusion is that it is impossible to grasp human life in its entirety; we can only capture a small portion of it. The choice of the portion is therefore essential in order for a social science to analyze it. It is up to researchers to define the limits of that portion, which are often dictated by their field of scientific expertise, the survey's cost, and its feasibility. We start with a detailed examination of the theories that, across the centuries, assigned a major but not exclusive role to demography. Before the nineteenth century, economics and population science were often practiced in tandem: the populationists believed that an increase in population would be matched by an increase in wealth, while a greater number of authors argued that population depended on wealth. In the late eighteenth century, new concepts emerged, most notably linked to the French Revolution. The notion of the *perfectibility* of the human species appeared in the writings of many authors such as Godwin and Condorcet, while Malthus developed a theological conception that went in the opposite direction. In the nineteenth century, the industrial revolution elaborated economic theories that made little room for demography. The theory of industrialism crowned the notion of *perfectibility*, whereas the theories of Proudhon and Marx were essentially economic. It was not until the twentieth century that Landry theorized the demographic revolution—freed from the grip of economics—through the notion of the *rationalization* of life. Most recently, the late twentieth and early twenty-first centuries have seen the

emergence of three main theories that have been adopted in many social sciences but are far from having won unanimous acceptance among demographers: *systemic theory*, developed by von Bertalanffy and applied to demography, most notably by Meadows; *agent-based models*, developed in demography by Billari and Prskawetz; and *viability theory*, developed by Aubin and applied to demography by Bonneuil. We go on to examine theories of memory and show that artificial intelligence, despite its successes, cannot constitute a theory of human memory. We must turn to neuroscience to see a productive application of *mechanistic theories* by Bechtel, Craver, and others, who try to describe how the parts of a mechanism are organized to produce human memory—while voicing doubts about the theories' exhaustivity. We then discuss *systemic theory*, and in particular Maturana and Varela's *autonomy theory*, which focuses on the organism as a whole and on how memory allows it to activate self-maintenance. These two approaches, which developed independently at first, have encountered each other very recently. To conclude this book, we show how, in combination, they offer a more effective approach to more general biological phenomena, while hermeneutics resist to a more scientific approach of human life.

**Part I. How certain approaches may
lead to misunderstanding human life?**

Chapter2

Predestination versus human liberty

In this first part, we restrict the meaning of *prediction*, discussed in the general introduction, to that of *predestination*. We must therefore examine in greater detail what the term can cover.

In French, the *Dictionnaire de l'Académie française* states that the term *prédestination* is attested by the twelfth century and was borrowed from the Christian Latin *praedestinatio* used as early as the fifth century by Saint Augustine. The dictionary distinguishes between a theological definition and a second definition that is less common but applicable to mantic methods:

1. Effect of the will of God, who for all eternity decides human fates and destines some persons—the chosen—to receive a special grace leading to eternal salvation. *In the fifth century, Saint Augustine defended the reality of predestination against the supporters of pelagianism. Protestant theologians argued the existence of the predestination of reprobates. The Council of Trent reasserted, against Calvin, that predestination does not rule out free will.*
2. The fact, for a person, of not being able to escape a fate or, for the course of events, of being determined in an ineluctable and

inevitable manner. *The effects of predestination. Predestination to glory, misfortune, crime.*²

As examined in greater detail in Chapters 3 and 4, the second meaning is wholly congruent with the definition of astrology (inability to escape one's fate) and eugenics (being determined ineluctably and inevitably by one's genetic endowment). In this chapter, we generalize the notion to all forms of divination, i.e., mantic methods. The first definition, linked to religion, will be discussed in Chapter 5.

Similarly, in English, the OED gives a synthetic definition of *predestination*:

The theory or the belief that everything that has been decided or planned in advance by God or by fate and that the humans cannot change it.

God and fate are thus combined here as entities presiding over predestination, without the *Académie Française*'s distinction. We therefore prefer to keep the Académie's definition as the reference for our purposes here.

In the first section of this chapter, we note the diversity of divination methods around the world, and discuss the reason for our special focus on astrology in Chapter 3; in the second section, we describe the origin of eugenics in human history; in the third and final section, we discuss the past evolution of the notion of freedom.

2.1 Diversity of predictions in the world

² French text: Effet de la volonté de Dieu décidant de toute éternité du destin des hommes, et vouant certains d'entre eux, les élus, à recevoir une grâce particulière conduisant au salut éternel. Au V^e siècle, saint Augustin défendit la réalité de la prédestination contre les tenants du pélagianisme. Des théologiens protestants ont soutenu la prédestination des réprouvés. Le concile de Trente réaffirma contre Calvin que la prédestination n'exclut pas le libre arbitre. Par affaibl. Le fait pour une personne de ne pouvoir échapper à un destin ou, pour le cours des choses, d'être réglé de manière inéluctable et fatale. *Les effets de la prédestination. Prédestination à la gloire, au malheur, au crime.*

We begin by examining how various signs have been used to predict future events. This approach, known as divination, establishes a connection between the sign used and the invisible forces supposedly controlling our world. Divination emerged very early in the history of humanity and took many forms.

Most of the divination arts have names ending in “-mancy”—from the Greek μαντεία (divination)—which Plato, in *Phaedrus* (244), traces back to μανία (mental derangement). They comprise more than a hundred methods involving the use of different objects: yarrowmancy (yarrow stalks), acultomancy (pins or needles), astragalomancy or astragyromancy (knucklebones or other small bones), cartomancy (playing cards), chiromancy or palmistry (reading the lines on a person’s palm), necromancy (invoking the dead), oneiromancy (interpreting dreams), taromancy (tarot cards), and others.³ Many of these methods are still practiced today.

A less commonly used suffix is “-logy” from the Greek λογία (science). It designates methods that more closely resemble the sciences, such as astrology, i.e., divination by the study of heavenly bodies. Like the “-mancies,” astrology is still practiced today, and we shall devote the Chapter 3 to it.

The use of the two suffixes, in our view, reflects a more profound reality. *Divination* (or “manticism”) involves randomness, that is, using events that cannot be predicted at the time they occur to foretell another, future event. Such unpredictable events include a card drawn at random by a cartomancer, the relative positions of beans cast by the favomancer, and the fortuitous signs observed in nature or living beings. By contrast, the “-logies” involve events that are more predictable through their reasoned observation, albeit—here as well—for the purpose of predicting another event in the future. For example, astrology and astronomy (whose suffix comes from the Greek νόμος or law) were practiced contemporaneously by the ancient Assyrians, Babylonians, Egyptians, Greeks, and others, who were already able to calculate the positions of heavenly bodies with reasonable accuracy. By the fifth century B.C.E., the

³ See https://en.wikipedia.org/wiki/Methods_of_divination.

Babylonians were using a system of celestial coordinates to determine these positions (Ossendrijver, 2016).

The number of different *mantic* methods is considerable. They are documented in all civilizations, both ancient and modern. The monograph *La divination* (Caquot and Leibovici, eds, 1968) fully demonstrates this by describing such methods in countries around the world. We offer some examples here, with no claim to exhaustiveness.

In 1500 B.C.E., during the reign of Thutmose I, the oracle of Amon at Karnak predicted that his daughter Hatshepsut would eventually succeed him as pharaoh (Vandersleyen, 1995). The oracle is a form of theomancy or divination through the supposed inspiration of a divinity. Methods practiced by the ancient Egyptians include idolomancy or divination using images, lecanomancy or divination using oil drops, and oneiromancy.

The library of Ashurbanipal (668-627 B.C.E.), which includes Babylonian and Assyrian tablets, contains an abundance of texts on divination, of which the oldest are undated (Finke, 2003). One text (Ashurbanipal inscription L⁴) states: *I was calculating the liver [which is] an image of heaven together with the [most] competent oil [divination] experts.*⁴ The Babylonians used many mantic methods, such as haruspicy (inspection of animal entrails), lecanomancy, oneiromancy, and teratomancy (observation of monsters).

Auguste Bouché-Leclercq inventoried multiple divination methods among the Greeks and Romans in his four-volume compendium, *Histoire de la divination dans l'antiquité* (History of divination in Antiquity) (1879-82). Examples of Hellenic divination include chresmology (divination using pure intuition), cleromancy (casting objects), necromancy, oneiromancy, divination by instinctive actions of living beings, and divination by signs read in the structure of inanimate objects.

In China, the *Hi ts'eu*, a divination manual dating from the fourth or third century B.C.E., shows *the exact correspondence*

⁴ Translation by Fincke (2003), p. 111.

between divination methods and the operations of nature (Granet, 1934, p. 75). The terms Yin and Yang occur frequently, linking divination to a vast set of Chinese methods and doctrines. The methods are highly diverse, ranging from cleromancy using yarrow stalks (I Ching) to cheloniomancy (using turtle shells), scapulimancy (using ox shoulder blades), and oneiromancy.

Madagascar's different ethnic groups are mainly of Indonesian origin. Over time, however, migrants from the Middle East, Africa, and Asia settled on the island. Their blending largely explains the diversity and originality of the island's divination practices (Molet, 1979). For example, *sikidy*, or *sikily*, derives from the Arabic *sikl* (figure). It comprises two variants: the first, *sikily alànana*, consists of amathomancy (divination by drawing lines in the sand); the second, *sikidy joria*, is a form of favomancy or divination by casting seeds or other parts of plants (bean seeds, corn seeds, blades of grass, and particularly fano seeds). But other divination methods are also practiced, such as chiromancy, ornithomancy (observing bird behavior, flight or song), and metoposcopy or metopomancy (observing lines of the forehead).

In concluding this brief overview of mantic methods around the world, we should recall that they have been and are still practiced in all countries. The “-logies” will be examined in greater detail, more specifically astrology in Chapter 3. We shall explore the multiple origins of this ancient belief—which was supposed to allow an at least partial prediction of a person's life or of an event—how it then broke away from astronomy, and why it nevertheless remains so popular today.

2.2 The origins of eugenics

There is another way to predict an individual's future behavior, outlined in this section.

It is, in fact, a recurrent and very ancient approach, addressed in writings as early as those of Plato, who quotes Socrates in *The Republic* (V, 459):

Why, I said, the principle has been already laid that the best of either sex should be united with the best as often, and the inferior with the inferior, as seldom as possible, and that they should rear the offspring of the one sort of union, but not of the other, if the flock is to be maintained in first rate condition. Now these goings on must be a secret which the rulers only know, or there will be a further danger of our herd, as the guardians may be termed, breaking out into rebellion. [...] There are many other things which they will have to consider, such as the effect of wars and diseases and any similar agencies, in order to prevent the State from becoming either too large or too small.⁵

Shortly after, he adds (V, 460):

The proper officers will take the offspring of the good parents to the pen or fold, and there they will deposit them with certain nurses who dwell in a separate quarter; but the offspring of the inferior, or of the better when they chance to be deformed, will be put away in some mysterious, unknown place, as they should be. Yes, he said, that must be done if the breed of the guardians is to be kept pure.⁶

These texts thus imply a choice of spouse defined by quality standards (“the best” opposed to “the inferior”) and a restriction of the right to procreate for the inferiors. This arrangement makes it possible to eliminate from the outset those individuals who might prove to be a burden or a danger to society. In particular, for consanguineous unions, Plato specifies (V, 461): “to prevent any embryo which may come into being from seeing the light,” and, in the event of a forced delivery, “the parents may understand that the

⁵English translation by B. Jowett, 2015. Greek text: Δεῖ μὲν, εἶπον, ἐκ τῶν ὁμολογημένων τοὺς ἀρίστους ταῖς ἀρίσταις συγγίγνεσθαι ὡς πλειστάκις, τοὺς δὲ φαυλοτάτους ταῖς φαυλοτάταις τοῦναντίον, καὶ τῶν μὲν τὰ ἔκγονα τρέφειν, τῶν δὲ μή, εἰ μέλλει τὸ ποιμνιον ὅτι ἀκρότατον εἶναι, καὶ ταῦτα πάντα γιγνόμενα λανθάνειν πλὴν αὐτοὺς τοὺς ἄρχοντας, εἰ αὖ ἡ ἀγέλη τῶν φυλάκων ὅτι μάλιστα ἀστασίαστος ἔσται. ... τὸ δὲ πλῆθος τῶν γάμων ἐπὶ τοῖς ἄρχουσι ποιήσομεν, ἵν' ὡς μάλιστα διασώζωσι τὸν αὐτὸν ἀριθμὸν τῶν ἀνδρῶν, πρὸς πολέμους τε καὶ νόσους καὶ πάντα τὰ τοιαῦτα ἀποσκοποῦντες, καὶ μήτε μεγάλη ἡμῖν ἢ πόλις κατὰ τὸ δυνατόν μήτε μικρὰ γίγνηται.

⁶ Τὰ μὲν δὴ τῶν ἀγαθῶν, δοκῶ, λαβοῦσαι εἰς τὸν σηκὸν οἴσουσιν παρά τινας τροφούς χωρὶς οἰκούσας ἔν τινι μέρει τῆς πόλεως· τὰ δὲ τῶν χειρόνων, καὶ ἂν τι τῶν ἐτέρων ἀνάπηρον γίγνηται, ἐν ἀπορρήτῳ τε καὶ ἀδήλῳ κατακρύψουσιν ὡς πρέπει.

offspring of such an union cannot be maintained, and arrange accordingly seeing the light.”⁷

Aristotle, while accepting the abandonment of deformed children, is more concerned about excess births. In *Politics* (VII, 1335b), he writes:

As to the exposure and rearing of children, let there be a law that no deformed child shall live, but that on the ground of an excess in the number of children, if the established customs of the State forbid that (for in our State a population has a limit), no child is to be exposed, but when the couples have children in excess, let abortion be procured before sense and life have begun; what may or may not be lawfully done in these cases depends on the question of life and sensation.⁸

Aristotle’s position on abandoning children thus differs from Plato’s. He makes no allusion to infanticide, accepts exposure only for deformed children, and proposes abortion with the couples’ consent. At the same time, however, he elaborates a theory of slavery as a natural practice (*Politics*, I, 2):

For that which can foresee by the exercise of mind is by nature intended to be lord and master, and that which can with its body give effect to such foresight is a subject, and by nature a slave; hence master and slave have the same interest.⁹

He describes the master-slave relationship here as the indispensable bond between that which commands by nature (ἄρχον φύσει) and that which is commanded (ἀρχόμενον) to ensure their common interest.

⁷ καὶ ταῦτά γ’ ἤδη πάντα διακελευσάμενοι προθυμεῖσθαι μάλιστα μὲν μηδ’ εἰς φῶς ἐκφέρειν κύημα μηδέ γ’ ἔν, ἐὰν γένηται, ἐὰν δέ τι βιάσῃται, οὕτω τιθέναι, ὥς οὐκ οὔσης τροφῆς τῷ τοιούτῳ.

⁸ Περὶ δὲ ἀποθέσεως καὶ τροφῆς τῶν γιγνομένων ἔστω νόμος μηδὲν πεπηρωμένον τρέφειν, διὰ δὲ πλῆθος τέκνων ἢ τάξεις τῶν ἐθνῶν κωλύη μηθὲν ἀποτίθεσθαι τῶν γιγνομένων· ὀρίσθηναι δὲ δεῖ τῆς τεκνοποιίας τὸ πλῆθος, ἐὰν δέ τισι γίγνηται παρὰ ταῦτα συνδυασθέντων, πρὶν αἰσθῆσιν ἐγγενέσθαι καὶ ζῶην ἐμποιεῖσθαι δεῖ τὴν ἄμβλωσιν· τὸ γὰρ ὅσιον καὶ τὸ μὴ διωρισμένον τῇ αἰσθήσει καὶ τῷ ζῆν ἔσται.

⁹ Τὸ μὲν γὰρ δυνάμενον τῇ διανοίᾳ προορᾶν ἄρχον φύσει καὶ δεσπῶζον φύσει, τὸ δὲ δυνάμενον τῷ σώματι ταῦτα πονεῖν ἀρχόμενον καὶ φύσει δοῦλον· διὸ δεσπότη καὶ δούλῳ ταῦτ’ ἐστὶ συμφέρον.

In this connection, we should bear in mind the large size of the slave population in Plato and Aristotle's time. A census conducted under Demetrius of Phalerum between 317 and 307 B.C.E.—about thirty years after Plato's death and ten years after Aristotle's—gives the following figures for the inhabitants of Attica: “the Athenians were found to amount to twenty-one thousands, and the metics to ten thousand, and the slaves to four hundred thousand” (quoted by Athenaeus, in *Deipnosophistae*, Book VI, 103¹⁰). A more detailed study of the period (Van Wees, 2011) shows that the enumeration requires an adjustment. To be more precise, Van Wees finds 21,000 propertied citizens, 10,000 citizens without political rights, and 400,000 women, children, and slaves. This reduces the number of slaves to 323,000, “so that for every free person in Attica there were three slaves—according to Demetrius' census, at least” (Van Wees, p. 107).

Children were sacrificed in Rome as well, for the law required the exposure of all those whose parents did not want to raise them. On this subject, Cicero notes (*De Legibus* III, 8, 19): “as one of those monstrous abortions which, by a law of the Twelve Tables, are not suffered to live [...]”¹¹ Indeed, the *Pater familias*, vested with the sacred right of life or death, was allowed to put his children to death deliberately.

In the Christian West, the elimination of deformed children was discontinued—at least officially—until the Renaissance, when some authors began to question religious prohibitions. Tommaso Campanella, in *La città del Sole* (The city of the Sun) (1602), clearly discusses the option of promoting eugenic unions:

Love is foremost in attending to the charge of the race. He sees that men and women are so joined together, that they bring forth the best offspring. Indeed, they laugh at us who exhibit a studious care

¹⁰ Ἀθήνησιν ἐξετασμὸν γενέσθαι ὑπὸ Δημητρίου τοῦ Φαληρέως τῶν κατοικούντων τὴν Ἀττικὴν καὶ εὑρεθῆναι Ἀθηναίους μὲν δισμυρίους πρὸς τοῖς χιλίοις, μετοίκους δὲ μυρίους, οἰκετῶν δὲ μυριάδας μ'

¹¹ Deinde quom esset cito necatus tamquam ex XII tabulis insignis ad deformitatem puer, brevi tempore nescio, ...

for our breed of horses and dogs, but neglect the breeding of human beings.¹²

He proposes an ideal society where parental choice is subjected to a detailed ritual, and generation is regarded as a collective good rather than a private one.

The eugenic idea re-emerged in the Enlightenment. In 1756, Vandermonde, a young physician, attempted to solve the mysteries of heredity and generation in *Essai sur la manière de perfectionner l'espèce humaine* (Essay on the means to improve the human species). Having observed human success in perfecting animals, he makes the following recommendation (p. 155):

By the explanation of this system, we can easily see that one can perfect animals, by varying them in different ways. Why should we not work for the human species as well? By combining all the circumstances we have discussed, by grouping our rules together, we would be able to make men more beautiful as surely as one can rely on an able sculptor to hew a model of beautiful appearance out of a block of marble.¹³

Vandermonde sees the “crossing of races” as a particularly efficient method of fostering the improvement of the human species. He accordingly suggests crossing individuals just as botanists graft plants or breeders cross animals.

In the nineteenth century, many French physicians defended the principle of selecting parents in order to combat degeneration. In 1801, Robert coined a term to describe this principle: *mégalanthropogénésie*, from the Greek roots for “great,” “man, and “procreation.” His goal was to create intelligent individuals by

¹² Amore ha cura della generazione, con unir li maschi e le femine in modo che faccin buona razza; e si riden di noi che attendemo alla razza de cani e cavalli, e trascuramo la nostra.

¹³ French text: Par l'explication de ce système, on voit aisément que l'on peut perfectionner les animaux, en les variant de diverses façons. Pourquoi ne travaillerait-on pas aussi pour l'espèce humaine ? Il serait aussi sûr en combinant toutes les circonstances dont nous avons parlé, en réunissant toutes nos règles, d'embellir les hommes, qu'il est constant qu'un habile sculpteur peut faire sortir d'un bloc de marbre un modèle de la belle nature.

crossing elite men and women. He takes up Vandermonde's argument (p. ij):¹⁴

[...] I have thought that the identity of physiological laws in man and animals allowed me to believe in the possibility of megalanthropogenesis without the social order, since it exists in the rural economy¹⁵.

He concludes his work by appealing to the French government (p. 341): "could you, for an instant, neglect the reproduction of great men [?]"¹⁶

The interested reader will find more details in Carol (1995) on the role of nineteenth-century French physicians in these medical practices, which, while not yet called eugenics, outlined a plan to improve the human species.

Darwin's first cousin Galton coined the term "eugenics" in 1883 and elaborated a theory of heredity. The theory claims to have a scientific basis, namely, the scrupulous observation of genealogies and the Darwinian theory of evolution. In Chapter 4, we shall see how Galton and his successors tried to predict the future of children from what their parents had transmitted to them.

2.3 The notion of freedom

The last chapter of Part 1 delves further into the reasons that lead people to believe that their future is predetermined. Its title, "How and why to restrict freedom," will lead us to address the complex notion of "freedom," whose origin we shall now explore.

¹⁴ We give the page numbers of the second edition (1803), as the author states that the first edition (1801) was prepared in haste and the second edition is far superior.

¹⁵ French text: j'ai pensé que l'identité des lois physiologiques chez l'homme et dans les animaux, m'autorisait à croire à la possibilité de la Mégalanthropogénésie, puisqu'elle existe depuis longtemps dans l'économie rurale.

¹⁶ French text: pourrais-tu négliger un instant la reproduction des grands hommes [?]

Many scholars have already discussed this complex concept at length. We refer the reader to Gary Brent Madison, *The logic of liberty* (1986), Jacqueline de Romilly, *La Grèce antique à la découverte de la liberté* (1989), Pierre Grimal, *Les erreurs de la liberté* (1989), and Peggy Avez, *L'envers de la liberté* (2017).

Rather than referring to a current definition of freedom, we begin by examining where and how it appeared in antiquity and the successive meanings it has acquired over time. We extend our survey to the modern age but not to the contemporary period, discussed in greater detail in Chapter 5. Similarly, we cannot reach back to cultures without a written language, so we shall need to restrict ourselves to those that have one.

2.3.1 Freedom in ancient civilizations

Ancient civilizations—including Assyrian, Egyptian, and Hebrew—have left us no trace of a word meaning “freedom,” although some scholars have identified rudimentary forms of the concept (Dietrich, 2019). Likewise, the major Asian religions that appeared around the fifth century B.C.E.—Buddhism, Taoism, and Confucianism—devoted scant attention to freedom. For instance, according to the scholars who have tried to find signs of its presence, Buddhism may or may not allow free thought (Federman, 2010, pp. 15-16). We shall not dwell on the topic here, for it is not our purpose to analyze texts in which the notion of freedom is not clearly stated. We begin by examining in greater detail how the Greeks and Romans first developed the concept of “freedom.”

In ancient Greece, we find several occurrences of the word ἐλεύθερος (free) to express the fear of serfdom as early as Homer’s *Iliad* (eighth century B.C.E.). But this notion of freedom did not acquire its full political meaning until the Median wars in the early fifth century B.C.E. In his *History* of these wars (written between 430 and 424 B.C.E., VII, 103), Herodotus clearly defines what such freedom meant to the Greeks in a dialogue between Xerxes I, king of Persia, and a former king of Sparta, Demaratus:

For come, let me examine it by all that is probable: how could a thousand or ten thousand or even fifty thousand, at least if they

were all equally free and were not ruled by one man, stand against so great an army? Since, as thou knowest, we shall be more than a thousand coming about each one of them, supposing them to be in number five thousand. If indeed they were ruled by one man after our fashion, they might perhaps from fear of him become braver than it was their nature to be, or they might go compelled by the lash to fight with greater numbers, being themselves fewer in number; but if left at liberty, they would do neither of these things: and I for my part suppose that, even if equally matched in numbers, the Hellenes would hardly dare to fight with the Persians taken alone. With us however this of which thou speakest is found in single men, not indeed often, but rarely; for there are Persians of my spearmen who will consent to fight with three men of the Hellenes at once: but thou hast had no experience of these things and therefore thou speakest very much at random.¹⁷

Xerxes is clearly unable to understand this concept of freedom, and believes he can easily defeat the Greek army, ten times smaller than the Persian army. The Persians obey a master, and the Greeks—in particular the Athenians—have been free since 514 B.C.E., when the tyrants of Athens, the Peisistratids, were chased out of the city. However, they are free in a well-defined sense and they have a master—the law—that they fear and that does not allow them to retreat before an enemy. The Median Wars, which lasted twenty years from 499 to 479 B.C.E., ended in a overwhelming victory of the Greek cities, particularly Athens, against the Persians at the land battle of Plataea and the naval battle of Mycale.

¹⁷ Greek text: ἐπεὶ φέρε ἴδω παντὶ τῷ οἰκότι· κῶς ἂν δυναίατο χίλιοι ἢ καὶ μύριοι ἢ καὶ πεντακισμύριοι, ἐόντες γε ἐλεύθεροι πάντες ὁμοίως καὶ μὴ ὑπ' ἐνὸς ἀρχόμενοι, στρατῷ τοσῷδε ἀντιστῆναι; ἐπεὶ τοὶ πλεῖνες περὶ ἓνα ἕκαστον γινόμεθα ἢ χίλιοι, ἐόντων ἐκείνων πέντε χιλιάδων. [4] ὑπὸ μὲν γὰρ ἐνὸς ἀρχόμενοι κατὰ τρόπον τὸν ἡμέτερον γενοίαντ' ἂν, δειμαίνοντες τοῦτον, καὶ παρὰ τὴν ἐωυτῶν φύσιν ἀμείνονες, καὶ ἴοιεν ἀναγκαζόμενοι μάστιγι ἐς πλεῖνας ἐλάσσονες ἐόντες· ἀνειμένοι δὲ ἐς τὸ ἐλεύθερον οὐκ ἂν ποίεοιεν τούτων οὐδέτερα. δοκέω δὲ ἔγωγε καὶ ἀνισωθέντας πλήθει χαλεπῶς ἂν Ἑλλήνας Πέρσῃσι μούνουσι μάχεσθαι. [5] ἀλλὰ παρ' ἡμῖν μὲν μούνουσι τοῦτο ἐστὶ τὸ σὺ λέγεις, ἔστι γε μὲν οὐ πολλὸν ἄλλὰ σπάνιον· εἰσὶ γὰρ Περσέων τῶν ἐμῶν αἰχμοφόρων οἱ ἐθελήσουσι Ἑλλήνων ἀνδράσι τρισι ὁμοῦ μάχεσθαι· τῶν σὺ ἐὼν ἄπειρος πολλὰ φλυηρέεις.

Thereafter, the Greeks often proclaimed this freedom (ἐλευθερία), most notably in their theater. For example, Aeschylus, in *The Persians* (472 B.C.E., 402-405), has the messenger state:

Now, sons of Hellas, now! Set Hellas free, set free your wives, your homes, Your gods' high altars and your fathers' tombs. Now all is on the stake!¹⁸

With the alliances between Greek cities, freedom lasted until 338 B.C.E., when Philip II of Macedon triumphed over the coalition of Greek cities at the battle of Chaeronea. Macedonia was an absolute monarchy, situated on the northern confines of the Greek cities. Greek freedom ended in Athens with the reform of the Athenian Constitution by the Macedonian general Antipatros, who restricted citizenship to the wealthiest and thus deprived more than half of the citizens of their civic rights.

But what is important here is to try to understand what the Greeks meant by freedom. For Athens, the concept—in essence democratic—applied above all to the management and defense of the autonomous city (*polis*). To prevent absolutist and arbitrary tyrannies such as that of Peisistratus, Clisthenes (Herodotus, VI, 66-69) established a new power structure in 508 B.C.E. called isonomy (ἰσονομία)—etymologically, the rule of equality—which came to be viewed as the first step toward democracy (Lévêque, Vidal-Naquet, 1973; Fouchard, 1986). Herodotus (430-424 B.C.E., III, 80), speaking through Otanes, praised its merits:

On the other hand the rule of many has first a name attaching to it which is the fairest of all names, that is to say 'Equality'; next, the multitude does none of those things which the monarch does: offices of state are exercised by lot, and the magistrates are compelled to render account of their action: and finally all matters of deliberation are referred to the public assembly. I therefore give

¹⁸ Greek text: 'ὦ παῖδες Ἑλλήνων ἴτε, °ἐλευθεροῦτε πατρίδ', °ἐλευθεροῦτε δὲ παῖδας, °γυναῖκας, °θεῶν τέ πατρῶων ἔδη, θήκας τε προγόνων: νῦν ὑπὲρ πάντων ἀγών.

as my opinion that we let monarchy go and increase the power of the multitude; for in the many is contained everything.¹⁹

This rule of equality rule was, however, sufficiently vague to allow accommodations with practices of domination and slavery characteristic of many ancient societies including Greece. In *Politics* (I, 3-8), Aristotle defended the theory of slavery and concluded (I, 5):

It is clear, then, that some men are by nature free, and other slaves, and that for these latter slavery is both expedient and right.²⁰

Aristotle's defense seems shameful today, but that did not prevent him from discussing slavery at length before concluding that it was valid. Similarly, ostracism denied the citizen's right as an individual by authorizing his banishment from political life. Ostracized citizens included Themistocles in 471 B.C.E., despite his victory in the naval battle of Salamis in 480 B.C.E. Even more severe was the sentencing of Socrates to death by the Athenian judges in 499 B.C.E. for—among other charges—having corrupted youth. In his public teaching, Socrates personified doubt in all its forms. Having been offered the possibility of fleeing to escape execution, he refused, arguing that he could not oppose the laws of his city as he did not want to jeopardize the freedom of his fellow-citizens. It was only far later than Stoicism took up Socrates' philosophy and elaborated on the idea that “only the wise man is free, for he alone possesses an assured knowledge of Truth” (Grimal, 2004, p. 151). While founded by Zeno of Citium in Athens in the third century B.C.E., Stoicism reached its apogee in Rome, which is why we shall discuss it in fuller detail in connection with Roman freedom.

¹⁹ Greek text: πλῆθος δὲ ἄρχον πρώτα μὲν οὐνομα πάντων κάλλιστον ἔχει, ἰσονομίην, δεύτερα δὲ τούτων τῶν ὁ μούναρχος ποιέει οὐδέν· πάλω μὲν ἀρχὰς ἄρχει, ὑπεύθυνον δὲ ἀρχὴν ἔχει, βουλευματα δὲ πάντα ἐς τὸ κοινὸν ἀναφέρει. τίθεμαι ὧν γνώμην μετέντας ἡμέας μοναρχίην τὸ πλῆθος ἀέξειν· ἐν γὰρ τῷ πολλῷ ἔνι τὰ πάντα.

²⁰ Greek text: Εἰ δ' ἐπὶ τοῦ σώματος τοῦτ' ἀληθές, πολὺ δικαιότερον ἐπὶ τῆς ψυχῆς τοῦτο διωρίσθαι· ἀλλ' οὐχ ὁμοίως ῥάδιον ἰδεῖν τό τε τῆς ψυχῆς κάλλος καὶ τὸ τοῦ σώματος.

Contrasting with the democratic freedom of Greek cities was the Greeks' belief in inescapable fate and in the absolute power of the gods over their lives. In §2.1 above, we referred to Bouché-Leclercq's work *Histoire de la divination dans l'antiquité* (1879-1882), whose first two volumes are devoted to Hellenic divination. The same author also published a book on Greek astrology (*L'astrologie grecque*) in 1899, which showed how this practice, suffused with philosophy and mathematics, transformed its Oriental sister. Greek astrology, which is attested well before Cleisthenes, was barely changed by his reforms. Its features remained, most notably: Moira or the three Moirai, who presided over the apportioned "lot" of each individual (god or human) by weaving the thread of life (Κλωθώ), unraveling it (Λάχεσις), and cutting it (Ἄτροπος); the gods and goddesses who could also influence fate; oracles, such as the Pythia in Delphi, who sought to decipher the messages sent by the gods; and the mantic methods that gave soothsayers access to knowledge beyond human understanding.

In sum, all citizens of a polity enjoyed the same political freedom provided they respected the city's written laws, but those very same individuals were subject to the laws of the gods. Many authors have tried to understand this dichotomy, which seems puzzling today but was perfectly understood by the Greeks. We quoted Aeschylus on freedom earlier; let us now see how Darius' ghost viewed the power of the gods (Aeschylus, *The Persians*, 472 B.C.E., 739-761):

I see all; 'tis the end foretold. How swift the oracle hath sped! The word of Zeus, I knew, must be fulfilled; and lo, on Xerxes' head it falleth. I had looked for this not until many years were gone, but when man hasteth of himself toward sorrow, God will help him on. Here is a spring of evils burst on us and ours, which all might know save him who, understanding not, in his hot youth, hath made it flow. He thought in fetters, like a slave, the holy Hellespont to bind, and Bosphorus, the stream of God, refashion to his mortal mind. With hammered bonds of iron he wrought for a great host a far-

flung road, and, not in wisdom, dreamed a dream that man could match himself with God, subdue Poseidon!²¹

In other words, according to his father Darius, Xerxes' defeat was due not only to himself but to several gods: Zeus, Io, and Poseidon. The text addresses the very same topic treated by Homer five centuries earlier when narrating the death of Patroclus (Homer, *Iliad*, 16, eighth century B.C.E., 844-850):

For this time, Hector, boast thou mightily; for to thee have [845] Zeus, the son of Cronos, and Apollo, vouchsafed victory, they that subdued me full easily, for of themselves they took the harness from my shoulders. But if twenty such as thou had faced me, here would all have perished, slain by my spear. Nay, it was baneful Fate and the son of Leto that slew me, [850] and of men Euphorbus, while thou art the third in my slaying.²²

Here the entities responsible for the death of Patroclus are Zeus, Apollo, Moira (translated here as “Fate” but designated in the Greek text by μοῖρα), Euphorbus, and Hector. Yet again, therefore, the death was caused by multiple agents.

Various authors have offered an explanation for this dual causality. Lesky (1961), with his “double motivation” model, sees the two sides—human and divine—of the same medal, with a focus on the subjects' identities. Vernant (1972), by contrast, argues that we should concentrate on the action envisaged rather than on the players. He speaks of the fundamental ambiguity of the tragic act,

²¹Greek^otext: °φεῦ, ταχεῖά γ' ἦλθε χρησμών πρᾶξις, ἐς δὲ παῖδ' ἐμὸν °Ζεὺς ἀπέσκηψεν τελευτήν θεσφάτων: ἐγὼ δὲ πού °διὰ μακροῦ χρόνου τάδ' ηὔχουν ἐκτελευτήσεν θεοῦς: °ἀλλ' ὅταν σπεύδῃ τις αὐτός, χῶ θεὸς συνάπτεται. °νῦν κακῶν ἔοικε πηγὴ πᾶσιν ἠϋρῆσθαι φίλοις. παῖς δ' ἐμὸς τάδ' οὐ κατειδὼς ἦνυσεν νέφ θράσει: °ὅστις Ἑλλήσποντον ἱρὸν δοῦλον ὥς δεσμώμασιν °ἤλπισε σχῆσειν ῥέοντα, Βόσπορον ῥόνον θεοῦ: °καὶ πόρον μετερρύθμιζε, καὶ πέδαις σφυρηλάτοις °περιβαλὼν πολλὴν κέλ ευθον ἦνυσεν πολλῶ στρατῶ, °θνητὸς ὢν θεῶν τε πάντων ᾤετ', οὐκ εὐβουλία, °καὶ Ποσειδῶνος κρατήσιν.

²²Greek^otext: °Ἐκτορ °μεγάλ °εὔχεο: °σοὶ °γὰρ °ἔδωκε °νίκην °Ζεὺς °Κρονίδης °καὶ °Ἀπόλλων, °οἱ °με °δάμασαν ῥηιδίως: °αὐτοὶ °γὰρ °ἅπ' °ὥμων °τεύχε °ἔλοντο. °τοιοῦτοι °δ' °εἰ °πέρ °μοι °εἰκόσιν °ἀντεβόλησαν, °πάντες °κ' °αὐτόθ' °ὄλοντο °ἐμῶ °ὑπὸ °δουρὶ °δ αμέντες. °ἀλλὰ °με °μοῖρα °ὀλοή °καὶ °Λητοῦς °ἔκτανεν °υἱός, °ἀνδρῶν °δ' °Εὐφορβος: °σύ °δέ °με °τρίτος °ἐξεναρίζεις.

which reflects a debate between the “past of the myth” and the “present of the city.” Darbo-Peschanski (2008) elaborates on this approach by proposing a model of the “distributed” act; like Vernant, she focuses on the act’s components rather than on identifying the actors, as Lesky did. From this standpoint, she shows that the act involves two agents, whether divine or human. More recently, a dossier on *Lectures anthropologiques de l’agir dans l’antiquité* (“Anthropological readings of acting in antiquity”), edited by Brouillet and Buccheri (2019), confirms and completes the interpretation by Vernant and Darbo-Peschanski, which we too find more convincing than Lesky’s.

We shall now discuss the Roman concept of freedom more briefly, even it is sufficiently similar to that of the Greeks, at least until the end of Greek ἐλευθερία. Roman *libertas* appeared in 509 B.C.E., almost simultaneously with Greek ἐλευθερία, when the Romans toppled the last Etruscan king, Tarquin the Proud. However, it lasted longer than in Greece, for we can date its end to 27 B.C.E., when Octavius, who received the title of Augustus, set up the new institutions of the Roman Empire and thus abolished the freedom that had existed for nearly 500 years.

Roman freedom was essentially an individual freedom that guaranteed the legal status of each citizen. There was also an equivalent of Greek ostracism: one of the first acts of the city of Rome was to deprive Tarquinius Collatinus of his citizenship for the sole reason that his name was linked to the royal lineage. As in Greece, freedom in Rome was effectively the opposite of slavery. The Roman divinities, also similar to their Greek counterparts, controlled the fates of all individuals, and politicians had to consult the gods for all important decisions. However, political freedom exercised by an assembly of citizens was inconceivable—unlike in Athens, where public officials were chosen by lottery. In Rome, the privileges granted to noble families were the chief prerequisite for occupying such positions of authority.

Although it originated in Greece after the end of its political freedom, the main driver in shaping a better defined notion of Roman freedom in the third century B.C.E. was Stoicism. Despite their prolific output, the school’s founders—particularly Chrysippus

of Soles (ca. 281-208 B.C.E.)—have left us only a few fragments (see Arnim, 1902-1925). It is notably thanks to Cicero (106-43 B.C.E.) during the period of Roman freedom, then to Seneca (ca. 4 B.C.E.-45) and Epictetus (ca. 50-130) under the Empire, that we have a fuller picture of the problem posed by the notion of freedom and its corollary, the concept of fate. We shall restrict ourselves to a concise overview of Stoicism without involving ourselves in a fuller discussion, which persists to this day (see, for example, Bobzien, 1998, contested by Mikeš, 2016).

How can one hope for a space of freedom in a doctrine where fate (*fatum*) is the predominant force? The grammarian Gellius, in his *Noctes Atticae* (ca. 150-180), quotes Chrysippus to the best of his recollection:

“Fate,” he says, “is an eternal and unalterable series of circumstances, and a chain rolling and entangling itself through an unbroken series of consequences, from which it is fashioned and made up.” But I have copied Chrysippus’ very words, as exactly as I could recall them, in order that, if my interpretation should seem too obscure to anyone, he may turn his attention to the philosopher’s own language.²³

How can human action have an effect on the world if fate is all-powerful? For the Stoics, human action does not occur outside *fatum*, but is one of its constituent elements. The Stoics must therefore broaden their vision of the world to include physics, logic, and ethics as a complex whole in which human reason can grasp the chain of events while forming part of it. Human action can therefore promote virtue when people train themselves to reflect and to perceive the order of things. Human action will then attain Stoic freedom, which Cicero defines as follows in *Paradoxa Stoicorum* (46 B.C.E., 34):

²³ Latin text: “Fatum est ” inquit “sempiterna quaedam et indeclinabilis series rerum et catena volvens semetipsa sese et implicans per aeternos consequentiae ordines, ex quibus apta nexaque est.” Ipsa autem verba Chrysippi, quantum valui memoria, ascripsi, ut, si cui meum istud interpretamentum videbitur esse obscurius, ad ipsius verba animadvertat.

What then is freedom? Ability to live as you wish. Who then lives as he wishes, if not the one who pursues upright things, who rejoices in duty, whose way of life is considered and planned, who doesn't obey the laws because of fear, but follows and cultivates them because he judges that to be most advantageous, who says nothing, does nothing, in fact thinks nothing unless it is willingly and freely, whose every plan and undertaking proceeds from and returns to him, nor is there anything which has more power for him than his own will and judgement, to whom even that which is said to have the most power. Fortune herself, yields, since, as the wise poet said, she shapes herself according to each man's own character? So this happens only to the wise man, that he does nothing unwillingly, nothing sorrowfully, nothing under duress.²⁴

Acting freely in this manner thus consists in wanting what fate wants. Clearly, such freedom can be attained only by a handful of wise men, whose qualities are enumerated above.

This particular vision of freedom is tied to Stoic philosophy as a whole, and cannot be treated as a separate entity. Accordingly, we have chosen not to elaborate on it as fully as we did with Greek freedom, for such a discussion would take us beyond the scope of our book.

Space also precludes a detailed account of Roman power and the extinction of Roman freedom, topics largely covered by Grimal (1989). After Cesar's assassination in 44 B.C.E., his chief heir Octavius succeeded in defeating Mark Antony and, under the name of Augustus, in becoming the head of a new imperial regime that

²⁴ Latin text: Quid est enim libertas? Potestas vivendi ut velis. Quis igitur vivit ut volt, nisi qui recta sequitur, qui gaudet officio, cui vivendi via considerata atque provisa est, qui ne legibus quidem propter metum paret, sed eas sequitur et colit quod id salutare esse maxime iudicat, qui nihil dicit, nihil faeit, nihil cogitat denique nisi lubenter ac libere, cuius omnia consilia resque omnes quas gerit ab ipso proficiscuntur eodemque referuntur, nec est ulla res quae plus apud eum polleat quam ipsius voluntas atque iudicium, cui quidem etiam quae vim habere maximam dicitur, Fortuna ipsa cedit, si, ut sapiens poeta dixit, suis ea cuique fingitur moribus? Soli igitur hoc contingit sapienti, ut nihil faciat invitus, nihil dolens, nihil coactus.

replaced the Republic in 27 B.C.E. The notion of freedom then disappeared from the Roman Empire.

2.3.2 Freedom in the monotheistic religions

Rather than provide a detailed description of the concept of freedom in monotheistic religions, we shall focus on how they differed from the Greek and Roman notions of freedom.

The first monotheistic religion was Judaism, whose foundational text is the Old Testament (Hebrew Bible). As God is transcendent, immanent, omnipotent, and omniscient, man has no freedom in his presence. For example, Abraham, one of the first Jewish prophets, born in time immemorial, is asked by his god Yahweh to sacrifice his only son Isaac. Without uttering a single protest, Abraham carries out the order exactly as told (Gen. 22:1-19). It is only when he raises his knife to slay his son that an angel stops him and praises him for having followed his God's orders to the letter. Yahweh's prescriptions are legion, and often extremely fierce, but are always carried out with the greatest respect. For instance, when a man gathered wood on the Sabbath, Yahweh tells Moses to execute him, and the entire community stones him to death (Numb. 15:32-36). All that counts is the emancipation from slavery, according to the Bible, of the Hebrews of Egypt or Babylon. We can conclude that Judaism requires of its faithful a total obedience to God's commandments, without allowing them any true freedom.

The Christian religions, which emerged after the death of Jesus, are also predicated on the single deity, in the form of the august Trinity. They could hardly accommodate the notion of freedom as formulated by the Greeks and Romans. Only God is truly free, but man is endowed with free will. This notion was elaborated in the earliest days of Christianity (second century), then with greater precision by Augustine of Hippo (354-430). In the second book of *De libero arbitrio* (387-391), the dialogue between Augustine and his disciple Evodius is devoted to free will (II, 1.1):

Evodius. Now explain to me, if you can, why God has given man free choice of will. For if man had not received this gift, he would not be capable of sin.

Augustinus. Do you know for certain that God has given man this gift, which you think ought not to have been given?

Evodius. As far as I thought I understood in the first book, we have free choice of will, and we only sin as a result.²⁵

We must therefore examine how this notion gained ground against Greek and Roman thought, which prevailed before Jesus Christ. Unlike the Greco-Roman gods, a single God must be perfect, omnipotent, and—above all—the only free entity. Accordingly, he cannot be held responsible for evil; only the free will that he has granted to men can lead them to evil. Thus God's freedom and human free will cannot be identical. Yet the quest for a definition of freedom applicable both to humans and to God poses a problem that runs through the entire history of Christianity, for, at the same time, it regards man as being in God's image. In *De Trinitate* (ca. 400-416, XIV, 4, 6) Augustine clearly states how that image is to be found in the human soul:

Therefore neither is that trinity an image of God, which is not now, nor is that other an image of God, which then will not be; but we must find in the soul of man, *i.e.*, the rational or intellectual soul, that image of the Creator which is immortally implanted in its immortality.²⁶

The image of God dwells in the human soul, but when man chooses evil, the image loses its beauty and its colors fade. Augustine can then draw a fundamental distinction between free will (*liberum arbitrium*) and freedom (*libertas*). Free will becomes the prerequisite for attaining true freedom, which Augustine defines as follows (*De libero arbitrio*, I, 16, 32):

²⁵ Latin text: Evodius. Iam, si fieri potest, explica mihi, quare dederit deus homini liberum arbitrium voluntatis, quod utique si non accepisset, peccare non posset. Augustinus. Iam enim certum tibi atque cognitum est deum dedisse homini hoc, quod dari debuisse non putas? Evodius. Quantum in superiori libro intellegere mihi visus sum, et habemus liberum voluntatis arbitrium et non nisi eo peccamus.

²⁶ Latin text: Nec illa igitur trinitas, quae nunc non est, imago Dei erit; nec ista imago Dei est, quae tunc non erit: sed ea est inveniendā in anima hominis, id est rationali, sive intellectuali, imago Creatoris, quae immortaliter immortalitati eius est insita.

Then there is freedom, though indeed there is no true freedom except for those who are happy and cling to the eternal law.²⁷

For Augustine, freedom here denotes a specific situation in which the soul reaches perfection in its accord with God (Trego, 2005). This notion has nothing to do with the Greeks' political freedom but is closer to the Stoic concept, with *fatum* being replaced by God. Both entities stand above human actions, which must comply with their existence in order to have any value. Just as few Stoic sages want what *fatum* wants, so few Christians fully accept their God's will.

Over time, the notions of free will and Christian freedom underwent changes, most notably with Thomas Aquinas in the thirteenth century, and Luther and Calvin's Reformation in the sixteenth century. However, the basic outlines of the two concepts provided by Augustine were not substantially altered.

The third monotheistic religion is Islam, which appeared in the seventh century with the prophet Mohammed. In the Koran, the term "freedom" is used only in contrast to slavery. Indeed, at its origin, Islam was in favor of the enslavement of conquered peoples, as we can read here (Quran, 33, 52, transl. Sarwar):

Besides these, other women are not lawful for you to marry nor is it lawful for you to exchange your wives for the wives of others (except for the slave girls), even though they may seem attractive to you. God is watchful over all things.²⁸

Free will is also part of Islam, naturally in opposition to divine will (Quran, 2, 256, transl. Sarwar):

There is no compulsion in religion. Certainly, right has become clearly distinct from wrong. Whoever rejects the devil and believes

²⁷ Latin text: deinde libertas; quae quidem nulla vera est nisi beatorum et legi aeternae adherentium.

²⁸ Arabic text: أَعْجَبَكَ وَلَوْ أَرْوَّاجٍ مِنْ بَهْوٍ تَبَدَّلَ أَنْ وَلَا بَعْدُ مِنَ النِّسَاءِ لَكَ يَجُلٌ لَا رَقِيبًا شَيْءٌ كُلٌّ عَلَى اللَّهِ وَكَانَ بِمِثْنِكَ مَلَكَتْ مَا إِلَّا حُسْنُهُنَّ

in God has firmly taken hold of a strong handle that never breaks.
God is All-hearing and knowing.²⁹

But while many Koranic verses, particularly in Surat 2 (The cow), recognize the legitimacy and existence of the other monotheistic religions (Judaism and Christianity), later jurisprudence abolished some of these verses, on the grounds invoked in Surat 3 (The family of Amran, 85, transl. Sarwar):

No religion other than Islam (submission to the will of God) will be accepted from anyone. Whoever follows a religion other than Islam will be lost on the Day of Judgment.³⁰

Islam's position on freedom is ultimately close to that of the other monotheistic religions, despite its divergence on many other points. For a more contemporary view of the concept of freedom in Islam we refer the reader to Étienne (2006) and Madani (2011), who give very different accounts of what remains a highly topical issue.

In sum, the monotheistic religions rejected the Greco-Roman notion of freedom and introduced the opposition between human free will and God's will. If man chooses to obey the single god, he is therefore regarded as having been emancipated, and therefore as free.

2.3.3 Philosophical and political freedom

The scientific revolution began in the sixteenth century and took hold in the seventeenth and eighteenth centuries. Its chief philosophical leaders and exponents were Bacon, with the *Novum Organon* (1620), and Descartes, with the *Discours de la méthode* (*Discourse on the method*: 1637) and *Les méditations métaphysiques*

²⁹ Arabic text:

لَا الْوُثْقَى بِالْعُرْوَةِ اسْتَمْسَكَكَ فَقَدْ بِاللَّهِ وَيُؤْمِنُ بِالطَّاغُوتِ يَكْفُرُ فَمَنْ الْغَيِّ مِنَ الرُّشْدِ تَبَيَّنَ قَدْ الدِّينِ فِي إِكْرَاهٍ لَا عَلِيمٌ سَمِيعٌ وَاللَّهُ لَهَا أَنْفِصَامٌ

³⁰ Arabic text: الْخَاسِرِينَ مِنَ الْآخِرَةِ فِي وَهُوَ مِنْهُ يُقْبَلُ فَلَنْ دِينًا الْإِسْلَامَ غَيْرَ يَبْتَغِ وَمَنْ

(*Metaphysical meditations*: 1647).³¹ What was the revolution's novel approach to freedom?

For Augustine, man's will (his free will) would not be free if it went against God's will. By contrast, Descartes (1647) argues that free will exonerates us from having to be God's subjects. In response to the sixth set of objections from various theologians, philosophers, and geometers (p. 372), he writes:

So human freedom relates to indifference very differently from how divine freedom relates to it. The thesis that the essences of things are indivisible isn't relevant here. For one thing, no essence that can be attributed to God can be attributed in the same sense to any of his creatures. Also, indifference isn't part of the essence of human freedom: we are free when ignorance of what is right makes us indifferent, but we are especially free when a clear perception impels us to pursue some object.³² (transl. Bennett, 2006)

Human freedom thus defined enables Descartes to engage in true scientific work focused on the facts of nature. That is what he does in his *Discours de la méthode*, for the purpose of managing reason properly and seeking truth in science. This mechanistic vision of science, which prevailed until the late nineteenth century, was challenged most notably by quantum mechanics and the various interpretations of its indeterminism.

While the Cartesian notion defines philosophical freedom emancipated from submission to God, another form of freedom developed in the eighteenth century. We find it in Montesquieu's *L'esprit des lois* (1748, Book XII, chapter 2, p. 296):

³¹ The text was initially published in Latin under the title *Meditationes de prima philosophia* in 1641. The French translation by the Duc de Luynes and approved by Descartes also includes six series of *Objections* with the author's replies.

³² French text: Et ainsi l'indifférence qui convient à la liberté de l'homme est fort différente de celle qui convient à la liberté de Dieu. Et il ne sert ici de rien d'alléguer que les essences des choses sont indivisibles; car, premièrement il n'y en a point qui puisse convenir d'une même façon à Dieu et à la créature; et enfin l'indifférence n'est point de l'essence de la liberté humaine, vu que nous ne sommes pas seulement libres, quand l'ignorance du bien et du vrai nous rend indifférents, mais principalement aussi lorsque la claire et distincte connaissance d'une chose nous pousse et nous engage à sa recherche.

Philosophical liberty consists in the free exercise of the will; or at least, if we must speak agreeably to all systems, in an opinion that we have the free exercise of our will. Political liberty consists in security, or, at least, in the opinion that we enjoy security.³³ (transl. Nugent)

This political freedom, which is supposed to free humans from insecurity, is very different from the philosophical freedom described by Descartes. However, the two are closely tied. By detaching science from prejudices and false idols—as Bacon so aptly describes them—philosophical freedom is intimately linked to political freedom, which allows people to express this new scientific approach.

It is important to realize the degree to which these currents of thought were threatened by the Church. Galileo's sentencing in 1633 caused Descartes to withhold publication of the *Traité du monde et de la lumière* (*The World, or Treatise on light*), which did not appear in print until 1664, and his works were placed on the Index in 1663. Similarly, *L'esprit des lois* (*The spirit of the laws*) by Montesquieu was placed on the Index in 1751 and condemned by the Sorbonne.

At the start of the French Revolution, Condorcet, in his *Esquisse d'un tableau historique des progrès de l'esprit humain* (*Sketch for a historical picture of the progress of the human mind*, 1794), recognized the importance of Bacon, Galileo, and, above all, Descartes in this liberation of human minds. But the Terror silenced his ideas.

Later, in 1819, Constant gave a speech at the Athénée Royal de Paris on *De la liberté des anciens comparée à celle des modernes* (*The liberty of ancients compared with that of moderns*) in which he went one step further and contrasted Greek and Roman freedom with modern liberty (p. 603):

³³ French text: La liberté philosophique consiste dans l'exercice de sa volonté, ou du moins (s'il faut parler dans tous les systèmes) dans l'opinion où l'on est que l'on exerce sa volonté. La liberté politique consiste dans la sureté, ou du moins dans l'opinion que l'on a de sa sureté.

Individual liberty, I repeat, is the true modern liberty. Political liberty is its guarantee, consequently political liberty is indispensable.³⁴

This is a perfect expression of the liberalism that had been gradually taking shape in Europe since the sixteenth century. Constant proposed the representative system, in which the people give a proxy to a certain number of elected officials because they do not have the time to defend their interests themselves, as is necessary in modern nations. Constant does point out the dangers of relinquishing the right to share in political power, but he does not address the complexity of social hierarchies.

The goal then becomes—through the political authority thus defined—to ensure security and a defense against the enduring threat of violence between individuals. Unfortunately, this ideal collapsed in the disastrous wars of the twentieth century, made possible and infinitely deadlier by scientific progress and liberal industrialization. The guarantees of freedom came up against the worst fascist regimes and the annihilation of peoples deemed undesirable by them. As a result, the legacy of this idea of freedom became vain, as a rationalism too confident in its principles.

2.4 Conclusion

As noted at the outset, we have examined the changing concepts of freedom up to the modern age; in Chapter 5, we discuss which new forms may apply in our time.

However, our brief overview has already shown us the great differences between the concepts, despite the fact that they all seem valid in their respective social contexts. Even more importantly, the paradigms that allow the definition of specific forms of freedom are not erased by later paradigms, for they persist in human memory.

³⁴ French text: La liberté individuelle, je le répète, voilà la véritable liberté moderne. La liberté politique en est la garantie; la liberté politique est par conséquent indispensable.

Each of these forms is intimately bound up with the culture and religion of the peoples considered, and it seems hard, if not impossible, to find a universal definition of the term. In fact, freedom is a continually renewed process, not an absolute, unattainable state. The process recycles elements of the earlier concepts of freedom, transforming them so as to adapt them to the latest world-view that is taking root. This requires a response to the problems posed by the new world-view while trying to circumscribe them in a new concept of freedom. At the same time, however, the need to adhere to the world-view will turn the aspiration to freedom into a desire for submission (Avez, 2017, p. 28).

Chapter 3

Astronomy and astrology: once indistinguishable, now clearly separate

Astronomy and *astrology* have been defined in many ways over the centuries, so we must begin by specifying exactly what we mean by the two terms. The Greek etymology of *αστρονομία* comprises *άστρον* and *νόμος*—literally, “the law of the stars”—which we shall define here as a science that studies the position, movements, structure, and evolution of heavenly bodies. The Greek *αστρολογία* is composed of *άστρον* and *λόγος*—literally, “discourse on the stars”—which we shall define here as a divination art that is based on the observation of heavenly bodies and seeks to determine their presumed influence on earthly event and human fate.

We begin by showing how astronomy and astrology were closely linked in antiquity—including Assyria, Babylon, Greece, and Egypt—to the point of being indistinguishable from each other. We then describe how these initial ties weakened over time, eventually resulting in two opposing approaches to our relations with celestial phenomena—the first becoming a science, the second a divination art. The final section discusses the present revival of scientific interest in astrology, both to condemn it as a superstition and to apply a new statistical approach to it. In conclusion, it is important to examine the reasons for astrology’s enduring popular appeal.

3.1 Astronomy and astrology in antiquity

An exhaustive account of the relationship between astrology and astronomy lies beyond the scope of our book. Our focus, instead, will be on the prediction of earthly events and human phenomena from the astronomical positions of heavenly bodies either at a time prior to the events or at the birth of individuals.

Apart from Hebrew civilization, all ancient civilizations, whether in Asia, Europe, Africa or the Americas, were polytheistic. They viewed man and earthly events as being closely connected to the universe and, more specifically, to the heavenly bodies. This explains the simultaneous development of early forms of astronomy, to measure and explain the movements of celestial bodies across the sky, and of astrology, to link these movements to the fate of humans on Earth.

We shall not describe all the connections between astronomy and astrology in the different parts of the ancient world, but rather concentrate on a small number of civilizations in which the two were very closely tied. We refer the interested reader to the works of historians who have been exploring this vast field since the nineteenth century, notably including: Auguste Bouché-Leclercq, in his four-volume *L'histoire de la divination dans l'antiquité* (1879-1882) and *L'astrologie grecque* (1899); Franz Cumont, who illustrates the religious aspects of astrology in *Astrology and religion among the Greeks and Romans* (1912) and *L'Égypte des astrologues* (1937); David Edwin Pingree, whose *The Yavanajātaka of Sphujidhava* (1978), *Jyotihsāstra: astral and mathematical literature* (1981), and *Astral science in Mesopotamia* (1999) show how borrowings from Greek astrological treatises introduced a new astrology in India, still taught in its universities; Ulla Koch-Westenholz also examines in detail the evolution of astrological practices throughout the history of Mesopotamia in *Mesopotamian astrology: an introduction to Babylonian and Assyrian celestial divination* (1995); Francesca Rochberg Halton has published a translation of *Babylonian Horoscopes* (1998) with commentary and a more general overview of cuneiform texts in *Before nature: cuneiform knowledge and the history of science* (2016); John M.

Steele provides a fuller account of astrology in Mesopotamia, Egypt, Greece, Rome, Byzantium, China, and India in *The Circulation of Astronomical Knowledge in the Ancient World* (2016).

Taking more specific examples, we shall try to describe the relationships between astronomy and astrology, to show if astrology allows a prediction of future events, and to determine whether such predictions are verified.

3.1.1 *Astronomy and astrology in Mesopotamia*

These two disciplines, now completely separate, were totally integrated in most ancient civilizations, particularly in Mesopotamia—a term used here to designate different elites living in the region. Their detailed study was made possible by numerous discoveries in the nineteenth and twentieth centuries.

The first step was the decipherment of cuneiform texts during the nineteenth century. This achievement was made possible by the equivalent of the Rosetta Stone for Egyptian hieroglyphs: the Behistun Inscription. Written in Old Persian, Elamitic, and Akkadian, it enabled Rawlinson and his assistants to decipher these three basic languages of Mesopotamia (1861-84).

The second step was the inventory of all the tablets found in the Mesopotamian archival and library sites. Notable examples include the following: in Nippur, some 30,000 tablets and tablet fragments were discovered, the oldest dating from the third millennium B.C.E. (Gibson, 1993; Hilprecht, 1906); in Assur, over 4,300 tablets were found at 50 sites, of which the oldest dates from the ancient Akkadian period, 2330-2150 B.C.E. (Pedersén, 1985); in Niniveh, more than 3,000 tablets and fragments from the Royal Library of Ashurbanipal have been unearthed, dating from 668-627 B.C.E..

The third step was the classification of these writings, which, among other things, made it possible to distinguish between astronomical texts, astrological texts, and texts belonging to both categories. This classification also identified many texts as copies of earlier versions, allowing a historical reconstruction.

Of the 1,594 literary and scientific tablets examined by Fincke in Niniveh (2003), for example, 746, or 46.8% of the total, concerned various divination methods, of which only 346 related to astrology and 13 to astronomy, often combined with astrology. While the Mesopotamians, as noted earlier, practiced many other divination methods, the predominant one was astrology.

Interestingly, astronomical research led to ever more sophisticated mathematical modeling of the movements of celestial bodies. Mansfield and Wildberger (2017) have shown that tablet Plimpton 322, dated between the nineteenth and sixteenth centuries B.C.E., is a sexagesimal—i.e., base-60—trigonometric table, far earlier than the first trigonometric tables of Hipparchos of Nicea (180-125 B.C.E.). Ossendrijver (2016) has shown that the method developed by the “Oxford calculators” in the fourteenth century to formulate the “mean speed theorem” was already described in texts by Babylonian astronomers written between 400 and 50 B.C.E.

What exactly was the Mesopotamian concept of astrology? It was very different from our modern definition, namely, the use of the configuration of the planets, the sun, and the moon to determine a person’s future at birth. For the Mesopotamians, the relevant notion is that of “judicial astrology,” which involves the prediction of events concerning the king, the country, and the people (Neugebauer, 1945, p. 39). The belief that the entire universe is causally connected may be found in the Babylonian Diviner’s Manual (Oppenheim, 1974, p. 204):

The signs on earth just as those in the sky give us signals. Sky and earth both produce portents though appearing separately, they are not separate (because) sky and earth are related. A sign that portends evil in the sky is (also) evil on the earth.

The correlations between the signs and what they signified give what they called “omens”, which are pairs of independent elements: “on the one hand a sign in the natural world or social environment, and on the other an event in social life” (Rochberg, 2010, p. 19). They mixed a scrupulous observation of the movements of the sun, the moon and the planets, with an interpretation of these phenomena

as divine signs permitting to establish the norms and anomalies by means of which to find the order of things. This was also an act of social control by the Kings of these countries. As Guinan (2014, p. 105) says:

Not only do divination and law share the same casuistic form the sun-god Šamaš is patron of both. During the day he enables justice to be transmitted to the king and through the king into the human arena. At night when he passes into the netherworld he presides over a divine court that issues divinatory decisions.

Once the idea of a parallel between celestial events and earth or human events is accepted, its use and development are a logical consequence.

For instance, Tablet 63 of the *Enūma Anu Enlil* (so called in reference to the opening words of its prologue: “When the gods Anu, Enlil and Ea designed heaven and earth”) discusses the movements of the planet Venus during the 21-year reign of Ammisaduqa (ca. mid-seventeenth century B.C.E.). The tablet—fortunately preserved in the form of copies made at least a millennium later—contains the following omens:

[...] in month X, nth day, Venus in the west became visible: the harvest of the land will prosper.

[...] if Jupiter remains (in the sky) in the morning, enemy kings will become reconciled (transcription by Reiner, 1975, p. 29).

These “celestial omens,” as the Mesopotamians called them, comprised a first part describing the observation of a celestial phenomenon and a second part that predicted a terrestrial event to come. The predicted events, however, were not inevitable. The scribes give fuller explanations in their letters to the sovereign. They offer solutions to avert such perils when foretold in omens. One solution is to perform a ritual called *namburbi*, meaning that the imminent misfortune predicted can be untied like a knot, so that it no longer holds together. When the sovereign’s death is foretold, one can, for example, designate a substitute sovereign vested with all the real sovereign’s powers. The real sovereign is thus protected and performs none of his duties for the 100-day duration of the omen.

This scenario is explicitly described in letters containing such statements as:

[...] as regards the substitute king: if the farmer my lord agrees, he can go to his fate tomorrow, but if not, he may sit on his throne for the full 100 days (cited by Hunger, 2009, p. 70).

The true sovereign is called “my lord farmer” and “to go to his fate” is a euphemism for “to die.”

In the second half of the first millennium B.C.E., new approaches were developed that may be regarded as the precursors of Greek horoscopes, discussed in the following section. Of approximately thirty known texts (Sachs, 1952; Rochberg, 1998), some have been dated with precision thanks to the astronomical information they contain. The earliest text dates from April 29, 410 B.C.E.. However, most offer no predictions about the future of the persons concerned. Only one text dating from April 203 B.C.E. gives some predictions on the person’s life after presenting the planetary data at the time of his birth:

He will be lacking property, His food (?) will not [suffice (?)] for [his] hunger (?). The property which he had acquired in his youth (?) will not [last (?)]. The 36th year (or: 36 years) he will have property. (His) days will be long. His wife, whom people will seduce (?) in his presence, will (or: His wife, in whose presence people will overpower him, she will bring (it) about] (?).) He will have ...’s and women. He will see (?) profit. Between travels concerning property [...] (translation by Rochberg, 1998, pp. 66-67, closely following the initial translation by Sachs, 1952, pp. 57-58).

This text marks a significant departure from the “celestial omens” for several reasons. First, its time horizon is not the immediate future but the longer term, and even the person’s total lifetime (“His days will be long”), without, however, specifying its duration. Second, as the text does not concern a sovereign, it does not lend itself to the “namburbi” ritual. Third, it involves “personal astrology” rather than the former “judicial astrology.” Events are not dated with precision, except for the date at which the person is supposed to become a property-owner.

The other texts provide only planetary data at the time of birth, but we can interpret them with the aid of surviving general documents. Astronomical texts called Almanacs contained the information needed to complete the horoscopes. Among others, Almanac TCL VI No. 14 found in Assur gives many examples:

If a child is born when the moon has come forth, [then his life (?) will be] bright, excellent, regular, and long. If a child is born when the sun has come forth, [then] [...] If a child is born when Jupiter has come forth, [then his life (?) will be] regular, well; he will become rich, he will grow old, [his] day[s] will be long (translation by Sachs, 1952, p. 68).

The terms used here are very similar to those of the previous quotation, and describe the state of each planet at the time of birth. As in the earlier horoscope, no dating of events is provided.

We may therefore conclude that this extension of celestial divination probably served as a model for Greek astrology and that Greek astronomers used the Mesopotamian discoveries. However, Mesopotamian astronomy and astrology were always practiced by priests and remained a religious pursuit.

3.1.2 Hellenistic astronomy and astrology

The *Babylonian Horoscopes* (Sachs, 1952) are wholly consistent with the *Greek Horoscopes* (Neugebauer and van Hoesen, 1959), and Greek astronomy carried on the research undertaken by Mesopotamian astronomers. The two disciplines remained closely linked, but the approach evolved because the two cultures were so different. We shall use “Hellenistic” to refer to a tradition followed more generally in the Mediterranean region from around the third century B.C.E. to the sixth century C.E.

While Mesopotamian astronomy relied largely on arithmetical processes, Hellenistic astronomy was inspired by geometric models.

The astronomer Eudoxus of Cnidus (408-355 B.C.E.), whose work is known to us only through quotations, developed a geocentric system comprising 27 spheres. In the third century B.C.E., Euclid

defined the axiomatic bases of geometry, but he is less well known as the author of the *Phaenomena* (Berggren and Thomas, 1996)—a treatise on spherical geometry for the study of celestial phenomena. The heliocentric hypothesis was defended by Aristarchos of Samos (ca. 310-230 B.C.E.), whom Heath (1913) calls the “Copernicus of antiquity.” Heath provides a detailed, but now partly obsolete, history of Greek astronomy. In the *Almagest* (ca. 150 C.E.), Ptolemy uses his calculations to show that the positions of the planets can be explained only if the circles on which the planets move are centered not on the Earth but on a point at some distance from it. This model is thus neither strictly geocentric nor strictly heliocentric. It remained in use until Kepler’s pure heliocentric system. It should be noted that Ptolemy also wrote an astrological treatise, the *Tetrabiblos* (ca. 168 C.E.), discussed later.

Let us now examine the differences between Hellenistic and Babylonian astrology as they relate to differences between Hellenistic and Mesopotamian culture.

Mesopotamian “celestial omens” implied a correspondence between human and celestial phenomena, some of whose consequences could be avoided by resorting, for example, to the “namburbi” ritual. In contrast, Greek astrology was anchored in the Stoic concept of life, where chance does not exist and all events are decided by fate. As Bouché-Leclercq clearly explains (1899, p. 31):

But what most notably predestined the Stoics to vouch for astrological speculations and seek demonstrative reasons for them was their unshakeable faith in the legitimacy of divination, of which astrology is merely a particular form.³⁵

These two doctrines equally concerned with knowledge and prediction, thus had a reciprocal influence from the outset. We will see in more details the view of Cicero (around 44 B.C.E.) on astrology and the Stoic concept of life in chapter 5.

³⁵ French text: Mais ce qui prédestinait tout particulièrement les Stoïciens à se porter garants des spéculations astrologiques et à leur chercher des raisons démonstratives, c’est leur foi inébranlable dans la légitimité de la divination, dont l’astrologie n’est qu’une forme particulière.

Interestingly, astrologers such as Vettius Valens (120-175) perpetuated this belief that all events are decided by fate. He spent at least twenty-five years (ca. 145-170 C.E.) writing a book in Greek known as *Anthologiarum Libri*, which contains nearly 125 horoscopes that are broadly correct in astronomical terms. Vettius visibly worked on data collected with reasonable accuracy by himself or his predecessors (Neugebauer and van Hoesen, 1959). The horoscopes were intended as examples for the various astrological theories discussed in the work and are therefore not, strictly speaking, predictive. They aim to show how the theories could have predicted the events, which he presents as having already occurred in the past. For example, in 87 of the 125 horoscopes, he gives the age at death or the occurrence of a major crisis, justifying the prediction with his theories.

Rochberg-Halton (1984, p. 117) sums up the difference between Mesopotamian and Greek astrology without emphasizing the underlying role of Stoicism:

The contrast between Babylonian and Greek methods and rationale for prognostication on the basis of celestial events can be expressed in terms of difference between a form of divination on the one hand, in which the deity provides ominous signs in the heavens to be read and interpreted by a specialist, and on the other, a mechanistic theory of physical causality, in which the stars and the planets themselves directly produce effects on earth.

However, Rochberg-Halton is obliged to admit an influence of Babylonian “omens” on the formulation of Greek astrological methods.

The first point to bear in mind is that there are only thirty or so Babylonian horoscopes dating from 410 B.C.E. to 68 B.C.E., versus over six hundred Greek horoscopes, dating from 71 B.C.E. to 621 C.E. (Neugebauer and van Hoesen, 1959). As noted earlier, Greek horoscopes are mainly based on a Stoic conception of life in which all events are fated to occur, whereas the Babylonian “omens” are regarded as signs whose effects can be averted.

Despite these major differences, Greek horoscopes seldom actually foretell events. The original documents compiled by Neugebauer and van Hoesen (1959) sometimes give a fairly vague

prediction. In document 3 (p. 17), for example, the astronomical details of the case studied yield the following prediction:

Take care for 40 days
because of Mars (translation from Grenfell and Hull, 1904,
p. 256³⁶).

As we can see, the prediction is extremely vague. Only the literary texts, such as the writings of Vettius Valens, offer detailed predictions—but *a posteriori*.

We conclude our presentation of Greek astrology with Ptolemy's *Tetrabiblos*, which differs in many respects from the works of other contemporary astrologers such as Vettius Valens. The *Tetrabiblos* follows the *Almagest*, Ptolemy's astronomical treatise. Its main goal is to reformulate astrology as a natural science. Ptolemy no longer regards celestial bodies as capable of telling us about the future, but examines whether they can influence various terrestrial events. He never discusses individual cases, never compiles a horoscope, and never describes an astrologer's daily work. Ptolemy's interest in astrology is visibly confined to theory rather than practice (Riley, 1987). He embodies the transition toward the following period.

3.2 Astronomy ascendant, astrology discredited

This new period is marked by many major events that changed the vision of the world.

With the exception of Judaism, the prevailing religious belief in the earlier period had been polytheism. It waned as the new monotheistic religions—Christianity and Islam in their different forms—gained ground. Whereas polytheism lived at ease with astrology, monotheism rejected it, for the divinities that astrology saw in the heavenly bodies could in no way compete with the single

³⁶ Papyrus no. 804, Greek text :

Φυλάττον ἕως ἡμερῶν(ν)

μ χάριν τού Ἀρεως

God of the monotheists. Nevertheless, astrology continued to attract many monotheists despite the risk that they would be accused of heresy.

From the time of Moses, Judaism strongly rejected astrology. In Deuteronomy (ca. 7th century B.C.E.), for example, we read:

And when you look up to the sky and behold the sun and the moon and the stars, the whole heavenly host, you must not be lured into bowing down to them or serving them. These the LORD your God allotted to other peoples everywhere under heaven (*JPS Tanakh*, 1985, Deuteronomy, chapter 4, verse 19³⁷).

Many other passages of the Hebrew Bible condemn astrology. Yet, outside the canonical Jewish literature, we find texts in the Judeo-Aramaic literature showing the use of astrology in the final centuries B.C.E. (Greenfield and Sokoloff, 1989).

Christianity, as well, rejected astrology from its earliest days. Augustine of Hippo (354-430), while admitting that he had been tempted by astrologers' doctrines in his youth (*Confessiones*, ca. 397-400), later condemned it violently:

But those who are of opinion that, apart from the will of God, the stars determine what we shall do, or what good things we shall possess, or what evils we shall suffer, must be refused a hearing by all, not only by those who hold the true religion, but by those who wish to be the worshippers of any gods whatsoever, even false gods (*De civitate Dei contra paganos*, ca. 410-427, V, 1, p. 178: translated by Dods, 1871³⁸).

He did recognize the influence of the Sun and other celestial bodies on a variety of physical phenomena, but denied their power over the

³⁷ Hebrew text : וּפְנֵי-הַשָּׁמַיִם עֵינֶיךָ הַשְׁמִימָה, וְרָאִיתָ אֶת-הַשָּׁמַשׁ וְאֶת-הַיָּרֵחַ וְאֶת-הַכּוֹכָבִים יֵט לְכָל הָעַמִּים, כָּל צָבָא הַשָּׁמַיִם, וְגִדְחָתָהּ וְהַשְׁתַּחֲוִיָּה לָהֶם, וְעַבְדָּתָם--אֲשֶׁר חֶלֶק יְהוָה אֱלֹהֶיךָ, אֲתָם, לְכָל הָעַמִּים, תַּחַת כָּל-הַשָּׁמַיִם

³⁸ Latin text: Illi vero, qui positionem stellarum quodam modo decernentium qualis quisque sit et quid ei proveniat boni quidue mali accidat ex Dei uoluntate suspendunt, si easdem stellas putant habere hanc potestatem traditam sibi a summa illius potestate, ut uolentes ista decernant: magnam caelo faciunt iniuriam, in cuius velut clarissimo senatu ac splendidissima curia opinantur scelera facienda decerni, qualia si aliqua terrena ciuitas decreuisset, genere humano decernente fuerat euertenda.

human mind. This approach enabled thirteenth-century theologians to accept the influence of celestial bodies on many human behaviors while continuing to reject their influence on mind and will.

The numerous authors of the period who reintroduced astrology include Robert Grosseteste (1175-1253) and his disciple Roger Bacon (1214-1294) at the University of Oxford, and Albertus Magnus (ca. 1200-1280) in Germany. Cecco d'Ascoli (1269-1327), professor of astrology at the University of Bologna, summarizes this attitude perfectly:

Each [celestial sphere] does not create necessity with its motion,
But rather disposes the human creatures
Through its qualities; if the soul follows these
And abandons judgement it makes itself cowardly:
A slave, a thief, a stranger to virtue,
It divests itself of its noble habitus
(translation by S.B. Fabian (2014) of *Acerba* II.i³⁹).

While this approach was accepted by the Church in England and Germany, the Italian Inquisition condemned Cecco d'Ascoli to be burned at the stake and banned the publication of his works. These fortunately continued to circulate after his death, and the *Acerba* was published as early as 1473.

In Islam, astrology experienced a similar fate. In the Koran (Muhammad, ca. 632-634), Allah says in verse 65 of chapter 27:

Say, "No one in the heavens or the earth knows the unseen except God, and no one knows when they will be resurrected."⁴⁰

³⁹ Original Italian text:

Non fa necessità ciaschum movendo,
Ma ben dispone creatura humana
Per quallità, qual l'anima seguendo
L'arbitrio abandona e fàssi vile
E serva e ladra e, de vertute estrana,
Da sé dispoglia l'abito gentile.

⁴⁰ Original Arabic text:

قُلْ لَا يَعْلَمُ مَنْ فِي السَّمَوَاتِ وَالْأَرْضِ الْغَيْبَ إِلَّا اللَّهُ وَمَا يَشْعُرُونَ أَيَّانَ يُبْعَثُونَ ﴿٦٥﴾

Those who practice astrology therefore claim the knowledge that Allah alone possesses, and they offer to those who believe them that which they cannot possess. Astrology is therefore totally prohibited and is a major sin. However, by the eighth century, astrology was introduced into the Arab world by the Caliph Al-Mansur (714-775), who employed an astrologer at his court, and Abu Ma'shar (Albumasar) (787-886) generalized the belief in the influence of celestial bodies on human fate in his works, originally written in Arabic but soon translated into Latin.

All monotheistic religions thus rejected astrology, yet all resorted to it in their non-theological practices. For the reasons why it fell out of favor, we must look elsewhere.

In the early seventeenth century, Francis Bacon (1561-1626) formulated a new approach to scientific research (*Novum Organon*, 1620, I, 19):

There are and can be only two ways of searching into and discovering truth. The one flies from the senses and particulars to the most general axioms, and from these principles, the truth of which it takes for settled and immovable, proceeds to judgement and to the discovery of middle axioms. And this way is now in fashion. The other derives from the senses and particulars, rising by a gradual and unbroken ascent, so that it arrives at the most general axioms at last of all. This is the true way, but as yet untried⁴¹ (translated by L. Jardine and M. Silverthorne, 2000).

Bacon called this approach “induction,” but the same term used by Mill (1843) and his successors had a very different meaning, namely, the generalization of particular facts. While the scientists who followed Bacon—most notably astronomers—did not refer to him directly, he visibly influenced them (see, for example, Ducheyne, 2005). Induction allowed them to find the general laws

⁴¹ Original Latin text: Duae viae sunt, atque esse possunt, ad inquirendam et inveniendam veritatem. Altera a sensu et particularibus advolat ad axiomata maxime generalia, atque ex iis principiis eorumque immota veritate judicat et invenit axiomata media; atque haec via in usu est. Altera a sensu et particularibus excitat axiomata, ascendendo continenter et gradatim, ut ultimo loco perveniatur ad maxime generalia; quae via vera est, sed intentata.

governing the movements of celestial bodies: Kepler (1561-1630) discovered the three laws of planetary movement that now bear his name, and Newton completed this synthesis (*Philosophiae Naturalis Principia Mathematica*, 1687) with his theory of universal gravitation and its six axioms.

As a result, astrology was totally excluded from the scientific field and lost all influence on scientists. Bouché-Leclercq, in his *Astrologie grecque* (1899, p. III), clearly sums up the status of astrology in his day:

I readily observe, indeed with pleasure, that few people are concerned with astrology today. While it lives on in the countries of the Orient, in our parts it belongs to the past and no longer interests anyone but historians.⁴²

This observation is not totally accurate, for the late eighteenth century witnessed a revival of interest in astrology in some circles in England and the United States (on this topic, we recommend the DVD by Graves, 2014, which contains 42 works on the “English astrological revival” published between 1784 and 1884) and in France (Christian, 1870-71, including a detailed study of Louis XVI’s horoscope, pp. 531-49).

In the next section, we discuss how astrology has been subjected to statistical testing in Western countries in modern times, even though it is no longer taught there.

3.3 Statistics and astrology in the current period

The current period is marked by the growing importance of statistics, which uses growing volumes of data (big data). As a

⁴² French text: Je constate volontiers, et même avec plaisir, que peu de gens se soucient aujourd’hui de l’astrologie. Si elle est encore vivante et agissante dans les pays d’orient, chez nous elle appartient au passé et n’intéresse plus que les historiens.

discipline, however, statistics is difficult if not impossible to define. Kendall (1943, p. 1) goes so far as to state:

Among the many subjects which statisticians disagree is the definition of their science.

Suffice it to say here that statistics seeks to determine the possible relations between data sets on a given population. The term “seeks” effectively denotes the imperfect nature of the approach. Whereas astrology previously worked on individual cases, it now sets out to work on a population, that is, on an aggregate of individual cases.⁴³

We begin with the tests performed to verify astrological arguments without involving astrologers. We then discuss the tests conducted on predictions made by astrologers themselves.

One of the first researchers to carry out tests to verify astrological claims was Paul Choïnard (1867-1930). A graduate of the École Polytechnique and author of many books on “scientific astrology,” Choïnard tested his theories on his many friends and acquaintances. This introduced bias in his data, and his proofs cannot be confirmed by reproducing his experiments.

Adopting a stricter approach, Michel Gauquelin (1928-1991) and Françoise Gauquelin (1929-2007) took all necessary precautions to obtain unbiased samples, such as: selecting a phenomenon that may be repeated on a regular basis; studying the phenomenon several times using new data; and performing statistical tests to verify whether certain hypotheses are valid. For example, in a book published in 1960, *Les hommes et des astres* (Of men and celestial bodies), Michel Gauquelin used 25,000 cases taken from civil registration records in Western European countries, including 3,142 military leaders, 3,305 scientists, 1,485 sports champions, and so on. Born under positions of specific planets (rise or culmination), they exhibit a positive correlation between their career success and those positions for the following planets: Mars and Jupiter for military leaders, Saturn and Mars for scientists, Mars for sports champions, and so on. But correlation is no way synonymous with causality: the

⁴³ Individual astrology, of course, has not disappeared in our time, but it remains confined within its former scope, which we assessed in critical terms earlier.

presence of hidden factors can explain a strong correlation or covariance between two variables that are not causally linked. For instance, a detailed study of French population cohorts born between 1931 and 1935 (Courgeau, 1985) showed that the classic curve linking mobility to age disappears entirely if we factor in the various stages of the person's life in society (family stages, economic stages, political stages, and so on). We must therefore look for all the causes that may generate the correlation between variables, and Gauquelin's analyses are unfortunately limited by the available sources (civil registers and hospital records).

Gauquelin's findings sparked fierce debate in the scientific and astrological communities, and were subjected to a number of tests, particularly to verify the Mars effect among athletes. The fact that the effect did not apply to the entire population examined but mainly to its elite is problematic. Moreover, the effect is very visible for champions born before 1950, but tends to disappear for those born later. Gauquelin explains this by the medical procedures disrupting the natural birth process, but his argument is hardly convincing. For our purposes, the correlations should be established on the basis of a well-defined theory. However, no genuinely scientific theory has been proposed for this effect (Good, 1987), and the cosmobiological theory suggested by Gauquelin fails to provide a sufficiently coherent explanation (Eysenck and Nias, 1982).

Gauquelin himself was well aware that his work had, in fact, nothing to do with astrology. In *The scientific basis of astrology* (1969, p. 145), he writes:

It is now quite certain that the signs in the sky which presided over our birth have no power whatever to decide our fates, to affect our hereditary characteristics, or to play any part however humble in the totality of the effects, random or otherwise, which form the larger part of our lives and mould our impulses to actions.

There is a great difference between an astrological effect that may emerge from statistical tests and a practice that leads to the formulation of predictions. In any event, the planetary effects detected by Gauquelin are far too weak to be of any value to astrologers.

The psychologist Hans Eysenck (1916-1997) was initially attracted by the Gauquelins' results and sought to verify the hypothesis of a link between the two main dimensions of personality—extraversion/introversion and emotionality/stability—and astrological signs at birth. The earth signs (Taurus, Virgo, and Capricorn) are regarded as practical and stable, whereas the water signs (Cancer, Scorpio, and Pisces) are emotional and intuitive. An initial article published with Mayo and White (1977) gives the results of a survey of 2,324 persons: the results fully corroborate the hypothesis.

However, in his book on astrology co-authored with David Nias (1982), Eysenck reported that when he studied the personality profiles of 1,160 children aged 11-17, with their known birth dates, no effect was visible. Looking at the results of other, similar studies in which respondents' astrological knowledge was tested, one can establish with certainty that prior knowledge of astrology influences the results of such studies. Eysenck and Nias therefore conclude (p. 215):

In none of the more convincing studies we have surveyed is there any indication that we are dealing with an effect that is decisive enough to be of practical importance.

Astrologers, who had initially taken a very positive attitude toward Eysenck, turned against him completely once they saw his findings. They regarded themselves as having been betrayed by the psychologist.

As a final example of verification of astrological hypotheses without involving astrologers, we can cite the study by Geoffrey Dean and Ivan William Kelly (2003) on "time twins," i.e., persons born at nearly the same time and in nearby localities but of different parents. From National Child Development Study in England, they extracted a sample of 2,100 time twins born in Greater London between March 3 and 9, 1958. In this period, Saturn was exactly near the horizon—a strong position, for astrologers. Dean and Kelly had 110 characteristics measured at ages 11, 16, and 23, most of which are included in horoscopes. The resemblance between time twins for each characteristic is measured by the serial correlation between successive pairs of individuals. According to astrology, we

should find a strongly positive serial correlation for these time twins. For the 110 characteristics examined in the aggregate, the study found a mean serial correlation of -0.003, not significantly different from zero. Similarly, when treated separately, the 110 serial correlations failed to support astrological assumptions.

The preceding statistical tests did not directly involve professional astrologers but focused only on the astrological predictions implicit in individual births. We now turn to tests based on predictions by astrologers themselves.

For such tests to be valid, they must be conducted on a double-blind basis, so that neither the astrologers nor the tester know the answers to the questions asked.

To our knowledge, the first to have carried out such a test is Vernon Clark (1961). In fact, he performed three tests, of which only the last was double-blind. For this third test, he sent ten pairs of horoscopes to thirty astrologers. The first horoscope concerned a person severely handicapped from birth with cerebral palsy. The second concerned a person with above-average intelligence who had never suffered severe illness. The astrologers, who had no information on these persons' lives, were asked to identify the horoscope of the cerebral palsy patient, which Clark himself did not know. The Student's test applied to the results suggested that there was one chance in a hundred of their having been obtained at random. But the small number of horoscopes tested (ten) weakened the results.

In the twenty-five years that followed, several roughly similar tests were conducted—with positive or negative results. Gauquelin (1973), for example, gave fourteen astrologers the horoscopes of three celebrities and asked them to identify the three. The result was very negative: a random choice would have yielded better results. In any event, these tests always involved a small number of astrologers and few horoscopes.

In 1985, Carlson published a new double-blind test on astrology in *Nature*. It was intended to assess both astrologers and the volunteers who had provided their dates of birth. The volunteers also respond to the California Personality Inventory (CPI), a test that

assigns an individual score for each of eighteen typical situations such as passiveness, femininity, and masculinity (CPI profile). The astrologers were asked to describe the volunteers' personalities on the basis of celestial body positions at the time of birth. The volunteers were given three descriptions of their personality, one supplied by the astrologer, two picked at random. They were unable to recognize themselves in the astrologer's description. They were also presented with three CPI profiles: their own and two others chosen at random. Again, they were unable to recognize their own profile. The astrologers who had the volunteers' horoscopes at their disposal failed to recognize their CPI profile among the three offered. Carlson concluded that astrologers were unable to predict an individual's personality from his or her horoscope better than at random.

We believe this overly peremptory verdict should be nuanced. First, the initially planned size of the test population had to be sharply reduced because of refusals to participate. Of the originally planned group of ninety astrologers, fewer than twenty-eight actually took part (the author does not even give their final number). Furthermore, the fact that the volunteers failed to recognize their CPI profiles more accurately than the astrologers casts doubt on the validity of such profiles for non-psychologists.

Several later studies have tried to overcome these difficulties while preserving the double-blind method. McGrew and McFall (1990), for example, involved astrologers in the choice of test questions in order to obtain a profile more consistent with astrological practice. But the number of astrologers participating in the study was still low (only six). The similar study by Nanninga (1996/97) tried, in addition, to increase the number of astrologers participating in the test (44). The results of both tests were identical to Carlson's: astrologers are incapable of predicting an individual's personality better than at random.

Many astrologers responded very negatively to all these statistical studies—whether or not they were invited to participate—arguing that they involved an excessive rationalization of something that belongs to the order of subjectivity (McRitchie, 2014, 2016). For instance, McRitchie (2014, p 34) writes:

Astrology is concerned with providing descriptions of one's personal potentials and how to make the best choice at different stages in life. This is not the same sort of information that is generated by psychological tests, which typically only measure the dimensions of psychology traits.

By denying any possibility of assessing the validity of astrology, in particular by means of psychological tests and statistics, he makes it unattackable but, at the same time, he drastically weakens its potential.

Dean and Kelly's response (2017) to his second article, published in 2016, offers arguments that further confirm this weakness.

For this purpose, they present meta-analyses of tests carried out by astrologers as well as by skeptics. As noted earlier, these tests were performed on small samples, undermining the reliability of their results. To be more precise, we can say that the 95%

fluctuation interval is approximately equal to $\left[p - \frac{1}{\sqrt{n}}; p + \frac{1}{\sqrt{n}} \right]$,

where n is the sample size and p the estimated proportion of successes. A meta-analysis of a larger number of tests conducted with small samples yields results that are far more reliable than those obtained with each analysis taken separately.

Dean (2008), who worked on 300 results of empirical studies, gives various examples of such analyses. First, to avoid all conflict with astrologers, he rejected no test. He collected 54 studies in which astrologers had to match horoscopes with individuals, as in Carlson's study, for a total of 742 astrologers and 1,407 horoscopes. A meta-analysis of these results confirms that astrologers are no better at predicting than a random choice. Similarly, in eighteen studies involving 650 volunteers and 2,100 profiles, the volunteers were unable to pick out their own profiles among those of other participants. This result too confirms Carlson's with many more volunteers.

These studies contradict McRitchie's conclusion (2016, p. 175) that "[...] there is no reliable evidence against astrological theory and practice," for they demonstrate that by using the right

statistical tools one can prove that astrologers are hardly capable of predicting a person's character with the sole aid of his or her horoscope.

3.4 Why is the belief in astrology still so strong?

The level of belief in astrology is still far from negligible. In France, a series of five surveys from 1982 to 2000 (Boy, 2004/5) shows that about 40% of the population believes in the explanation of personal character by astrological signs, and some 25% believe in predictions based on astrological signs (horoscopes), with weak variations from year to year. In England, Canada, and the United States, Gallup surveys conducted between 1975 and 2005 show that approximately 25% of adults answered "yes" to questions such as "do you believe in horoscopes?" (Campion, 2017). It is worth noting how close the percentages of believers in horoscope predictions are in the different countries observed.

But can this type of survey accurately measure popular belief in astrology? Many authors are doubtful and have tried to ask more detailed questions. Martin Bauer and John Durant (1997), for example, use a British survey of 1988 that began by asking "Do you sometimes read a horoscope or a personal astrology report?". Respondents who answered "yes" were then asked "How often do you read a horoscope or personal astrology report?" and "how seriously do you take what these reports said?". While 73% replied "yes" to the first question, only 44% replied "often" or "very often" to the second, and just 6% took the results seriously or very seriously. Clearly, the wording of the question strongly influences respondents' answers.

Another way to measure popular belief in astrology is to use the "Google Trends" tool, which shows the changes in the number of searches for different terms since a given date—here, "astronomy," "astrology," and "horoscope." The curve does not show an absolute number but a ratio to the sum of the search

volumes of all possible queries for the terms. Figure 1 shows the curve for worldwide searches for the three terms.

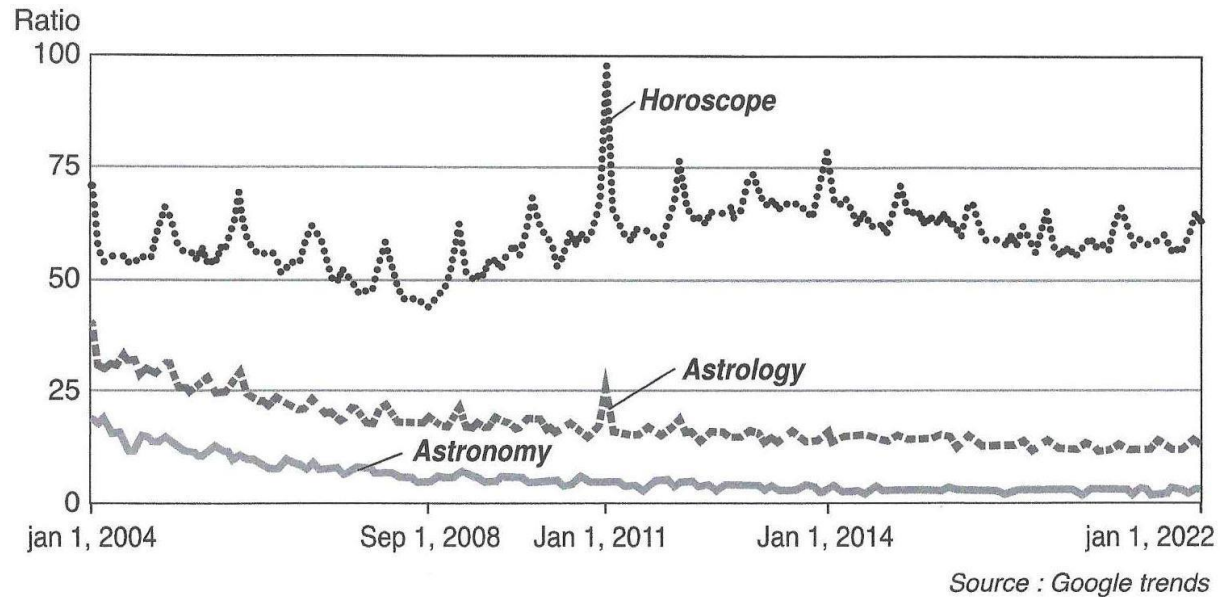


Figure 3.1. Change in search interest for “astronomy”, “astrology”, and “horoscope” in all countries since Jan. 1, 2004. Data source: Google Trends.

The first conclusion is that interest in horoscopes is three times as great as interest in astrology and ten times as great as interest in astronomy, showing the predominance of the first term in the current period. While the search interest for “horoscope” peaks every January, when users are looking for predictions for the year ahead, there have been few variations for the rest of the year since 2004: a dip from 54% to 45% between February 2004 and August 2008, followed by a slight upturn from September 2008 to 68% in April 2014, and a near-stagnation until August 2018. The pick observed for Jan. 1, 2011 is linked to the announcement of an horoscope change, all zodiac signs being shifted up by one position as the earth axis has shifted since the past 3000 years by precession, proposed but not accepted by many of the practitioners. The search interest for “astrology” declined slightly from 30% in February 2004

to 15% in August 2011 then stalled, with persistent January peaks, but less sharp than those for “horoscope.” The search interest for “astronomy” decreased from 18% to 4% in August 2011 then stagnated, but without January peaks.

It is also interesting to see the popularity of the terms “astrology” and “astronomy” on YouTube, the world’s most popular video site. The results are shown in figure 2.

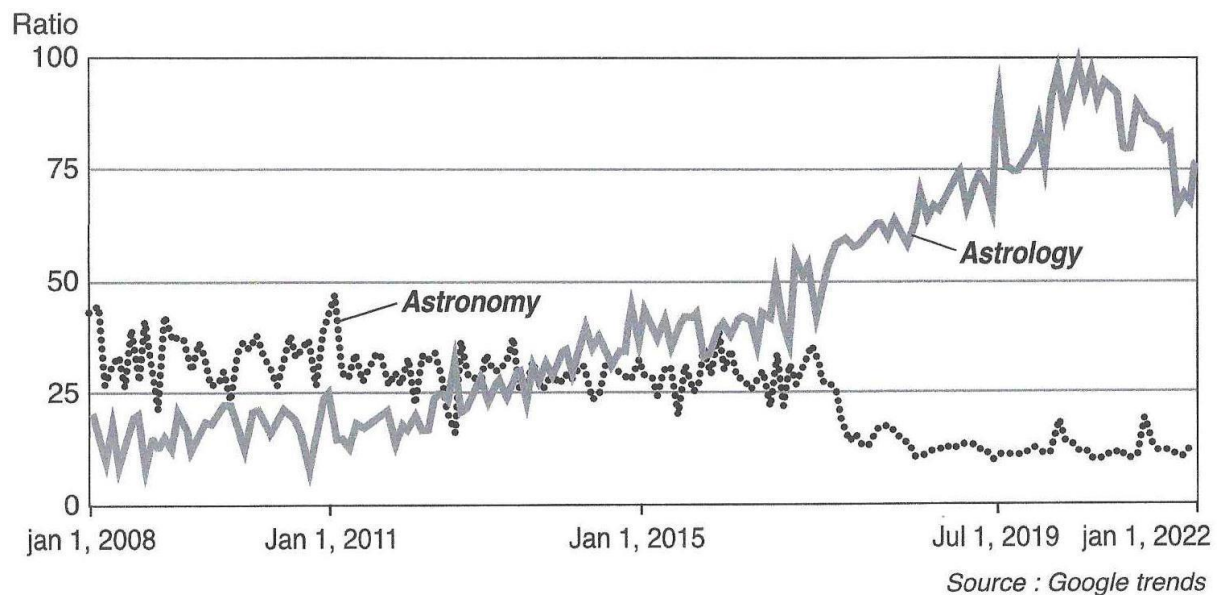
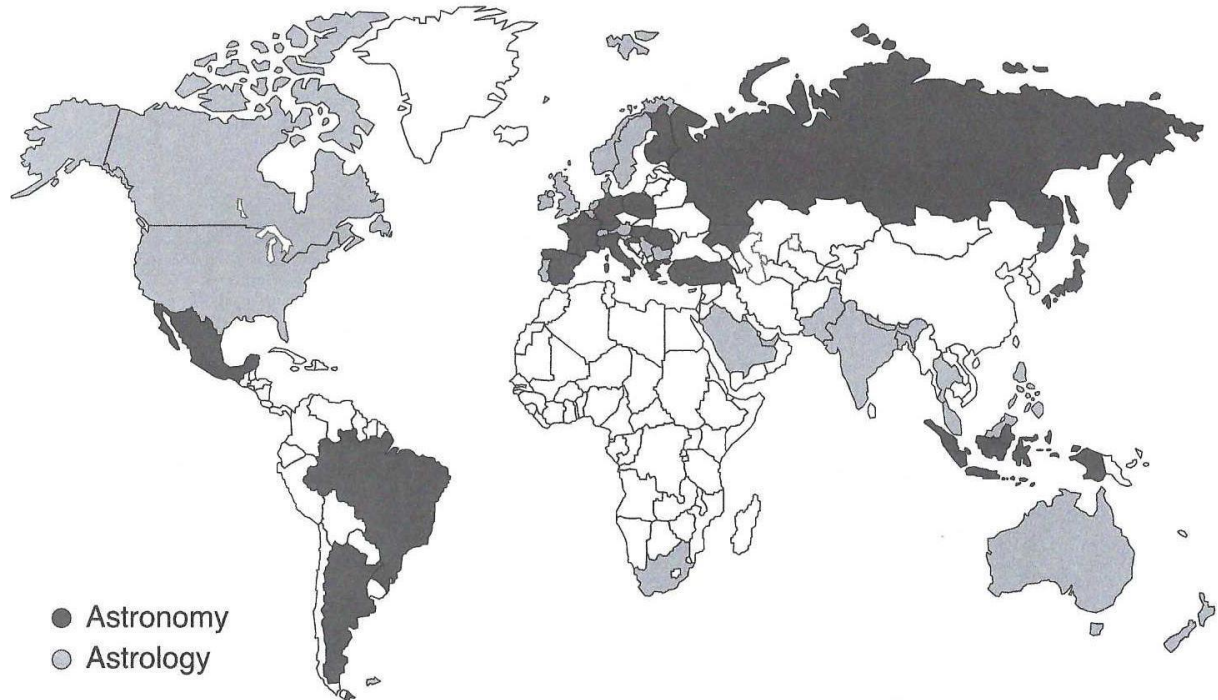


Figure3. 3.2. Change in search interest for “astrology” and “astronomy” on YouTube in all countries since Jan. 1, 2008. Data source: Google Trends.

The curve shows the contrasting change in the search for videos whose title contains one of the two words: a decline from near 40% in January 2008 to 10% in January 2022 for “astronomy,” versus a rise from 27% in January 2008 to near 100% in last years for “astrology”, with an intersection in mid-2013.

It is interesting to see the countries in which astrology predominates. Map 1 shows the distribution:



Source : Google trends

Map 3.1. Breakdown by country of search interest for astrology (grey) and astronomy (black.)

Data source: Google Trends.

Astrology ranks first in India, Nepal, Sri Lanka, the United Arab Emirates, Pakistan, and North America, while Europe (excluding the United Kingdom, Norway, and Sweden) and South America prefer astronomy.

We can conclude that if the belief in astrology and horoscopes remains very strong in all countries, it is stronger in North America, India, Australia and some other countries in the world. As noted earlier, it is even still taught in Indian universities.

How, then, can we explain this contradiction between the rejection of astrology and horoscopes based on scientific proof, and the persistent popular belief in the two?

To begin with, astrologers have developed highly effective communication resources, including: major, frequent international conferences, such as the United Astrology Conference (UAC), a five-day event that has attracted over a thousand astrologers from more than forty countries since 1986; numerous international organizations such as the International Society for Astrological Research; many training centers for young astrologers, of which more than 100 in the United States (see U.S. astrology classes: <https://www.findastrologer.com/astrology-education/local-astrology-classes/>); and, as noted earlier, websites offering not only numerous videos but also abundant information on astrologers and their qualifications.

Many sociologists and psychologists have also tried to understand the interest in astrology. Their studies, however, date from before 2005 and so, unfortunately, cannot shed light on the recent changes that we have documented with Google Trends.

A very detailed study was attempted by Daniel Bois and Guy Michelat (1986) and extended by Daniel Bois (2004-2005), who analyzes the results of twenty years of surveys on the subject in France. Bois finds no major change in belief over the two decades studied, and concludes that “supply and demand for parascience” remained “fairly constant” (Bois, 2004-2005, p. 59) during the period. However, we observed earlier that supply and demand have risen sharply worldwide since 2013. Lastly, examining the social groups most inclined to believe in these phenomena (women, young people, the middle classes, and the non-religious), Daniel Bois shows that the difficulty in mastering one’s future may be one explanation for such beliefs.

Bauer and Durant conducted a similar study in Britain in 1997. Their conclusion (p. 69) is very close to that of the French study:

It seems that in Britain, as in Germany or France, belief in astrology is prevalent among particular social groups which, as we have

indicated, may be experiencing difficulty in accommodating their religious feelings to life in an uncertain post-industrial culture. Paradoxically as it may seem, therefore, we conclude that popular belief in astrology may be part and parcel of late modernity itself.

They add that the belief in astrology is not due to mere ignorance but reflects a “deeper opposition both to the authority of science and to a certain conception of modernity” (p. 69).

A more recent study in the United States (Pew Research Center, 2009) offers another similar portrait of persons who believe more strongly than others in astrology: women, young people aged 18-29, the least educated, and the non-religious. The study adds groups that were not in the French and British surveys: Hispanics, African-Americans, Democrats, and liberals.

Thus, in both Europe and the United States, sociological analyses converge toward a very similar model before 2010. But has the model persisted? Only analyses using Google Trends hint at a possible change that will require deeper investigation by means of new sociological surveys.

3.5 Conclusion

In this chapter, we believe that we have provided a negative answer to the question “Can astrology predict a human life?”. Mesopotamian astrology allows a person to avert an outcome that, being ultimately not inevitable, is unpredictable. Even Hellenistic astrology, which the Stoics basically regarded as predictive, manages to foretell few events without the possibility of determining whether or not they have actually occurred. Lastly, statistical astrology, by its very definition, cannot predict any individual event, as Gauquelin clearly concluded.

In contrast, astronomy which was undistinguishable from astrology in ancient times, became independent of it during the Renaissance and acquired the status of a science with the works of Kepler, Newton, etc.

Chapter 4

Eugenics and the theory of inheritability

If our life cannot be read in the heavenly bodies that preside over our birth, could it be that our heredity consists of the book in which our fate is already partly written? That is what Galton (1822-1911) and his successors tried to demonstrate with eugenics. In this chapter we show the extreme misuses resulting from this conceptually flawed approach.

Eugenic research on heredity actually traces its roots to Galton's first cousin, Charles Darwin, whose *On the Origin of Species by Means of Natural Selection* (1859) provided the main inspiration. Darwin's theory of natural selection rests on a comparison between domesticated species and wild species. Its starting point is the observation of artificial selection by livestock breeders and farmers to obtain domesticated animal races or plants. Darwin deduces the existence of a natural selection operating on all living beings, which prompts him to state (p. 170):

Whatever the cause may be of each slight difference in the offspring from their parents—and a cause for each must exist—it is the steady accumulation, through natural selection, of such differences, when beneficial to the individual, that gives rise to all the more important modifications of structure, by which the innumerable beings on the face of this earth are enabled to struggle with each other, and the best adapted to survive.

The theory of the origin of species, which had a momentous impact on the science and culture of its time, was continuously elaborated later into a general theory of evolution. The focus of this chapter, however, is not evolutionary theory but eugenics. While we can draw a connection between the two despite their major differences, we shall not dwell further on the theory of evolution itself.

Galton read the first edition of *On the Origin of Species*, which he saw as opening up “an entirely new province of knowledge” (F. Darwin and S. Darwin, 1903, p. 129). His reading played a decisive role in awakening his interest in heredity. In an article published in 1865 on “Hereditary talent and character,” Galton returns to the comparison between domesticated species and wild species. He recognizes that, for domesticated species, the physical structure of future generations is controlled by the breeder’s objectives. He deduces that human physical, mental, moral, and intellectual characteristics must also be predictable and controllable. Galton supports his argument with many examples of heredity among scientists, writers, painters, musicians, chancellors, and others. He conceded that this does not constitute proper proof of his deduction (p. 158):

All that I can show is that talent and peculiarities of character are found in the children, when they have existed in either of the parents, to an extent beyond all question greater than in the children of ordinary persons.

However, this does enable him to set out the principle of what he later called eugenics (p. 319):

No one, I think, can doubt from the facts and analogies I have brought forward, that, if talented men were mated with talented women, of the same mental and physical characters as themselves, generation after generation, we might produce a highly bred human race, with no more tendency to revert to meaner ancestral types than is shown by our long established breeds of race-horses and fox-hounds.

Heredity can thus make it possible to predict the future of a lineage, just as astrology had made it possible to predict a person’s future, but in very different conditions. It is no longer a matter of observing

stars and planets, but of observing and acting upon lineages of human beings in order to have an effect on their descendants. But how should one go about this? That is the main problem posed by eugenics.

This initial text already discusses the notion that ancestral contributions are distributed in a geometrical series (p. 326):

The father transmits, on an average, one half of his nature, the grandfather one fourth, the great-grandfather one eighth; the share decreasing step by step, in a geometrical ratio, with great rapidity.

Galton elaborated on these points with great constancy in his later writings.

We begin by examining in fuller detail how eugenics took hold in the nineteenth century under Galton's guidance and developed throughout the first half of the twentieth century with the establishment of the Nazi and fascist regimes. Next, we look at the reasons for its apparent rejection after World War II and its transformation into a heredity-based theory aimed at controlling the growth and quality of the world population.

4.1 Galton establishes eugenics

After 1865, Galton committed himself to an intensive research program centered on heredity and set out to demonstrate its value by statistical means. In the process, he moved away from Darwin's thought—focused on the origin of species and natural selection—with the aim of theorizing heredity in statistical language.

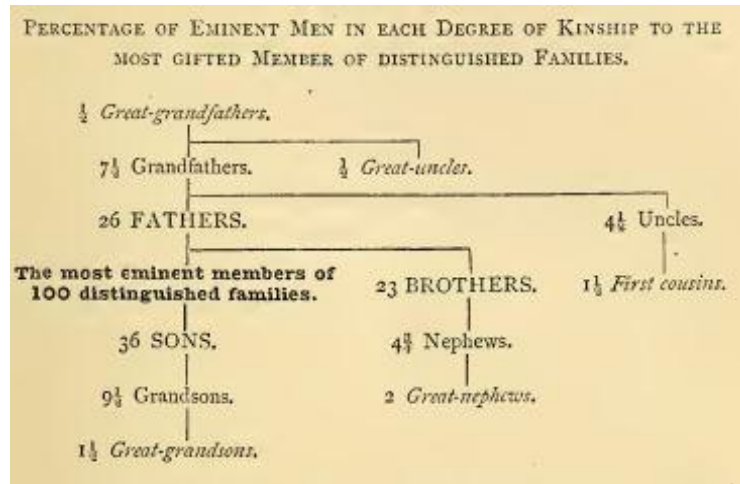
In 1869, he published *Hereditary Genius*. The first edition had little success, as he noted twenty-three years later in the "Prefatory chapter to the edition of 1892." Darwin, however, wrote a highly laudatory letter to Galton: "I do not think I ever in all my life read any thing more interesting and original ..." (Pearson, 1924, p. 6). While the hereditary transmission of human physical capacities was accepted at the time, there was little support for the

transmission of intellectual capacities. Even Darwin remained convinced that the main distinguishing criteria between human beings were “zeal and hard work.”

To demonstrate that intellectual capacities can be transmitted in the same way as physical capacities, Galton generalizes the mathematical law of the frequency of errors, which Quetelet (1846) had applied to human physical traits such as chest size and waist size. By analogy, Galton applies the law to human intellectual faculties such as talent and intelligence. He assumes that the statistical method appropriate for physical characteristics is valid for intellectual ones. The justification for this argument, however, is not very clear, as Galton himself recognizes in a later work (*Natural Inheritance*, 1889, p. 56):

It had been objected to some of my former work, especially in *Hereditary Genius*, that I pushed the application of the Law of Frequency of Error somewhat too far. I may have done so, rather by incautious phrases than in reality; but I am sure that, with the new evidence now before us, the applicability of that law is more than justified within the reasonable limit asked for the present book.

Pursuing this approach, he constructs a scale for each intellectual faculty measured by the reputation of the members of these classes, for example, their income or selections made by historians or critics. He then examines their relatives to determine the percentages of “eminent” kin at different degrees and thus show the transmission of their capacities. Figure 3.1 illustrates his findings for the ancestors and descendants of English judges since the Reformation.



Source: Galton, 1869, p. 83.

Figure 4.1. How the percentage of “eminent” members of the families of English judges decreases with the degree of kinship.

According to the table, 36% of their children are “eminent” versus 9.5% of their grandsons and 1.5% of their great-grandsons. By contrast, 26% of their fathers are “eminent” versus 7.5% of their grandfathers and 0.5% of their great-grandfathers. The geometric law predicted in Galton’s 1865 article is thus verified, but only approximately. And this study, too literary in its approach, is still far from providing a fully satisfactory statistical demonstration of the role of heredity in the transmission of intellectual characteristics.

In 1873, Galton published an article on “Hereditary Improvement” in which he further developed his theories. One of his proposals was that a society could be established to perform various scientific tasks such as surveys on human heredity or even maintain a register of eminent families. Darwin, while interested in the article, was rather skeptical about the society and the register (Pearson, 1930, vol. II, p. 176):

But the greatest difficulty, I think, would be in deciding who deserved to be on the register. How few are above mediocrity in health, strength, morals and intellect; and how difficult to judge on these latter heads.

Nevertheless, he remained convinced that “the object seems a grand one” and continued to engage in substantial correspondence with Galton until his death in 1882.

In fact, it was not until 1883 that Galton introduced the term “eugenics” in a work entitled *Inquiries into Human Faculty and its Development* (pp. 24-25):

[This book’s] intention is to touch on various topics more or less connected with that of the cultivation of race, or as we might call it, with “eugenic” questions, and to present the results of several of my own separate investigations.

In a footnote he indicates that the term is derived from that Greek *eugenes*, which means that the individual is “hereditarily endowed with noble qualities.” He proposes that individuals with “good” genes should be tested for these qualities and should be rewarded if they marry young and have children early.

To put this theory on a firm foundation, Galton developed the concepts of statistical regression and later of correlation in the 35 years after his 1865 article. We refer the interested reader to the chapter on “The English Breakthrough: Galton” in Stigler (1986). The author presents and discusses Galton’s statistical approach, whereas our focus here is its application to the eugenic doctrine.

In 1891, at the Seventh International Congress of Hygiene and Demography, Galton delivered a Presidential Address (1892) in which he set out a more detailed view of the doctrine without ever naming it. He clearly expressed his interest in the relative fertility of different social classes and “races.” Using the example of bees, where the workers are sterile, he envisaged the sterilization of the members of a human community of low social value. He concluded that the improvement of future human generations is largely, albeit indirectly, under our control. His call had little impact on the demographic community.

These same demographers, however, began to show concern for fertility by social class in the Sixth Session of the International Institute of Statistics in 1897. While standard statistics did not make it possible to classify population movements by social class, their

detailed existence for each urban quarter enabled Jacques Bertillon (1898) to characterize quarters by the degree of comfort of the majority of its inhabitants. He was thus able to compile a grid ranging from the poorest to the richest quarters for four major European capitals: Paris, Berlin, Vienna, and London. Comparing their total fertility rates (ratio of births to the number of women of reproductive age), he obtained table 3.1.

Classification.	Paris.	Berlin.	Vienna.	London.
Very poor quarters	108	157	200	147
Poor quarters	95	129	164	140
Comfortable quarters	72	114	155	107
Very comfortable quarters	65	96	153	107
Rich quarters	53	63	107	87
Very rich quarters	34	47	71	63
Average.....	80	102	153	109

Source: Newsholme and Stevenson, 1906, p. 66.

Table 4.1. Total fertility rates in the late nineteenth century for Paris, Berlin, Vienna, and London by degree of comfort of quarters

The results, which are fully consistent for all four capitals, show that the fertility of the richest quarters is approximately three times as low as that of the poorest quarters. A similar study (Newsholme and Stevenson, 1906) on London metropolitan boroughs conducted for the 1901 census yielded comparable results.

This evidence of fertility differentials led a growing number of persons to reconsider their attitude toward eugenics. Galton also took advantage of his findings to give fresh impetus to his theory at the turn of the century.

His first step was to found the journal *Biometrika* with Weldon and Pearson in 1901, for the initial purpose of providing a mathematical basis for Darwin's theory of evolution. Next, in 1904,

he sought to establish a laboratory with solid credentials to study eugenic issues. To this end, he set out to develop a fuller definition of eugenics, involving extensive discussions with University of London faculty members. The following definition was finally approved in October 1904:

The term National Eugenics is here defined as the study and the agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally.

We can easily see how this definition differs from the one provided in 1883, with the emphasis on “agencies under social control” and the goal of improving racial qualities of future generations.

Also in 1904, the Eugenic Record Office was established under Galton’s supervision; in 1907 it became the Francis Galton Eugenic Laboratory, headed by Karl Pearson (1857-1936). Thus did eugenics enter British academia, and many eugenics laboratories were set up in other countries as well. In 1904, Germany founded the first eugenics journal, the *Archiv für Rassen- und Gesellschaftsbiologie* (*Journal of Racial and Social Biology*). In 1909, the first issue of *Eugenics Review* was published by the Eugenics Education Society, founded in 1907 with Galton as its first president. The year 1909 also saw the founding of the Swedish Society for Racial Hygiene. In 1910, the Eugenics Record Office was established in the United States. Eugenics thus took root rapidly throughout the world.

Despite this success, we must now consider the dangers of such a doctrine, for Galton viewed it as new religion that must be introduced into the national conscience (Galton, 1905, p. 50). In the same article, he spelled out the more specific goal that he had in mind for it (p. 47):

The aim of eugenics is to bring as many influences as can reasonably be employed to cause the useful classes in the community to contribute more than their proportion to the next generation.

While he clearly defined his objective, he did not specify the means to attain it. As noted earlier, these “useful classes” were already the least fertile at the time. It is therefore hard to see how their fertility could increase given that it was linked to the birth control desired by those very classes and probably almost unknown to the poorer classes. The only means to lower the fertility of the poorer classes would be to give them access to birth control, but was it needed to ensure that their fertility rate would fall below that of the well-to-do classes? A final possibility might be to make the poorer classes sterile through means imposed by the rich.

Galton clearly envisaged the latter solution in his novel, *The Eugenic College of Kantsaywhere* (1911), first published on the centenary of his death in 2011. He describes a fictional society whose young citizens are tested to determine their place in society. The fittest must quickly choose a wife among the women having obtained the same grade in the exam and they must rapidly procreate. The least fit are forbidden to reproduce, and if they disobey the ban, they are cast out of the society. This scenario foreshadows the practices applied by Nazi and fascist regimes a quarter-century after Galton’s death.

The possible connections between Galton’s heredity theory and Mendel’s laws (1865) are also worth examining. First, it should be noted that Mendel’s laws were not rediscovered until 1900 by three European botanists: De Vries in Holland, Correns in Germany, and Von Tschermak in Austria. After 1900, there are few references to Mendel in Galton’s publications or correspondence. In a letter to Karl Pearson, he writes:

By the way I find that I have the honour of being born in the same year, 1822, as he was. (Pearson, 1930, p. 335)

Note the humor in this comment on their matching birth years, with no allusion to the importance of Mendel’s work. However, the very first volume of the journal *Biometrika*, founded by Galton in 1901, contains an article by William Weldon (1902) on Mendel’s laws—albeit highly critical as to their universal validity—followed by many others, mostly by Weldon, in later volumes.

It is worth taking a more detailed look at the controversy that lasted from 1900 to 1906, the year of Weldon's death, between "ancestrians" and "Mendelians" (Froggatt and Nevin, 1971). The "ancestrians" included Karl Pearson and Raphael Weldon, who supported Galton's "ancestral law of heredity," stating that ancestral contributions are distributed geometrically. Among the "Mendelians," William Bateson defended Mendel's laws, arguing that only the contributions of direct parents influenced children. In 1910, Bateson founded the *Journal of Genetics* with Reginald Punnett. Galton, who was 78 in 1900, stayed out of the dispute. The readers wanting to have a general view of definitions and genetic terminology may find them in the Annex of this chapter.

The controversy pitted two different approaches to genetics against each other. The "ancestrian" approach was based on a statistical regression analysis of a population. The aim was not to predict an individual's offspring, but to use a regression equation to link the presence of a character in an individual to its presence in ancestors of earlier generations. The geometrical series would then be roughly verified by observations. Weldon drew the following conclusion:

The degree to which a parental character affects offspring depends not only upon its development in the individual parent, but on its degree of development in the ancestors of that parent (Weldon, 1902, p. 248).

This is indeed a statistical distribution that does not imply an actual contribution of earlier generations. Moreover, it applies to continuous characteristics such as an individual's size.

By contrast, the "Mendelian" approach sought to predict the characteristics of the descendants of a given individual. This was an exercise not in statistics but in probability: what is the probability that a child will have a given characteristic that one of his two parents possesses? This enabled Bateson to respond to Weldon's article as follows:

The next step was at once to defend Mendel from Professor Weldon. That could only be done by following this critic from statement to statement, pointing out exactly where he has gone

wrong, what he has misunderstood, what omitted, what introduced in error (Bateson, 1902, p. viii).

Here, we are dealing with a probabilistic biological law that links a characteristic observed in a child to the same characteristic in its parents. The law is applied to binary data, as the individual does or does not possess the characteristic.

In reality, this was a dialogue of the deaf, with each participant using his own specific language—Weldon, the biometrician, with his statistical approach to populations; and Bateson, the geneticist, applying his individual approach and using a simple probabilistic language with no knowledge of the mathematics employed in statistics. Their exchanges continued until Weldon's death in 1906.

Other voices, however, attempted to establish a potential convergence between the two approaches. In 1902, Yule sought to show that they could not be totally inconsistent—as Bateson claimed—but he failed to provide a perfect demonstration. In 1904, Pearson admitted that Mendel's laws and Galton's Ancestral Law of Heredity were not necessarily contradictory. But it was not until 1918 that Fisher tried to merge them, although he laid down axioms that needed to be verified for that purpose. We examine his approach in greater detail in the following section.

4.2. Development of eugenics in the first half of the twentieth century

In 1912, a year after Francis Galton's death, the First International Eugenics Congress was held in London. Dedicated to his memory, it was attended by more than 400 persons from all over the world, under the chairmanship of Major Leonard Darwin, Charles Darwin's son. In his presidential address, he stated that the main goal of the Congress was to promote the improvement of the "race," for natural selection was incapable of doing so. He cited the example of the

United States, where eight states had already passed laws allowing or requiring sterilization of certain categories of individuals.

Ronald Fisher (1890-1962) joined the Eugenics Education Society in 1910. In 1914, he published an article in *The Eugenics Review* expressing his hopes as a eugenicist, and, in 1918, an important article in which he interpreted Galton's biometrical results with the aid of Mendel's laws.

To arrive at a more accurate analysis of the causes of human variability, he formulated the following assumptions: (1) there are polygenes that act additively; (2) they segregate independently; (3) the influence of the environment is unrelated to that of genes; (4) the population is in Hardy-Weinberg equilibrium, i.e., with no inbred individuals, migration, mutation or selection; (5) to simplify the algebra, the number of polygenes is supposed infinite.

Each of these assumptions allows the variance of a phenotypic trait ($Var P$) to be decomposed into additive parts. A more detailed demonstration is provided in Vetta and Courgeau (2003, p. 406), yielding the following formulation:

$$Var P = Var G + Var E = Var A + Var D + Var E \quad [1]$$

where $Var G$ is the genetic variance, decomposed into its additive part $Var A$ and its dominance part $Var D$. $Var E$ is the environment variance. Obviously, if assumption (3) does not hold, we need to add an interaction and a covariance term between the effects of genes and of the environment. This will preclude an additive formulation.

On the same assumptions, we can define "heritability in the narrow sense":

$$h^2 = \frac{Var A}{Var P} \quad [2]$$

and "heritability in the broad sense":

$$H^2 = \frac{Var A + Var D}{Var P} \quad [3]$$

While these notions were used previously with somewhat different meanings,⁴⁴ the concept of heritability was spelled out more precisely by Lush (1936), and animal and plant breeders started to use the “narrow” and “broad” definitions. However, even Lush (1949, p. 373) found that the estimates of heritability were surprisingly high:

If breeders have been selecting intensely and if heritability is as high as these estimates, the breed average should have been improving rapidly for many generations and should still be doing so. But the actual evidence does not indicate improvements that rapid. Admittedly the evidence on the actual rate of improvement is scanty.

These breeders tried to verify some of Fisher’s assumptions in their tightly controlled animal or plant experiments, where subjects with different genotypes can be provided with a near uniform environment, allowing a prediction of responses to selection (Crusio, 1990; Visscher et al., 2008). However, given the complexity of the underlying gene action, such analysis had not gone beyond the black-box level (Hill, 2010), and the non-verification of Fisher’s other assumptions could lead to incorrect results.

Part 3 will examine how Fisher’s theories were taken up and expanded by behavior genetics in the 1970s.

After this presentation of Fisher’s article and its direct impact on research in population genetics, let us return to the development of eugenics after World War I.

The Second International Congress of Eugenics was held in New York in 1921 under the chairmanship of Henry Osborn (1889-1961), who played a major role in the dissemination of eugenic ideas. Fisher, one of the many attendees, gave three papers. At its close, the Congress adopted a resolution calling for an international organization, which was eventually founded in 1925: the International Federation of Eugenics Organizations (IFEEO), headed by the American Charles Davenport. That same year, Davenport wrote a letter to Professor Hansen in which he stated:

⁴⁴ See Jacquard (1983) for the different usages of “heritability.”

But, alas, for the criminalistic and the degenerates, since it seems to be impracticable to put them all on ships and keep them traveling back and forth on the Atlantic Ocean thru the rest of their lives, I see no way out but to prevent breeding them (Davenport, 1925, p. 1).

He was thus advocating the elimination of the unfit from the population through measures such as forced sterilization and laws to prevent their reproduction.

The German eugenicists, who had not been invited to the Congress, nevertheless continued to publish. In 1921, Erwin Baur (1875-1933), Eugen Fischer (1874-1967), and Fritz Lenz (1887-1976) published *Grundriss der menschlichen Erblchkeitslehre und Rassenhygiene* (Principles of Human Heredity and Racial Hygiene). The notion of “race”—rejected by most researchers today—is discussed at length, and the book already praises the “Nordic race.” In 1924, after French forces withdrew from the Rhineland, the Germans rejoined international discussions on eugenics.

Eugenic practices became increasingly politicized in the 1920s.

In the United States, for example, the Eugenics Record Office—founded in 1910, as mentioned earlier—set out to organize and perform eugenic research with a view to informing lawmakers, judges, and government officials. In 1921, Harry Hamilton, its Assistant Director, published a very detailed study of sterilization laws now enacted in eighteen states, up from eight in 1911. By 1937, thirty states had laws on mandatory sterilization. In the same period, similar laws were passed in many other countries including Mexico and Argentina in the Americas, and Germany, Denmark, Norway, Finland, and Sweden in Europe.

In Italy, Corrado Gini (1884-1965) founded the Società Italiana di Genetica e Eugenica in 1919. After Mussolini assumed full powers as head of government of the Kingdom of Italy in 1925, Gini was able to play a hegemonic role in Fascist eugenics. At the International Congress of Eugenics in Rome in 1929, Davenport and Eugen Fischer wrote a memorandum to Mussolini urging him to implement eugenics at “maximum speed” because of the

“enormous” risk that undesirable reproduction might run out of control (Sprinkle, 1994, p. 91). It was not until 1938, however, that *Il Giornale d'Italia* published the “Manifesto degli scienziati razzisti” (Manifesto of Racist Scientists), defining race as biological concept and announcing the existence of a pure “Italian Race” of Aryan descent, from which the Jews were excluded (Casetti and Conca, 2015, p. 107). This text, prepared at Mussolini’s request, led to a series of racial laws, particularly against the Jews, and their deportation to concentration camps.

More insidiously, Margaret Sanger (1879-1966) founded the American Birth Control League in New York in 1921 for the purpose of promoting the dissemination of contraceptive methods. But in an article published the same year, she added other goals:

We need one generation of birth control to weed out the misfits, to breed self-reliant, intelligent, responsible individuals. Our migration laws forbid the entrance into this country of paupers, insane, feeble-minded and diseased people from other lands. Why not extend the idea and discourage the bringing to birth these same types within our borders. Let us stop reproducing and perpetuation [sic] disease, insanity and ignorance (Sanger, 1921, p. 1).

This comes very close to the eugenic objectives regarding misfits that Galton advocated in his utopian college of Kantsaywhere.

In 1925, Sanger organized the sixth International Neo-Malthusian and Birth Control Conference in New York, which included sessions on the “eugenic racial and public health aspect” (the first conference had been held secretly in Paris in 1900 because of the French government’s ban on all forms of birth-control advocacy). The event also allowed her to spell out her action in favor of negative as against positive eugenics. Negative eugenic actions are targeted at persons who should not procreate, whereas positive eugenic actions aim to encourage those who should reproduce more. At the end of the Conference, the eugenicist Roswell Johnson (1877-1967) introduced the following resolution:

Resolved, that this conference believes that persons whose progeny give promise of being of decided value to the community should be

encouraged to bear as large families, properly spaced, as they feel they feasibly can (Sanger, 1925, p. 163).

This explicitly positive resolution was adopted, but soon elicited comments and criticism in the U.S. and British press. Sanger responded with an editorial (1925) specifying that, while the American Birth Control League was in favor of population control—i.e., negative eugenics—it could not accept the resolution. Sanger explained that it was difficult for the League to predetermine individuals whose progeny could be valuable to society, or even to offer advice to adults capable of making their own decisions.

The coming to power of the Nazis in Germany consecrated the coalition of eugenicists and political leaders. Significantly, Germany had been the first country to publish a *Journal of Racial and Social Biology*⁴⁵ in 1904, and to establish a Society for Racial Hygiene in 1905.⁴⁶ A further step was taken in 1927 with the establishment of the Kaiser Wilhelm Institute for Anthropology, Human Heredity and Eugenics⁴⁷ in Dahlem, headed by Fischer, the German eugenicist previously cited. At the time, however, Fischer stated that the concept of race studies (*Rassenkunde*) should be treated in a scientific manner, independently of all other considerations. Meanwhile, the stock-market crash of 1929 and its dramatic repercussions on the labor market both in the U.S. and Europe (by 1933, one-third of the German working population was unemployed) brought Hitler to power on January 30, 1933.

By July 1933, the meeting of the Kuratorium (Board of Directors) of the Kaiser Wilhelm Institute “sealed the Faustian bargain between the Dahlem director and the Nazi state medical bureaucracy” (Weiss, 2010, p. 70). The agreement served as the basis for the Law for the Reestablishment of the Professional Civil Service and the Law for the Prevention of Genetically Diseased Offspring.⁴⁸ The two laws banned all non-Aryans, particularly Jews,

⁴⁵ In German: *Archiv für Rassen- und Gesellschafts-Biologie*.

⁴⁶ In German: *Deutsche Gesellschaft für Rassenhygiene*.

⁴⁷ In German: *Kaiser-Wilhelm-Institut für Anthropologie, Menschliche Erblehre und Eugenik*.

⁴⁸ In German: *Gesetz zur Wiederherstellung des Berufsbeamtentums* and *Gesetz für Verhütung erbkranken Nachwuchses*.

from all civil-service positions in Germany and allowed the forced sterilization of persons declared unfit by so-called racial hygiene experts, without possibility of appeal. As a result, ten million medical-genetic case files were prepared in 1,100 Health Offices by 2,600 government-employed doctors, assisted by 10,000 other physicians (Bock, 1986). One million citizens were singled out for sterilization and their cases processed by 205 Hereditary Health Courts.⁴⁹

In 1935, two even more coercive laws were adopted in Nuremberg: the Law of the Reich Citizen⁵⁰ stripped all non-Aryans of German citizenship, and the Law for the Protection of the German Blood⁵¹ prohibited unions or sexual intercourse with non-Aryans. While the term “non-Aryan” notably targeted Jews, the laws also applied to Poles, Czechs, Romani (gypsies), and other Slavs. This paved the way for the Shoah, which exterminated over five million Jews; Aktion T4, involving the extermination of nearly 250,000 physically and mentally handicapped persons; the Porajamos, which exterminated almost 500,000 Romani; and other actions. There is no need here to dwell on the horror of these exterminations, but it is important to stress that all were carried out in the name of eugenics.

Eugenics also had a powerful influence on the social sciences between the wars—most notably demography, our focus here.

The International Union for the Scientific Study of Population Problems (IUSSPP) was founded in 1928 (it became in 1947 the International Union for the Scientific Study of Population: IUSSP). Both its officers and its first congresses were clearly influenced by eugenicists. Corrado Gini—an ardent supporter of Mussolini’s fascist regime, as noted earlier (Cassata, 2006)—was vice-president of the IUSSPP.

In 1935, the IUSSPP held its congress in Berlin under the chairmanship of the eugenicist anthropologist Fischer, mentioned previously. German biologists used the venue to promote extreme eugenic theories in 59 of the total 126 papers presented.

⁴⁹ In German: *Erbesundheitsgerichte*.

⁵⁰ In German: *Reichsbürgergesetz*.

⁵¹ In German: *Gesetz zum Schutze des Deutschen Blutes und des Deutschengesetz*.

At the following congress, held in Paris in 1937, all papers containing elements of the radical Nazi doctrine were grouped together in the same section with papers from a few other participants opposed to it. The proceedings were published as *Problèmes qualitatifs de la Population* (UIESP, 1938). The German-American anthropologist Franz Boas (1938, p. 83), who was of Jewish origin, responded clearly:

Lack of clarity in regard to what constitutes a type is the cause of the incredible amount of work produced for more than a century, but particularly by modern race enthusiasts.

This did not prevent German researchers, in their report on the congress, from stating that they had totally refuted the allegations by Jewish participants thanks to what they called the “sword of our science”⁵² (Weiss, 2005, p. 5). Also in the same section, new measures were proposed by the American Frederick Osborn (1938, p. 117), which exactly anticipated what would become behavior genetics:

We are also beginning to determine scientifically the extent to which psychological differences are due to external circumstances or, on the contrary, to genetic factors. At present, the latter seem to be the more influential.

He drew his conclusions from an examination of differences in intelligence between individuals from different social groups. He compared differences between individuals in the same group with differences between group averages. The demonstration is hardly convincing, but the basic idea is indeed there.

To sum up, after Galton’s death eugenics spread across the world and led to the extermination of millions of people in the name of improving humanity. This tidal wave would appear to have died out at the end of World War II with the surrender of the fascist and Nazi regimes. In the next part, however, we shall see that this was not the case and that eugenics has continued to hold even greater sway, although it is no longer explicitly invoked.

⁵² “das Schwert unserer Wissenschaft.”

4.3 A new face for eugenics

The postwar years were marked by swift progress in public health, unfortunately not always followed by an equivalent economic progress. As Alfred Sauvy noted:

[...] it is easier to produce a serum to save one million people than to provide food for them afterward (Sauvy, 1948, p. 10).

The discovery of the insecticide properties of DDT (Dichlorodiphenyltrichloroethane)—tested by the Allied armies during the war to control malarial- and typhus-carrying insects—led to spectacular results. Released on the market in 1945, it allowed the eradication of malaria in several countries. For example, in Ceylon (now Sri Lanka), the number of malaria cases plunged from nearly three million in 1946 to only 29 in 1964 thanks to DDT spraying, raising hopes that the battle against malaria had been won (Tren and Bate, 2001, p. 36). Many countries in Europe, North America, Asia, and Africa recorded similar results, leading the World Health Organization (WHO) to launch a malaria eradication campaign in 1955 chiefly based on the use of DDT. The campaign ended in 1969 after doubts emerged regarding its impact on wildlife. We shall return to this interruption, which had disastrous effects on the evolution of malaria. The relevant point here is the growth in world population not only in capitalist and communist countries but especially in the underdeveloped Third World countries, as Sauvy defined them in 1952:

The underdeveloped countries—the Third World—have entered a new phase. Some medical techniques can be introduced rather quickly, for a major reason: their low cost. An entire region of Algeria was treated with DDT against malaria: the cost was 68 francs per person. Elsewhere, as in Ceylon and India, similar results have been recorded. For a few cents, a man's life is extended several years. These countries thus register our mortality rate of 1914 and our birth rate of the eighteenth century. [...] For this Third World too—ignored, exploited, and scorned like the Third Estate—wants to exist at last (Sauvy, 1952, p. 14).

This unprecedented population growth in what were then referred to as Third World countries—now renamed developing countries—enabled American eugenicists to re-establish their prominence. At the Third International Conference on Planned Parenthood in Bombay in 1952, Sanger created the International Planned Parenthood Federation (IPPF), aimed at extending to the Third World the goals of the American Birth Control League, discussed earlier. Now, however, the underlying objective was to counter the population growth entailed by medical methods. Back in 1950, Sanger had already stated (Lasker Award Address, p. 3):

We have gone far in the field of preventative medicine, let us now have a little preventative politics and a system of thinking that will probe to the roots and heart of this human problem.

The IPPF promoted family planning “for those who need it most,” a phrase that eluded the question of whether the need was felt by the individuals themselves or by those who knew better than them (Connelly, 2006, pp. 221-222.). That same year, the Indian Premier, Nehru, submitted to his parliament the first world plan to limit his country’s population.

At the IPPF’s Fifth Conference in Tokyo in 1955, Pincus, contacted by Sanger in 1950, announced the possibility of the first oral contraceptive pill, which was being tested on mammals. The drug, called Enovid, was then tested on 123 women living in Puerto Rico, for such tests were banned and punishable by law in many U.S. states. However, many women dropped out of the program during the tests, leading Pincus—in an effort to sway the Food and Drug Administration (FDA)—to claim that the test had covered 1,279 cycles, with no mention of contraceptive effects. The FDA approved Enovid in 1957 for use in treating menstrual disorders. The true purpose, however, was contraception. In 1959, Enovid was re-submitted to the FDA but this time for birth control. Eight hundred women had been enrolled in tests but only 130 took the pill for a year or more. The FDA conducted a survey among 61 doctors, of whom 36 approved the pill, 14 admitted lacking sufficient experience, and 21 rejected it (Eig, 2014). Despite this low endorsement rate, the FDA approved its use in May 1960. It was rapidly distributed in the U.S. despite opposition from the Catholic

and Protestant churches; its dissemination was slower in Europe and very limited in the Third World, most notably because of its cost. Soon after the FDA decision, the IPPF informed Pincus that it would no longer fund his research. The pill, which Sanger had intended as a means to decrease fertility in poor countries, ended up being used mainly in the developed countries.

The Population Council was founded by John Rockefeller III⁵³ in 1952, and Osborn—the eugenicist discussed earlier—was its president in 1957-59. The institution played a key role in the initial programs to limit the number of births—i.e., what has come to be known as birth control. As Osborn later wrote, in 1968 (p. 104): “Eugenics goals are more likely to be attained under a name other than eugenics.” Poverty and the fact of living in a Third World country would replace the “dysgenic qualities of body and mind.” Rather than allow these countries to achieve economic takeoff, the Population Council sponsored a vast campaign to restrict their fertility. It worked with the IPPF to launch large-scale programs to implant intra-uterine devices (IUDs) and perform vasectomies in India, Pakistan, South Korea, and Taiwan. These sterilizations were very inexpensive but were often carried out without the interested parties’ clear consent, for example after giving birth, or in exchange for payment.

The United Nations Population Fund (UNPF) was established in 1969 with Rafael Salas as director. Salas had been the Executive Secretary of the Republic of the Philippines under President Marcos. His leadership of the new international institution came under strong criticism. In particular, when China introduced its one-child policy in 1979, the UNPF granted an initial subsidy of \$50 million for 1980-1984 to help the Chinese government develop its population policy, for “the new 1979 Constitution explicitly advocates and promotes family planning” (UNPF, 1980, p. 3). In 1983, it awarded one of its first two United Nations Prizes for Population to the Chinese family planning minister, Qian

⁵³ The Rockefeller Foundation supported eugenics research in Germany in the 1920s and continued to do so when the Nazis came to power.

Xinzhong.⁵⁴ It is no longer necessary to point out that the coercive birth control measures enforced by Chinese policy were a new massacre of the innocents (Aird, 1990).

The main goal of all these newly created international institutions was to reduce fertility in Third-World countries, regardless of whether the local population wanted to or not, and without envisaging their economic development as a means of curtailing their population growth. But another approach could be considered to reduce and even halt that growth: it would consist in not allowing the dissemination of the medical methods that had previously extended the lives of their inhabitants. In 1968, Ehrlich proposed this solution in his book *The Population Bomb* (p. 17):

[...] there are only two kinds of solutions to the population problem. One is a “birth rate solution,” in which we find ways to lower the birth rate. The other is a “death rate solution,” in which ways to raise the death rate—war, famine, pestilence—*find us*. The problem could have been avoided by population control, in which mankind consciously adjusted the birth rate so that a “death rate solution” did not have to occur.

Ehrlich was thus admitting that international organizations had failed to reduce the fertility of Third-World populations. Even if some readers may think that in the last sentence Ehrlich is making a contingent prediction, setting out a default (if we fail to limit population growth by lowering fertility, it will be limited by rising mortality), other ones may think that such a sentence may permit a “death rate” solution, as the ban adopted in 1972 to reduce the use of DDT, as shown below. In this case, his proposal would not only deny them access to medical methods but also revive all the scourges that had afflicted humanity in the past. This was indeed a new form of eugenics even worse than what Galton had envisaged: the goal was no longer to eliminate the unfit, but to eliminate as many Third-World people as possible, on the grounds that they were unfit for our living conditions.

⁵⁴ The second prize was awarded to the Indian Premier Indira Gandhi, whose government tightened mandatory birth control procedures, including sterilization.

The implementation of this second solution required a certain number of actions, particularly involving the WHO, in order to stop the distribution of effective medicines in the Third World. Ehrlich clearly indicated that this could concern DDT. The insecticide had already come under attack in the U.S. In her book *Silent Spring* (1962), Rachel Carson had criticized the use of DDT despite the fact that it had already allowed the eradication of malaria in the southern U.S. and southern Europe, and had reduced its impact on mortality in many Third-World countries. She questioned its harmlessness and claimed that its effects persisted for long periods after spraying, that it was carcinogenic, and that it accumulated in the fat of animals consumed by humans. But she offered scant evidence to support these accusations.

The tremendous impact of Carson's book on public opinion led the WHO to end its DDT-based malaria eradication campaign in 1969. In 1972, the new Environmental Protection Agency (EPA) in the U.S. banned the use of DDT, regarding it as toxic for humans and restricting its use to emergencies. The ban was soon adopted by other governments and heavily reduced the use of DDT for combating malaria.

The WHO turned to other methods, but they proved far less effective than DDT. In particular, pesticides such as methyl parathion—approved by the EPA in 1972 as a DDT substitute—were finally recognized as extremely dangerous in 1999. By the mid-2000s, several African countries reversed their policy with regard to DDT. For example, the government of Mozambique reauthorized the use of DDT in July 2005. It was not until 2006 that the WHO accepted DDT once again as a means to fight malaria:

Nearly thirty years after phasing out the widespread use of indoor spraying with DDT and other insecticides to control malaria, the World Health Organization (WHO) today announced that this intervention will once again play a major role in its efforts to fight the disease. WHO is now recommending the use of indoor residual spraying (IRS) not only in epidemic areas but also in areas with constant and high malaria transmission, including throughout Africa (WHO, 2006, p. 1).

Estimates of mortality due to malaria have varied considerably—from 655,000 for the WHO (2010) to 1.2 million for the Institute for Health Metrics and Evaluation (IHME). Despite this uncertainty, an article by Murray et al. (2012) offers a confidence interval for estimating the figure. World deaths due to malaria rose from 995,000 in 1980, the first year of their study (with a 95% confidence interval ranging from 711,000 to 1,412,000), to a peak of 1,817,000 in 2004 (with a 95% confidence interval ranging from 1,430,000 to 2,366,000). In 2005, the curve started to move downward, reaching 1,238,000 in 2010 (with a 95% confidence interval ranging from 848,000 to 1,591,000). Since then, it has declined continuously. It would be hard not to view this as a change in attitude toward policy with regard to the Third World, as Murray et al. clearly state (p. 428):

Our findings also signal a need to shift control strategies to pay more attention to adults—eg, they lend support to the strategy of universal coverage of insecticide-treated bednets among household members rather than focusing on women and children as was the case in the initial distribution campaign.

The authors, however, fail to explain how a policy of abandoning insecticides, including DDT, could have lasted thirty-three years from 1972 to 2006, despite the fact that it was the only method capable of preventing millions of malaria-induced deaths in Third-World countries (Roberts et al., 2010).

As regards scientific research, a new discipline—behavior genetics—emerged with the article by Jinks and Fulker (1970), although earlier publications already named it (Fuller and Thompson, 1960) but without supplying its foundations. The discipline rests on all of the hypotheses and concepts formulated by Fisher 1918 (see §3.2), applied to human populations. The year 1970 also saw the founding of the Behavior Genetics Association and its journal *Behavior Genetics*, inaugurating a flood of papers and books on a number of psychological or medical traits such as intelligence measured by IQ, personality, alcoholism, smoking, homosexuality, obesity, soda or fruit juice intake, and so on.

While we can control some or all environmental effects in plant and animal experiments, we cannot do so in human populations. As a result, Fisher's third assumption is not satisfied. However, Jinks and Fulker (1970) devised a method for measuring this genetics/environment (GE) interaction, which enables us to use heritability models for human populations. Eysenck (1973, p. 5) wrote that this paper "is the corner-stone on which any future argument about heritability may be based"; Hewitt, in his obituary of Fulker (1998, p. 165) regards it as "one of the most influential methodological papers in human behaviour genetics."

Let us see whether Fisher's assumptions still hold after 1970.

Most of the models used by behavior geneticists derive from variants of the analysis of variance by Jinks and Fulker. They had been applied mainly to twin data but may be generalized for general genetic relatedness. For example, Kohler et al. (1999, p. 260) write:

In this article we primarily follow the regression approach, for which the term DF analysis (after DeFries and Fulker 1985) has been coined, and the extension of this approach to probit and tobit models.

They use such an approach to analyse Danish twin data on fertility for 1870-1910 and 1952-1954 birth cohorts. Their analysis leads them to estimate such values as heritability in the narrow sense (h^2), the ratio of dominance to total phenotypic variance ($H^2 - h^2$), and the ratio of shared-environment variance to total variance. We have already criticized their approach to the heritability of fertility (Vetta and Courgeau, 2003). Let us recall our main objection.

Their analysis ignores assortative mating because they claim to have no information on it: in fact this coefficient between husband and wife must be nearly 1 (the "nearly" takes care of infidelity). For a population in Hardy-Weinberg equilibrium there should thus be no filial regression, and for a population far from genetic equilibrium this will create a complex problem. In any case, the standard twin model used for heritability analysis, based on Fisher's assumptions, is unsuitable for fertility analysis. Unfortunately this model is now used in most biodemographic analyses of fertility.

For other demographic phenomena, such as mortality or migration, a standard twin model may be used without our earlier objection. In this case, however, Vetta (1981) pointed out that there is an algebraic error in Jinks and Fulker (1970) and that when this error is corrected their method is not valid (Capron et al., 1999⁵⁵). In the rest of their paper, Jinks and Fulker used correlations between relatives and environmental effects given by Fisher (1918), under assortative mating. Fisher's formulae, however, are not correct (Vetta, 1976). As human populations mate assortatively, the concept of heritability cannot be applied to them, so that Fisher's fourth assumption will not hold.

More generally, we can state that heritability estimates have no value for human populations, for which we cannot always control environments or levels of genetic variation by experimental means.

Despite Plomin's assertion (2001, p. 1104) that "the genetics of behavior is much too important a topic to be left to geneticists," he oddly uses models devised by geneticists such as Fisher and Jinks, whose hypotheses now need to be tested.

Aschard et al. (2012), while adding a broad range of hypothetical GE interactions, finally show that genetic information does not improve risk predictions for complex diseases.

The DNA structure was discovered by Watson and Crick in 1953. By 1960, biologists believed that humans might have two million protein-coding genes (Kauffman, 1969). However, the Human Genome Project eventually found only 19,797.⁵⁶ That number is well below that of rice, whose genome has 50,000 genes, as do many simpler organisms. Let us see in greater detail how this research affects Fisher's hypotheses.

⁵⁵ In their paper, Capron et al. state that Vetta found this error in 1974 and discussed it with Jinks, who acknowledged it. However, the editor of the *Psychological Bulletin*, in which the Jinks and Fulker paper originally appeared, refused to publish the correction. It was eventually included as an appendix to Hirsch (1981) and later in Capron et al. 1999.

⁵⁶ This figure is provided, for example, in <http://fr.slideshare.net/GenomeRef> (as of 2015).

First, the polygenic hypothesis assumes that a trait is determined by a large number of polygenes either uniquely or in combination with polygenes associated with another trait. However, the human characteristics studied by behavior genetics are innumerable—including fertility, nuptiality, longevity, intelligence, personality, homosexuality, alcoholism, femininity, autism, manic depression, aggression, happiness, spatial and verbal reasoning, criminal behavior, obesity, vote choice, political participation, and so on. It is therefore implausible that they could be linked to such a small number of genes. Similarly, the human body produces well over a million proteins. The polygene hypothesis cannot explain this with only 20,000 genes. Therefore, Fisher's assumption (5) is not satisfied. Most crucially, Fisher did not know that genes are grouped together in 23 pairs of chromosomes: in meiosis (cell division), two characteristics undergo segregations that are either independent, if they are controlled by genes located on two distinct pairs of chromosomes, or totally linked, if they depend on genes located on the same pair of chromosomes. In reality, exchanges can occur between two chromatids, and genes can recombine. It can no longer be argued, therefore, that polygenes act independently (assumption 1), subject to independent segregation (assumption 2). Their transmission is thus impossible to quantify. As we have already seen that assumptions (3) and (4) are not verified, we can conclude that none of Fisher's assumptions is verified. As Gottlieb (2001, p. 6125) clearly states:

[...] it is now known that both genes and environments are involved in all traits and that it is not possible to specify their weighting or quantitative influence on any trait, [...] this has been a hard-won scientific insight that had not yet percolated to the mass of humanity.

In other words, the use of the concept of heritability linked to Fisher's assumptions leads to a dead end.

However, behavior geneticists remained silent about these criticisms and kept making the same errors. Not even the advent of the genomic era reduced their audience. Rodgers et al. (2001, p. 187) had this to say about human fertility:

[...] the molecular genetic and behavioural genetic research lead to the same conclusions [...] In the future, the important theoretical questions in this arena may well merge from the human genome project.

Many papers have been published in recent years using classical twin studies⁵⁷ and genomic methods simultaneously (Van Dongen et al., 2012). These genomic studies try to link specific human behaviors with specific genetic markers. For example, genome-wide association studies (GWASs)—which define genomic regions associated with individual traits or complex diseases—have identified “around 2,000 robust associations with more than 300 complex diseases and traits” between 2006 and 2013 (Manolio, 2013, p. 549). These studies were designed to demonstrate the links between DNA and human traits and behaviors. However, as Manolio explained:

[the] initial euphoria [...] has dimmed somewhat with the recognition that GWAS-defined loci explain only a very small proportion of different traits’ heritability, [and] they have met considerable skepticism regarding their clinical applicability.

Moreover, when large numbers of genetic markers are screened, there is a high risk of false positive associations.

To deal with the problem of missing heritability, a genome-wide complex trait analysis (GCTA) was developed more recently. It scans the genomes of thousands of unrelated persons in order to see if those who are concordant for a trait share more single nucleotide polymorphisms (SNPs) than those who are not concordant. It can therefore estimate the proportion of trait heritability that can be attributed to shared SNPs. These studies show that twin studies yield higher heritability estimates than GCTAs. For example, a twin study of “callous-unemotional” behavior finds a heritability of 64% compared with a GCTA finding of only 7%—a non-significant figure given the sample size (Viding et al., 2013). Many GCTA-based studies even yield null heritability estimates. Similarly, heritability estimates based on structural

⁵⁷ Twin models may be extended to other relatives, such as parents, siblings, spouses or offspring.

equation modeling (SEM) produce estimates that are of the same magnitude as SNP-based estimates and largely below the values obtained using classical twin studies (Munoz et al., 2016). In fact, they suffer from serious methodological problems and generate faulty estimates of the genetic contribution to variation in the majority of traits.

As a research approach, heritability is therefore a dead end. Heritability, it should be recalled, is a population concept. As noted earlier, narrow heritability is the proportion of additive variance in the total phenotypic variance of a trait, while broad heritability is the proportion of genetic (additive + dominance) variance in the phenotypic variance. Once the heritability of a trait has been estimated, there is nothing more to add apart from expressing sympathy with individuals displaying a low value for the trait, as they are “doomed” to keep displaying that lower value. Very little can be done to improve their genes or the genes in the population without selective breeding for the trait. We should also emphasize that behavior geneticists invariably use incorrect formulas in their models.

Scientists use mathematical models to test hypotheses. A scientist will compare the prediction of his or her model with an actual measurement and will accept or reject the model based on the relative accuracy of its prediction. This is not possible in BG models, which is why behavior geneticists keep finding different heritability estimates for a trait year after year. No progress is possible.

After deciphering the human genome, the science of genetics has lately been undergoing important changes. As Charney (2012, p. 331) writes:

Recent discoveries, including the activity of retrotransposons, the extent of copy number variations, somatic and chromosomal mosaicism, and the nature of the epigenome as a regulator of DNA expressivity, are challenging the nature of the genome and the relationship between genotype and phenotype.

We refer the interested reader to more detailed papers on these topics: for retrotransposons, Sciamanna et al., 2009; for copy

number variations, Redon et al., 2006; for chromosomal mosaicism, Templado et al., 2011; for epigenetics, Weaver et al., 2004.

These studies indicate that DNA can no longer be viewed as the sole biological agent of heritability or be regarded as fixed at the moment of conception. It is necessary to introduce a broader point of view encompassing all these recent discoveries, some of which concern factors that continue to play over the life course and may be environmentally responsive. Moreover, this action is no longer deterministic but highly stochastic (Kupiec, 2008), introducing a new handicap for heritability studies.

As Charney (2012, p. 332) clearly shows:

[...] the cumulative evidence of recent discoveries in genetics and in epigenetics calls into question the validity of two classes of methodologies that are central to the discipline: twin, family, and adoption studies, which are used to derive heritability estimates, and gene association studies, which include both genome-wide and candidate-gene association studies.

These developments of the postgenomic era call into question the validity of standard behavior genetics and the more recent behavioral genomics. There are now multilevel interactions involved in the network described by recent discoveries. Genes are situated a long way from their supposed phenotypic effects, exerted through different levels of biological organization with the influence of the environment (Noble, 2008).

Yet today's behavioral researchers do not hesitate to advocate an approach based on behavioral epigenetics—i.e., an examination of the role of epigenetics in shaping human behavior. Some continue to use twin studies. Of the twenty-four commentaries to Charney's 2012 paper, only five still defended classical twin models. We refer the interested reader to Charney's detailed response to these commentaries and to the simplistic conception of human nature they have fostered. As another example, Tan et al. (2015, p. 138) state:

By treating gene expression or DNA methylation levels as molecular phenotypes, the classical twin design can be applied at different ages to explore the age-dependent patterns in the genetic

and environmental contribution to epigenetic modification of gene activity, which can be linked to ageing-related phenotypes (e.g. physical and cognitive decline) and diseases.

Once again, the authors fail to take into account the complexity described earlier, and use simplistic paths from the genome, epigenome, and other factors to the phenotype.

Like those of their predecessors, the views of behavioral epigenesists are radically at odds with recent research in the field of molecular genetics, biophysics, and systems biology—to name just three of several scientific disciplines that are not in agreement with their assumptions.

To sum up, the hypotheses on which behavior genetics is based are not verified, and the approaches used to try to confirm its results are increasingly regarded as fruitless. A more rigorous scientific examination clearly shows that behavior genetics is fundamentally unable to distinguish between genetic and environmental influences using the analytical tools that existed at its origin and the genomic or postgenomic discoveries of recent years. Instead of continuing down the blind alley of heritability, historical demographers should find it more fruitful to consider the social, economic, political, climatic, and geographic factors available for study.

4.4 Conclusion

While eugenic methods have been proposed by philosophers such as Plato ever since antiquity, the major developments in eugenics date from Galton's work in the late nineteenth century, in the wake of discoveries on heredity.

In reality, eugenics is a political attitude and not a scientific one, even though it was formulated by a scientist—Galton—and certain pseudosciences such as behavior genetics use its premises. Eugenics postulates the existence of persons regarded as disadvantaged and unfit by an “elite”—easily recognizable by its political power (Hitler or Mussolini), economic power (the

Rockefeller dynasty), and scientific power (Galton and Fisher). It advocates either negative eugenics, leading to the sterilization and physical elimination of persons regarded as disadvantaged and unfit, or positive eugenics, promoting the reproduction of persons regarded as fit. The two policies often coexist, as in Nazi Germany, where sterilization, deportation, and the massacre of populations viewed as unfit went hand in hand with the promotion of the selective reproduction of the Aryan race.

Throughout this chapter, we have shown the main effects of eugenics since its introduction by Galton to the present.

Today, it has taken a more devious form, as it can now be practiced not just by a group of persons, but by single individuals vested with the power of acting on their offspring. Let us take a more detailed look at what this power represents and how it may be regarded as a new form of eugenics.

We refer to new biomedical procedures that are being increasingly recommended to parents for detecting potential genetic problems in the unborn child. Whereas eugenics used to be essentially political and thus a collective practice, is it possible that an individual form of eugenics is at work—with collective consequences?

In 1996, the philosopher Philip Kircher clearly articulated the problem in his book *The lives to come*. He specifically discussed eugenic abortion (p. 199):

Individual choices are not made in a social vacuum, and unless changes in social attitudes keep pace with the proliferation of genetic tests, we can anticipate that many future prospective parents, acting to avoid misery for potential children, will have to bow to social attitudes they reject and resent. [...] Laissez-faire eugenics is in danger of retaining the most disturbing aspects of its historical predecessors—the tendency to try to transform the population in a particular direction, not to avoid suffering but to reflect a set of social values.

Individuals do not make choices outside their society: the standards prevailing in the society will influence their choices.

For example, as a child's sex can now be determined well before its birth, this many induce abortions of girls by parents who want to have a boy. The sex ratio at birth, which stands at approximately 1.06 at the global level (106 male births per 100 female births), is far higher in certain countries. The growing recourse to selective abortions made possible by biomedical methods has led to sex ratios of 1.15 in China, 1.11 in India, 1.10 in Vietnam, and 1.13 in Armenia in 2017.

The fact that this imbalance of the sexes at birth may seem to be solely due to individual choices leads some authors to view individual eugenics as acceptable. Caplan et al. (1999, p. 1285), for instance, conclude their article with these words:

In so far as coercion and force are absent and individual choice is allowed to hold sway, then presuming fairness in the access to the means of enhancing our offsprings' lives it is hard to see what exactly is wrong with parents choosing to use genetic knowledge to improve the health and wellbeing of their offspring.

While such an argument is valid for a genetic malformation, it becomes very dangerous when a child's sex is concerned. These individual practices are implied by the country's prevailing social and political rules, and have major collective effects such as an increased proportion of males remaining never married when reaching adulthood. In China, for instance, the sex ratio at birth started rising in 1979 as a result of the single-child policy, enforced until 2016. The consequence is already visible, but will intensify all the way to the end of the twentieth century: a high rate of males who will remain single. This can have dramatic effects, such as a rise in crime (Edlund et al., 2007) and the difficulty in finding a wife (Guilmoto, 2012). The result of these behaviors can truly be described as a new form of eugenics, no longer collective but individual.

In conclusion, eugenics in all its forms leads individuals or human societies to harmful behavior whose effects— in many circumstances—can even be dramatic.

4.5 Annex: Definitions and genetic terminology

The name “behaviour geneticist” is used by two distinct groups of researchers. One group specialises in laboratory experiments on animals. Their experiments are well designed and well executed. We acknowledge their contribution to science and this chapter does not relate to their work. The other groups of “behaviour geneticists” owe their allegiance to Jinks & Fulker (1970). They do not conduct experiments but fit *statistical* models of the components of variance type to *observed* data. They could be described as *observational* behaviour geneticists. The parametric values obtained from fitted models, they believe, enable them to solve the nature-nurture problem. As not all readers of this volume are specialists in population genetics, we define the genetic terms and concepts used in this chapter.

The basic unit of human heredity is a “chromosome”. The name arises from the fact that chromosomes have an affinity for certain stains (chroma = colour and soma = body) and is due to the 19th century German biologist Walter Flemming. The fundamental hereditary material in a chromosome, DNA (deoxyribonucleic acid) is composed of a double-stranded helix of sugar phosphate held together by pairs of nucleotide bases, that carry information by means of the linear sequence of its nucleotides. Humans have 23 pairs of chromosomes (46 chromosomes). In females all 23 pairs are identical. In males 22 pairs are identical but the 23rd pair, called the sex chromosome, is not identical. Gene, a molecule of DNA, is situated on a chromosome. It can have many forms that are known as “alleles”. The average number of genes on a human chromosome is about 760. The exact position at which a gene is situated is called “locus”. On homologous chromosomes, an allele of the gene will be situated at the same position on each chromosome. The whole set of genes carried by a species is called the “genome” of the specie. If a person has two identical alleles at a locus, he is “homozygous”; otherwise it is “heterozygous”. Among humans germ cells (egg and sperm) are produced by a process, called *meiosis*. It is the type of

cell division that reduces the amount of genetic material. Thus, each egg and sperm has only 23 chromosomes. When a sperm impregnates the egg, each of the 23 chromosomes in the sperm joins its counterpart in the egg and the process forming a human begins with 23 pairs of chromosomes. An individual's "genotype" is the complete set of all alleles at all loci. The human genome has less than 20k genes.

Mendel was the first to study a qualitative trait. A Mendelian or qualitative trait is under the control of one gene residing on a chromosome pair. Assume this gene has two alleles, A and a one on each chromosome. As we receive one allele each from mother and father, the population will consist of three genotypes AA , Aa and aa with respect to this gene (we do not distinguish between Aa and aA). When we can distinguish between the genotypes, the trait is known as a qualitative trait and we can study the effect of the gene. Blood groups are an example of a qualitative trait. A Mendelian trait may exhibit dominance. If, for example, allele A is completely dominant over allele a , then Aa looks like AA . If dominance is partial, then Aa will be nearer AA than aa . In absence of dominance Aa will be a mixture of the effects of allele A and a .

Behaviour genetics is not concerned with qualitative traits. It is concerned with *quantitative* traits. A quantitative trait is determined by a large number of genes. Consider a second gene B . It will also have three genotypes BB , Bb and bb . Thus, two genes will give rise to 9 genotypes (each of the three A genotypes combining with each of the three B genotypes, i.e. $AABB$, $AABb$, $AAbb$, ... $aabb$). For n genes, the number of genotypes will be 3^n . A quantitative trait e.g. height, is measured on a continuous scale. Some genotypes may give rise to similar phenotypes and we may not be able to distinguish between these genotypes. Thus, there is no 1-1 correspondence between genes and their effect. Environment may also affect the trait in which case an individual's "phenotype" may not be a true reflection of the genotype.

A behaviour geneticist collects data on the phenotype of a trait and then tries to make inferences about the genotype. Therefore, a phenotypic value needs to be associated with the underlying genotypic value or with the genotype. Without association no

genetic inference can be made. Therefore, we need new concepts not used in Mendelian genetics. “Genotypic value” is one of these new concepts. Regrettably, we can define it for one gene only and then, inappropriately, ‘generalise’ it. The genotypic values of the three genotypes AA , Aa and aa are defined as the *regression* of their phenotypic values on genotypic frequencies. We cannot find this line of regression because genotypic values are *hypothetical* constructs. Another new concept we need is that of “additive value”. We play the same trick and define additive values as the *regression* of genotypic values on genotypic frequencies. Additive values are also hypothetical and may or may not exist. The deviations from this hypothetical regression of genotypic values on genotypes are called “dominance values”. In Mendelian genetics dominance effects are real. In quantitative genetics they are random fluctuations from this regression. This distinction is not generally understood. The reason for constructing hypothetical concepts using statistical linear regression is that the originator of Quantitative Genetics, R A Fisher did so in his 1918 paper. To explain the concept of additive values, textbook writers give genotypes AA , Aa and aa hypothetical values a , d and $-a$ (please note that equally spaced values for the three genotypes would not reflect “dominance”). This, however, does not mean that they are “real”. We emphasise that genetic, additive and dominance values are hypothetical statistical constructs and may or may not exist.

Chapter 5

Why and how to restrict freedom

What can lead people to believe that another entity—whether a celestial body or a gene—can determine their future? The *Methodos Series*, in which this book is being published, is devoted to examining and solving the major methodological problems faced by the social sciences. My opening question, therefore, deserves fuller examination here. We begin by discussing the basic hypotheses of astrology and eugenics on the one hand, and those of astronomy and genetics on the other. Next, we explore the deep reasons that drive individuals to believe in astrology, eugenics, and—more broadly—in a religion. We conclude by discussing the negation of human freedom and the means to avoid it.

5.1 Axioms used to predict the future or establish a true science

In our chapter on astrology and astronomy, we noted that Francis Bacon proposed two approaches to research in the early seventeenth century. The first, commonly used in his time, rested on the premise that the most general principles were established and unassailable. The second, by contrast, started with factual observation and experimentation, in order to ultimately derive the axioms consistent

with this thorough investigation. But what specific meaning should we assign to the term “axiom,” which is present in both approaches?

If we consider a science as an enterprise to discover the principles governing things, such principles have been referred to as *axioms* ever since Euclid (Franck, 2007). However, as Bacon points out (*Novum Organon*, 1620, I (23):

[...] they are either names of things which do not exist (for as there are things left unnamed through lack of observation, so likewise are there names which result from fantastic suppositions and to which nothing in reality corresponds), or they are names of things which exist, but yet confused and ill-defined, and hastily and irregularly derived from realities.⁵⁸

The first type of principles is therefore based on generalities, and Bacon classifies these notions into four categories that he calls “idols.”⁵⁹

The *Idols of the Tribe* search for more order and regularity in the world than it actually displays, and he clearly states (*Novum Organon*, 1620, I, 46):

And such is the way of all superstition, whether in astrology, dreams, omens, divine judgments, or the like; wherein men, having a delight in such vanities, mark the events when they are fulfilled, but when they fail, though this happens much oftener, neglect and pass them by.⁶⁰

In other words, by the early seventeenth century, Bacon had already debunked astrology and other divination methods, whose axioms are not verified by experiment.

⁵⁸ Latin text: ...aut enim sunt rerum nomina, quae non sunt (quemadmodum enim sunt res, quae nomine carent per inobservationem; ita sunt et nomina, quae carent rebus, per suppositionem phantasticam), aut sunt nomina rerum, quae sunt, sed confusa et male terminata, et temere et inaequaliter a rebus abstracta.

⁵⁹ For more details: Courgeau et al. (2014).

⁶⁰ Latin text: Eadem ratio est fere omnis superstitionis, ut in astrologicis, in somniis, ominibus, nemesibus, et huiusmodi; in quibus homines delectati huiusmodi vanitatibus advertunt eventus, ubi emplentur; ast ubi fallunt, licet multo frequentius, tamen negligunt et praetereunt.

The *Idols of the Cave* arise in the human mind, which tries to construct a complete thought system from a mere handful of observations and ideas. The *Idols of the Market Place* stem from the words that relate to our understanding of the world. The *Idols of the Theater* are those issued from philosophical systems such as religion and theology.

The second type of axiom uses the *induction* method⁶¹ (Franck, 2002, p. 289):

[...], induction consists in discovering a system's principle from a study of its properties, by way of experiment and observation.

Bacon, however, distinguishes between different types of axioms ranging from the lowest, which are close to experimentation, to the intermediate, which define the frontiers of research, and all the way up to the most general (*Novum Organon*, 1620, I, 104).

But the elucidation of our world's structure is never complete. The discovery of new properties—thanks, for example, to more efficient means of observation—can lead to the finding of new axioms. For example, Einstein's theory of relativity adds to the classic space-time axioms a new axiom on the invariance of the speed of light in a vacuum, verified by a multitude of experiments (Suppes, 2002).

5.1.1 Principles and axioms for astrology and astronomy

The principles used in astrology are, as Bacon already observed, of the first type. Some may not have been defined with great clarity in

⁶¹ This form of induction should not be confused with ampliative induction, about which Bacon writes (*Novum Organon*, I, 105): "For the induction which proceeds by simple enumeration is childish; its conclusions are precarious and exposed to peril from a contradictory instance; and it generally decides on too small a number of facts, and on those only which are at hand." (Latin text: *Inductio enim quae procedit per enumerationem simplicem res puerilis est, et precario concludit, et periculo exponitur ab instantia contradictoria, et plerumque secundum pauciora quam par est, et ex his tantummodo quae praesto sunt, pronunciat.*) Yet it is this form of induction that was recommended by the empiricist tradition embodied by John Stuart Mill (1906-1873) and many others.

the past; others may have varied from one astrologer to another. All, however, consistently display certain features in their formulation. For our purposes, the so called axioms, which are in fact principles, put forward by the astrologer Richard Vetter in 2000 seem to fairly represent the goal and content of astrology:

- The *principle of analogy* or correspondence
- The conception of *time's quality and contents*
- The conception of the *number's quality* (the mainly geometric horoscope model) (Vetter, 2000, p. 84).

The first principle is common to all the other divination methods, as Vetter himself acknowledged (p. 85). Its symbols are metaphorical: they function as parables and rely on a certain parallelism between microcosm and macrocosm. The second is also the key principle of all oracular methods such as cartomancy. It regards time as full of significances—a sort of transcendent, unlimited storehouse. The moment when a person's life begins existence will reveal all of his or her qualities and potentialities to the astrologer. The third principle distinguishes astrology from the other divination methods by introducing numerology. The geometry of the position of the heavenly bodies at a person's birth yields his or her horoscope, which is a stylized model of astronomical realities.

Thus stated, these principles can be generalized to the other divination methods—justifying our initial choice not to examine all of these, which would have been an exercise in redundancy. However, as shown in Chapter 3, the principles above do not derive from a detailed observation of facts, but are posited from the outset as the basis of these approaches without questioning their soundness—which, as we have seen, is unverified. How can one assert the parallelism between microcosm and macrocosm when it can hardly be verified by experiment? This is clearly an example of the first approach defined by Bacon, which no longer corresponds to what we now regard as a science, but belongs more specifically to the *Idol of the Tribe* category, as Bacon already noted.

Astronomy, by contrast, developed from the observation of celestial bodies over millennia, and this meticulous accumulation allowed Newton to define its axioms for classical mechanics with

the aid of Baconian induction (Newton, 1687, pp. 12-13, translated into English by M. Andrew, 1779):

1. Every body perseveres in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impress'd thereon.
2. The alteration of motion is ever proportional to the motive force impress'd; and is made in the direction of the right line in which that force is impress'd.
3. To every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.⁶²

As Stephen Ducheyne has clearly shown (2005), these axioms are of the second type recommended by Bacon. They remained valid until new observations at the atomic and subatomic level required their change with the introduction of quantum mechanics in the first half of the twentieth century. While Newton's axioms still apply as a limit case for long-distance observations of celestial bodies, they need to be modified for the observation of atomic particles.

Such is the fundamental difference between astrology and astronomy, which Bacon had identified by 1620. Is this difference equally valid for eugenics versus Mendelism?

5.1.2 Principles and axioms for eugenics and Mendelism

While the goal of eugenics is evident—to improve the racial qualities of future generations—Galton did not elaborate clear principles for it. We can nevertheless regard his hypotheses on

⁶² Latin text:

1. Corpus omne perseverare in statu suo quiescendi vel movendi uniformiter in directum, nisi quatenus a viribus impressis cogitur statum illum mutare.
2. Mutationem motus proportionalem esse vi motrici impressae, & fieri secundum lineam rectam qua vis illa imprimitur.
3. Actionis contrariam semper & aequalem esse reactionem: sive corporum duorum actiones in se mutuo semper esse aequales & in partes contrarias dirigi.

intelligence, talent, and virtue—which he failed to justify—as constituting its principles.

To begin with, Galton viewed these intellectual capacities as subject to the same transmission as physical qualities, which, by contrast, are measurable. He deduced that a measure of intellectual capacities must surely exist, and that it can therefore serve to verify the generalization of the Law of Frequency of Error. His proposed measure for estimating individuals’ “worth” is largely based on the prevailing political views of his time. His scale combines social class and merits, with “Ministers of State, heads of Departments, Bishops, Judges, Commanders and Admirals in Chief, Governors of colonies and other appointments” ranking highest (Galton and Galton, 1998, p. 100). Galton never actually justifies this measure in empirical terms. He himself pointed out the questions it could raise, yet he used it to quantify human intelligence. We could therefore treat it as a first principle to justify eugenics: *intelligence, talent, and virtues are measurable*.

The introduction of IQ by Binet and Simon in 1905—i.e., in Galton’s lifetime—seems more convincing than previous attempts to measure intellectual capacities. But the two authors are far less bold than Galton, and clearly state the impossibility of measuring intelligence (pp. 134-195, translation by Elizabeth S. Kite, 1916):

This scale properly speaking does not permit the measure of the intelligence, because intellectual qualities are not superposable, and therefore cannot be measured as linear surfaces are measured, but are on the contrary, a classification, a hierarchy among diverse intelligences; and for the necessities of practice this classification is equivalent to a measure.⁶³

Despite these shortcomings, it was the U.S. adaptation of IQ by Lewis Terman in 1916—known as the Stanford-Binet test—that led to its acceptance as a unit measure of mental processes. Many

⁶³ French text: Cette échelle permet, non pas à proprement parler la mesure de l’intelligence, —car les qualités intellectuelles ne se mesurent pas comme des longueurs, elles ne sont pas superposables, —mais un classement, une hiérarchie entre des intelligences diverses; et pour les besoins de la pratique, ce classement équivaut à une mesure.

versions were later developed. Terman was an influential member of the Eugenics Research Association, and his work was heavily informed by eugenics. For example, in his book *The Measurement of Intelligence* (1916, pp. 3-4), he clearly states his goal:

The trouble was, they were too often based upon the assumption that under the right conditions all children would be equally, or almost equally, capable of making satisfactory school progress. Psychological studies of school children by means of standardized intelligence tests have shown that this supposition is not in accord with the facts. It has been found that children do not fall into two well-defined groups, the “feeble-minded” and the “normal.” Instead, there are many grades of intelligence, ranging from idiocy on the one hand to genius on the other. Among those classed as normal, vast individual differences have been found to exist in original mental endowment, differences which affect profoundly the capacity to profit from school instruction.

This classification into well-defined groups later served as the basis for racial segregation policies in U.S. schools. Terman claims that children with high IQ (of course, nearly all of them white) will become future leaders in science, industry, and politics. By contrast, children with low IQ, notably blacks, must be educated in separate classes, because: “Their dullness seems to be racial, or at least inherent in the family stocks from which they come” (Terman, 1916, p. 91).

This argument was taken up by Jensen in 1967 to try to prove that the Head Start Program for Black Children in the USA was useless (Vetta and Courceau, 2003, pp. 409-410). Later, Herrnstein and Murray’s *The Bell Curve* (1994) used the notion of unit intelligence to show that eugenics could lead to the emergence of a cognitive elite (Vetta and Courceau, 2003, p. 410). Gould’s review of the book in 1996 clearly shows its errors, for the authors believe intelligence can be measured by a single index, IQ—a claim disproved by experiment.

In other words, the assertion that intelligence is measurable—which we may view as an axiom posited by Galton—is not verified empirically and has a political connotation, to which eugenics has always given priority.

Galton's second claim, made in 1865, is that genius, talent, and character are hereditary. But what does he mean by "heredity"—a concept that raised many questions even in his day? In 1872 (p. 394), he had this to say about the doctrines of heredity:

From the well known circumstances that an individual may transmit to his descendants ancestral qualities which he does not himself possess, we are assured that they could not have been altogether destroyed in him, but must have maintained their existence in a latent form.

He therefore postulated the existence of two largely independent elements: the individual's latent part, known to us only through its effects on offspring, and the manifest part. The latter is largely shaped by the person's living environment and only a very small share is passed on to the descendants, whereas the latent part is passed down in full. Galton was thus able to formulate a law of hereditary transmission in 1886 concerning the height of children with respect to that of their parents. Assuming the law to be universal, he concluded his article by stating (p. 261) that:

The results of our two valid limiting suppositions are therefore (1) that the mid-parental deviate, pure and simple, influences the offspring to $\frac{4}{9}$ of its amount; (2) that it influences it to the $\frac{6}{11}$ of its amount. These values differ but slightly from $\frac{1}{2}$, and their mean is closely $\frac{1}{2}$, so we may fairly accept that result. Hence the influence, pure and simple, of the mid-parent may be taken as $\frac{1}{2}$, of the mid-grandparent $\frac{1}{4}$, of the mid-great-grandparent $\frac{1}{8}$, and so on.

To obtain this result, Galton was convinced that he had demonstrated—from a sample of 205 parents and their 930 children—that the children were more "mediocre"⁶⁴ than their parents, for he had made his observations at the individual level. But Maraun et al. (2011) have clearly shown that such a "regression towards mediocrity" does not apply to individual entities: it is valid only at the aggregate level. They accordingly characterize Galton's

⁶⁴ He uses "mediocre" to mean that the slope of the regression line linking the parents' height on the x-axis to their children's height on the y-axis is equal to $\frac{2}{3}$.

approach as “mythological,” for it demonstrates nothing at the individual level. Moreover, while this result is **always** obtained with two normal distributions—which Galton assumes to be valid here—it is not consistently obtained with non-symmetric or bimodal distributions (Schwartz and Reike, whose 2018 article focuses on “Regression away from the mean”). Lastly, the linearity that Galton assumes for his regression is not, in fact, fully verified (Wachsmuth et al. 2003) and the observed data do not fit the proposed model.

Galton did not present a “statistical law of heredity” to describe bisexual offspring until 1897. As so often, he combines statistical calculations with a study of physiological or biological phenomena. He thus justifies his statistical results by arguing that they match his hypotheses on heredity (p. 403):

Now this law is strictly consonant with the observed binary subdivisions of the germ cell, and the concomitant extrusion and loss of one half of the several contributions from each of the two parents to the germ cell of the offspring. The apparent artificiality of the law ceases on these grounds to afford the cause for doubt; its close agreement with physiological phenomena ought to give a prejudice in *favour* of its truth rather than the contrary.

Having set out all the conditions that he sees as necessary for the law, he states it in the form of the series already presented in 1865 (p. 326) and in many of his articles:

The father transmits, on an average one half of his nature, the grand-father one fourth, the great-grand-father one eighth; the share decreasing step by step, in a geometrical ratio, with great rapidity.

This “law” assumes that all ancestors are known, whereas in fact it can be verified for only a small number of ancestors. But even if the unknown residuals are small, it hardly qualifies as a law. We shall regard it here as the second axiom of Galton’s theory.

The assumption raised difficulties for many authors in the late nineteenth and early twentieth centuries. Pearson, for example, was initially a strong advocate of the law, which he called the “law of ancestral heredity.” In 1897-1898, he wrote (p. 412): “with all due reservations, it seems to me that the law of ancestral heredity is

likely to prove one of the more brilliant of Mr. Galton's discoveries." However, he expressed reservations, notably in regard to selection. He showed that while the law was verified, it did not discredit the Darwinian notion of selection applied to a continuous variation—as Galton argued. In 1903, Pearson went even further by showing that the law was purely statistical and independent of any physiological or biological theory of heredity—a view contrary to Galton's, as noted earlier. Lastly, he showed that the geometric series of ratio $\frac{1}{2}$ proposed by Galton is not applicable to many observations.

Yule explicitly stated in 1902 (p. 204): "Being unable to accept Mr. Galton's law of heredity, *a fortiori* I cannot accept it as *the* law, and have therefore applied the phrase to a more general statement." His Law of Ancestral Heredity, offered as an alternative (p. 202), assumed that "the mean character of the offspring can be calculated with the more exactness, the more extensive our knowledge of the corresponding characters of the ancestry." Instead of Galton's rigid mathematical law, Yule proposed a more flexible version that allowed a more accurate prediction of the mean value of a trait when certain ancestors of an individual were known.

Naturally, the "Mendelians" either rejected this axiom altogether or viewed it as an occasional and relatively insignificant consequence of Mendel's laws. For example, in his book on *Mendel's Principles of Heredity* (1909), Bateson wrote (p. 6):

Galton's method failed for want of analysis. His formula should in all probability be looked upon rather as an occasional consequence of the actual laws of heredity than in any proper sense one of these laws.

The positivism of Galton and his successors consisted in rejecting causality in favor of statistics and correlation, whereas Mendelism relied on an individual probability.

Galton's eugenics came 300 years after Bacon, who therefore could not classify it among his four idols. As we have seen, the essential aim of eugenics was political. In Bacon's day, however, all political goals lay in the hands of absolute monarchs claiming divine right. For example, James I, King of England and Scotland at the

time of Bacon, had this to say about royal power in his work on *The True Law of Free Monarchies*, included in the volume of his collected works in 1616 (p. 193):

As there is not a thing so necessarie to be knowne by the people of any land, next to the knowledge of their God, as the right knowledge of their alleageance, according to the forme of government established among them, especially in a Monarchie (which form of government, as resembling the Divine, approacheth nearest to perfection, as all the learned and wise men from the beginning have agreed upon; [...])

The King defended his divine right against the obstacles that Parliament sought to put in his way, and he regarded this body as merely the head court of the king and his vassals.

Since James I's accession in 1603, Bacon had enjoyed a fast-track career that propelled him to the position of Lord Chancellor in 1618. It was therefore impossible for him to directly challenge the monarchy and its absolute political power, for he was totally indebted to it.

After the collapse of the absolute monarchies, the policies introduced by governments have reflected the different approaches of their framers. Some have rested on solid scientific foundations. Many public-health policies, for example, supported by scientific discoveries such as vaccination, have allowed the eradication of many diseases that previously took a heavy toll on populations. Other policies, by contrast, have been based on idols in the Baconian sense and should be debunked as such.

Eugenics, for example, can be regarded as an Idol of the Market Place, for it uses "names of things which do not exist, . . . or exist, but yet confused and ill defined, and hastily and irregularly derived from realities"⁶⁵ (*Novum Organon*, 1620, I, 60). Its main principles are based on abstruse and scientifically unsubstantiated concepts. Its proposed policy line is "formed by the intercourse and

⁶⁵ Latin text: ... sunt rerum nomina, quae non sunt ... aut sunt nomina rerum, quae sunt, sed confusa et male terminata, et temere et inaequaliter a rebus abstracta.

association of men”⁶⁶ (*Novum Organon*, 1620, I, 43), and eugenics organizations have been set up around the world—leading, as noted earlier, to many crimes against humanity.

After World War II, while eugenics continued to be active politically under other guises such as birth control, the concept of heritability gave rise to a new idol: hereditarianism. Its purpose was to show that human behavior can be broken down into two additive parts: a genetic part and an environmental part. This approach qualifies as an Idol of the Tribe, for “The human understanding is of its own nature prone to suppose the existence of more order and regularity in the world that it finds”⁶⁷ (*Novum Organon*, I, 45). Behavior genetics uses Fisher’s assumptions to attempt to connect genetics to eugenics—an endeavor that we have shown to be unacceptable.

This strong theoretical rejection of eugenics and hereditarianism leads us to examine whether Mendelism relies on axiomatics better supported by observation.

First, we must note that Mendel’s very precise and detailed observations in 1865 initially produced not axiomatics but a set of conclusions. His discoveries were surprising in an age that knew nothing about chromosomes, genes, and DNA. However, what he called “traits” corresponded to what we now call “alleles,” i.e., the sets of genes situated in the same locus.⁶⁸ By presenting the results of his experiments in simple terms, Mendel was able to develop principles, but they attracted little attention.

Not until his results had been rediscovered by various scientists at the turn of the twentieth century were his conclusions transformed into a small set of axioms. Despite some variations across the century (see Marks, 2000), these display some constant

⁶⁶ Latin text: propter hominum commercium et consortium, appellamus.

⁶⁷ Latin text: Intellectus humanus ex proprietate sua facile supponit majorem ordinem et aequalitatem in rebus.

⁶⁸ Although the definition of all the terms used in genetics lies outside the scope of our book, it is useful to note here that a gene is “a unit of information that encodes a genetic characteristic,” an allele is “one of two or more alternate forms of a gene,” and a locus is “a specific place on a chromosome occupied by an allele” (Pierce, 2012, p. 46).

features. Curiously, it is the biometrician Weldon who, in 1902, formulated two initial principles of Mendelism (p. 229), which he called Law of Segregation and Law of Dominance—in order to criticize them. This triggered the controversy between “ancestrians” and “Mendelians” (see Chapter 3).

After Weldon’s death in 1906, Mendelism triumphed. In 1909, Bateson published *Mendel’s Principles of Heredity*, in which he reproduced both principles—now substantiated—in exactly the same terms (p. 13). He noted, however, that the “dominance of certain characters is often an important but never an essential feature of Mendelian heredity.” In 1916, Morgan proposed another law, the Law of Independent Assortment, which relied on his own work on the relations between genes and chromosomes. This law is often violated, however, for the genes present on the same chromosome are inherited together.

Of these various laws, we believe only the first—the Law of Segregation—can be regarded as a true axiom, of the highest type. It has since been verified by a large number of experiments and displays no exception. We can define it as follows:

A diploid individual possesses a pair of alleles for any particular trait and each parent passes one of these randomly to his or her offspring.

This axiom is consistent with the theoretical behavior of chromosomes proposed by Sutton in 1903 in his article “The Chromosomes in Heredity” (p. 237):

Thus the phenomena of germ-cell division and of heredity are seen to have the same essential features, viz., purity of units (chromosomes, characters) and the independent transmission of the same.

It then took fifty years to gradually demonstrate that a chromosome is composed of two long molecules of deoxyribonucleic acid—DNA—wrapped around each other in a helix. Watson and Crick discovered the structure in 1953. It consists of a sequence of four types of nucleotides, which carry and reproduce genetic information.

Without describing the complex process in detail, we can say that the DNA nucleotide sequence allows the formation of the sequence of amino acids in a protein, which may be regarded as an elementary characteristic effectively manifested by an individual.

The other two laws have many exceptions and are not a key element of Mendelian heredity. We cannot regard them as general axioms in the Baconian sense, but only as intermediate axioms, requiring specific conditions to be valid.

The Law of Dominance states that certain alleles are dominant and others recessive, so that an individual with a dominant allele will only express the effect of that characteristic. Although it applies frequently, it led Bateson (1909, pp. 13-14) to write:

The consequences of its occurrence and the complications it introduces must be understood as a preliminary to the practical investigations of the phenomena of heredity, but it is only a subordinate incident of special cases, and Mendel's principles of inheritance apply equally to cases where there is no dominance and the heterogeneous type is intermediate in character between the two pure types.

The latter type of dominance—called incomplete dominance—cannot be regarded as a genuine law of hereditary transmission, for it concerns the phenotypic expression of a genotype.

The Law of Independent Assortment states that the alleles of genes for different traits segregate independently of one other. Again, far from being universal like the first law, it is very often disproved by experiment. This is due to the fact that a gene is linked to a chromosome: if the different traits depend on genes located on distinct chromosomes, their segregations will be independent; if they depend on genes located on the same chromosome, their segregations will be totally linked.

The discovery of DNA as the medium of Mendelian genetics thus crowned the theory by establishing the notion of a genetic program embedded in DNA and sufficient to explain the complete functioning of an organism.

However, the sequencing of the human genome, completed in 2003, shows that it contains only 22,000 genes, or one-half the number in a paramecium. This makes it hard to imagine that they can single-handedly govern human phenotypes, which are far more abundant. While they have allowed advances in the therapy of rare monogenic diseases, they are of little value for most diseases and phenotypic traits. Subsequent discoveries have deeply transformed the genetic approach, just as quantum mechanics has modified Newtonian theory. These discoveries include, among others, regulatory RNA or noncoding RNA, alternative splicing, epigenetic splicing, and metagenomic splicing.⁶⁹

In their book *Ni Dieu Ni gène* (Neither God nor Gene) published in 2000, Jean-Jacques Kupiec and Pierre Sonigo restrict the Mendelian approach by proposing a broader theory (p. 194):

[...] heredity is not written in DNA. It is the result of random draws by natural selection. It is the principles of this selection that we must understand, rather than desperately hoping to read in genes that which is not written in them.⁷⁰

The theory that they offer for this purpose generalizes Darwin's theory of evolution by applying it to "the populations of cells and molecules, as we do for populations of plants or animals"⁷¹ (p. 214).

We have thus shown that—as with astrology and astronomy—there is a clear distinction between eugenics and Mendelism reflecting the two different approaches defined by Bacon. Also, as with Newton's laws, new discoveries have led to a fuller, more satisfactory approach to Mendelism.

⁶⁹ For more details on these discoveries, see *L'hérédité sans gènes*, 2013.

⁷⁰ French text: ...l'hérédité n'est pas écrite dans l'ADN. Elle résulte des tirages de la sélection naturelle. Ce sont donc les principes de cette sélection qu'il faut comprendre, plutôt que d'essayer désespérément de lire dans les gènes ce qui n'y est pas écrit.

⁷¹ French text:... appliquer strictement la théorie de l'évolution aux populations des cellules et de molécules, comme nous le faisons pour les populations de plantes et d'animaux.

5.2 Reasons to believe in the prediction of the future

We must now ask why these approaches have had so much success throughout human history—in the case of astrology, since remotest antiquity; for eugenics, since the late nineteenth century, although it was already latent in far earlier times. We shall also try to understand why astrology, although now rejected as a science, continues to capture the attention of so many people. Similarly, eugenics—despite the avoidance of the term since the end of World War II—has been applied by many political leaders with gigantic resources at their disposal for the task. Hereditarianism is still practiced as a science by a great number of researchers, despite the obvious falsity of its scientific premises.

We therefore believe it is important to seek the deep reasons that lead so many persons to deny human freedom by putting their faith in these pseudosciences.

5.2.1 Why and how should one continue to believe in divination?

In this section, we discuss not only astrology, but also all the other forms of divination mentioned in our introduction. Many are still relatively widespread in various parts of the world, so we begin by examining to what extent.

All the graphs generated by Google Trends show the global supremacy of astrology since 2004, all other practices being negligible in English as well as French and Spanish. A more detailed examination of certain countries reveals the presence of cartomancy and chiromancy in Switzerland, although their frequency is less than one-tenth that of astrology.

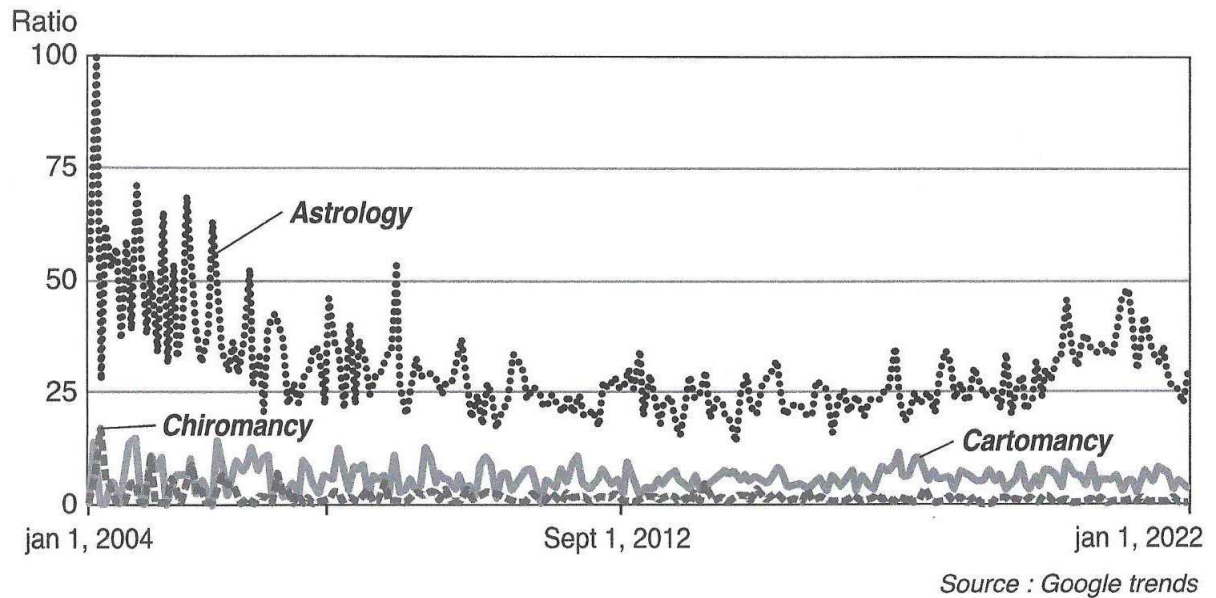


Fig. 5.1 Change in searches for “astrology”, “cartomancy”, and “chiromancy” in Switzerland since Jan. 1, 2004. Source: Google Trends.

In France as well, searches for “cartomancy” and “chiromancy” are not insignificant, but less frequent than in Switzerland. It would have been interesting to compare these figures with those for other languages or other countries. For example, how prevalent is chiromancy today in Japan or China? However, the results obtained for three major languages—English, French, and Spanish—will suffice here, for the purpose of our study is not to be universal but to identify the main reasons that still drive people to believe in divination.

As noted earlier, all these forms of divination have played an important role in the past and in a large majority of civilizations. Let us examine how such methods were regarded in antiquity.

In the first century B.C.E., Cicero (106-43 B.C.E.) wrote *De natura deorum* (*On the nature of gods*), *De divinatione* (*About divination*), and, at the end of his life, *De fato* (*Concerning fate*). We shall focus here on *De divinatione* (around 43 B.C.E), where he

presents his views in the form of a dialogue between Marcus (himself), who mocks superstition, and his brother Quintus, who defends the values of divination. In what follows, we rely mainly on Quintus' arguments to understand the motives for belief in divination, for we have already described Marcus' arguments at some length.

Quintus begins by distinguishing the two main forms of divination (I, 11):

“There is, I assure you,” said he, “nothing new or original in my views; for those which I adopt are not only very old, but they are endorsed by the consent of all peoples and nations. There are two kinds of divination: the first is dependent on art, the other on nature.”⁷²

In Latin, the words *ars* and *scientia* are equivalent, and Quintus uses them interchangeably to designate knowledge. However, as *scientia* differs from what we now call “science,” we prefer to use “art” here. This art is mainly represented not only by astrology but also by various predictions based on the examination of entrails, lightning, and other phenomena. In addition to astrology, the Romans regarded other predictions as “arts,” for they were codified in texts reflecting extensive observations. The Roman augurs, for example, had a highly elaborate—but secret—corpus of doctrine called “augural right.” The sixteen augurs in Cesar’s time served as the interpreters of Jupiter, who conveyed to them the approvals, warnings or refusals of the celestial will. Interestingly, Cicero was elected augur in 53 B.C.E.

“Natural” divination was based on dreams and prophetic divinations. These were not codified in texts, but their predictive content could be revealed by the dreamer’s or the prophet’s inspiration. Quintus distinguishes these two forms of divination (I, 56):

⁷² Latin text: “Nihil,” inquit, “equidem novi, nec quod praeter ceteros ipse sentiam; nam cum antiquissimam sententiam, tum omnium populorum et gentium consensu comprobata sequor. Duo sunt enim divinandi genera, quorum alterum artis est, alterum naturae.”

As in seeds there inheres the germ of those things which the seeds produce, so in causes are stored the future events whose coming is foreseen by reason or conjecture, or is discerned by the soul when inspired by frenzy, or when it is set free by sleep.⁷³

He goes on to describe the reasons for Roman belief in divination.

The first and main reason is found in Stoic philosophy which, although born in Greece in ca. 300 B.C.E., was by far the prevailing current in the Roman period. Stoicism assigned a role to fate (*fatum*) as a force governing the universe—a chain of events. Quintus defines it as follows (I, 55):

Now by Fate I mean the same that the Greeks call εἰμαρμένη, that is, an orderly succession of causes wherein cause is linked to cause and each cause of itself produces an effect. That is an immortal truth having its source in all eternity. Therefore nothing has happened which was not bound to happen, and, likewise, nothing is going to happen which will not find in nature every efficient cause of its happening.⁷⁴

This deterministic vision of fate does not rule out human action but incorporates it in its causalities. While individuals are powerless to alter the events affecting them, they do control their attitudes and responses to them.

This philosophical approach is also intimately linked to the existence of the gods and their intervention in human affairs. As Quintus states (I, 5):

My own opinion is that, if the kinds of divination which we have inherited from our forefathers and now practise are trustworthy,

⁷³ Latin text: Atque ut in seminibus vis inest earum rerum, quae ex iis progignuntur, sic in causis conditae sunt res futurae, quas esse futuras aut concitata mens aut soluta somno cernit aut ratio aut coniectura praesentit.

⁷⁴ Latin text: Fatum autem id appello, quod Graeci εἰμαρμένη, id est ordinem seriemque causarum, cum causae causa nexa rem ex se gignat. Ea est ex omni aeternitate fluens veritas sempiterna. Quod cum ita sit, nihil est factum quod non futurum fuerit, eodemque modo nihil est futurum cuius non causas id ipsum efficientes natura contineat.

then there are gods and, conversely, if there are gods then there are men who have the power of divination.⁷⁵

Like the Greeks, Roman religion had many gods, but it gave precedence to Jupiter.

Another factor drove the Romans to believe in divination: their political regime. According to tradition, the augurs existed since Rome's foundation in ca. 753 B.C.E. Cicero describes the event (*De divinatione*, 1. 48), when Romulus and Remus, as augurs, and through the observation of birds, asked the gods to tell them which of the two would rule the city. The appearance of twelve birds on the side favorable to Romulus expressed the divine choice. Ever since, the augurs had served as representatives of Roman power and made all the key decisions:

I think that, although in the beginning augural law was established from a belief in divination, yet later it was maintained and preserved from considerations of political expediency.

Augural art was thus applied to Rome for domestic and external policy alike.

The Romans were also extremely fond of predictive readings of individual fates. In particular, Chaldean astrologers competed with the haruspices, who also predicted the future by examining animal entrails. The belief in these predictions was very strong, most notably after Caesar's death in 44 B.C.E., and prevailed until the fall of the Roman Empire in the West at the end of the fourth century C.E.

Marcus, for his part, criticizes and even mocks superstition, rebutting Quintus' arguments one by one in the second part of the work. He offers a lucid vision of the role of divination in Roman society, and his conclusion leaves the reader free to believe in it or not.

Divination thus appears to have been a general attitude—indeed, even a theory—espoused by the entire Roman population.

⁷⁵ Latin text: Ego enim sic existimo, si sint ea genera divinandi vera, de quibus accepimus quaeque colimus, esse deos, vicissimque, si di sint, esse qui divinent.

The theory assumes the existence of gods acting as a force that can communicate with humans by a variety of means. The force operates at every level of society—from Stoic philosophy to religion, politics, and the fate of individuals.

In modern times, several disciplines have sought to explain not only divination methods but, more generally, religious practices. These disciplines notably include sociology (Durkheim, 1912), history (Bouché-Leclerc, 1879), psychology (James, 1902), and anthropology (Lévy-Bruhl, 1931; Evans-Pritchard, 1937). Lisdorf (2007) presents these various approaches in detail. We shall focus here on the contributions of cultural, psychological, and cognitive approaches. They seek to understand not only the different forms of divination but, more generally, all religious experiences, which involve one irrational element (monotheisms) or several (polytheisms). This generalization is necessary to embrace the full spectrum of religious phenomena.

We can currently distinguish four main theories that aim to explain the evolution of these behaviors and beliefs. They have been developed in the past thirty years, chiefly in psychology, biocultural anthropology, and cognitive sciences. They seek to offer a fresh approach to the issues most widely discussed in our times concerning the origin, representation, and transmission of religion with the aid of the cognitive structures of the human mind.

The first theory is based on the work of Stewart Gunther (1993), Pascal Boyer (1994), and Justin Barrett (2000). Their initial hypothesis is that religious concepts have emerged from cognitive processes that—from earliest antiquity—offered solutions to numerous problems relating to the natural and human environment. These concepts can now be tested empirically by means of relevant experiments. Boyer (1994) explains the diffusion and persistence of “minimally counterintuitive” ideas, of which religious concepts are a subset, by the fact that they are more attractive than others. While some psychological studies support this hypothesis, Barrett himself (2000, p. 10-11) believes that these concepts do not suffice to explain religious sentiments:

However, counterintuitive concepts such as invisible sofas rarely occupy important (if any) roles in religious systems.

Counterintuitive beings or objects of commitment in religious belief systems are most often intentional agents.

This leads Barret to assume that, from remotest antiquity, humans have also possessed “hyperactive agent-detection devices” (HADDs) that would, for example, enable a hunter to detect an imaginary tiger in his surroundings in order to prevent the failure to detect a real tiger. While this is an attractive explanation of supranatural phenomena, its verification is problematic (Powell and Clark, 2012). To begin with, no neural mechanism has yet been found to confirm the hypothesis. Most important, experiments show that there are not one but several neural systems to detect different types of agents (Zmigrod et al., 2016). The theory also largely ignores the culture in which the individual lives. Boyer does distinguish between small archaic societies and more complex societies—our focus here—ranging from Mesopotamia to modern nations (2018, p. 121):

Religions appeared with large-scale kingdoms, literacy and state institutions. Before them, people had pragmatic cults and ceremonies, the point of which was to address specific contingencies, misfortune in particular.

However, he maintains his view that religious sentiments have a common origin. Yet it is obvious that people’s cultural environments strongly determine their sentiments and beliefs. It is therefore worth examining whether other theories can better explain religious behavior.

The second theory derives from research on the cultural evolution of societies. It takes fuller account of individuals’ living environments in order to explain their irrational beliefs. After all, why do beliefs vary from one place to another and from one culture to another (Gervais and Henrich, 2010)? The best explanation is that people live in different cultures, espousing their beliefs, norms, and behaviors. Ritual behaviors accordingly function as “credibility-enhancing displays” (CREDs) making people more willing to believe in the existence of supernatural forces acting on their society. In the words of Norenzayan et al. (2016, p. 5), CREDs complement the previous approach:

Credibility-enhancing displays (CREDs), or learners' sensitivity to cues that a cultural model is genuinely committed to his or her stated or advertised beliefs. If models engage in behaviors that would be unlikely if they privately held opposing beliefs, learners are more likely to trust the sincerity of the models and, as a result, adopt their beliefs.

This theory seeks to explain the emergence and current prevalence of religions that it qualifies as “prosocial,” as they are more efficient in promoting large-scale cooperation in our societies, and as the groups concerned can, *ipso facto*, be advantaged by the inclusive fitness of their genes, defined by Hamilton (1964, p. 8):

Inclusive fitness may be imagined as the personal fitness which an individual actually expresses in its production of adult offspring as it becomes after it has been first stripped and then augmented in a certain way. It is stripped of all components which can be considered as due to the individual's social environment, leaving the fitness which he would express if not exposed to any of the harms or benefits of that environment. This quantity is then augmented by certain fractions of the quantities of harm and benefit which the individual himself causes to the fitnesses of his neighbours. The fractions in question are simply the coefficients of relationship appropriate to the neighbours whom he affects: unity for clonal individuals, one-half for sibs, one-quarter for halfsibs, one-eighth for cousins, . . . and finally zero for all neighbours whose relationship can be considered negligibly small.

For example, several studies have shown a high positive correlation between belief in “prosocial” religions and the size or complexity of societies (e.g. Roes and Raymond, 2003; Botero et al., 2014). But correlation does not necessarily mean causality, and these studies should be viewed with caution. Moreover, the concept of inclusive fitness is an artificial construct incorporating additive effects of genes—as does behavior genetics, whose fallacies we exposed in the previous chapter. Hamilton himself, like Fisher, believed in eugenics. An article by Nowak et al. on “The evolution of eusociality” (2010) attacked and showed the limits of this concept, which has been used in biology for nearly sixty years. The subsequent discussion of eusociality's relevance is far from over (Birch, 2018).

A third theory seeks to show that religion is an adaptive phenomenon by introducing cooperation between individuals. It explains the evolution of religions over time by concentrating on the costs and benefits of a religious attitude. Given the huge costs involved in the observance of a religion with its prohibitions and complex rites, we may initially imagine that such an approach is unlikely to yield results. However, its defenders use biologists' "signaling theory" to show that it does allow progress. The theory assumes that the greater the constraints placed on a group's members, the stronger its solidarity.

Sosis (2000) compared the stability of 277 religious communities and secular communities (e.g. socialist and anarchist) in the United States over a 120-year period spanning the nineteenth and early twentieth centuries. Over the entire period, secular communities had an average annual probability of dissolution four times as high as religious communities. A more detailed study of communities (Sosis and Bresler, 2003) incorporated the number of restrictions enforced (on the consumption of coffee, alcohol, tobacco or meat, on communication with other communities, on jewelry, and so on). It showed that the effect of these prohibitions on the longevity of religious communities was proportional to their number, whereas they had no effect on secular communities. The authors can therefore attribute this stability to rituals (p. 230):

Trust emerges because participants direct their ritual efforts toward the same deity or spirit. The ritual action itself signals belief in this nonmaterial supernatural entity, an entity whose existence can accordingly not be demonstrated. By directing rituals' referents toward the unfalsifiable, religions attach themselves to ultimate beliefs that are unverifiable and hence potentially eternally true. These ultimate sacred postulates are not subject to the vicissitudes of examination; they are beyond examination, making them much stabler referents than those employed by secular rituals.

Having thus demonstrated the fitness of religious phenotypes, they go on to investigate how religion promotes it by strategies that promote higher fertility among couples, for example by requiring stable unions and banning abortion (Sanderson, 2008). However,

they fail to identify the phenotypes that can induce these behaviors (Powell and Clarke, 2008).

A fourth theory, developed by the anthropologist Maurice Bloch (2008), argues that the phenomenon to be explained is not religion but, more generally, the establishment by human societies of institutions linked to States. Given the problems encountered by the previous theories summarized above, Bloch offers the following proposal (p. 2055):

The alternative story I propose here avoids these problems. It argues that religious-like phenomena in general are an inseparable part of a key adaptation unique to modern humans. This is the capacity to imagine other worlds, an adaptation that I shall argue is the very foundation of the sociality of modern human society. This neurological adaptation occurred most probably fully developed only around the time of the Upper Palaeolithic revolution.

The author thus goes back to the period of the origins of astrology. As Émile Durkheim (1912) had recognized before him, astrology did not differ from astronomy at the time, and Bloch adds that it was tied to the political organization of complex social groups. He regards humanity as capable of handling the “transactional social” and the “transcendental social” simultaneously. We share the transactional with chimpanzees, whereas the transcendental is specific to us. The entry into the transcendental, like a symbolic second birth in many civilizations, opens mankind to imagination. It enables us to understand the roles played by individuals and the resulting social groups. It offers a simultaneous explanation of religious rituals and of the gods created as members of these transcendental groups.

This theory seems at odds with cognitive approaches, yet Bloch himself (2016)—although stating that he is not terribly fond of such labels—and his most recent defenders such as Connor Wood and John Shaver (2019) note that the theory does not repudiate the earlier approaches but reconciles them by opening up a new perspective (pp. 13-14). However, the very notion of transcendence, used in philosophy by many authors with very different meanings, is not sufficiently analyzed in a scientific manner. In his 2007 article,

Bloch envisages the use of “mirror neurons” theory⁷⁶ to explain the notion of social transcendence— “the action of *alter* requires from us a part of the same physiological process” (pp. 289-290)—but he admits that this theory is contested (for more details see Hickok, 2009). Moreover, it was developed for humans as well as primates, contradicting Bloch’s position on transcendence.

These four current theories are thus far from explaining the complexity of religious phenomena. Even Norenzayan et al. (2016, p. 16), while supporting the second theory, fully recognize their deficiencies:

Despite recent progress, the evolutionary study of religion is in its infancy, and important gaps remain in our knowledge and much work needs to be done to reach a more complete understanding.

We take the argument a step further by pointing out that these theories use concepts whose definition and value have been largely challenged by many studies. Such concepts include hyperactive agent-detection devices, credibility-enhancing displays, inclusive fitness, signaling theory, and mirror neurons. Only Bloch’s original theory, which holds that “religion theory is nothing special,” might be exempt from this weakness, but his additional words “is central” diminish its value considerably. In fact, his recent defenders, Wood and Shaver, now regard it as a mere sequel to earlier theories.

Psychological studies of religion, as well, have introduced instruments for measuring religious spirituality and assigned them a major role. The Daily Spirituality Experience Scale (DSES), for example, is regarded as “one of the most significant recent innovations in the conceptualization and measurement of religiousness and spirituality” (Ellison and Fan, 2008, p. 247). It is used in thousands of articles to show the positive effects of religion. A detailed analysis of these effects in Australia (Schurmmans-Stekhoven, 2011, p. 144) shows that they are incorrectly interpreted and concludes:

⁷⁶ “A mirror neuron is a neuron that fires both when an individual performs an action and when the individual observes the same action performed by another individual.” (Stemmer and Whitaker, eds., 2008, p. 237)

The results suggest that those truly interested in discovering the causes of well-being would do well to remember that civil behaviour and dispositions are not exclusive to those high on spirituality or religiosity and once these broad variables are considered the effects for theistic experience and belief vanish.

A similar analysis of Japan (Schurmmans-Stekhoven, 2018) fully confirms these results for another culture.

These criticisms are well summarized by Luther Martin and Donald Wiebe (2012, p. 17):

Like semiotics, the history of Religious Studies has been one of simultaneous institutional success and institutional bankruptcy. On the one hand, there are now numerous departments, institutes, associations, congresses and journals dedicated to Religious Studies. On the other hand, the academic study of religion has failed to live up to earlier promises of theoretical coherence and scientific integrity; indeed, such promises have been severely undermined.

This conclusion is all the more striking as Wiebe (1983), in total agreement with Martin, believed the opposite thirty years earlier.

A final comment: these studies generally ignore the notions of atheism and agnosticism, which have existed since antiquity and would require an analysis similar to that of religion (LaBouff, et al., 2012). In the final section of this chapter, we shall return to these notions—which lie outside the field of religion—by drawing a connection between atheism and political anarchism, as Bloch initially did when he wrote (2008, p. 2058): “The creation of an apparently separate religion is closely tied to the history of the state.”

5.2.2 Why and how should one still believe in eugenics in its present forms?

In Chapter 4, we examined the various approaches put forward to justify eugenics and hereditarianism. It is worth asking what drives many people today to believe in these doctrines, whose nefarious

and criminal legacy we presented. They may seem different now, for they produce an abundant literature that—despite its pseudoscientific character—is promoted by a large community of researchers; at the same time, they offer a wide array of genetic tests to all of humanity, so all individuals can learn their future.

The geneticist Arnold Munnich (2008, p. xxi) describes this program clearly:

Have geneticists replaced card-readers and other fortune-tellers in our contemporaries' imagination? How have we come to accredit the notion that genetics would make it possible to understand everything, prevent everything, and avoid even the worst events? It's no doubt because, in the minds of many, genetics specializes in origins and destiny. The geneticist is a sort of oracle with a clear vision of the past and, consequently, of what the future holds for us. . . . And lo and behold, genetics has become a moral issue, a means of ideological pressure, or the opportunity for taking positions of a denominational nature, or even for taking action in the name of a given chapel or divinity . . .

There is only one point in this text with which we might take issue: card-readers and other fortune-tellers are hardly about to disappear. Having said that, let us examine the impact of behavior genetics and its means of persuasion.

The Behavior Genetics Association (BGA), founded in the U.S. in 1970, initially comprised 44 members who had manifested their interest in this line of research (Loehlin, 2009). Its activities were U.S.-centered until 1980, but it then began to hold international meetings in other countries—a sign that its approach was attracting a wider audience. Its publication resources also expanded steadily, and articles in its field were published by many journals such as *Behavior Genetics*, *Acta Geneticae, Medicae et Gemmelologiae*, *Social Biology*, *Genes, Brains, and Behaviour*, and *Twin Researches*. The discipline found its way back first into American universities including the University of Colorado at Boulder, the University of Minnesota, and the University of Texas, then internationally at Kings College (London), the Vrije Univesitet (Amsterdam), and elsewhere. Interestingly, the list includes no

Francophone universities. The BGA annual conferences are now attended by nearly 1,000 persons.

Behavior genetics has been abundantly criticized, most notably by renowned geneticists and psychologists such as Jerzy Hirsch in his book *To “Unfrock the Charlatans”* (1981). BGA members, however, generally ignore these attacks, leaving the questions raised in abeyance. However, the issue of differences between black and white “races” sparked a major debate in the U.S. on the validity of the analyses that lead to a genetic hypothesis concerning these differences. The members of the Genetic Society of America first voted overwhelmingly in favor of a report supporting Hirsch (1981); in the end, his arguments were rejected and a watered-down version of the report was drafted and approved. This was in response to criticisms from a geneticist-mathematician who was well-known but not even mentioned in the report (letter from David Suzuki to Hirsch, 1984, quoted in the French edition of Hirsch’s book). The episode gives an idea of the political power of behavior geneticists.

It is important to measure the impact of these studies on the general population. Psychological studies on the effect of the media, which disseminate the results of behavior genetics research, can measure their effect on public beliefs. The findings by Alexandre Morin-Chassé (2014) are essential to understanding this influence.

Morin-Chassé conducted a double-blind survey of 1,413 Americans. He divided his respondents into three groups and had each read one of three press articles. The first article reported the discovery of a “cancer gene”; the second was on the discovery of a “liberal gene” affecting people’s political views; the third discussed a “debt gene” found in persons with negative credit-card balances. After the groups had read the articles, Morin-Chassé asked all respondents to indicate their belief that fourteen individual characteristics were influenced by genes, on an 11-point scale ranging from 0% to 100% genetically caused. These characteristics, which ranged from skin color to a preference between Apple and Microsoft, had already been tested in earlier surveys for their influence on respondents. The characteristics also included those discussed in the articles previously read by respondents.

The first group provided a ranking very similar to the one found in many studies (Schneider et al. 2018) covering the entire population: the more a trait is biological (such as skin color or size), the more it is perceived as gene-related. The second group attributed political behavior to genetic factors by a far greater margin than the other groups. It therefore revealed a strong influence of the earlier reading of the article about the “liberal gene.” This influence, however, was also strong for all the other traits regarded as weakly related to genetics by the first group. The third group saw the genetic factor as the cause of negative credit-card balances by a larger margin than the other groups. This provides further confirmation of the effect of reading the article on the “debt gene.” As with the second group, the article influenced views about traits weakly linked to genetics.

These findings clearly show the role of the press, which often overstates the impact of the results of behavior genetics studies, and the powerful influence of their articles on their readers’ views.

5.3. Human freedom

Let us now return to the prevalence of atheism in today’s populations. Atheism may be defined as the absence or the rejection of any belief in any divinity whatsoever, whereas agnosticism holds that the existence of a god or gods cannot be determined. Two surveys were conducted in 2005 and 2012 to measure religiosity and atheism worldwide on a sample of men and women across 39 countries for the first survey and 57 countries for the second, which covered more than 50,000 respondents. The following question was asked:

Irrespective of whether you attend a place of worship or not, would you say you are a religious person, not a religious person or a convinced atheist? (WIN-Gallup International, 2012, p. 3)

The responses allow a rough categorization into religious persons, agnostics, and atheists, for the non-response rates are generally low. In 2012, 59% of the world population described itself as religious,

23% as agnostic, and 13% as atheist; 5% did not answer the questionnaire. Between 2005 and 2012, the percentage of “religious” persons fell and that of agnostics and atheists rose.

A recent, more detailed, and more accurate study of atheists in the U.S. (Gervais and Najle, 2017) found a far higher Bayesian estimate of 26%. By extrapolation, the number of atheists worldwide would be about two billion. While confirming these results would require further investigation, we can see that the number of non-religious people in the world is significant, and that we should not confine studies to religious persons—as many researchers do.

Next, what do we know about the origins of religious sentiment in archaic societies? We have gone back very far in the history of humanity—up to Mesopotamia—to find the origin of astrology and religions. But all these ancient civilizations were already States whose elaborate political and social organization could entail an obligation for their populations to observe their rules. What was the situation in earlier times, in which Boyer (2018) discerns no religious organization? The studies of Ukrainian “Mega-Sites” dating from 4000 to 3200 B.C.E., covering 100-400 hectares and with a population of several thousand people, show no sign of a centralized authority, of monuments or, no doubt, of an official religion (Wengrow, 2015). While hard to fully understand and transpose to today’s world, these egalitarian societies appear to tell us that political and religious powers are neither necessary nor indispensable for a human society to exist. But this is merely an assumption whose robustness we cannot verify, given the remoteness of these cultures from the present.

The lack of written sources for archaic societies makes researchers dependent on the evidence collected on their populations by ethnologists and anthropologists over the centuries. Pierre Clastres (1974, p. 23) commented on such ethnocentrism:

A Copernican revolution is at stake, in the sense that in some respects, ethnology until now has let primitive cultures revolve

around Western civilization in a centripetal motion, so to speak.
(English translation by Robert Hurley)⁷⁷

Clastres' premature death at age 43 prevented him from completing that revolution. He did not, in fact, examine the role of religion. Rather, he confined his investigation to the role of political power in archaic Amazonian societies, while failing to answer David Graeber's question (2004, p. 23):

The most common criticism of Clastres is to ask how his Amazonians could really be organizing their societies against the emergence of something they have never actually experienced.

Despite this weakness, Clastres did make progress in the critique of modern anthropology.

Unfortunately, the latter is still conducted using data bases that collect observations by ethnologists and archeologists in the form of binary data files (did the society studied experience a given form of religious thought or not), such as the Standard Cross-cultural Sample developed by George Murdock and Douglas White (1969). These data are not exempt from the cultural bias singled out by Clastres, and we should be highly cautious in interpreting the findings of the studies based on them.

The study by Peoples et al. on *Hunter-Gatherers and the Origin of Religion* (2016) is open to such criticism. It is based on a sample of 33 hunter-gatherer societies, taken from the Standard Cross-cultural Sample. It shows that all these societies practiced animism—which the authors do not regard as a religion—but that only 15% had what they call “active high gods.” Again, given the source used, Clastres' objections apply, and the findings are questionable.

The debate on religious sentiment in archaic societies is thus far from settled, and the ethnocentrism of our societies offers little prospect of progress.

⁷⁷ French text: C'est de révolution copernicienne qu'il s'agit. En ce sens que, jusqu'à présent, et sous certains rapports, l'ethnologie a laissé les cultures primitives tourner autour de la civilisation occidentale, et d'un mouvement centripète, pourrait on dire.

Nevertheless, we can state that the establishment of an entity—whether celestial body, god or gene—that cannot be influenced by humans but determines their fate is an invention of complex societies endowed with a strong political authority, for the purpose of controlling their members by curtailing their freedom. Like religion, freedom is a concept with multiple meanings, and we must specify how we interpret the term here.

While the methodological objective of this book precludes a discussion of Jean-Paul Sartre's philosophy, we believe that it has best captured the notion of freedom as it pertains to our subject, for it eliminates the notion of divinity as a deterministic figure. Sartre spells out what he means by "freedom" in the following passage (1946, p. 37):

Everything is indeed permitted if God does not exist, and man is in consequence forlorn, for he cannot find anything to depend upon either within or outside himself. He discovers forthwith, that he is without excuse. For if indeed existence precedes essence, one will never be able to explain one's action by reference to a given and specific human nature; in other words, there is no determinism—man is free, man *is* freedom. Nor, on the other hand, if God does not exist, are we provided with any values or commands that could legitimise our behaviour. Thus we have neither behind us, nor before us in a luminous realm of values, any means of justification or excuse. — We are left alone, without excuse. That is what I mean when I say that man is condemned to be free. Condemned, because he did not create himself, yet is nevertheless at liberty, and from the moment that he is thrown into this world he is responsible for everything he does. (English translation by Philippe Mairet, 1956)⁷⁸

⁷⁸ French text: En effet, tout est permis si Dieu n'existe pas, et par conséquent l'homme est délaissé, parce qu'il ne trouve ni en lui, ni hors de lui une possibilité de s'accrocher. Il ne trouve d'abord pas d'excuses. Si, en effet, l'existence précède l'essence, on ne pourra jamais expliquer par référence à une nature humaine donnée et figée ; autrement dit, il n'y a pas de déterminisme, l'homme est libre, l'homme est liberté. Si, d'autre part, Dieu n'existe pas, nous ne trouvons pas en face de nous des valeurs ou des ordres qui légitimeront notre conduite. Ainsi, nous n'avons ni derrière nous, ni devant nous, dans le domaine lumineux des valeurs, des justifications ou des excuses. Nous sommes seuls, sans excuses. C'est ce que

In fact, for Sartre, very few people are ready to accept and assume their freedom. They prefer to pin responsibility for their situation on someone else or something else in order to free themselves from it. This offers a perfect explanation for the strong persistence of the belief in an external god (for religion), or in an unfortunate gene passed down from our ancestors (for eugenics). This attitude has also been imposed on most individuals by the successive political regimes that have arisen throughout human history.

j'exprimerai en disant que l'homme est condamné à être libre. Condamné, parce qu'il ne s'est pas créé lui-même, et par ailleurs cependant libre, parce qu'une fois jeté dans le monde, il est responsable de tout ce qu'il fait.

Part II. What can one capture of a human life, and how?

Chapter 6

Imaginary life stories to forge and nourish our mind

In Part I, we showed that the divination arts and eugenics seek to demonstrate the predictability of a person's future, and we examined the reasons for their enduring success. Despite the latter, we debunked their claims with specific arguments. We now turn to the many difficulties encountered when trying to capture even a portion of an individual life, the problems we face when attempting to analyze it, and the resources we can apply to overcome those obstacles.

Chapter 6 looks at the various ways of imagining or recording a life story, and the difficulties this involves.

From our earliest childhood our mind is shaped—like an iron blank reddened by fire—by myriad epics, tales, legends, myths, and other narratives. Once forged, our mind is again nourished throughout our lives by novels, films, plays, and other works, which revive that initiation by reinforcing it or—on the contrary—contradicting it, for our mind is ever watchful.

This chapter takes a closer look at the various types of imaginary narratives. We offer a classification by focusing on those that recount the lives of one or more characters in a partial manner, without ever attaining exhaustiveness, given that those lives are so complex. We set aside the categories for which the narratives are secondary, artificial, or even unnecessary. We discuss the methods

used for the purpose, and the importance attached by their authors to certain specific aspects of those lives.

We will then look in a more detailed way to some of these imaginary life stories, in order to see how they are symbolic of their time.

First, the *Epic of Gilgamesh* at the dawn of human civilizations marks the advent of a patriarchal culture in opposition to the matriarchy that preceded it. The later epics of Homer in Greece and the Mahābhārata in India and the Old Testament of Jewish people are quite similar but mark so different cultures, like many others epics and myths all around the world. We may also wonder why nowadays there seems to be a lack of new epics characterizing the decline of Judeo-Christian civilizations.

Second, the Sophocles' tragedy of *Oedipus Tyrannus* may be defined by the concept of the necessity of human fate. Aristotle preferred tragedy to epics, as it was more effective in condensing action. Like epics this dramatic genre knew a great number of kinds even in our days.

Third, the romances emerged in the Middle-Ages, and became important later as novels. We analyze here the devout romances inspired by the life of Henry de Joyeuse, as a model for the spiritual ascension of a penitent and a mystic, omitting his previous life of luxury before his conversion. From the late eighteen century the novel reached maturity and is still now a very important part of the literature.

We close with a general discussion of the role played in our lives by all these kinds of imaginary life histories.

6.1 Imaginary life stories

Our first question is: what are the distinctive features of these various kinds of narratives, some of which tell the story of one or more individuals either partially (by presenting an episode of their life) or more fully, but never exhaustively? The theory of this

literature—its narratology—goes back to the earliest times. We outline different points of view on the narratives without going into excessive detail.

In Greek antiquity, Plato initially directed his attention to what the Greeks called *ποίησις* (*poiesis*) (Duchemin, 1985), a term that encompasses not only epic but tragedy, comedy, dithyrambic poetry, and even tales (Manson, 2004). *Poiesis* is also closely linked to music, and, more broadly, constitutes the Platonic notion of *μίμησις* (*mimesis*) which has two main meanings: imitation proper, and representation in general (Brancacci, 2013). Plato's purpose was not to define different kinds of narratives but to describe different types of imitations, not mutually exclusive. For instance, in the *Republic* (ca. 360 B.C.E., III, 394 b-c), he writes:

there is one kind of poetry and tale-telling which works wholly through imitation, as you remarked, tragedy and comedy; and another which employs the recital of the poet himself, best exemplified, I presume, in the dithyramb; and there is again that which employs both, in epic poetry and in many other places, if you apprehend me.⁷⁹

Thus the poet will imitate, or invent, or combine the two modes. A fuller analysis of Plato's critique of these imitations—which he vehemently excludes from his ideal Republic—lies beyond the scope of our discussion. However, for the reader seeking fuller information on the topic, we recommend *Plato and the poets* (Destrée, Herrmann, 2011) and *Exiling the poets* (Naddaff, 2003).

Aristotle, in his *Poetics* (ca. 350 B.C.E.), goes further and addresses its generic constitution. He opens his work by stating (1447a):

I propose to treat of Poetry in itself and of its various kinds, noting the essential quality of each, to inquire into the structure of the plot as requisite to a good poem; into the number and nature of the parts

⁷⁹Greek^otext: ὅτι τῆς ποιήσεώς τε καὶ μυθολογίας ἡ μὲν διὰ μιμήσεως ὅλη ἐστίν, ὥσπερ σὺ λέγεις, τραγωδία τε καὶ κωμωδία, ἡ δὲ δι' ἀπαγγελίας αὐτοῦ τοῦ ποιητοῦ—εὐροῖς δ' ἂν αὐτὴν μάλιστά που ἐν διθυράμβοις—
ἡ δ' αὖ δι' ἀμφοτέρων ἐν τε τῇ τῶν ἐπῶν ποιήσει, πολλαχοῦ δὲ καὶ ἄλλοθι, εἴ μοι μανθάνεις.

of which a poem is composed; and similarly into whatever else falls within the same inquiry. Following, then, the order of nature, let us begin with the principles which come first.⁸⁰

Aristotle is therefore indeed referring here to categories defined by their specific purposes. While still resembling Plato's types of imitation, the categories differ in that they are sufficiently distinct to be clearly separated. Aristotle eliminates Plato's proposed combination of modes, which is not suited to his specification as the categories must be distinguishable. He recognizes only two modes of enunciation: narrative poetry and dramatic poetry. However, he continues to admit the epic genre and the dramatic genre (tragedy and comedy, although his book on comedy is now lost), as well as music—to which he adds painting as a form of imitation. He prefers tragedy to epic, most notably because it condenses actions better. His classification is based on the formal characteristics of the works more than on their deeper significance. A final comment on Aristotle's view of *ποίησις*: it clearly contrasts with Plato's, for it recognizes the importance of *ποίησις* to philosophy. For a fuller analysis, we refer the interested reader to Hallwell (1998), *Aristotle's Poetics*.

Neither Aristotle nor Plato discusses lyric poetry as defined today. They merely distinguish between several kinds of poetry, such as dithyrambs and elegies, without devoting great attention to them. It was only in the eighteenth century that Batteux (1746) extended Aristotle's genres to lyric poetry, which he defines as follows (p. 240):

The other kinds of poetry are mainly concerned with actions. Lyric poetry is entirely devoted to feelings. That is its manner, its essential aim.⁸¹

⁸⁰ Greek text: περὶ ποιητικῆς αὐτῆς τε καὶ τῶν εἰδῶν αὐτῆς, ἣν τινα δύναμιν ἕκαστον ἔχει, καὶ πῶς δεῖ συνίστασθαι τοὺς μύθους εἰ μέλλει καλῶς ἔξειν ἢ ποιήσις, ἔτι δὲ ἐκ πόσων καὶ ποίων ἐστὶ μορίων, ὁμοίως δὲ καὶ περὶ τῶν ἄλλων ὅσα τῆς αὐτῆς ἐστὶ μεθόδου, λέγωμεν ἀρξάμενοι κτὰ φύσιν πρῶτον ἀπὸ τῶν πρώτων.

⁸¹ French text: Les autres espèces de poésie ont pour objet principal les actions: la poésie lyrique est toute consacrée aux sentiments, c'est sa manière, son objet essentiel.

In other words, lyric poetry imitates feelings, just as tragedy evokes pity and fright.

Another type of literature also emerged in the Middle Ages as romances, but became important mainly in our times: the novel. But was it a new genre? For Dumézil (1968)—who included the cycle of Arthurian romances and Indian epics in the same complex—symbols and functions are expressed “either in epic narratives in the proper sense, or in romances inseparable from epic” (p. 25). From the standpoint of comparative mythology, it seems normal to regard romance and epic as one. However, to examine the cultural formation and genesis of the forms of the imaginary, we need to consider them separately. As Paquette (1971) admits (p. 36):

And if the epic—despite a common narrative system that it shares with the novel—must be regarded as a clearly distinct genre, it is because it imparts to the formation of the language that engenders it the significance of an absolute beginning.⁸²

He argues that the epic is the history of the origins of an ethnic group, whereas the novel is a literary work about that group.

More recently, some authors have explored the significance of a literary genre and its boundaries. Such a classification assumes the existence of clear resemblance criteria that make it possible to distinguish between genres. Schaeffer (1989), after giving a history of the various theoretical proposals to resolve this classification problem, concludes (p. 63):

[. . .] not one of Aristotle’s few illustrious successors was able to go further than the author of *Poetics*; on the contrary, each endeavored to make the problems even more unfathomable than his predecessor already had.⁸³

⁸² French text: Et si l’épopée, en dépit d’un système narratif commun qu’elle partage avec le roman, doit être considérée comme un genre nettement différencié, c’est qu’elle donne à la formation du langage qui l’engendre la signification d’un commencement absolu.

⁸³ French text: ...aucun des rares illustres successeurs d’Aristote n’a réussi à aller plus loin que l’auteur de la *Poétique*, chacun s’ingéniant au contraire à rendre les problèmes encore plus insondables que ne les avait déjà rendus son prédécesseur

In the face of this failure, Schaeffer proposes the replacement of the theory of literary genres by four generic logical sequences to address any work (p. 185):

[...] any text is, indeed, an act of communication; any text has a structure from which one can extrapolate *ad hoc* rules; any text [...] is positioned relative to other texts, and thus has a hypertextual dimension; lastly, any text resembles other texts.⁸⁴

Accordingly, he views the creation of a text in terms of discursive conventions, which can be either constitutive, regulatory or traditional. Schaeffer defines as constitutive (p. 159) the conventions that enter into the definition of a genre without, however, fully defining it. Regulatory conventions add new rules to a form of existing communication. Traditional conventions concern the meaning of linguistic expressions. Multiple types of discursive conventions usually apply to any given work, and the notion of genre is no longer very meaningful in this context.

Nevertheless, genre is still commonly used as an analytical tool by many scholars and as a method for classifying texts in bookstores, libraries, and elsewhere. More recently, some authors have even tried to rehabilitate the notion of genre, no longer with the aid of formal classification criteria, as scholars did after Aristotle, but by arguing that works are the expression of a body of thought. As a result, the goal becomes to “understand” genres, i.e., to grasp their deeper meaning rather than focusing on reproducible criteria regarding their form and features.

Before Schaeffer, Peter Szondi (1974), discussing studies by the historian of antiquity Schlegel (1772-1829) and the philosopher Schelling (1775-1854), had already offered another approach to these texts. He would not define (p. 50):

[...] the various genres in a descriptive manner, based on their elements, but deduce them from a specific concept (in the case of tragedy, from the concept of necessity). The tragic hero faces this

⁸⁴ French text: ...tout texte est en effet un acte communicationnel ; tout texte a une structure à partir de laquelle on peut extrapoler des règles *ad hoc* ; tout texte ... se situe par rapport à d'autres textes, donc possède une dimension hyper textuelle ; tout texte enfin ressemble à d'autres textes

necessity as he confronts his fate, with the “moral independence” that Schlegel, in the same passage, attributes to Prometheus and Antigone—tragic hero and tragic heroine—but denies to the epic hero Achilles.⁸⁵

Thus breaking with the classic conception of *ποίησις* as a set of reproducible generic traits, Szondi sets out to seek their origin. Szondi, in another book (1975) on: *Einführung in die literarische hermeneutik* (*Introduction to literary hermeneutics*) traces the development of hermeneutics through examination of the work of eighteenth-century German scholars. He introduces here the main role of hermeneutic theory in literary studies.

Later, Goyet (2006) showed that epic allows a society to find radically new solutions to a major political, cultural, and social crisis by embodying it in characters in order to think it through and reconfigure the world. Vinclair (2015) compares the effect of epic and the novel on societies. He shows that one can characterize the novel by its ethical effort to emancipate the individual, and epic by its political effort to redefine common values (Vincclair, 2016). This new path should extend to all literary genres and reverse the prior approach. No longer focused on the formal characteristics of genres—which had led Schaeffer to reject them—it describes them on the basis of their thought patterns, and the hermeneutic way in which they lead the reader to think and live (Bertho, 2016).

The notion of genre thus revived, we can now take a closer look at the genres of relevance to our discussion, as they examine lives that are imaginary yet well rooted in the society that produces them.

We begin with the genesis of epics, which—in Vinclair’s words (2015, p. 348)—endeavor:

⁸⁵ French text: ...les différents genres de façon descriptive, en se basant sur leurs éléments, mais les déduisent d’un concept précis (dans le cas de la tragédie, du concept de nécessité). Cette nécessité, le héros tragique l’affronte comme son destin avec cette « indépendance morale » que Schlegel, dans le même passage, reconnaît à Prométhée et à Antigone, héros tragiques, mais dénie au héros épique Achille.

[...] to think (through polylogy and trials) and to introduce new, common political values (through a pragmatic approach to recognition) [...]⁸⁶

The term epic derives from the ancient Greek ἔπος, “that which is expressed by speech,” and ποιέω, from the verb “to create.” The epic is thus a vast verse or prose composition that sets out a historical theme and celebrates the actions of a model hero or the great deeds of a group. For our purpose, we focus here on the actions or even the entire life of a hero. However, we must distinguish these epics—composed in the form of literary works—from oral myths existing in many versions. Hence the importance of specifying the differences between the two categories, which can be significant. It will be useful, for this purpose, to compare the approaches of two scholars: Vernant and Lévi-Strauss.

Vernant (1974, p. 246) clearly sets out the differences between his approach, based on historical psychology (1965), and that of Lévi-Strauss, based on structural analysis (1958):

It will be noted in this respect that Lévi-Strauss works on a corpus of oral narratives offering a very large number of variants. The manner itself in which the research is conducted calls for a systematic comparison of the narratives in order to identify the formal elements that recur in each myth, according to relationships of homology, inversion, and permutation. At the same time, it rules out a philological analysis of each version. The problem is different in the case of a heavily structured and elaborate written work such as the *Theogony* or *Works and Days*. Here, one cannot give precedence to elements found, with greater or lesser changes, in other versions. One must strive to provide an exhaustive analysis of the myth in the details of its configuration.⁸⁷

⁸⁶ French text: ...à penser (par polylogie et par épreuves) et à faire advenir [...], en commun, de nouvelles valeurs politiques, ...

⁸⁷ French text: On notera à cet égard que Lévi-Strauss travaille sur un corpus de récits oraux offrant un très grand nombre de variantes. La manière même de la recherche appelle une comparaison systématique des récits pour en retenir les éléments formels qui se répondent de mythe en mythe, suivant des rapports d’homologie, d’inversion, de permutation. En même temps elle exclut une analyse philologique fouillée de chacune des versions. Le problème est différent dans le

As our focus here is on written epics, we shall set aside the structural approach, while recognizing its value for the study of oral myths. The problem is, in fact, similar to that of tragedy, discussed later. Lévi-Strauss' comparison—in *La Potière jalouse* (1985)—of Sophocles' *Oedipus Rex* (ca. 349 B.C.E.) with Labiche's comedy *Un chapeau de paille d'Italie* (1851) in no way describes the content of each play, but only their common form (Salmon, 2007). By contrast, Vernant and Vidal-Naquet (1986) place *Oedipus Rex* in the context of its time and try to understand the thought process specific to Greek tragedy of the fourth century B.C.E.. That is our preferred approach here as well. We can sum up the two approaches by saying that Lévi-Strauss joins Aristotle in focusing on the structure of generic traits, whereas Vernant joins Vinclair by looking at their genesis and thought patterns.

Let us examine a few selected examples of epics.

The oldest known epic is that of Gilgamesh, which narrates a part of the life of the fifth sovereign of the first dynasty of the Mesopotamian city-state of Uruk in ca. 2650 B.C.E. We discuss the epic in greater detail below (Bottéro, 1992; George, 1999).

Homer, believed to have lived around the eighth century B.C.E., is the author of the two Greek epics, the *Iliad* and the *Odyssey*, but both texts have a far older origin. The *Iliad*, for example, reflects a society in which countless petty rulers are subservient to a more powerful king, and its content presumably dates from the Bronze Age (Severyns, 1964).

In India, the Mahābhārata (the epic history of the Bhārata's descendents) began to acquire its current form in the fourth century B.C.E., but its origins may go back further. Some mythical traits may be Vedic or Pre-Aryan. This long Indian poem recounts a family drama spread across three generations. Dumézil's detailed analysis (1968) enables us to grasp its deep meaning.

cas d'une œuvre écrite, fortement charpentée et élaborée, comme la *Théogonie* ou *Les travaux et les Jours*. Il ne peut s'agir alors de privilégier les éléments qu'on retrouve, plus ou moins transformés, dans d'autres versions. On doit s'efforcer de donner du mythe, dans le détail de sa configuration, une analyse exhaustive.

The books of the Old and New Testament are not generally regarded as epics. This is surprising, for the life stories of the prophets do celebrate the actions of key figures such as Abraham, Moses, Daniel, and Jesus Christ, and they show the vision of the world shared by many peoples today. In reality, what is regarded as a Biblical epic is the adaptation of texts from various books of the Bible in dactylic hexameters produced from the early fourth century up to the Renaissance (Faïsse, 2008). However, the fact that the original texts form the bedrock of several current religions (Judaism, Christianity, and Islam) also sets the Bible apart from pagan epics.

By contrast, can we regard as epics the many epic poems produced in Europe from the sixteenth century onward, such as Ronsard's *Franciade* (1572) and Milton's *Paradise Lost* (1667)? In terms of their formal characteristics, these works are obviously epics. If, however, we look to them for radically new solutions for interpreting the world, we must admit that they are failed epics. As Vinclair clearly states (2015, p. 213):

Failed epics because, through a misguided interpretation of the theory of genres, the heroic poet (in keeping with the opinion of contemporary critics) thinks that by imitating the phenotypic properties he could achieve a work of the same kind as those of Homer or Virgil.⁸⁸

Can we also conclude that the epic genre is now dead? We do not think so, for with the decline of Christian civilization, a new culture should arise. In the late nineteenth century, Nietzsche wrote in *Die fröhliche Wissenschaft* (1882, sect. 125):

God is dead! God remains dead! And we have killed him!⁸⁹

One might have imagined that the decline of Judeo-Christian civilizations would foster the rise of a new epic in our world. That is

⁸⁸ French text: Des épopées ratées parce que, se fourvoyant sur la théorie des genres, le poète héroïque (suivant l'opinion des critiques de l'époque) pense que l'imitation des propriétés phénotypiques lui permettrait d'accomplir une œuvre de même nature que celles d'Homère ou de Virgile.

⁸⁹ German text: Got ist todt! Got bleibt todt! Und wir haben ihn getödtet!

certainly what Mallarmé intended with his planned *Livre (Book)*, which he never wrote. Before Nietzsche, he had come to believe that God does not exist. As he wrote in a letter to Cazalis in 1867 (*Correspondance 1854-1898*, 1, 241):

After a supreme synthesis, I am slowly gaining in strength—unable, as you can see, to be distracted. But how much more unable I was, several months ago, first in my terrible struggle with that old and evil plumage—God—fortunately knocked to the ground. But as that struggle had taken place on his bony wing—which, by an agony more vigorous than I could have suspected in him, had swept me into the Shadows—I fell, victorious, madly and infinitely so [. . .]⁹⁰

To found this new godless civilization, glimpsed by Mallarmé and Nietzsche, a new epic was required. But neither writer was able to compose it, no doubt because of its sheer magnitude, and one hundred and fifty years later, religion still maintains a strong presence and is far from having vanished from the minds of our contemporaries.

Let us now turn to tragedy.

Greek tragedy emerged several centuries after Homer's epic and acquired its definitive form with Aeschylus (ca. 525-456 B.C.), when his play *The Persians* was first performed in 472 B.C.E. The term "tragedy" derives from the ancient Greek [τραγωδία](#), which combines [τράγος](#) (he-goat) and [ὥδή](#) (song, sung poem). It first designated the ritual chant accompanying the goat's sacrifice at the feasts of Dionysus in archaic times. Later, as Szondi noted, tragedy was defined by the concept of the necessity of human fate.

We have also seen that, in formal terms, Aristotle preferred tragedy to epic, as it was more effective in condensing actions. This narrower scope could prevent it, at least in part, from telling a fuller

⁹⁰ French text: J'en suis, après une synthèse suprême, à cette lente acquisition de la force – incapable tu le vois de me distraire. Mais combien plus je l'étais, il y a plusieurs mois, d'abord dans ma lutte terrible avec ce vieux et méchant plumage, terrassé heureusement, Dieu. Mais comme cette lutte s'était passée sur son aile osseuse qui, par une agonie plus vigoureuse que je ne l'eusse soupçonné chez lui, m'avait emporté dans les Ténèbres, je tombai, victorieux, éperdument et infiniment ...

and more elaborate life story. It would often concentrate on a specific episode of life. To quote Aristotle (Poetics, 1449b):

Epic poetry agreed with tragedy only in so far as it was a metrical representation of heroic action, but inasmuch as it has a single metre and is narrative in that respect they are different. And then as regards length, for Tragedy endeavours, as far as possible, to confine itself to a single revolution of the sun, or but slightly to exceed this limit, whereas the Epic action has no limits of time.⁹¹

Aristotle's observation became the basis for the rule of unity of time championed by Boileau and Corneille in the seventeenth century, together with unity of action and place.

However, as noted earlier, if we drop Aristotle's definition—which is linked to generic traits—the recounting of past events in the unfolding of a tragedy made it possible to extend the life span considered.

For example, Sophocles' tragedy *Οἰδίπους Τύραννος* (*Oedipus Tyrannus*) begins when the king—the better part of his life behind him—consults the oracle in order to determine the cause of the plague raging in Thebes. The oracle, however, entails the successive recapitulation of all the major events that marked his life since birth. The necessity of his fate then becomes inescapable, up to the point when his wife/mother commits suicide and he blinds himself. We examine this tragedy as an example of the genre in a later section.

The use of the three-unities rule was not rejected until the nineteenth century, in Victor Hugo's preface to his play *Cromwell* (1828). Here is what he writes about the unity of time (p. 27):

Unity of time is no more solid than unity of place. Action, forcibly framed in twenty-four hours, is as ridiculous as if it were framed in the entrance. Every action has its own duration just as it has its specific place. Pouring the same dose of time into all events!

⁹¹Greek^otext: ἢ μὲν οὖν ἐποποιία τῇ τραγωδίᾳ μέχρι μὲν τοῦ μετὰ μέτρου λόγῳ μιμησις εἶναι σπουδαίων ἠκολούθησεν: τῷ δὲ τὸ μέτρον ἀπλοῦν ἔχειν καὶ ἀπαγγελίαν εἶναι, ταύτῃ διαφέρουσιν: ἔτι δὲ τῷ μήκει: ὅτι δὲ τῷ μήκει: ἢ μὲν ὅτι μάλιστα περᾶται ὑπὸ μίαν περίοδον ἡλίου εἶναι ἢ μικρὸν ἐξαλλάττειν, ἢ δὲ ἐποποιία ἀόριστος τῷ χρόνῳ καὶ τούτῳ διαφέρει.

Applying the same measure to everything! One would laugh at a cobbler who wanted to fit the same shoe to all feet. Crossing unity of time with unity of place, like bars on a cage, in which—pedantically, following Aristotle—one introduces all the facts, all the peoples, all the figures that providence bestows in such massive amounts in reality! That's to mutilate men and things, that's to make history wince.⁹²

In fact, he calls his work a “drama,” not a “tragedy,” highlighting a sub-genre of Greek tragedy that already existed in antiquity as τὸ σατυρικόν δράμα (satirical drama). Oddly enough, though, the drama complies with unity of time, since it takes place on June 26, 1657, from three in the morning to noon. However, Hugo's later dramas and those of the other Romantics departed from the rule.

The twentieth century saw a revival of ancient tragedy in different forms: Eugene O'Neill's trilogy *Mourning becomes Electra* (1931); as tragicomedy or dramatic comedy with *La guerre de Troie n'aura pas lieu* by Jean Giraudoux (1935); as drama with *Les mouches* by Jean-Paul Sartre (1943); or as dark drama with *Antigone* by Jean Anouilh, performed in 1944 and published in 1946. We may conclude that Greek tragedy can keep renewing itself and will never die.

Let us now turn to the new literary genre that emerged in medieval Europe, evolved during the Renaissance to take root across the centuries, and was given different names from one country and period to another. In English, it was first known as “romance” in the Middle Ages and became “novel” at the end of the XVIIth century (Millet, 2006; Lee, 2014). In French, German, and other languages, it has kept its name *roman* since the Middle Ages (Lee, 2014). As

⁹² French text: L'unité de temps n'est pas plus solide que l'unité de lieu. L'action, encadrée de force dans les vingt-quatre heures, est aussi ridicule qu'encadrée dans le vestibule. Toute action a sa durée propre comme son lieu particulier. Verser la même dose de temps à tous les événements ! appliquer la même mesure sur tout ! On rirait d'un cordonnier qui voudrait mettre le même soulier à tous les pieds. Croiser l'unité de temps à l'unité de lieu comme les barreaux d'une cage, et y faire pédantesquement entrer, de par Aristote, tous ces faits, tous ces peuples, toutes ces figures que la providence déroule à si grandes masses dans la réalité ! c'est mutiler hommes et choses, c'est faire grimacer l'histoire.

observed earlier, the romance or novel took on its particular characteristics with respect to the epic and developed its own way of thinking.

The words *romance* (English) and *roman* (French) derive from the Latin adverb *romanice*, meaning “in the manner of the Romans,” i.e., in accordance with the spoken language, not the written language. The English *novel* derives from the old French *nouvel*, meaning “new, young, fresh, recent,” i.e., a new form of literature. It should be noted, however, that a *nouvelle* in French is a sub-genre of the novel, being a short, dense story. In English, by contrast, *romance* has become a sub-genre of the *novel*.

If we consider the epic and the novel on the basis of the presence of reproducible generic traits and processes, we have seen that we could not distinguish between the two, for both told individual life stories. Yet, despite the many sub-genres that have appeared since the Middle Ages, Vinclair’s detailed study of the novel leads him (2015, p. 348) to define it as seeking:

[. . .] to conceive (by experience and by polyphenism) and to bring into existence [...] new forms of salvation, on a solitary basis.⁹³

Therefore, in terms of the thought pattern, the novel does indeed belong to a totally different domain from the epic.

As before, we shall give some examples—with no attempt at exhaustiveness—of novels from different periods to show their diversity and, at the same time, what unites them.

The romances recounting the life of Tristan and Yseult were written in different versions and in different parts of Europe in the twelfth and thirteenth centuries. Only fragments remain. These texts opened the genre to the feeling of passionate love between two persons: the German poem by Eilhart von Oberg, the fragment by the Norman juggler Bérout, the poem by Thomas of England, the unfinished poem by Gottfried of Strasbourg, and other versions show the novel’s widespread circulation in a feudal society. More generally, the Arthurian romances represent a revolution in

⁹³ French text : ...à penser (par expérience et par polyphénie) et à faire advenir [...] en solitaire, de nouvelles formes de salut.

Medieval European literature that combines religion, armed struggles, and love. For further details, see the *Handbook of Arthurian Romance* edited by Tether and McFadyen in 2017.

In the seventeenth century, an abundant series of romances on the life of Henri de Joyeuse (1563-1608) fueled the genre still known as *romans dévots* (devotion romances), all written by clergymen. Their subject was the biography of an important member of a then famous family. Henri was the brother of Anne de Joyeuse, who played a key role during the reign of Henri III of France. Later we describe in detail how he became a full-fledged novelistic character in the seventeenth century.

The novel reached maturity in the late eighteenth century and its apogee in the nineteenth. As an example, we take Leo Tolstoy's (1828-1910) *Война и миръ* (*War and Peace*) (1868-1869), which, strictly speaking, represents a sub-genre—the epic novel—for it combines two overlying strata of narrative (Vinclair, 2015, p. 337):

a novelistic stratum that recounts, as an experience of consciousness, how the characters “continue to lead their normal lives”; and a theological-historical stratum, which relates the progress of History, which cannot be controlled either by great men, who are its instruments, or—*a fortiori*—ordinary people, who are its spectators.⁹⁴

Individuals are portrayed as unwitting instruments serving historical and social purposes. Although the novel has more than 550 characters, it focuses on the life stories of the three main characters: Natasha Rostova, Andrei Bolkonsky, and Pierre Bezukhov, from 1805 to 1820. Of the many studies devoted to it, we refer the reader to the article by Lee Trepanier (2011), which discusses a number of these analyses and weighs their merits.

In the twentieth and early twenty-first centuries, authors' interest in the genre was unabated, and new sub-genres developed

⁹⁴ French text: un plan romanesque qui raconte, sur le mode de l'expérience de la conscience, la manière dont les personnages « continuent à mener leur vie normale » ; et un plan théologico-historique qui raconte la progression de cette Histoire sur laquelle n'ont prise ni les grands hommes, qui en sont les instruments, ni *a fortiori* les hommes du commun, qui en sont les spectateurs.

such as science fiction, novels inspired by the Letterist movement, crime novels, and parodic novels.

We shall not dwell here on the other literary genres, which resort far less to biographical narratives, the category of relevance to our study. Aristotle's *Poetics* was supposed to contain a section on the theory of comedy, but it has not survived. However, in his discussion of tragedy, we find a definition of comedy (1449a):

Comedy, as we have said, is a representation of inferior people, not indeed in the full sense of the word bad, but the laughable is a species of the base or ugly. It consists in some blunder or ugliness that does not cause pain or disaster, an obvious example being the comic mask which is ugly and distorted but not painful.⁹⁵

Clearly, his definition does not involve a life story, but merely a representation of “inferior” individuals. Similarly, de Guardia (2004) offers an in-depth analysis of the possibility of comedy as opposed to tragedy, and observes (p. 131):

Molière gave up the primacy of plot and shifted the focus of comedy to characters. The goal was no longer to tell a story that would cause laughter, but to *describe* people in a way that would cause laughter.⁹⁶

The life story told in a comedy is thus purely conventional, and hence of little relevance to our study. Likewise, lyric poetry, with its exclusive focus on feelings—as Batteux had noted in 1746—has no use for life stories.

As for fables, tales, and legends, they are too condensed and imaginary to describe a detailed life story. However, as tales shape our minds from our earliest childhood, we may view them as equal to myths in their ability to impart meaning to our lives (Bettelheim,

⁹⁵ Greek text: ἡ δὲ κωμωδία ἐστὶν ὥσπερ εἵπομεν μίμησις φαυλοτέρων μὲν, οὐ μέντοι μέντοι κατὰ πᾶσαν κακίαν, ἀλλὰ τοῦ αἰσχροῦ ἐστὶ τὸ γελοῖον μῶριον. τὸ γὰρ γελοῖον ἐστὶν ἀμάρτημά τι καὶ αἰσχος ἀνώδυνον καὶ οὐ φθαρτικόν, οἷον εὐθύς τὸ γελοῖον πρόσωπον αἰσχρόν τι καὶ διεστραμμένον ἄνευ ὀδύνης.

⁹⁶ French text : Molière a renoncé à la primauté de l'intrigue et a déplacé l'enjeu de la comédie vers les caractères. Il s'agit alors non plus de raconter une histoire en faisant rire, mais de *décrire* des hommes en faisant rire.

1976). Tales offer us simple but profound images, which we can incorporate into our existence, rather than complex life stories as epics do (von Franz, 1970). We therefore exclude them from our analysis.

Let us now take a closer look at examples of the various kinds of life stories recounted in the major literary genres considered here.

6.2 The Epic of Gilgamesh

The Epic of Gilgamesh is more than 1,000 years older than Homer's epics and the Mahābhārata, making it the oldest known literary work along with the Atrahasis Epic (Frimer-Kensky, 1977), the equivalent of the Biblical Genesis. The *Sumerian list of kings* (ca. 2000 B.C.E.) tells us that Gilgamesh was the fifth ruler of the city of Uruk in Mesopotamia, after the flood. He reigned from ca. 2461 to 2400 B.C.E., according to Gertoux's estimate (2016, p. 61), which he obtained by synchronization with astronomical data and events occurring among other peoples (Sumerians and Egyptians).

There are many versions of the epic in Sumerian and Akkadian (see §3.1.1 for more details on Akkadian) spanning a period of about 2,000 years, but all are incomplete. By comparing them, one can reconstruct two main versions: an ancient Babylonian version, with many gaps, and a fuller standard version, translated in English by George (1999) and in French by Bottéro (1992), with older texts. The text then vanished in ca. 250 B.C.E. to be rediscovered in the mid-nineteenth century on Assyrian tablets that could now be translated. Despite its many variants, the text of the epic displays great unity from its oldest version to its most recent version.

Through the fictional life story of Gilgamesh, the Mesopotamians—in Bottéro's words (1992, p. 294)—infused it with:

[. . .] the reflected image of their way of life and way of thinking, their culture, their desires, their problems, their values, and their

limits, everything that informed their existence and gave it meaning, and—even beyond that—their more universally human reactions to the great issues of our fate [. . .]⁹⁷

That is indeed what characterizes epic as a literary genre: the establishment of new values.

Although we cannot be certain of this, given the lack of earlier texts, the Epic of Gilgamesh would appear to reflect the suppression of early Mesopotamian matriarchal societies (Gange, 2006) by a new patriarchal hegemonic order represented by its hero's superhuman power. Gilgamesh is portrayed from the outset, because of his birth, as two-thirds God and one-third man—as the builder of the ramparts of Uruk to defend his city from attackers and as the mighty commander of his troops. He also acts as master of fertility by taking an adolescent girl away from her mother and her betrothed, exercising his right to possess her on her wedding night. Gilgamesh thus performs the three functions outlined by Dumézil (1968): sovereignty, military force, and fertility.

However, his excesses against women lead them to ask the Mother-Goddess Aruru, who trained him, to calm his ardor. This marks the revival of the power of matriarchal societies, which Gilgamesh is attempting to suppress. Aruru raises Enkidu in the steppe, endowing him with a force equal to that of Gilgamesh. Enkidu, who resembles a god of wild beasts, is the opposite of the wholly civilized Gilgamesh, who must humanize him with the aid of a courtesan in order to bring him to Uruk, where he intends to fight him. When Enkidu arrives in Uruk, Gilgamesh takes part in a wedding where he must possess the bride before the spouse. Enkidu blocks the door to Gilgamesh and starts to fight him. The combat, however, ends with Gilgamesh acknowledging Enkidu's force, and the women's complaint remains unresolved.

⁹⁷ French text : ... l'image réfléchie de leur façon de vivre et de penser, de leur culture, de leurs désirs et de leurs problèmes, de leurs valeurs et de leurs limites, de tout ce qui baignait leur existence et lui donnait un sens, et, par-delà encore, des réactions plus universellement humaines qui étaient les leurs devant les grands problèmes de notre destin ...

The two now inseparable companions set out to conquer the Cedar Forest in order to find the timber lacking in the Uruk region. But the forest is guarded by Humbaba, a superhuman monster placed there by Enlil, the sovereign of the gods. Before departing on their dangerous expedition, the two companions seek advice from Ninsun, Gilgamesh's mother-goddess and lady of the wild cows. Once again, the epic tells of an intervention by an all-powerful goddess who warns her son of all the dangers of this risky adventure—warnings that he largely ignores.

After a long journey, the two companions battle Humbaba, behead him, and return to Uruk with their load of felled trees. On their return, Ishtar—chief goddess of Uruk, goddess of love, fertility, and war—asks Gilgamesh to marry her. This hierogamy (sacred marriage) would have legitimized his crown, as his father Lugulbanda had by marrying the goddess Ninsun. But Gilgamesh rejects her offer, noting that Ishtar's previous unions had brought misfortune to her consorts. As Lanoue points out (2016, p. 566):

However, a marriage with Ishtar would not have settled the succession issue, for their children would have received an ambiguous inheritance from their mother. Ishtar is a goddess of sex but also of war and death—two sides of the same coin presented in a metonymic syntagm: sex increases population, while war reduces it.⁹⁸

Moreover, to assert the power of his sex, Gilgamesh would be ill advised to wed a powerful goddess. Yet again, therefore, his opposition to the matriarchate is what causes him to reject a union with Ishtar.

As a goddess, Ishtar complains bitterly to the supreme god Anu, asking him to create the Celestial Bull, who will lay waste the entire region of Uruk for her. Anu grants her request, and the bull descends to Uruk and begins his destruction. But Gilgamesh and

⁹⁸ French text : Cependant, un mariage avec Ishtar n'aurait pas réglé la question de succession, car leurs enfants auraient reçu de leur mère un héritage ambigu : Ishtar est une déesse du sexe, mais elle est aussi une déesse de la guerre et de la mort, deux faces de la même monnaie présentées sous un syntagme métonymique : le sexe augmente la population et la guerre la diminue.

Enkidu, on the strength of their success in the Cedar Forest, attack him and slay him. Since Gilgamesh's mother is the "lady of the wild cows," we realize that he has thus slain his own maternal root (Fognini, 2008, p. 53).

Unfortunately this dual attack on the gods spells death for Enkidu, who endures a slow, twelve-day agony in which he relives and reinterprets his life, even questioning Gilgamesh's friendship.

Enkidu's death leads Gilgamesh to embark on a long quest to understand the meaning of human life. He encounters the immortal ancestor, Uta-napishti—foreshadowing the Biblical Noah—who survived the flood with his family and all the animals that he had placed in his boat. After the detailed account of the flood, Uta-napishti asks Gilgamesh to spend seven sleepless days and nights in order to achieve immortality. On the very first day, however, Gilgamesh falls into a sleep that lasts the following seven nights and days. He thus cannot escape death. But just as Gilgamesh is leaving them, Uta-napishti's wife convinces her husband to let Gilgamesh reach the plant that prolongs life. Gilgamesh promptly seizes it, but on his way back to Uruk, he decides to bathe in a pool of fresh water and a snake steals the plant.

All he can do now is return to his city, which he administers until his death. This conclusion repeats the description in the first tablet exactly. It is only after his death that he is finally deified as the sovereign and judge of the dead in hell.

This epic, which has remained very popular for nearly twenty centuries, thus marks the advent of a patriarchal culture in opposition to the matriarchy that preceded it. Even the female goddesses who prevailed before this revolution were masculinized: the goddess Aruru was replaced by male divine entities, and the great gods of local pantheons were invoked as being endowed with her capabilities (Frank, 2011).

There are many similarities between this epic and the later epics of Homer and the *Mahābhārata*. A recent work on these topics may interest readers seeking further information (Geler, 2014).

6.3 Sophocles' tragedy: Oedipus Tyrannus

The Greek tragic genre appeared in the late sixth century B.C.E., when epic—as Homer conceived it—ceased to be in step with Athenian political society. Having discussed Aeschylus' tragedies (§2.3.1), we now turn to Sophocles' tragedy: *Oedipus Tyrannus*.

Our first question is: what else do we know about the author? He is said to have lived in Thebes (Greece) around the thirteenth century B.C.E., i.e., more than a millennium after Gilgamesh. We have little information on earliest Greek antiquity. Linear B script was not deciphered until 1953, thanks to the linguist Michael Ventris. But very few of these tablets contain information on the rulers of the time.

For slightly more information on the reign of Oedipus, we must look at Homer's epics. In the *Odyssey* (11, 271-280), we find a short passage on Oedipus:

I also saw the lovely Epicástē,
mother of Oedipus; unknowingly,
she'd shared in a monstrosity: she married
her own son. And she wed him after he
had killed his father. But the gods did not
wait long to let men know what had been wrought.
Yet since they had devised dark misery,
the gods let him remain in handsome Thebes;
and there, despite his dismal sufferings,
he stayed with the Cadméans as their king.
But she went down into the house where Hades
is sturdy guardian of the gates; for she,
gripped by her grief, had tied to a high beam
her noose. But when she died, she left behind
calamities for Oedipus—as many
as the Avengers of a mother carry.⁹⁹

⁹⁹Greek^otext^o: °μητέρα τ' Οἰδιπόδαο ἴδον, καλὴν Ἐπικάστην, °ἣ μέγα ἔργον ἔρεξεν
αἰδρεΐησι νόοιο °γῆμαμένη ὧ νῦν: ὁ δ' ὄν πατέρ' ἐξαναρίζας °γῆμεν: ἄφαρ δ' ἀνάπυ-
στα θεοὶ θέσαν ἀνθρώποισιν. °275 ἄλλ' ὁ μὲν ἐν Θήβῃ πολυηράτῳ ἄλγεα πάσχων °
Καδμείων ἥνασσε θεῶν ὀλοὰς διὰ βουλὰς: °ἣ δ' ἔβη εἰς Αἴδαο πυλάρταο κρατεροῖ-
ο, °ἀψαμένη βρόχον αἰπὸν ἀφ' ὕψηλοιο μελάθρου, °ὧ ἄχεϊ σχομένη: τῷ δ' ἄλγεα κ

In this outline of the life of Epicaste (Jocasta), Oedipus' mother and wife, Homer does not mention their four children, for Epicaste's death occurs here just after her marriage, nor does he speak of the fact that Oedipus left the palace after blinding himself. In Homer's account, he continues to reign on the Cadmeans. Other versions say that, after Epicaste's death, Oedipus had two other wives who bore him his children (Lacore, 1999).

Sophocles' tragedy dates from 429 B.C.E., in the period when Greek freedom was flourishing (see §2.3.1). We must therefore view the play in the context of Greek society of its time. As noted previously, the democratic freedom of Greek citizens came up against the belief in an inescapable fate, partly represented by Hellenic astrology (see §3.1.2). Being informed by the concept of necessity, tragedy served to show how an individual—thanks to freedom—could fight against the higher power of his or her fate.

Because of the need to concentrate on a short period of time, the tragedy unfolds at the point when Oedipus is about to lose power. However, by inserting timely reminders of past events, Sophocles reconstructs a fuller life story leading up to the present situation. As the tragedy is well known and has already been the subject of many studies, we shall simply focus on certain aspects of Oedipus' ambiguous life story, which is revealed during the entire course of the play.

At his birth, his parents, Laius and Epicaste, are reigning over Thebes. They consult the oracle of Delphi, who predicts that their son will kill his father. The parents decide to eliminate him and Epicaste asks a slave to leave him out in the open, which—in Greece—would entail his death. But the slave does not carry out the order and hands the boy to a shepherd, who takes him to Corinth and entrusts him to the local monarchs, Polybus and Merope. They adopt Oedipus and raise him as their son. When he reaches adulthood, however, a rumor claims that he was adopted.

Oedipus decides to consult the oracle of Delphi to find out the truth. But the oracle does not answer his question and tells him

ἀλλ' ὅπισσ' ὅ πολλὰ μάλ', ὅσα τε μητρὸς Ἐρινύες ἐκτελέουσιν.
translation by A. Mandelbaum.

English

that he will slay his father and marry his mother. To avoid this, he leaves Corinth for Thebes. On the way, he meets an old man. They quarrel, and Oedipus kills him in self-defense without knowing that the man is his true father.

Oedipus arrives in Thebes, a city tormented by the presence of the Sphinx, who is devouring its inhabitants and visitors because they cannot answer his question (not revealed in the tragedy). Oedipus gives the right answer, freeing the city.

As a reward for his action, the city asks him to rule it and forces him to marry its queen, Epicaste. Oedipus reigns for about twenty years, and the couple have four children.

The play actually begins at this point, with the outbreak of an epidemic whose cause Oedipus wants to discover—a search that will lead him to reveal his own fate. This triggers a reversal, turning him from superhuman to subhuman (Vernant, Vidal-Naquet, 1972). When he puts his eyes out so as not to see the world any more, because he cannot bear it, he clearly states (Sophocles, 1330-1335):

It was Apollo, friends, Apollo who brought these troubles to pass, these terrible, terrible troubles. But the hand that struck my eyes was none other than my own, wretched that I am! Why should I see, when sight showed me nothing sweet?¹⁰⁰

Oedipus therefore distinguishes between the divine causality brought on by Apollo and his human action due to his misfortune. It is hard not to link this event to the death of Socrates (described earlier in §2.3.1) as a conflict leading him to accept the judges' sentence. Schelling (1914, p. 85) shows the implications for Sophocles' play:

It is by letting its hero battle the higher power of fate that Greek tragedy honored human freedom. So as not to transgress the barriers of art, tragedy had to ensure that he succumbed; but, to make up for this humiliation of human freedom torn away by art, it was also

¹⁰⁰Greek^otext: [Ἀπόλλων τάδ' ἦν, Απόλλων, φίλοι, ὃ κακὰ κακὰ τελῶν ἐμὰ τάδ' ἐμὰ πάθεα. ἔπαισε δ' αὐτόχειρ νιν οὐτις, ἀλλ' ἐγὼ τλάμων. τί γὰρ ἔδει μ' ὀρᾶν, ὅτ' ὦ γ' ὀρῶντι μὴδὲν ἦν ἰδεῖν γλυκύ.](#)

necessary—and this, also for the crime committed by fate—that he should undergo the punishment.¹⁰¹

Schelling wrote this text in 1795 in a series of “philosophical letters,” but it not published in his lifetime. Other interpretations have been offered for Oedipus’ reaction: Vernant and Vidal-Naquet (1972, p. 70), for example, do not see an opposition but, on the contrary, a union. We find Schelling’s interpretation closer to Sophocles’ likely intent, although it is impossible for us today to put ourselves in his state of mind or to surmise exactly what he wanted to convey to his audience.

6.4 Romances about the life of Henri de Joyeuse

For the lives of Gilgamesh and Oedipus, we lack contemporary evidence. All we have is an epic or a tragedy, written well after their death. In contrast, for the life of Henri de Joyeuse (1563-1608), we have enough documentation to compare with the novels written about his life.

The Duke Henri de Joyeuse was the brother of Anne de Joyeuse, the male favorite of Henri III, king of France. At age 18, he married Catherine de Nogaret de la Valette, who died in 1587 after giving birth to their daughter. His wife’s death convinced him to become a Capuchin monk a month later. That same year, his brother Scipio drowned in the Tarn during the siege of Villemur. In 1592, Henri was allowed by his superiors to return to civilian life. First commander of the armies in Languedoc, he became Governor of the province and Marshal of France. The Edict of Nantes restored

¹⁰¹German text: Die griechische Tragödie ehrte menschliche Freiheit dadurch, daß sie ihren Helden gegen die Uebermacht des Schicksals k ä m p f e n ließ: um nicht über die Schranken der Kunst zu springen, mußte sie ihn u n t e r l i e g e n , aber, um auch diese, durch die Kunst abgedrungne, Demüthigung menschlicher Freiheit wieder gut zu machen, mußte sie ihn – auch für das durch's S c h i c k s a l begangne Verbrechen – b ü ß e n lassen. So lange er noch f r e i ist, hält er sich gegen die Macht des Verhängnisses aufrecht.

freedom of religion to French Huguenots in 1598, and Henri rejoined the Capuchins a year later. His life became that of an exemplary penitent and superior, whose sermons in Paris and the provinces ensured his success. At the same time, he was a mystic subject to ecstasies. Despite his weak health, he traveled to Rome in 1608 to attend the general chapter and died on the way back at the Convent of Rivoli in Italy. His remains were returned to Paris in a triumphal procession and buried in the church of the Feuillants Convent. This life story was reconstructed from several historical sources, most notably Raynal's *Histoire de la ville de Toulouse* [. . .] (1759, pp. 311-321).

Henri's life was thus marked by sharp contrasts—at once a courtier and intimate of Kings Henri III and Henri IV living in luxury in Toulouse and Paris, and a Capuchin monk whose fiery sermons and apostolic ardor drove him to warm up at a crossroads with beggars (Brousse, 1621).

After his death, he inspired what were known as “devout romances” (*romans dévots*) intended to promote a new form of salvation in Catholicism. The term references Vinclair's more general definition of the novel (2015, p. 248).

The first of these romances (du Lisdam, 1619) is devoted not to the life of Henri de Joyeuse, but to the conversion of Leopolda and Lindarche to religion, inspired by several examples including the life of the courtier-priest. While the text never mentions Henri by name, the account of his life was explicit enough for everyone to recognize him less than twenty years after his death. The narrative, however, does not try to conceal his “debauchery” and “worldly licentiousness” before his second retreat (p. 599):

It is said that he committed a thousand debaucheries, but that when he was thought to have wholeheartedly embraced worldly licentiousness, he ran to the fathers who had given him the monk's habit. He persevered with such constancy that his death was the end of his penance.¹⁰²

¹⁰² French text : L'on dit qu'il fist mille débauches, mais que lors qu'on pensoit qu'il eust du tout donné son cœur aux licences mondaines, il alla se jeter entre ces

The reader will notice that the use of the phrase “it is said” suffices to exonerate Henri from his excesses, all the more so as he returned to religious life after this six-year interval.

The second romance, by Jacques Brousse (1621), was published three years later. Here, Henri is clearly named and the work is dedicated to his only daughter. The episode of his return to secular life is now barely mentioned and the Duke is never described as a Marshal of France but always as a man of peace, even though he fought the Huguenots fiercely during his spell as a layman.

A third romance, by Philippe d’Angoumois, was published in 1625 under the title *Les triomphes de l’amour de dieu en la conversion d’Hermogene* (The triumphs of the love of God in the conversion of Hermogenes). The narrative incorporates an extensive account of Henri de Joyeuse’s career as a model for the spiritual ascension of the former courtier Hermogenes. The author contrasts the Duke’s life of luxury before his conversion with the rigors of his Capuchin life. There is no mention of his return to military and worldly life for six years. This omission erases an important part of his life in order to focus on his monastic career.

For a fuller description of these fictionalized biographies told by Catholic clergymen, we refer the reader to Nancy Oddo’s account (2000, 2008) of their invention in the seventeenth century. Here, we should like to contrast them with the romance by d’Aubigné (1630), who set out to combat Catholic preaching methods.

The early seventeenth century was marked by the incessant religious controversy between Catholics and Protestants. In d’Aubigné’s romance, Ange de Joyeuse is repeatedly cited for his sermons, which the author openly criticizes. While his claims seem too burlesque to be real, some (p. 799) are confirmed by the diary of his contemporary Pierre de l’Estoile (p. 598):

At that point the great preacher rolled his eyes, remained for a long time as if having fainted, and came back to his senses to dwell at length on the pains of the Passion, which he compared to all the

pères qui lui ont donné l’habit. Il a persévéré avecque tant de constance, que sa mort a esté le bout de sa pénitence.

pains he could recall, scorning all sorts of fevers and maladies, which he enumerated, and then slight wounds and other ills; then he fainted for the second time and, utterly transported by fury, pulled out of his pocket a rope made like a halter with a noose; he placed it around his neck, stuck out his tongue, and—according to some—would have strangled himself had he pulled really hard; the companions of the lesser observance rushed up and removed the halter rope. The entire vault resounded with the cries of spectators, who had changed their laughter into laments, the comic opening into tragedy, which, however, was a bloodless sacrifice.¹⁰³

By thus ridiculing Father Ange, d'Aubigné castigated an individual at the same time as a religious order (Fantoni, 2011, p. 279). This shows how the romance could either legitimize a Catholic sentiment or condemn it from a Protestant standpoint.

6.5 What role will these imaginary life stories play in our own life?

In this chapter, we have seen that the method to analyze these imaginary life stories may be “comprehensive” in the sense given by philosophical hermeneutics, for example by Dilthey (1883). This was clearly shown by Szondi (1975) and his followers. Let us recall here some of its principles.

¹⁰³ French text : Là-dessus ce grand prédicateur tourna les yeux en la teste, demeura longtemps comme esvanouy, se reprend pour s'estendre sur les douleurs de la Passion, desquelles il fit comparaison avec toutes douleurs dont il peut se souvenir, mesprisant toute sorte de fievres et de maladies, qu'il cotta de rang, et puis les blessures legeres et les autres maux ; là il se pasma pour la seconde fois, et tout transporté de fureur, tira de sa poche une corde faite en licol avec le nœud courant ; il se la mit au col, tirant la langue, et pour certains se fust estranglé s'il eut tiré bien fort ; les compagnons de la petite observance y accoururent et lui osterent la corde du licol. Tout la voute retentissait de cris des spectateurs, qui avaient changé les ris en plaintes, l'entree comique en tragédie, laquelle fut toutefois sacrifice non sanglant.

The term “comprehension” is polysemic, and we must begin by examining its multiple meanings. The first is to “comprehend” individual behavior, i.e., to understand the reasons for a person’s acts and the significance he or she assigns to them. This applies perfectly to the writing of an imaginary life story. The process might also consist of arriving at a more general “comprehension” of a set of facts or events, i.e., producing an interpretation of the set in order to show its exact significance. In this case, the facts or events do not concern a particular individual but are more general and apply, for example, to the history of a social group. This second meaning is less relevant to us here, but is of the utmost interest to the historian.

We have discussed this “comprehensive” approach for imaginary lives (epics, tragedies, comedies, novels, and other genres), showing how it enables us to extract their key elements. As Mesure notes (1990, p. 231):

To begin with, it is confirmed that comprehension does consist in taking real-world experiences and building the *set* that brings them together; from what was a mere sequence, [comprehension] achieves the emergence of what properly constitutes a *life*, i.e., a totality directed toward an end that imparts meaning to each stage [...]¹⁰⁴

In this way, the object of the sciences of the mind obtains a deeper justification, and simultaneously its philosophical foundation.

In the introduction to this chapter, we noted the importance of these imaginary lives in our own life. Do the selected lives that we have presented in greater detail enable us to better identify the reasons for this importance?

Will they take us to the confines of the unfettered imagination of the inventors of these lives—albeit so different from ours—and simply entertain us?

¹⁰⁴ Il se confirme tout d’abord que la compréhension consiste bien, en partant des expériences vécues, à construire *l’ensemble* qui les réunit et, de ce qui n’était qu’une simple succession, fait émerger proprement une vie, c’est-à-dire une totalité orientée vers une fin qui donne sa signification à toute les étapes ; ...

If this hypothesis has some basis in fact, it is because our own life is so dull that we seek diversion through reading. Ettore Scola's film *A Special Day* shows us the life of a mother under Mussolini's fascist regime: she is neglected by her husband and confined to the repetitive chores of managing her many children and her household. While her husband and children go off to a large fascist celebration, she encounters by chance another outcast of the regime, a homosexual, who reveals another universe to her. Before his arrest by the police of the regime—which is uncompromising for those who do not think like it—the man leaves her Alexandre Dumas' novel *The Three Musketeers*. The woman, who can barely read, may perhaps be able, with the aid of the novel, to open herself up to different world from the regime in which she is a captive. This possibility is suggested by the film's ending, where she begins to decipher the book in secret. In this case, however, we discover another aspect of imaginary life stories: the change of course in the woman's life can go much further if she accepts the opening toward another person's life that the novel will offer her.

Actually, these imaginary life stories were not written for mere entertainment. Their substance is far deeper. To begin with, epics have served as foundations for civilizations for thousands of years. The Epic of Gilgamesh was the basis for the ancient Assyrian regimes, whose rediscovery in our time opens our minds to another way of thinking about our own civilization. Sophocles' tragedies nourished the Athenian regime in the sixth century B.C.E. by placing human freedom above the inescapable fate of the individual. Today, they still provide food for thought, as contemporary performances perfectly demonstrate. The romances on the life of Henri de Joyeuse give us insights on the role of Christian religion—a role that persists to this day. All the other examples that we could have discussed contain important reflections on the society in which they were created, and now help us to better understand the society in which we live.

Reading these life stories—beyond the narratives of their author or authors—will therefore nourish our existence by offering another possible world that is essential to our lives, for they remain imprisoned in a regime whose degree of freedom can vary. The

following chapter looks at these actually lived lives and shows the limits to our understanding of them.

Chapter 7

Real life stories to celebrate or to study humans

This chapter will examine how human memory develops with the aim of capturing life stories and what it records of them; we then explore how these processes are analyzed by the social sciences. We discuss the two main approaches: philosophical hermeneutics and the scientific approach to social science advocated by Bacon in 1620 and implemented by Graunt in 1662.

However, the non-fictionalized accounts of real individuals' lives will also be examined. Such texts exist at least since the fifth century B.C.E.. Skylax of Caryanda reportedly wrote a life of Heraclides, tyrant of Mylasa, in ca. 480 B.C.E. Although no text survives, it is cited in the *Suda*, a Byzantine encyclopedia on the ancient Mediterranean world of the tenth century, under the title "The story of the tyrant (or king) Heraclides of Mylasa"¹⁰⁵ (Momigliano, 1971, p. 29).

Several kinds of life stories later featured in human history, such as biographies of illustrious figures beginning in antiquity, individual journals (*livres de raison*) from the Middle Ages, private notebooks and diaries, and memoirs. This approach to life stories—both imaginary and real—should be viewed in connection with philosophical hermeneutics, which originated with Schleimacher and

¹⁰⁵Greek title: τὰ κατὰ Ἡρακλείδην τὸν Μυλασσπιν βασιλέα.

Dilthey, and gained substance in the twentieth century with Heidegger, Ricœur, and others.

By the seventeenth century, however, a more scientific approach to life stories emerged. It was linked to the beginnings of population and probability sciences, and it developed further in later centuries. This chapter takes a closer look at these narratives—whose detailed structure varies substantially from one author and one period to another—and the advent of scientific analysis of life stories.

7.1 Life stories to celebrate humans

The imagined life and the real life of Brother Ange de Joyeuse, we analyzed in the previous chapter, could be similar yet very different according to the source (romances or historical documents). In this section, we show how these life stories or biographical narratives—viewed here as the closest reflection of the lives of the persons concerned—nevertheless select the events regarded as worthy of recall.

While the biographical genre emerged in earliest antiquity, it encompasses highly varied texts, described in greater detail below. We shall examine how the social sciences appropriated them as a research method.

In Alexandre Gefen's words (2004, p. 60):

A deceptively simple genre, biography stands at the crossroads of human life. It offers a field where the paradigms and skills deployed by social science, profane and sacred spirituality, and the symbolic forms specific to literature are confronted with one another.¹⁰⁶

¹⁰⁶ French text : Genre faussement simple, la biographie est située au carrefour des représentations de la vie humaine ; elle offre un champ où se confrontent les paradigmes et les compétences déployés par les sciences humaines, la spiritualité profane ou sacrée et les formes symboliques propres à la littérature.

It is indeed impossible to transcribe all the instants of an individual life, and the events selected for inclusion in a life story are therefore subject to the biographer's somewhat arbitrary choice. Similarly, the choice of individuals as subjects of a biography is far from arbitrary and must be examined as well. We begin by discussing the method used for such choices.

There are three broad periods in which new forms of life stories appeared. The first is Greek and Roman antiquity, which saw the creation of life stories of which Arnaldo Momigliano's *The development of Greek biography* (1971) offers an interesting but partial account, since he deals mostly with ancient Greece. The biographies were those of rulers, leading philosophers or poets. The second period, running up to the early twentieth century, saw not only the persistence of earlier forms of biography but also the development of life stories of less prominent persons who sought to leave a trace through their biographies. From the seventeenth century to the twentieth, many social sciences introduced full-fledged research methods some of them more recently closely tied to the "event-history" (i.e., biographical) approach.

To conclude, we show that biography is inherently transdisciplinary, for it pertains to all the social sciences, serving as a tool to understand human societies. Consequently, it belongs to no single one of those disciplines.

7.1.1 Life stories in antiquity

As noted in the introduction to this chapter, the life-story genre goes back to at least the fifth century B.C.E. How much of the complexity of an individual life did it capture, and in what form?

First, which broad categories of persons did ancient biographies cover, and what types of events did they relate? It is also important to distinguish *autobiographies* from *biographies*, before attempting to define a more general paradigm.

Ancient biographies concerned noteworthy figures: political leaders, philosophers whose acts and ideas influenced many other persons, and—starting in ancient Rome—poets and aristocrats. Most

of these exceptional individuals made their mark on the history of their city or country.

The *biographies* were written by authors who frequently lived well after the life stories they recount. As a result, their narratives are less reliable, although they attempted to gather as much information as possible on their subject. It is therefore better to rely on *autobiographies* even though their authors may embellish their actions when recounting them.

For the fifth century B.C.E., we have only fragments of *biographies* or *autobiographies* by authors often born outside Greece, such as Skylax of Caryanda, Ion of Chios, and Xanthos of Lydia. The fourth century B.C.E., by contrast, saw the flourishing of the genre, of which Xenophon and Plato appear to have been the true creators.

Although he did not sign his *Anabasis* (ca. 370 B.C.E.), Xenophon (ca. 430-355 B.C.E.) does tell the story of his campaigns and successes during the retreat of the Ten Thousand Greek mercenaries conscripted by Cyrus the Younger. Artaxerxes was the eldest son of Darius II, king of the Persian Empire from 423 to 404 B.C.E.. He succeeded his father in 404 B.C.E. His younger brother, Cyrus the Younger, rebelled against him in 401 B.C.E.. Cyrus had several hundred men at this disposal, including ten thousand Greek mercenaries, Xenophon among them. Cyrus was defeated and killed at the battle of Cunaxa, about a hundred kilometers from Babylon. But the Greek mercenaries, who had won a victory over Artaxerxes' troops, managed to escape them under Xenophon's command. In this *autobiographical* account, Xenophon describes the retreat in detail, with great clarity and precision. He also wrote *biographies* such as the *Cyropaedia* (ca. 370 B.C.E.), describing the education of Cyrus the Great, who had lived more than a century earlier.

Some time later, Plato (ca. 428-346 B.C.E.) is thought to have written *The seventh letter* (ca. 354 BC) to the parents and friends of Dion (408-354 B.C.E.), tyrant of Syracuse, after his death. We use the phrase "thought to have" for many scholars have questioned the letter's authenticity, arguing that it was written by

one of Plato's assistants ten or twenty years after Dion's death. The latest of these claims dates from 2015. Put forward by Burnyeat and Frede, it has been criticized by many commentators including Kahn (2015). While a discussion of its merits lies outside the scope of our study, we should point out that most commentators recognize Plato's style and thought in the text. For example, Momigliano (1971, p. 60-62), after carefully examining the arguments presented, admits that the text is indeed an autobiography and not a biography by one of his disciples. Similarly, an in-depth computer analysis of Plato's style led Ledger (1989) to conclude that the letter was the work of Plato himself. We find these arguments sufficiently convincing to view the text as *autobiographical*.

Plato not only gives us a detailed account of his three stays in Sicily between 388 and 361 B.C.E., but he also tells us about his youth and his hopes of setting up a truly republican government in Athens. In 404 B.C.E., the city was under the tyrannical rule of the Thirty, who had replaced the earlier Athenian democracy. Although democracy was restored a year later—albeit with a general amnesty—Socrates' death sentence in 399 B.C.E. caused Plato to question the Athenian regime. He wrote (VIIth letter, 325 c, d):

When, therefore, I considered all this, and the type of men who were administering the affairs of State, with their laws too and their customs, the more I considered them and the more I advanced in years myself, the more difficult appeared to me the task of managing affairs of State rightly.¹⁰⁷

Hence his decision to visit Sicily in 388 B.C.E. in order to persuade the kingdom's ruler, Dionysius I (ca. 431-367 B.C.E.), to subscribe to his philosophy. As it turned out, Plato became friends with Dion (ca. 408-354 B.C.E.), Dionysius' young brother-in-law, who greatly appreciated Plato's ideas and seemed ready to apply them in the event that he should reign in Sicily. On his return to Athens, Plato learned of Dionysius' death, and Dion summoned him back to

¹⁰⁷Greek^o text: σκοποῦντι δὴ μοι ταῦτά τε καὶ τοὺς ἀνθρώπους τοὺς πράττοντας τὰ πολιτικά, καὶ τοὺς νόμους γε καὶ ἔθνη, ὅσω μᾶλλον διεσκόπουν ἡλικίας τε εἰς τὸ πρῶτον ὅσθι προύβαινον, τοσούτω χαλεπώτερον ἐφαίνετο ὁρθῶς εἶναί μοι τὰ πολιτικὰ ὁδὸν οἰκεῖν.

Sicily, despite the fact that the country was now run by his young nephew Dionysius II (ca. 397-343 B.C.E.). After Dion tried to establish a more moderate government on Plato's advice, Dionysius II banished him from Sicily and expelled Plato to Athens. In 361 B.C.E., however, Plato was again invited to Syracuse by Dionysius II to decide Dion's fate and kindle his own philosophical flame. Alas, Plato soon realized that Dionysius II had understood nothing of his philosophy and that he had composed a work, after listening to Plato just once and boasting of being very knowledgeable himself. Violating his written commitment to Plato, Dionysius II stripped Dion of his possessions and, after placing him under house arrest, sent Plato back to Athens. Around 357 B.C.E., Dion raised an army and took Syracuse by surprise. In Plato's words (VIIth letter, 351 c):

For neither Dion nor any other will ever voluntarily aim thus at a power that would bring upon himself and his race an everlasting curse, but rather at a moderate government and the establishment of the justest and best of laws by means of the fewest possible exiles and executions. Yet when Dion was now pursuing this course, resolved to suffer rather than to do unholy deeds—although guarding himself against so suffering—none the less when he had attained the highest pitch of superiority over his foes he stumbled. And therein he suffered no surprising fate.¹⁰⁸

Dion was unfortunately assassinated in 354 B.C.E., making all of Plato's efforts vain.

We have described Plato's letter in some detail for it clearly illustrates his goal in writing this *autobiography*. He spells out his plan, explains the reasons, and shows his failure to implement it. By contrast, he barely mentions his repeated journeys between Athens

¹⁰⁸Greek^otext: οὕτω μὲν γὰρ οὔτε δίωκ' οὔτε ἄλλος πετὲ οὐδεὶς ἐπὶ δύναμιν ἐκὼν εἴσιν ἀλιτηριώδη ἑαυτῷ τε καὶ γένει εἰς τὸν αἰὲ χρόνον, ἐπὶ πολιτείαν δὲ καὶ νόμων κατασκευὴν τῶν δικαιοτάτων τε καὶ ἀρίστων, οὐ τι δι' ὀλιγίστων θανάτων καὶ φόνων γιγνομένην· ἃ δὲ δίωκ' νῦν πράττων, προτιμήσας τὸ πάσχειν ἀνόσια τοῦ δρᾶσαι πρότερον, διευλαβοῦμενος δὲ μὴ παθεῖν, ὅμως ἔπταισεν ἐπ' ἄκρον ἐλθὼν τοῦ περιγενέσθαι τῶν.

and Syracuse, which were anything but plain sailing. For example, on his first return to Athens in 387 B.C.E., he was forced onto a Spartan boat whose crew, having stopped at Aegina—then at war with Athens—put him up for sale as a slave. Luckily, Anniceris of Cyrene, who knew him personally, bought him for twenty or thirty minas and sent him home to Athens (Diogenes Laertius, III, 20). Thus Plato did not set sail as an adventurer, but in order to have his political and philosophical theories put into practice.

Later, the Romans too produced excellent *autobiographies*, such as Julius Cesar's *Commentaries: Commentarii de bello Gallico* (ca. 51 B.C.E.) and *Commentarii de bello civili* (ca. 46 B.C.E.). We do not know for certain whether these texts were written day by day (or rather year by year), or, instead, at the end of the two conflicts in question. However, we can characterize them as a self-celebration rather than an autobiography covering all aspects of his life—whether military, political or literary. This self-praise is cleverly orchestrated, as a large number of living witnesses could contradict his assertions. This explains the omission of events such as the crossing of the Rubicon, the river separating his province of Cisalpine Gaul from Roman Italy, which he did not rule. Julius Cesar's move sparked a civil war in 49 B.C.E. He had thus put himself in an illegal situation, for no general was allowed to cross the river with an army, but he makes no mention of this in his commentaries. Suetonius (I, 32), in his life of the Cesars, credited him—as did many later authors—with the famous phrase *Alea jacta est* (The die is cast) when he crossed the Rubicon. For more details on the historical distortion of Cesar's life, we recommend Rambaud (1953).

We conclude this overview of ancient *biographies* and *autobiographies* with Plutarch's *Parallel Lives* (ca. 100-110). The comparison between the lives of a Greek and a Roman, selected among the 23 pairs covered by Plutarch,¹⁰⁹ shows that one take can take a set of illustrious men of Greece and Rome and match individuals of the same weight—even in regard to vice—against one

¹⁰⁹Of the fifty lives recounted, only four are not paired: Artaxerxes, Aratos, Galba, and Otho.

another (for example, Theseus versus Romulus, Alexander the Great versus Cesar, Demosthenes versus Cicero). Plutarch's *biographies* stand in contrast to many of his predecessors, as he explains in his preface to the life of Alexander (Plutarch, *Alexander*, 1, 2):

For it is not Histories that I am writing, but Lives; and in the most illustrious deeds there is not always a manifestation of virtue or vice, nay, a slight thing like a phrase or a jest often makes a greater revelation of character than battles where thousands fall, or the greatest armaments, or sieges of cities.¹¹⁰

His *biographies* describe the different facets of his subjects' personalities without dwelling on their actions.

7.1.2 From the Edict of Milan to the early twentieth century

When the cult of Christian martyrs was legitimized by the Edict of Milan in 313, hagiographies—i.e., the lives of saints—began to circulate in many regions of the world. As Saintyves noted (1907), these narratives merely followed the model of the lives of pagan gods. By highlighting the saints' miracles, these stereotyped accounts, which have more in common with imaginary lives than with actual biographies, are of scarce value for studying real lives, so we shall not discuss them further.

The war memoirs of Xenophon and Cesar gave way to memoirs by persons who led more peaceful but no less illustrious lives, in which they recorded contemporary events that they witnessed or in which they took part. Their goal was to recount not their own lives but the events they experienced. Such narratives are thus less relevant for our purposes, even though the events may have affected the personalities or life stories of the people involved. The perfect example is the *Mémoires-Journaux de Pierre de l'Estoile* (1546-1611), a magistrate of the Parlement de Paris, who recorded

¹¹⁰Greek^otext: °οὔτε γὰρ ἱστορίας γράφομεν, ἀλλὰ βίους, οὔτε ταῖς ἐπιφανεστάταις πράξεσι πάντως ἔνεστι δῆλωσις ἀρετῆς ἢ κακίας, ἀλλὰ πρᾶγμα βραχὺ πολλάκις καὶ ῥῆμα καὶ παιδιὰ τις ἔμφασιν ἦθους ἐποίησε μᾶλλον ἢ μάχαι μυριόνεκροι καὶ παρατάξεις αἱ μέγιστα καὶ πολιορκίαι πόλεων.

for nearly thirty years the events that occurred in the reigns of Henri III and Henry IV of France.

Admittedly, *biographies* and *autobiographies* of prominent figures continued to be produced, covering an ever greater number of persons in ever more diverse walks of life. Emperors, kings, princes, and nobles are, of course, particularly well represented, but so were their ministers in proportion to the importance of their role. There was also a growing number of biographies or autobiographies not only of philosophers, but of scholars, writers, poets, painters, sculptors, and other noteworthy individuals.

Most significantly, however, persons of lesser social standing began to write their *autobiographies* and the lives of their families. This genre appeared in most European countries in the thirteenth century, and even earlier in other parts of the world, for example the *ta'rikh* in Islam in the eleventh century (Makdisi, 1986), and the *Murasaki Shikibu Nikki* in Japan in the same period.

Although their names vary from country to country (*Libri di famiglia* in Italy, *Livres de raison* in France, *Diaries* in England and the United States, and so on), these documents share many common features.

The *Libri di famiglia* first appeared in Italy in the early thirteenth century and have been the subject of numerous studies. They often seem linked to *Libri amministrativi*, which recorded the management of assets (Mordenti, 2004) and reflect the ability of craftsmen, traders, property owners, and legal professionals of that period to take a long-term view. The first known example, written in Calabria, dates from the 1230s (Tricard, 2002). It consists largely of a register of births, marriages, and deaths in a family. Soon, however, the *Libro di famiglia* became a distinct genre from the *Libro amministrativo* and spread across Italy. Its purpose was now to serve as a book of memory, updated continuously, and focused on the family (Mordenti, 2004, p. 794). The *Libri* became ever more common in the fifteenth and sixteenth centuries, then disappeared in the late nineteenth century. However, they are far from entirely truthful. Mordenti (2004, p. 795) clearly notes:

Consequently, to grant the information they contain an absolute value of objectivity and conformity to truth could only be a profound mistake. Cross-checks performed with the data handed down—as is the case for some eighteenth- and nineteenth-century books—have shown that the data are often inaccurate. At the very most, the “true” information conveyed by these texts (exactly as with autobiographies) lies in the degree of distortion, in the bias introduced by the writer when preparing the text. Their historical truth therefore lies, above all, in this sort of distorting gaze, which the memorial texts transmit to us and to which they “objectively” bear witness.¹¹¹

The *Libri di famiglia* are therefore the imperfect—but nevertheless highly valuable—witnesses to Italian society from the late Middle Ages to the late nineteenth century. They give us information not only on family life (pregnancies, miscarriages, births, nursing, illnesses, prescriptions and medical care, deaths, and epidemics), but also on family assets (properties, inheritances, dowries, debts and receivables) as well as on the family’s broader social life (political offices, honors, education, skills, and trades) and, lastly, on unusual events (catastrophes, celestial signs, astronomical phenomena, prophecies, and dreams).

In France, the *Livres de raison* appeared somewhat later, as the earliest forms date from the fourteenth century (Tricard, 2002, p. 1006). Most were written by notaries, merchants, officers, clergymen, and teachers. Only a minority of *Livres de raison* were kept by aristocrats or, on the contrary, peasants. They were found all over France, but primarily south of the Geneva-Saint Malo line (Lemaître, 2006, p. 5). Whereas the Italian *Libri* emphasized family,

¹¹¹ French text: Dès lors accorder à l’information qu’ils contiennent une valeur absolue d’objectivité et de conformité à la vérité ne peut qu’être profondément erroné : des recoupements effectués à partir de données transmises – comme c’est le cas pour certains livres du XVIII^e et XIX^e siècle – ont démontré que celles-ci étaient souvent inexactes. Tout au plus l’information « vraie » que ces textes véhiculent (exactement comme pour les autobiographies) est-elle à rechercher dans le degré de déformation, dans le clinamen que le rédacteur introduit lors de sa mise en texte. C’est donc surtout dans cette sorte de regard déformant, que les textes mémoriels nous transmettent et dont ils rendent « objectivement » témoignage, que se situe leur vérité historique.

the French *Livres* focused on *raison* (reason). The word derives from the Latin *ratio*, whose many meanings include balance-sheet, account, method, reasoning, and proof. For example, the *Livre de raison* long served as proof in court by providing a “reasoned” account of the family’s actions and assets. In 1879, de Ribbe (pp. 3-4) defined it as follows:

The specific character of the *Livre de raison*, when properly kept, was to offer, in a few lines and in a simple manner, all that constituted the family and the household in moral and material terms. Its pages would record the genealogy of the ancestors, the biography of the parents, births, marriages, and deaths, the main events in the family, the growth of the family, i.e., the uses to which savings were put, the inventory of property, and the final advice given to children.¹¹²

Like the *Libro di famiglia*, the *Livre de raison* therefore ensured the preservation of a certain form of family memory. While there were differences in composition, content, and scope (Tricard, p. 1002), they are not relevant to our study. As in Italy, the *Livres* disappeared in the late nineteenth century.

In England, the habit of keeping a *Diary* (or *Journal*, a less common term) began to spread in the mid-fifteenth century. The oldest known *Journal* is anonymous and dates from 1442-1443. The author offers a daily chronicle, in Latin, of the main activities of his master Thomas Beckington (Bochaca, 2013). By 1600, diaries had become commonplace among the nobility and bourgeoisie. They would record family mores, marriage, and births (Bourcier, 1976). Ponsonby (1923, p. 1) describes diaries in these words:

A diary, that is to say the daily or periodic record of personal experiences and impressions, is of course a very different thing

¹¹² French text: Le caractère propre du Livre de raison, quand il était bien tenu, était de présenter en quelques traits, et avec simplicité, tout ce qui moralement et matériellement constituait la famille et le foyer. Sur ses pages on inscrivait la généalogie des ancêtres, la biographie des parents, les naissances, mariages et décès, les principaux événements du ménage, l’accroissement de ce ménage, c’est-à-dire l’emploi de l’épargne, l’inventaire des biens, les derniers conseils laissés aux enfants.

from history, although some of the older diaries have been of great use in furnishing the historian with facts and giving him examples of contemporary opinions.

They were very common from the eighteenth century to the late nineteenth, but—unlike the Italian *Libri* and French *Livres*—they are still produced today. The *Diary* is more centered on its writer's impressions than the Italian and French texts, and has preserved all its appeal.

These myriad documents record the events in the lives of individuals, generally from the middle class, whose proportion has risen in all countries.

7.1.3 From the twentieth to the twenty-first century

While *Livres de raison* and *Libri di famiglia* were gone by the early twentieth century, all the other forms of biography not only endured but became more diverse. Today, there are websites where members can write their own life stories with the aid of a narrator and print their text. Here are three examples from a very extensive list: <https://www.bl.uk/projects/national-life-stories> in the United Kingdom, <https://lifestoriesaustralia.com.au/> in Australia, and www.entoureo.fr/ and www.leromandemavie.fr/ in France.

At the same time, a more general reflection on the significance of life stories—both imaginary and real—took shape.

As we previously said, philosophical hermeneutics sought to offer a more complex view of life stories by incorporating them into the “sciences of the mind” or “human sciences” (*Geisteswissenschaften*).

The term “hermeneutics” derives from the Greek ἐρμηνευτική τέχνη, meaning “the art of interpreting,” for the god Hermes was the messenger and interpreter of the other gods' orders. Initially devoted to explaining Greek and Latin literary works, it later turned to the study of religious texts (Rico, 2003). Philosophical hermeneutics emerged in the early twentieth century. Here, we look at the insights it can give us into real life stories.

First, Dilthey attempted to establish a philosophy capable of capturing human life. He argued that, since the unity of a physical person must be grasped over the course of the person's life, biography is the core of knowledge. While he did regard human life as unfathomable, he did not believe that the human sciences should be deprived of explanation. Mesure comments (1990, p. 214):

Rather than an “exclusive opposition” between explanation and comprehension, it would be fair to speak here, as Dilthey does explicitly, of a “reciprocal dependence between the two types of approaches.” On the one hand, as we have just seen, explanation requires comprehension in order to meet the goal of intelligibility that defines it. On the other hand, and reciprocally, the identification of causal relationships is one of the means of revealing, between the different moments of a process or the different aspects of an era, the interdependence that makes them part of an interactive whole, to which the comprehensive approach then applies.¹¹³

Unfortunately, Dilthey never managed to achieve the emergence of a complex of human sciences in which explaining and comprehension would not be dissociated. His last book (1911) offers three “world-views” (*Weltanschauungen*) for understanding life: the religious, the poetic, and the metaphysical. We may well ask, however, if these three categories cover all the civilizations that have followed one another over time. Is philosophy itself not a world-view created for and by a specific epoch?

Heidegger conducted his research along the hermeneutical path laid out by Dilthey, as his Cassel Lectures of 1925 show (Gens, 2003). By then, however, he was already expressing his divergence from Dilthey, who, for his part, acknowledged the validity of natural

¹¹³ French text : Plutôt que d'une « opposition exclusive » entre explication et compréhension, serait il juste de parler ici, comme le fait explicitement Dilthey, d'une « dépendance réciproque entre les deux types de démarches » : d'une part, nous venons de l'apercevoir, l'explication appelle la compréhension pour achever le projet d'intelligibilité qui la définit ; d'autre part et réciproquement la mise en lumière de relations causales est un des moyens qui révèlent entre les divers moments d'un processus ou les divers aspects d'une époque cette interdépendance qui fait d'eux les éléments d'un ensemble interactif auquel s'applique alors la démarche compréhensive.

sciences. The key point here is Heidegger's rejection of rationalism. In the mid-1920s, he regarded philosophy as something totally different from science, and he soon began to assert that science does not think. He elaborated on this position in many texts (Perrin, 2013). His 1952 lecture entitled *Was Heißt Denken?* (*What Does Thought Mean?*) recalls and expands the argument (p. 158):

Science does not think in the way that thinkers think. But it in no way follows that thought has no need to turn to science. The statement "Science does not think" implies no permission for thought to take its ease by engaging in storytelling.¹¹⁴

Heidegger saw the contemporary scientific approach, initiated by Francis Bacon and Descartes, as a mere technique that does not ask about the essence of things but proceeds in a mechanical manner by counting.

In his wake, Ricœur, in his three volumes on *Temps et récit* (*Time and narrative*) (1983-1985), develops philosophical hermeneutic theory by taking up the subjects discussed by Aristotle in the *Poetics* and Saint Augustine in his *Confessiones* (ca. 397-401) concerning time. On the two thinkers, Ricœur observes (*Temps et récit. III Le temps raconté*, p. 375):

What is surprising here is that Augustine and Aristotle confront each other not only as the first phenomenologist and the first cosmologist, but as men carried by two archaic currents issuing from different sources—the Greek source and the Biblical source—that later mingled their waters in Western thought.¹¹⁵

¹¹⁴ German text: Vorlesung. Die Wissenschaft denkt nicht im Sinne des Denkens der Denker. Aber daraus folgt keineswegs, daß das Denken sich nicht an die Wissenschaften zu kehren brauche. Der Satz „Die Wissenschaft denkt nichts“ enthält keinen Freibrief, der dem Denken erlaubte, sich gleichsam freihändig dadurch zu bewerkstelligen, daß es sich etwas ausdenkt.

¹¹⁵ French text: L'étonnant, ici, est qu'Augustin et Aristote ne se font pas seulement face en tant que premier phénoménologue que premier cosmologue, mais en tant que portés par deux courants archaïques, issus de sources différentes – la source grecque et la source biblique –, qui ont ultérieurement mêlé leurs eaux dans la pensée de l'occident.

Ricœur effectively links philosophical hermeneutics to ancient hermeneutics. Likewise, he considers that imaginary life stories (literary narratives) and real life stories, far from being mutually exclusive, are mutually complementary (*Soi-même comme un autre* (*Oneself as another*), 1990, p. 191). This is consistent with our intention to examine one category in the previous chapter and the other in the present chapter.

However, when Ricœur seeks to reconcile hermeneutics and social science by rejecting the duality between explanation and comprehension, his arguments are not very persuasive. In *Temps et Récit, I*, p. 154, for example, he writes:

Historical demography, i.e., demography in a temporal perspective, presents the biological evolution of humanity regarded as a single mass. At the same time, it identifies world rhythms of population that place *longue durée* [the long term] on a semi-millennial scale and challenge the periodization of traditional history.¹¹⁶

Rather than showing a reconciliation between historical demography and hermeneutics, this quotation perfectly demonstrates the incompatibility between the two approaches: the first examines humanity as a single mass, whereas the second examines humans as individuals.

7.2 Life stories to study humankind

In contrast, a more scientific approach to the same events emerged in the seventeenth century, driven by Bacon (1620). At the start of Chapter 5, we noted his inductive approach, which began with observation and led up to a true scientific analysis. The application of this approach to life stories totally changed the way they were

¹¹⁶ French text: La démographie historique, c'est-à-dire la démographie en perspective temporelle, met en tableau l'évolution biologique de l'humanité considérée comme une seule masse. En même temps, elle fait apparaître des rythmes mondiaux de population qui installent la longue durée à l'échelle du demi-millénaire et remettent en question la périodisation de l'histoire traditionnelle.

measured and analyzed over time.¹¹⁷ The starting point, however, was the examination of very few elements of the life story by John Graunt (1620-1674).

In his dedication to Robert Moray, Graunt (1662) presents himself as a follower of Bacon, describing his discourses on life and death as natural history. Graunt's *Observations* laid the foundations of a true population science. To achieve this goal, he begins with the measurement—now as exhaustive as possible—of deaths and some other phenomena.

The recording of certain human events was actually an old practice, but Graunt's totally novel approach turned it into a true measurement method suitable for an emerging population science. For this purpose, Graunt used the bills of burials, marriages, and christenings kept in England and Wales since 1538, as ordered by Thomas Cromwell. This record-keeping by the clergy was not yet a regular practice, particularly under the reign of Mary Tudor, marked by the persecution of Protestants. In 1598, Elizabeth I ordered the records to be kept in parchment books, along with the bills compiled since the start of her reign in 1558. But registration on a nearly continuous basis did not begin until the start of James I's reign in 1603. In 1653, Olivier Cromwell transferred responsibility for the registers from the clergy to elected members for each parish, and fees were introduced for each registration. The restoration of Charles II in 1660 spelled the end of these civil registers, which had become religious again by the time Graunt was writing his book.

Bills of mortality—of which one of the oldest known dates from 1532—were primarily designed to give an idea of the number of deaths and their trends, particularly for deaths due to the plague, which was raging at the time. Bills of marriage, which began to record the names of godfathers and godmothers in 1557, were intended to curb the rise in divorces. Previously many people had been able to divorce by declaring that they had married their godfather or godmother's son or daughter. This invalidated the marriage, for the Church regarded it as a spiritual incest. Fears of a

¹¹⁷The author undertook this analysis, in a less elaborate form and in French, in Courgeau (2013).

new tax proved warranted in 1653, when fees were introduced for all registrations. In sum, while the bills served religious, political, social, administrative, tax-related, and other purposes, they manifestly had no scientific purpose at the outset.

Indeed, Graunt clearly noted how the registers were generally used by those who received them (p. 1):

[They] made little other use of them, then to look at the foot, how the *Burials* increased or decreased; And, among the *Casualties*, what had happened rare, and extraordinary in the week current: so as they might take the same as a *Text* to talk upon, in the next Company; and withall, in the *Plague-time*, how the Sickness increased, or decreased, that so the *Rich* might judge of the necessity of their removal, and *Trades-men* might conjecture what doings they were like to have in their respective dealings.

Moreover, the measurement of phenomena regarded as God's secret was somewhat of a challenge. As Graunt observed, discussing the population of London (p. 59):

I had been frighted with that misunderstood Example of David, from attempting any computation of the People of this populous place.

This enumeration performed without an order from the Lord entailed three days of devastating plague on Israel.

To comply with Bacon's goal of starting from the facts in order to develop a science, Graunt used the bills to show regular patterns or features that could not be grasped without them. In fact, he set out to discover an underlying order for these phenomena, which at the time were regarded as acts of God and hence not amenable to forecasts or any other calculation. Let us look at the major directions of his research and the measurements that he associated with them.

As its *unit*, the first measurement adopted the *event*, specifically death (often for a stated cause), baptism, and marriage. For example, Graunt treated all observed deaths as equivalent, stripping them of their human, political, and religious complexity. We can see how closely this measurement resembles what Plato

defined in antiquity by counting the number of units observed, without regard for the particularities of each unit. Likewise, in this context, Graunt could simply enumerate these *facts*, sometimes filtered by classification criteria such as causes of death (unnumbered page: *Epistle dedicatory to the Honourable John Lord Roberts*):

[. . .] so far succeeded therein, as to have reduced several great confused *Volumes* into a few perspicuous *Tables*, and abridged such Observations as naturally flowed from them, into a few succinct *Paragraphs*, without any long Series of *multiloquious Deductions*[.]

However, he subjected the figures to critical analysis, estimated the degree of confidence with which he could accept them, and adjusted them. His book discusses in great detail these entire operations, which were specific to the *direct measurement* of events and intended to guarantee the reliability of his research findings.

Graunt then tried to go further by taking the individual as *unit* and attempting to estimate London's total population without distinguishing a subset that would be useful solely for military, political or religious purposes. This marks the emergence of the notion of *statistical individual*—stripped precisely of individual attributes—which allowed the introduction of a science of man. To achieve this goal, however, Graunt had no general population census available or even a partial census of the kind conducted in antiquity. To estimate the total population, he resorted to a concept—later called the “multiplier”—that amounted to an *indirect measurement*. The estimate was made under different assumptions and from various observed and measured facts. The basic assumption was that these facts maintain *a constant, necessary relationship with the population and that their existence is an assessment criterion* (Moheau, 1778). Here, Graunt estimated the London population from various facts observed in it: deaths, births (whose number was assumed to be twice that of fertile women), families, surface area, and so on (see the details on the assumptions made for each of these estimates in Vilquin's notes to his 1977 French translation of Graunt's book).

These hypotheses are very rough, however, and cannot yield a truly satisfactory estimate of the population. Laplace (1783) later used the “multiplier” method—with the aid of a genuine population sample—to yield a more precise estimate of the errors committed.

Let us now examine another approach introduced by Graunt to measure the population from its deaths.

During his estimation test, Graunt realized that he lacked another essential measure for making progress in his analysis: his sources did not record the age at which the various events occurred. Determining age seemed essential for moving forward in these disciplines, although its value would be downplayed later. To proxy the proportion of deaths at each age, Graunt resorted to the notion of *probability*, which had only just made its first appearance in the scientific world and would prove indispensable for population sciences.

Before we continue, therefore, we must briefly outline how the new discipline of probability took shape through games of chance, shortly before the emergence of population sciences.

Probability arose in the discussion between Fermat and Pascal on wagers (1654a) and Huygens’ first treatise on probability (1657). Pascal defined the new science as follows (1654b):

Thus, by combining the rigor of scientific demonstrations with the uncertainty of chance, and reconciling these apparent opposites, it can, drawing its name from both, rightfully claim this astonishing title: *The Geometry of Chance*.¹¹⁸

This announces the introduction of a new measure for approximating uncertain phenomena: mathematical expectation. But Pascal’s studies were not published until 1665, while Huygens—who took them up—published his treatise in 1657. As Huygens clearly stated (p. 1):

¹¹⁸ French text: Ainsi, joignant la rigueur des démonstrations de la science à l’incertitude du hasard, et conciliant ces choses en apparence contraires, elle peut, tirant son nom des deux, s’arroger à bon droit ce titre stupéfiant : *La Géométrie du Hasard*.

Although in games depending entirely upon Fortune, the Success is always uncertain; yet it may be exactly determin'd at the same time, how much more likely one is to win than lose.

He now assigned a measure to this “chance,” i.e., to this probability, making it possible to reason mathematically on games. The probability is intrinsically objective, for it implies the existence of events that can be repeated in identical conditions.

Graunt applied probability theory not to games but to humans, although it is doubtful that the events examined are capable of repeating themselves as in games of chance. When he set out to estimate the population of London, in the absence of a census, he resorted to probability as a means to deduce the population at risk from the number of deaths. For this purpose, he used the concept of fair game (p. 59):

Next considering, That it is esteemed an even Lay, whether any man lives ten years longer, I supposed it was the same, that one of any 10 might die within one year.

Unlike Hacking (1975), who claims that Graunt’s probabilistic reasoning is correct, we have shown that it is actually far from perfect. We shall not describe his errors in detail here (see Courgeau, 2010) but simply outline the principle of his method.

Graunt initially assumes that the annual probability of dying between ages 10 and 60 is constant. If so, although Graunt does not spell out his calculation, we can estimate the population aged 10-60 from the ratio of the sum of actual deaths to the annual probability. Thus, if we assume—as he does at the outset—that the probability of dying within ten years is 1/2, the constant annual probability is 0.067 and yields a multiplier of 14.925. With 10,000 deaths observed, we therefore arrive at a London population aged 10-60 close to 150,000.¹¹⁹ That is a far cry from the 6-7 million estimated by *men of great experience in this City*, although Graunt does not include children under 10 and old people over 60 in his count. However, the

¹¹⁹Because of errors in his reasoning, Graunt actually arrived at an estimate of 100,000.

estimate of his multiplier is not based on any precise measure and is therefore highly questionable.

From this calculation, the notion of an underlying life table clearly emerges. Graunt elaborates on it, starting with the idea that the distribution of age-specific deaths in ten-year periods after age 6 follows a geometric progression with a root of 64 and a ratio of 5/8, and not 1/2 as he assumed in the previous calculation. The estimates were refined in the hundred years that followed, until Wargentin's publication of a life table broken down by age and sex, based on data from the census introduced in Sweden in 1749.

The advent of exhaustive censuses in most European countries by the early nineteenth century made the preparation of further such estimates of population useless. A direct measurement of population size was finally possible, provided it was carried out within a brief lapse of time (to avoid double counting, notably of internal migration) and with great accuracy (to avoid omissions). Ideally, the censuses should have been conducted by agencies independent of political, religious, and tax authorities so as not to arouse fears of new taxes potentially generated by the operation. Unfortunately, that was not always the case. In France, for instance, the First Division of the Interior Ministry ordered *préfets* to enumerate the population of their *départements* in 1801, while the Statistics Bureau was in charge of analyzing and preparing the data for possible publication.

The census questionnaires yield not only the population of the entire country or its administrative subdivisions, but also exhaustive counts of the phenomena occurring in the population, provided that the phenomena are covered by one or more questions in the individual forms. The questions most often asked concern name, sex, current and earlier place of residence, date and place of birth, nationality, marital status, education, labor-market status and occupation, native language and language commonly used, and religion.

Meanwhile, vital events continue to be recorded in three main registers: birth registers, marriage registers, and death registers. Some countries also maintain a population register that records basic

information on each individual, particularly on changes in place of residence, whose reporting is essential to the smooth functioning of the system. Such population registers provide a continuous record of internal migration. The registers are properly kept in a small number of countries, where the census becomes necessary only for checking their quality and providing information that they do not collect.

One can then estimate all age-specific rates¹²⁰ for the phenomena studied, for a given year or period. Such estimates no longer even require a calculation of their precision, given the high degree of the latter relative to the size of the population measured (Courgeau, 2012). However, these simple rates—which express the ratio of occurrences of an event to a population—are inadequate for certain phenomena. For example, while we can determine a ratio of international migration to the population of the country concerned, internal migration between two areas of the same country requires what are called intensity indices. We need to calculate the ratio of migrants between two areas to the product of the population of origin and the destination population, with which they are directly related (Ravenstein, 1885). Similarly, to study marriage, which involves two populations at risk—never-married men and women—we could use comparable intensity indices, for example by age. But given that spouses are not of identical age in most human populations, such rates have hardly ever been used.

To round out this arsenal of simple indices, the researcher will try to represent a set of measures in condensed form. Examples include *synthetic or summary indices*, which, like “total” rates for demographic events, replace a series of measures by a single figure measuring the intensity of a given event. For instance, the total fertility rate, or simply total fertility, is the sum of age-specific fertility rates calculated for a given year. It can be interpreted as the mean number of children that a group of women would have had in their lifetime if, at each age, their fertility had been equal to the rate observed for that year. This type of measure was widely used in population sciences, especially before World War II.

¹²⁰For details of the rates computed, see Landry (1945).

After the measurement of facts, let us look at the measurement of *relationships* between facts, when we have at our disposal—notably thanks to censuses—the number of people having experienced various phenomena, demographic or other. How do we identify and measure the potential relationships between these facts?

In the early nineteenth century, Legendre, Gauss, and Laplace proposed the use of the least-squares method—with successive improvements—for what effectively constituted a regression analysis. The method solves a linear equation system containing fewer variables than equations. But its use was long confined to astronomy and geodesy. The reason is that the regression coefficients owe their significance to an external theory such as Newtonian physics for astronomy, or geometry for geodesy, and the theory depends on a small number of abstract concepts defined by axioms. This method eliminates the random fluctuations introduced by the empirical measurement of phenomena, yielding an optimal measure.

By contrast, the social sciences in the early nineteenth century could only observe the multitude of factors influencing human life, without being able to impose an order on them. Comte (1839) pushed his criticism of the use of probability in the social sciences to an extreme (27th Lecture, note 18):

It is the basic notion of assessed probability that I find directly irrational and even sophistic: I view it as essentially unfit to guide our conduct in any instance, or at most in games of chance. It would routinely lead us in practice to reject, as numerically implausible, events that will occur nevertheless.¹²¹

However, although some contemporaries endorsed Comte's view (Poinsot and Dupin, 1836), it was not shared by most of those who were working in the social sciences. For instance, in the same period, Quetelet (1835) and Cournot (1843) wrote books to show

¹²¹French text: C'est la notion fondamentale de la probabilité évaluée, qui me semble directement irrationnelle et même sophistiquée: je la regarde comme essentiellement impropre à régler notre conduite en aucun cas, si ce n'est tout au plus dans les jeux de hasard. Elle nous amènerait habituellement, dans la pratique, à rejeter, comme numériquement invraisemblable, des événements qui vont pourtant s'accomplir.

that no mathematical tool other than probability could turn social science into a true science.

Let us now briefly describe¹²² how the measurement of relationships between social facts by means of regression methods gained ground in the nineteenth century and eventually established itself in the social sciences. While the researchers mentioned below worked in different fields (we indicate the main area of interest for each), all became involved in statistics. Their goal was to show how the measurement of human facts could be incorporated into the search for the connections between them, and how probability allows a clear measurement of those links.

In 1835, the statistician Quetelet's theory of the *average man* sought to develop a *social physics*, focused on the mean distributions of many physical and social facts observed in a great number of populations. Quetelet showed that an abundance of facts can be represented by a normal distribution, but he ultimately failed to provide a measurement method capable of classifying or interlinking them. Cournot (1848) spelled out the limitations of this approach:

The average man thus defined, far from being, as it were, the species type, would simply be an impossible man, or at least there are no grounds so far for regarding him as possible.¹²³

In other words, Quetelet's methods, too close to those of physics, could not show the diversity of human responses to a situation. Nor could they connect sub-populations that were homogeneous in respect of a given phenomenon to other sub-populations homogeneous in respect of another phenomenon.

The statistician Lexis (1879) tried to give a better characterization of human heterogeneity by measuring the dispersion of a series of demographic rates, for example using an index. An index value greater than unity means that the series are unstable, i.e., that we cannot regard them as having the same underlying

¹²²For more details of the implementation of regression methods, see Courgeau (2012).

¹²³French text: L'homme moyen ainsi défini, bien loin d'être en quelque sorte le type de l'espèce, serait tout simplement un homme impossible, ou du moins rien n'autorise jusqu'ici à le considérer comme possible.

probability. In fact, most of the series that he examined seemed unstable. Quetelet had found that all the distributions he observed were normal but was incapable of devising a means to classify them more fully. Lexis, in contrast, used a measure that was too precise and showed him that he was practically incapable of distinguishing a stable series. Yet he did not supply a method for analyzing this instability either.

The anthropologist Galton (1875)—whose views on eugenics we criticized in Chapter 4—did, however, make some improvements in statistics. He went further by showing that under the apparent unity of an approximately normal distribution, as observed by Quetelet, one could identify a mix of very different populations—all of them, however, binomial or normal—when their number exceeded 17. In his 1886 studies on heredity, despite his unawareness of Mendel's contemporaneous research (1865), Galton isolated several pairs of normal sub-populations (e.g., parents/children, brothers/sisters) and introduced the conditional expectation that led him to the notion of regression. However, instead of using the least-squares method, he resorted to various other procedures for obtaining a rough estimate of the regression parameters. The economist Edgeworth, following in Galton's footsteps (1883), generalized Galton's analysis of the bivariate case to the multivariate case by introducing correlations between each observed characteristic. Edgeworth even went so far as to correctly state the goal to be reached:

What is the *most probable* value of one deviation x_r corresponding to *assigned* values x'_1, x'_2 &c. of the other variables? and What is the *dispersion* of the values of x_r about its mean (the other variables being assigned)?

In the end, however, Edgeworth did not answer the questions and continued to use approaches other than least squares, leaving Yule (1897) to formalize and solve his problem.

The sociologist Durkheim (1895) also used a regression method on aggregated data, which he called the concomitant-variation method. However, he was unaware of the advances in the

method in England and continued not to estimate the parameters. He wrote:

The reason is that, for [the method] to be demonstrative, there is no need to strictly exclude all of the variations that differ from the ones being compared. The simple parallelism of the values taken by the two phenomena, provided that it has been established in a sufficient number of sufficiently varied cases, proves a relationship between the two. The method owes this privilege to the fact that it arrives at the causal relationship not from the outside, as the previous methods do, but from the inside.¹²⁴

Durkheim applied the method to suicides (1897) to show, for example, that when the proportion of Protestants increased in the provinces of Prussia and Bavaria, the percentage of suicides there rose in a linear pattern. In other words, he assumed that the Protestant sub-population was sufficiently homogeneous in regard to suicide as to enable a verifiable effect to be deduced from this method using aggregate data. Durkheim concluded that religion manifestly influenced suicide. He applied the method to other cases such as the relationships of suicide to education and family size. However, as we shall see in §6.2.3, the method entailed a risk of ecological fallacy.

The statistician Yule (1897), working in demographic economics, studied the links between pauperism and various personal characteristics. He too used a linear regression between aggregate variables, but introducing ordinary least squares to estimate its parameters.

It is important to distinguish here between correlation and regression, which were often confused in the late nineteenth century. The correlation between two characteristics is symmetrical and involves no other theory than statistical theory. This explains the

¹²⁴French text: En effet, pour qu'elle soit démonstrative, il n'est pas nécessaire que toutes les variations différentes de celles que l'on compare aient été rigoureusement exclues. Le simple parallélisme des valeurs par lesquelles passent les deux phénomènes, pourvu qu'il ait été établi dans un nombre suffisant de cas suffisamment variés, est la preuve qu'il existe entre eux une relation. Cette méthode doit ce privilège à ce qu'elle atteint le rapport causal, non du dehors comme les précédentes, mais par le dedans.

publication of many spurious correlations, such as the recent claims of a strong correlation between chocolate consumption in a given population and the per-capita number of Nobel prizes (Messerli, 2012) or serial killers. In reality, we should be looking for the economic, social, and cultural factors that lead people to consume chocolate and at the same time to reach a given level of education allowing potential access to a Nobel prize. That is precisely what a regression does when it introduces dissymmetry between variables, as a consequence of a deeper analysis of the underlying causality. Here, we have one characteristic that will depend on other characteristics. Naturally the analysis must be performed with the utmost rigor, and the underlying paradigm of the discipline concerned will play the leading role—as we shall see.

Yule was thus in a position to say that a regression allowed an assessment and comparison of the effects of different aggregate variables introduced to explain the changes in the measurement of pauperism that he was using. He no longer even needed to factor in their normality, provided that the regression was linear.¹²⁵ In Stigler's words (1986, p. 360):

In regression analysis, conditional probability made possible the very definition of the quantities about which the statistician was interested in making inferences.

However, the risk of omission of an important characteristic can always introduce undesirable effects, as Yule fully recognized. We could call this the effect of unobserved heterogeneity.

To sum up, the introduction of human lives into the field of science strongly altered the ways in which they might be viewed. They ceased to be seen as individual lives that cannot be compared with one another. On the contrary, the scientific goal became to search for configurations of relationships that can interconnect lives. However, throughout the period discussed here, that quest was essentially a science of the moment, i.e., one that used the observation of human facts at a specific instant without considering

¹²⁵ Although this conclusion is not fully justified, it freed social scientists at the time from the obligation to perform complex normality tests for multivariate distributions.

the length of time in which the person has been in a given state. The following period—from the twentieth to the twenty-first century—has been completing that observation with the aim of producing a fuller approach to human life.

Setting aside hermeneutics for the moment, let us examine how sociology can use life stories. Between 1918 and 1920, the sociologists Thomas and Znaniecki published their seminal study on *The Polish peasant in Europe and America*, in five volumes. The authors collected the life stories of fifty families of Polish immigrants to the United States through their correspondence. The result is an original, in-depth analysis of migration. It shows that family and community of origin play a more decisive role than the economic factor. The disaggregation effect of the American capitalist economy contrasts with the reconstruction of migrant families. In other words, Thomas and Znaniecki effectively draw inspiration from philosophical hermeneutics.

Their work initiated what came to be known as the Chicago School of American sociologists, who successfully analyzed the life stories of many communities settled in the United States, up to the outbreak of World War II.

Immediately after the war, marked by the horror of the concentration camps, some direct eyewitness accounts of life in the camps were published. Their number was small, so brutal were the living conditions there (on this point, see Pollak, 1990, p. 15). One outstanding book should be noted here: *Les Françaises à Ravensbrück (French Women in Ravensbrück)* (1965), which gathers many testimonies chosen for the way in which they reflect the reactions of female deportees. The sociologist Marie-Josée Chombart de Lauwe was a member of the editorial committee.

It was not until the 1970s that the subject of the camps truly entered the field of sociology. In 1973, Bertaux noted (p. 355):

In other words, when one has not gathered the socio-occupational histories of individuals, it is impossible to reconstruct them from mobility flows alone.¹²⁶

Interestingly, Bertaux linked this approach to longitudinal analysis in demography, and particularly to the work of Louis Henry, which we discuss later. This led Bertaux to propose a new biographical approach in sociology in 1976, which would treat biographies “not as life stories but as *narratives of practices*” (p. 199). These practices, observable via a survey, enabled him to capture social relations between individuals—which, for their part, are not observable. This time, sociology would turn to explanation rather than comprehension.

By contrast, during the 1980s, Pollak undertook the task of “comprehending”—in Dilthey’s sense—the concentration-camp experience. In *La gestion de l’indicible (Managing the Unspeakable)* (1986), he analyzed in detail the life story of a victim of the Nazi regime and showed how she managed to overcome that period by building a working career and a private life. Moreover, Pollak perfectly demonstrates (p. 32):

[....] that all individual histories and memories fit into a collective history and memory.¹²⁷

From his close scrutiny of this particular narrative, Pollak extracted a hard core—a leitmotiv of sorts—that he identified in his 46 other long interviews of survivors. This gave him the possibility of “explaining” the survivors’ behaviors, which he put to use in his book *L’expérience concentrationnaire* (1990), marking a convergence with the Chicago School approach.

Interestingly, Pollak’s article appeared in the issue of the journal *Actes de la recherche en Sciences Sociales* that Bourdieu, the

¹²⁶ French text: Autrement dit il est impossible, quand on n’a pas recueilli les histoires socio-professionnelles des individus, de les reconstituer à partir des seuls flux de mobilité.

¹²⁷ French text: ... l’inscription de toute histoire et de toute mémoire individuelles dans une histoire et mémoire collectives.

journal's editor and Pollak's doctoral dissertation supervisor, entitled *L'illusion biographique*—the very same title as Bourdieu's own article in the issue (1986). Without discussing Bourdieu's concept of “structural constructivism” in detail here, let us simply note that he invokes it in dogmatic fashion to launch a blistering attack on the biographical approach, which he wrongly rejects (p. 69):

This inclination to make oneself the ideologist of one's own life—by selecting, on the basis of an overall intention, certain *significant* events and by drawing connections between them that will give them coherence, such as [the connections] implied by their establishment as causes or, more often, as ends—meets with the natural connivance of the biographer, who has every reason, starting with his propensities as an interpretation professional, to accept this artificial creation of meaning.¹²⁸

As we saw in our examination of Pollak's article, that “inclination” is not due to a scrupulous sociologist paying close attention to the form of the testimony and the conditions in which it was recorded, to the examination of legal depositions, to the organization of the narrative, and so on. We are dealing here not with “an artificial creation of meaning” but with a far-reaching scrutiny of the interviewee's words. Heinich (2010, p. 429) quite rightly concludes his article with an attack on this fallacy:

And it's pitiful to realize—rereading it more than twenty years later—how far the superb intelligence that was Bourdieu's strayed into the typical form of foolishness of our time consisting of all-round suspicion, blind and systematic criticism.¹²⁹

¹²⁸ French text: Cette inclination à se faire l'idéologue de sa propre vie en sélectionnant en fonction d'une intension globale, certains en fonction d'une intension globale, certains événements *significatifs* et en établissant entre eux des connexions propres à leur donner cohérence, comme celles qu'impliquent leur institution en tant que causes ou, plus souvent, en tant que fins, trouve la complicité naturelle du biographe qui tout, à commencer par ses dispositions de professionnel de l'interprétation, porte à accepter cette création artificielle de sens.

¹²⁹ French text: Et c'est pitié, en y revenant plus de vingt ans après, que de réaliser à quel point la superbe intelligence qui fut celle de Bourdieu a pu se dévoyer dans

By attacking micro-history, Bourdieu tried to assert his presence in a field whose importance he failed to grasp.

On this topic, the *Revue Française de Sociologie* published an issue in January-March 1990 devoted to the biographical approach. One article in particular (de Coninck, Godard) describes three basic models that can be used in sociology: an archeological model, a change-centered mode, and a structural model. The authors conclude (p. 51):

Identifying causal relations that go beyond individual cases allows a comparison of the few regularities thus revealed, but this does not mean that the researcher presumes to be able to predict individual paths.¹³⁰

While that is a far cry from Bourdieu's rejection of the biographical approach, the "explanation" of the relations does not concern individuals, of course, but only the population examined, as we shall see for population sciences.

In sum, sociology has focused at times on the "comprehension" of social facts, at times on their "explanation," showing a possible convergence of the two approaches but without ever proving it.

In the population sciences, the approach prevailing since the seventeenth century persisted until the end of World War II. Its underlying paradigm was that of *cross-sectional analysis*, which assumes that social facts exist independently of the people who experience them (statistical individuals). The facts are explained by the social, economic, political, religious, and other characteristics of the society as a whole. The approach is essentially based on aggregate measures.

cette forme de bêtise typique de notre époque que sont le soupçon généralisé, la critique aveugle et systématique.

¹³⁰ French text: Mettre en évidence des relations causales qui dépassent les cas individuels autorise l'opération de comparaison sur les quelques régularités mises ainsi en évidence et ne signifie pas pour autant que le chercheur s'arroge une capacité de prédiction sur les trajectoires individuelles.

Although in use for over 280 years, the paradigm ran into a series of problems due to the characteristics of some of the measures. At a deeper level, its problems were due to its underlying assumptions.

First, the summary indices currently used in cross-sectional analysis can become misleading during periods when the timing of a phenomenon changes. For example, at the end of World War II, the cumulated first-marriage frequency largely exceeded unity, whereas the index might logically have been expected to remain consistently below unity—as in a real cohort. Henry (1966, p. 468) observed:

[. . .] in a recovery period, behavior is influenced by the earlier lag; accordingly, to assign to a fictitious cohort a series of indices observed in a recovery period means postulating the existence of a cohort engaged in a lifelong effort to make up for a delay that it had never experienced.¹³¹

The period factors are actually experienced in life stages that differ considerably from one cohort to another. They may also entail different consequences, which summary indices utterly fail to capture.

Second, the regression methods used incorporate quantities aggregated on different criteria. This creates a strong risk of interpreting the results in terms of individual behavior—an outcome known as the ecological fallacy. Durkheim (1897) was in danger of committing the fallacy when he measured a positive connection between the percentage of Protestants in a region and its suicide rate. This finding rests entirely on the assumption that social facts exist independently of the people who experience them. Similarly, we have shown a positive link between the percentage of farmers and the percentage of migrants between Norwegian regions for men aged 22 born in 1948 (Courgeau, 2007). Later, we shall see that this

¹³¹French text: ...au cours d'une période de récupération, le comportement est influencé par le retard antérieur ; attribuer à une cohorte fictive une série d'indices observés en période de récupération revient alors à postuler l'existence d'une génération qui, d'un bout à l'autre de sa vie, s'emploierait à rattraper un retard qu'elle n'aurait jamais pris.

assumption is totally invalidated at individual level, and that farmers actually migrate far less than the rest of the population.

The period vision of cross-sectional analysis strips human life of all its density, for the analysis looks at a given moment and assumes that the phenomena studied are determined by the characteristics of the population just before their occurrence. If, instead, we give priority to the time spent by individuals in a given state, we shall emphasize duration and be better able to describe the sequence of events.

In these conditions, it is useful to adopt another point of view on the phenomena without, however, fundamentally changing the measurement of the facts. These will continue to be measured by population censuses and register data. But we shall track them over the lifetime of a generation or cohort instead of examining them during a year or another given period.

The calculation of new types of indices, called probabilities (in French: *quotients*), sought to eliminate interferences between phenomena occurring simultaneously in a generation or cohort. The goal was to measure each phenomenon in its *pure state*, i.e., separating the effect of the phenomenon studied from those of the other phenomena, regarded as disturbing (Henry, 1972). For this purpose, we need to assume that the phenomena are *independent* of one another.

For example, to measure a probability of first marriage in a population experiencing mortality, emigration, and immigration simultaneously, we need to assume independence between these three phenomena and marriage in order to obtain a measure of marriage in its pure state. We can then show that the probability of marriage is approximately equal to the ratio of first marriages observed at a given age to the never-married population initially at risk minus one-half of the deaths and emigration flows plus one-half of the immigration flows occurring in this initial population.

To be fully valid, however, our calculation will require another assumption. To study nuptiality, we have succeeded in eliminating the effect of certain disturbing phenomena—mortality, emigration, and immigration—but we have no certainty regarding

the effect of many other characteristics that will influence the decision to marry. For the previous calculation to be fully valid, we must therefore posit a new hypothesis: the lifelong *homogeneity* of the population studied. In other words, a person's probability of marrying will not be affected by his or her education, occupation, nationality, religion, and so on. Although we can easily see how implausible this assumption is, we need it for now, and we shall see later the unfortunately vain attempts to remove it via differential longitudinal analysis.

We do have the option of generalizing this order-specific measure of the event to events for all orders combined by calculating, for example, age-specific fertility rates, which always eliminate the effect of the other disturbing phenomena.

Under these conditions, we can calculate summary indices of the *intensity* of phenomena across the life of a generation or cohort, and we can easily see that they do not display the disadvantages of cross-sectional indices. For instance, the intensity of first marriages will always be less than, or at most equal to, unity—unlike the cumulated first-marriage frequency. These indices will provide a better tracking of the changes in the phenomena studied by generation or cohort.

However, we must bear in mind that we cannot determine the indices until the phenomenon can no longer occur in the population studied: the age at menopause for fertility, and the total extinction of the generation or cohort for most other phenomena. This is obviously a major drawback. By contrast, period indices offered a cumulative measure that could be used immediately.

We noted above the need for the population to meet the *homogeneity* condition in order for the longitudinal analysis to be satisfactory and, at the same time, the need to waive that condition because of its lack of plausibility. The introduction of *differential analysis* was an attempt to resolve this problem. Let us see if the solution works.

Differential analysis seeks to study the occurrence of a given phenomenon in initial groups defined by characteristics such as education, occupation, and religion. The definition of notionally

homogeneous groups can be problematic to begin with. As Lavoye and Mayer (1984, p. 145) noted:

at best, from one or more well-known variables, we can determine the categories that may define homogeneous sub-populations (or sub-populations assumed to be homogeneous) and measure the demographic differences between these groups. But the determination of homogeneous groups is not always so simple, for we may want to identify subsets that have many characteristics in common [. . .]¹³²

The authors clearly state the principle of this approach and some of its limitations when seeking a finer breakdown of the population studied. Let us take a closer look at the problem.

First, we need a measure of the variables that distinguishes between sub-populations. If we are dealing with characteristics measured by civil-registration records, we know that they capture a small number of individual characteristics, and only the use of fuller population registers, such as those of Denmark,¹³³ would enable us to perform such an analysis properly. For instance, when the register gives the person's occupation at the time of marriage, we can analyze family formation by initial occupational group, without actually being able to analyze the interaction between occupational change and fertility. By contrast, if we are dealing with characteristics measured by censuses, the situation is more complex, for these enumerations—typically conducted at ten-year intervals—will not allow us to define a person's status when he or she enters the group considered. A census will record the person's occupation at a different date from that of his or her entry into the sub-population studied. For example, we will know someone's

¹³²French Text: dans le meilleur des cas, on peut partir d'une seule ou de plusieurs variables bien connues, déterminer des catégories susceptibles de définir des sous-populations homogènes (ou qu'on suppose telles) et mesurer les différences démographiques entre ces populations. Mais la détermination de groupes homogènes n'est pas toujours aussi simple, car on peut vouloir identifier des sous-ensembles qui aient en commun un grand nombre de caractéristiques [...]

¹³³In Denmark, a single identification number for each individual provides an interconnection for 35 statistical registers (Thygesen, 1983).

occupation not at the time of marriage, as before, but only in the census nearest the marriage date.

For a clearer view of the conditions that indices must satisfy in order to allow a differential analysis of this kind, let us look at a more specific example.

Suppose we want to analyze the legitimate fertility of a cohort of married women in the non-metropolitan areas of a given country. In addition to mortality and international migration, the analysis will obviously need to cover annual movements between metropolitan and non-metropolitan areas. While mortality and international migration can be easily incorporated into the estimated probabilities, the same is not true of movements to and from metropolitan areas, whose probability greatly exceeds that of deaths and international migration. Moreover, while we may assume that the first two disturbing phenomena are relatively *independent* of each other, the independence between migration and fertility is far harder to confirm. As noted earlier, the links between fertility and migration are too strong to be neglected.

But even if this analysis is feasible, would it have identified a homogeneous sub-population of married women? There is no reason to believe so. As Henry noted (1959, p. 32):

To determine exactly what is the practical impact of the heterogeneity of human groups, we would need to extend research in differential demography all the way to individual physical and psychological characteristics, taking care to study both the dispersion and the correlation of demographic indices within the fairly general groups that we have considered so far.¹³⁴

In a footnote (p. 25), he added:

¹³⁴French text: Pour savoir exactement, quelle est la portée pratique de l'hétérogénéité des groupes humains, il faudra pousser les recherches de démographie différentielle jusqu'aux caractéristiques individuelles physiques et psychologiques, avec le souci d'étudier à la fois la dispersion et la corrélation des indices démographiques à l'intérieur des groupes, assez sommaires, considérés jusqu'ici.

Given the practical difficulties, one cannot avoid asking whether the problem posed can be solved.¹³⁵

Today, we can say that the problem cannot be solved by means of differential longitudinal analysis and that the only solution is an event-history approach.

Distinguishing between two sub-groups, such as women living in non-metropolitan or metropolitan areas, is not enough to permit a true differential analysis. As Lavoye and Mayer observed in the earlier quotation, it is essential to incorporate a very large set of characteristics for the analysis to be valid. This, however, will yield groups too small for a longitudinal analysis. Furthermore, we shall never be certain of having included all of the population's heterogeneity factors. There will always remain an unobserved heterogeneity whose effect on the estimated probabilities will be totally unknown. As we shall see, this problem does not occur in event-history analysis.

In conclusion, differential analysis does not allow population heterogeneity to be taken properly into account, forcing us to make do with the assumption that the population studied is *homogeneous*.

In light of the above, we can define the paradigm of longitudinal analysis by means of the following postulate: one can only study the occurrence of a single event, during the lifetime of a generation or cohort, in a population:

[...] that maintains *all of its characteristics and the same characteristics* for as long as the phenomenon occurs¹³⁶ (Blayo, 1995, p. 1504).

For the analysis to be feasible and for the measures of the phenomena studied to be meaningful, the population must be regarded as *homogeneous* and the disturbing phenomena must be *independent* of the phenomenon studied.

¹³⁵French Text: Étant donné les difficultés pratiques, l'on ne manquera pas de se demander si le problème posé est soluble.

¹³⁶French text: [...] qui conserve *toutes ses caractéristiques et les mêmes caractères* tant que le phénomène se manifeste.

Books on longitudinal analysis, such as Henry's (1972), devote a separate chapter to each phenomenon, since they have been isolated in a pure state: marriage, fertility, mortality, and migration.

Although it dispels some of the criticisms leveled against cross-sectional analysis, this approach raises some new problems of its own.

First, probabilities in longitudinal analysis are calculated under the assumption of independence between the phenomena studied and the disturbing phenomena. This hypothesis is broadly verified for disturbing phenomena such as mortality and international migration in the study of marriage and fertility. For other phenomena, however, it is far more questionable. When we study marriage, for instance, the concurrent effect of cohabitation introduces a selection bias that eliminates from the population at risk a set of persons who undoubtedly exhibit special characteristics. This invalidates the independence assumption and makes the calculation of the corresponding probabilities largely meaningless.

Second, as the paradigm used allows the study of only one phenomenon, we cannot analyze concurrent events. Accordingly, studies of cause-specific mortality are not recommended, for the eradication of one cause of mortality will obviously change the probabilities of dying from other causes, in a manner virtually impossible to predict as long as the first cause exists. Likewise, "we must renounce the idea of studying a population in which several events allow entry" (Blayo, 1995), as in the example discussed above of women living in non-metropolitan areas. In other words, there are a great many cases indeed in which the postulate of longitudinal analysis makes it impossible to calculate clearly meaningful probabilities.

Third, as noted earlier, differential demography does not allow a proper examination of population heterogeneity. The breakdown of a given population into sub-populations that can be regarded as homogeneous soon yields groups too small to allow any meaningful longitudinal analysis.

In these conditions, making analytical progress requires the definition of a new paradigm with which we can validate the

calculations and indices that are not valid or cannot be estimated in longitudinal analysis.

Census and register data were exhaustive for the main demographic phenomena, but covered very few other facts that would have provided a better understanding of the behavior of individual members of the population. To obtain this fuller information, we need to perform surveys, which—for reasons of cost and even feasibility—cannot be exhaustive. Surveys yield a different measurement of facts and a set of indices that, once again, must incorporate their own dispersion, so that we can draw more robust conclusions. As we shall see, this new form of measurement—unlike differential analysis—allows us to establish very clear connections between many facts as they unfold over time.

The method of choice for collecting a maximum number of events in a person's life history is the prospective or retrospective survey.

The prospective survey typically collects once a year the events that have occurred during that year. It is the best means for obtaining information that is reliable because of its great timeliness. Its main disadvantage is the need to wait many years after its start before using the event histories collected. For example, the prospective surveys of retirees carried out by Françoise Cribier's team (Cribier, Kich, 1999) had to track them from ages 65 to 90 to obtain final results. Another drawback is the risk of attrition, as many interviewees may eventually grow tired of responding.

The retrospective survey, instead, collects a large number of events that occurred in a sometimes distant past from an already elderly cohort. Its chief disadvantage is that respondents may have trouble recalling dates of remote events or may even forget some altogether. The survey that I conducted in 1981 (Courgeau, 1999), called *Triple event history* (work, family, and migration), covered cohorts born between 1911 and 1936, who had therefore lived a large part of their lives. Faced with respondents' difficulties in remembering old events, we performed a similar survey in a country maintaining population registers that allowed a quality check on the information gathered retrospectively (Poulain et al., 1991; Courgeau,

1991). Our analyses showed that, in most cases, dating errors act as background noise from which we can extract consistent information regardless of source: man, woman, couple or register. Memory therefore seems reliable in situations where the analysis requires it. Moreover, retrospective surveys are not subject to the attrition risk inherent in prospective surveys, since each respondent is interviewed only once.

This new approach focuses not on the event (marriage, birth, migration, change of occupation, and so on) but on the person's entire life history, regarded as a complex process in which the phenomena studied are in permanent interaction. The goal is to see how an event can influence the sequence of other events in a person's life. Similarly, time is not a discrete variable as in longitudinal analysis, measured over one or more years, but will be regarded as continuous. Lastly, a number of the events studied may be unobserved, for the observation period is limited by the date on which the retrospective survey is performed or the date when the prospective observation stops. The period is described as censored or truncated.

All these developments will lead to new measurement methods, which we cannot discuss in detail here, for they are based on complex mathematical and probabilistic concepts: martingale theory (Doob, 1953; Dellacherie and Meyer, 1980) and counting-process theory. To summarize this new approach, we can say that it regards transitions between many states as a multivariate counting process on which one can define a matrix of intensities of transition between each state (probabilities combined over time)—a matrix that changes over time. As we are dealing with survey data, the variance of the estimate is now necessary and is itself estimated simultaneously. We can thus eliminate the *independence* condition for the phenomena—which had been set in longitudinal analysis—and focus instead on a detailed examination of the multiple *dependencies* that may exist between them.

By measuring the combined cumulative probabilities, we can study, for example, the links between family formation and migration to metropolitan areas (centered on Paris, Lyon, and Marseille) in France in the period 1925-1950 (Courgeau, 1989). We

find that women's migration to metropolitan areas entails a steep fall in fertility, irrespective of birth order, whereas migration to low-urbanized areas increases fertility. What we observe, therefore, is a very rapid adjustment to the behavior of the host environment, although the adjustment differs according to the migrants' origin. Migration to metropolitan areas attracts women whose pre-migration behavior already closely resembles that of the host environment. By contrast, migration to less urbanized areas attracts women whose pre-migration fertility does not differ from that of large cities. The first type of migration reflects selective behavior, while the second type illustrates adaptive behavior. Naturally, we can perform the analysis in the other direction, to see how successive births influence female mobility. The results indicate a reciprocal dependence: the probability of migrating to metropolitan areas decreases with each birth, whereas mobility in the other direction rises after each birth. This example illustrates how a true differential analysis—impossible to conduct in a longitudinal framework—becomes entirely possible here.

This analysis also illustrates the complexity of dependencies that can be identified by measuring combined probabilities. We can speak of local dependence when only one process influences the other without reciprocity (Schweder, 1970) and total independence when the phenomena have no influence on one another. The latter condition, imposed in longitudinal analysis, rarely occurs in reality when we perform an event-history analysis.

Lastly, event-history analysis can incorporate the equivalent of the double rates that we described in cross-sectional analysis. In his study of *drosophila* mating, Aalen used a double rate measuring the number of male and female flies simultaneously at risk (Aalen, 1978). One could do the same for the study of marriage or human migration between areas but, to our knowledge, no such attempts have yet been made.

Whereas longitudinal analysis was incapable of measuring the effects of different personal characteristics on the phenomena studied, or did so very poorly, event-history analysis has no such difficulty. It thus allows us to waive the homogeneity condition for the population needed in longitudinal analysis.

The models used generalize the regressions discussed in our presentation of cross-sectional analysis, but now with the addition of the time factor. For this purpose, we could distinguish between two types of models—parametric and semi-parametric (Courgeau and Lelièvre, 1992)—but we shall confine our examination here to the second type, which is far more flexible to use. It achieves this flexibility by means of an underlying combined probability on which no parametric formalization of the duration-of-stay effect is imposed, while the effect of the various characteristics is estimated with the aid of parameters—hence the name “semi-parametric.”

These models were initially proposed by Cox (1972), but without a true underlying theory. This was developed later by incorporating martingale theory and counting-process theory (Aalen, 1975), as was done with the measurement of facts. Such models can include individual characteristics either in multiplicative form (proportional-risk models or accelerated failure time [AFT] models) or in additive form as in the classic regression model. Again for reasons of space, we cannot provide an overview of the assumptions and mathematical estimation methods applied to the models. Let us see instead how the relevant characteristics are measured and give a simple example of the application of the models.

The characteristics may be fixed, such as those of the respondent's parents, or on the contrary they may vary over time, such as the respondent's occupation. They are generally measured by surveys and can be embodied in variables that are binary (the individual displays or does not display the characteristic at a given time), polytomous (the individual does or does not display a multiple characteristic, which can be either nominal or ordered, at a given time) or continuous (a person's income at a given time).

As an example of the use of such methods, we continue the earlier analysis of the links between family and urbanization (Courgeau, 1989), in which we now incorporate various characteristics of the population groups involved.

Let us see, for instance, the effect on the interaction between the birth of the third child and mobility between metropolitan and non-metropolitan areas of various characteristics such as the

mother's education, position in her own family (eldest, number of siblings), father's occupation, own occupation, and so on—all of which are assumed to have a multiplicative impact on the combined probabilities. We can examine a few of these effects here in greater detail. Having a farmer father has an effect on the third birth, regardless of the mother's area of residence at the time of birth. If, however, the birth occurs before migration, it will be delayed, whereas after migration this effect disappears. Other aspects of behavior will not be affected by migration. A woman with many siblings will always be more likely to have a third child regardless of her area of origin. Once all these characteristics have been factored in, the effect described above—i.e., migration to metropolitan areas substantially reduces the probability of having a third child—will endure, whereas migration to less urbanized areas will continue to increase fertility.

Another issue deserves to be raised concerning these analyses, which cover a large number of personal states. As a result, the impact of age—essential in the earlier paradigms—is considerably weakened, whereas entries and durations of stay in these states become the dominant factors. For instance, in the study of internal migration (Courgeau, 1985), the age effect, which was strong before the introduction of these states, diminishes and even disappears altogether in certain generations once we have introduced states into family life, the workplace, and social life.

Like regressions on aggregate characteristics, event-history models depend on unobserved heterogeneity. But now we can measure the effects of characteristics, subject to conditions that are often met. When the unobserved characteristics are independent of those we observe, Bretagnolle and Huber-Carol (1985) successfully demonstrated that they reduce the absolute estimated values of the parameters corresponding to the characteristics observed but do not change their signs. As a result, if the effect of a characteristic had seemed significant when other characteristics were omitted, their introduction into the model will merely strengthen the effect of the first characteristic. In contrast, some characteristics that appeared to have no significant effect can become quite influential when we introduce the initially unobserved characteristics.

These findings are very important because they enable us to be sure of the meaning of the effects observed, despite our not knowing if we have introduced into the models all the characteristics influencing the duration of stay. We should note, however, that these characteristics are independent of those already introduced.

The paradigm of the event-history approach can be summarized as follows: throughout his or her life, a person follows a complex trajectory that depends at a given moment on his or her earlier trajectory and on the information that he or she has acquired in the past (Courgeau and Lelièvre, 1996). The population to which these persons belong can now be regarded as *heterogeneous* and the phenomena observed are generally *dependent* on one another. In any event, the analysis will show if these conditions are met or not, whereas in longitudinal analysis the homogeneity of a population and the independence between phenomena were part of the paradigm.

The event-history approach therefore dispels some of the criticisms directed at longitudinal and cross-sectional analysis, but at the same time it raises new issues.

First, it does not lend itself to the criticisms leveled at differential longitudinal analysis. We no longer need to break down the population into sub-populations too small to allow conclusions. The regression methods used in event-history analysis prove to be very powerful and do not require any decomposition of the population. However, we must be watchful of problems due to unobserved heterogeneity. We have already reported the results obtained when the heterogeneity was independent of the phenomena observed. To solve this broader problem, many researchers have tried to introduce an unobserved heterogeneity in the form of a function called *frailty* and have estimated its parameters (Vaupel and Yashin, 1985). Let us take a closer look at how they proceed, for they incorporate into their models a series of measures that we could describe as fictitious.

Frailty is an unknown function whose purpose is to model the underlying behavior of the members of the population observed. We use different frailty distributions to see how their introduction

alters the effects of the characteristics observed. If they modify the effects in a manner that does not depend significantly on the underlying distribution, we may conclude that the introduction of frailty is useful. Unfortunately, the effects of the variables observed are strongly influenced by the hypothetical distribution of the unobserved variable. Trussel and Richards (1985) show that some distributions can even change the signs of certain parameters. The instability of these results casts doubt on the usefulness of introducing unobserved heterogeneity. In fact, we can show that, for the analysis of non-repetitive phenomena, there is only one model that can be estimated without unobserved heterogeneity, but when we try to introduce one, there are an infinity of models that adjust identically to the data with different estimated probabilities (Trussel, 1992). Here, the choice of a distribution to represent unobserved heterogeneity—with no other event-history information or other kinds of information on its form—seems of little use or even harmful.

Second, the event-history paradigm eliminates the risk of *ecological fallacy* associated with the cross-sectional paradigm. As we are now working on individual data, the relationships identified operate at individual level. For instance, the positive link previously noted between the percentage of farmers and migrants in Norway will now appear as negative: farmers will migrate far less than the rest of the population. But, while this finding seems more normal than the surprising result of the cross-sectional analysis, it does not explain the earlier positive relationship. The reason is that, by eliminating the risk of *ecological fallacy*, the event-history approach can generate a risk of *atomistic fallacy* by neglecting the context in which behaviors occur.

We shall therefore turn to the contextual approach, followed by the multilevel approach, to see how they can enable us to resolve this difficulty.

Human beings do not live in isolation. On the contrary, they are closely involved in different social groups on which their existence strongly depends. By shifting our emphasis to these groups and identifying a plurality of levels, we abandon the dualist vision, which pits society in the cross-sectional approach against the

individual in the event-history approach. In these conditions, as Franck (1995, p. 79) notes:

Once we have admitted the metaphysical or metadisciplinary concept of hierarchy, it no longer makes sense to choose between holism and atomism, and—as regards the social sciences—between holism and individualism. [. . .] the point is to find out the true connections between the different stages or levels, from top to bottom and from bottom to top.¹³⁷

We thus need to focus on these groups if we want to understand their behavior and identify new measures that will allow their inclusion in the population sciences.

Social groups can be highly diverse and variable from one society to another. We therefore cannot supply a description of them that will apply to all societies. We can only show their diversity.

A first type of universal grouping comes to mind immediately: the family. Although often treated as a single entity, it is already complex in itself. For example, we can work on the group of children to study phenomena such as the age of departure from the family home (Murphy and Wang, 1998), or on the group of parents to study their types of successive jobs (Courgeau and Meron, 1996). Other groupings of family or friends are also possible, such as the contact network (Courgeau, 1973) or the contact circle (*entourage*) (Bonvalet and Lelièvre, 2012), if we define them with precision.

Other communities can be considered, such as the business firm or government office where a person works, the class or school where a pupil studies, or the hospital or clinic where a patient is being treated.

Very often we shall need to fall back on geographic or administrative groups whose effect is less direct. However, it will be

¹³⁷French text: Une fois admis le concept métaphysique ou métadisciplinaire d'hierarchie, il n'y a plus de sens à choisir entre holisme et atomisme, et pour ce qui est des sciences sociales, entre holisme et individualisme. [. . .] il s'agit de savoir comment s'articulent véritablement les différents étages ou niveaux, du haut vers le bas et du bas vers le haut.

far easier to work on these groups, which are notably used for censuses and surveys. In France, for example, we can use geographic divisions such as the municipality (*commune*), city, *département* or region. Many data are gathered, aggregated, and published for these areas—on their population, mortality, fertility, health, education, economy, and so on. The multilevel analyses performed on these divisions often yield very significant results, suggesting that the official divisions are approximations of divisions that would be better suited for such studies, but for which no statistics are collected.

We can also conduct such analyses on groups of countries. The effect of national policies on the behavior of a country's population is obvious and makes this segmentation wholly relevant. For example, Wong and Mason (1985) employed it to study the use of contraceptive methods in a number of developing countries.

Such studies naturally require statistics that clearly distinguish the various groupings mentioned above. We also need information on their size, properties, and characteristics. Specialists generally classify the measures required for multilevel analyses into three broad groups (Lazarsfeld and Menzel, 1969). The first group consists of *analytical* variables, which we prefer to call aggregate characteristics. For instance, the number of pupils, the proportion of boys, and other variables are aggregated measures for a given class or school. The second group comprises *structural* variables based on relationships between individuals in a group. For example, the density of friendship ties in a class is a structural measure for the class. The third group consists of the *general* characteristics of each unit, such as the fact that a school is public or private.

To measure a relationship between an individual fact and personal and group characteristics, one solution is to aggregate the characteristics at different levels and include them in an event-history analysis. The analysis, therefore, still centers on the individual level, but the characteristics taken into account can be both specific to the person and specific to the groups of which he or she is a member. This becomes what is called a contextual analysis.

As noted earlier, the measures used are initially individual and are then aggregated in different ways. Often, the aggregation simply consists of the average of an individual characteristic for all members of a group. However, the aggregation may be of another kind, such as a measure of the dispersion of the characteristic in the group or other, more general measures of the group to which the person belongs.

Such an analysis will enable us to eliminate the risk of *ecological fallacy*, at least in part, for the aggregate characteristic will measure a construction that differs from its equivalent at individual level. It does not act as a substitute—as some authors of cross-sectional analyses believe—but as a characteristic of the sub-population that will affect its members' behavior. At the same time, we avoid the *atomistic fallacy*, as we make allowance for the context in which the person lives. We should ask ourselves, however, if the inclusion of aggregate characteristics is entirely sufficient to take the context into account. As we shall see, a truly multilevel analysis is needed.

Before conducting one, let us see how the introduction of aggregate characteristics modifies our earlier analyses of migrations of farmers compared with other occupations in Norway. We now include both the fact that the person is a farmer and the percentage of farmers living in his or her region. A contextual analysis of this kind clearly shows us how to reconcile the contradictory results of the two previous analyses. First, we note that farmers are less likely to migrate than non-farmers. The probability is constant regardless of the percentage of farmers living in the region. Durkheim's hypothesis that social facts—here, migration—exist independently of the individuals who experience them is verified by the sub-population of farmers, for their probability of migration remains identical whatever their region of origin. By contrast, we see that the fact of living in a region with a high percentage of farmers will increase the probability of migrating for other occupations. Thus Durkheim's hypothesis does not hold for non-farmers, and the contextual approach enables us to show this. One possible explanation, in regions with a high proportion of farmers, is the relative lack of non-farm jobs that leads other occupations to

emigrate when seeking new jobs—all the more so given the large number of farmers.

The use of contextual models imposes highly restrictive conditions for their formulation. The models notably assume that individuals in a group behave independently of one another. In practice, the risk exposure of a member of a given group is more likely to depend on the risks encountered by other members of the same group. Overlooking this dependence generally produces biased estimates. Furthermore, we can show (Courgeau, 2007) that, in a contextual model, the relative risks for members of different groups are interlinked by strict relationships. Hence the importance of trying to remove the restrictions.

We could adopt the opposite solution, which consists in treating each group separately and performing an event-history analysis of each. This would totally free the analysis from the above constraints, if there are enough groups to ensure robust results. But this condition is seldom met, either for cost reasons in the case of surveys, or for more basic reasons, such as the size of certain classes when the analysis concerns education sciences. This can generate a very high error for the estimated parameters when the size of some groups is very small or the number of characteristics observed very high. If so, it will become almost impossible to obtain reliable results.

We must therefore seek a compromise between a contextual model that imposes overwhelming constraints and models that impose no constraints but make it almost impossible to produce significant estimates. The solution to this dual problem lies, in our view, in a multilevel model.

Multilevel models impose constraints looser than those of a contextual model, but sufficient to yield clear and significant results, even when certain groups are restricted. To achieve this, multilevel models will introduce several levels—for example, in education sciences, one level for the pupil, another for his or her class, and so on (Goldstein, 2003). We can then show that it is possible to estimate parameters at these different levels but in the same model—a model that enables us to take into account the various

characteristics, both individual and specific to the chosen levels, as well as random parameters specific to each level. Again, space precludes a detailed mathematical description of the underlying hypotheses and estimation of multilevel models. For their more detailed application to population sciences, we refer the interested reader to the studies by Goldstein—who first proposed an initial linear model in 1986 and later developed these methods for different types of mathematical models (2003)—and Courgeau (2007).

For a simpler illustration here, we take some of the results obtainable with the model. We return to the example of migration in Norway, now adding many characteristics (Courgeau, 2007). First, the multilevel model confirms the results of the contextual analysis by showing, in addition, that the introduction at individual level of the proportion of farmers in the region where non-farmers live cancels the random parameter of being a farmer at regional level. It also shows the effect of many other characteristics—both family-related and occupational—at individual level. Some new characteristics influence random parameters at regional level. For instance, having spent more than 12 years in education and being economically active introduce regional differences.

This new approach, which we can describe as a multilevel event-history approach, enables us to flesh out the conceptual framework of the event-history approach without upsetting it. The new approach completes the previous one by introducing effects of more complex groups while continuing to study individual behavior.

In the new paradigm, individual behavior depends not only on the person's past history, viewed in all its complexity, but also on external constraints on the individual, whether or not he or she is aware of them. People's behavior may be influenced by their contact circle, composed of members of their more or less extended family, friends, and other work or leisure acquaintances. The living environment and information received from the press and television can also influence a person's future actions. More generally, pressure from the society in which people live can influence their behavior without their being fully aware of it. For example, people living in an environment with heavy unemployment or a severe lack of jobs in their economic sector may be more likely to migrate to a

distant area than if they were living in a region with full employment in that sector. Likewise, we can now incorporate effects of broader characteristics into the analysis. For demographic or epidemiological studies, for instance, we can introduce the fact that the city has a hospital.

Such a paradigm allows us to reconcile discordant results obtained with the earlier paradigms, as the study of migration by Norwegian farmers and non-farmers showed. It is immune to both the ecological fallacy inherent in the cross-sectional paradigm and the atomistic fallacy inherent in the event-history paradigm. However, it raises new problems, which will surely require solutions involving new measures.

First, what significance should we assign to the different aggregation levels that we can use? Some—such as family, contact network, contact circle, firm, class, and school—have clear meanings and pose no problem. Others—such as municipality, *département*, and region—will raise a number of problems, for they do not seem linked to a structure of our society but are defined more or less arbitrarily for administrative and geographic reasons. Admittedly, we can find justifications for them, as the administrative link can influence behavior through regulations specific to each level. We could also argue that these levels serve as approximations of other levels for which we have no measures. If so, however, we must try to gain a better understanding of these levels, which we may regard as fuzzy. For instance, if it were possible to define proper boundaries for “employment areas” (*bassins d’emploi*) or areas of influence around cities (Courgeau and Lefebvre, 1978), their use would, no doubt, yield more satisfactory results than the use of a strictly administrative division.

Second, we have already noted that this paradigm, while incorporating multiple aggregation levels, uses an individual approach to explain behavior by characteristics measured at these levels. Hence the need to complement it with an approach to the behavior specific to each level, and then connect these behaviors together. For instance, isolated actions in a given community may generate awareness of a problem that actually concerns the entire community. This may lead policy-makers to take decisions at a more

aggregated level, which can then apply to the entire community. These decisions will naturally affect individual behavior and may lead to new actions to neutralize their perverse effects, and so on.

Third, we believe it is essential to take into account the more detailed social structure of groups defined by criteria that are satisfactory for a multilevel analysis. For example, we previously mentioned the family—in itself, a complex group where each member plays a well-defined role that may differ from the roles of other members. We should take into account the interactions between group members and their changes over time in order to properly incorporate their social structure into our analysis. That is yet another difficult task, requiring the implementation of new measurement methods and new analytical tools.

We can now turn from this general view to consider the two main concepts without which no population science would be possible.

The first is the creation of an abstract fictitious individual, whom we can call a *statistical individual* as distinct from an *observed individual*. As Aristotle (330 B.C.E.) noted: “individual cases are so infinitely various that no systematic knowledge of them is possible.” Graunt (1662) was the first to introduce the possibility of a population science that would set aside the observed individual and use statistics on a small number of characteristics, from which a statistical individual would be obtained. As Courgeau wrote in 2012:

Under this scenario, two observed individuals, with identical characteristics, will certainly have different chances of experiencing a given event, for they will have an infinity of other characteristics that can influence the outcome. By contrast, two statistical individuals, seen as units of a repeated random draw, subjected to the same sampling conditions and possessing the same characteristics, will have the same probability of experiencing the event.

The key assumption allowing the use of probability theory here is that of *exchangeability*¹³⁸ (de Finetti, 1937): n trials will be said to

¹³⁸In this first paper on the topic, de Finetti called it *equivalence*.

be exchangeable if the joint probability distribution is invariant for all permutations of the n units. We shall use it here for the residuals, given the explanatory characteristics measured for these individuals.

The second concept is the *statistical network*, which differs from *observed networks*. It appeared more recently, for example in Coleman's work (1958). While *observed networks* may be as diverse as the infinite kinds of ties existing between observed individuals, *statistical networks* may be more precisely defined by using statistics on ties and choosing criteria to circumscribe them. Here as well, the key assumption allowing the use of probability theory is that, given the explanatory characteristics introduced at each level, the residuals are exchangeable.

7.2 Conclusions

The events that mark our life from birth to death are regarded as private, non-repeatable, and unique to each of us. They include the stages in our education, our first job, our partnerships, the birth of our children, our changes of residence, our job changes, our unemployment spells, our retirement, and so on. Other less decisive events can also play an important role in our lives, but they can be even harder to commit to memory. This raises the question of imparting meaning to life stories: what methods can do so, with what advantages and drawbacks?

As in the last chapter, we have shown that the "comprehensive" method developed by philosophical hermeneutics (Dilthey, 1883) can be used. But also a new one, the "explanatory" method of the social sciences has been used to understand these life histories.

First, the method used to collect life stories must be capable of capturing their essence, as the hermeneutics method was asking. That is a major problem to be resolved: down to what level of detail must the interviewer go, and how can the respondent's memory succeed in recalling all the details? The next chapter will take a closer look at these memory-related issues.

Secondly, it is only recently in the history of humanity, during the seventeenth century, that the idea of developing a population science emerged—a science with an “explanatory” purpose. Dilthey himself did not think that the “sciences of spirit” may go short of explanation, as he said that a descriptive psychology is also possible (1894). The goal of the explanatory purpose was to erase all the inexpressible aspects of these facts of our life in order to tackle more precisely defined objects such as mortality, fertility, migration, occupational mobility, and marriage. But these objects do not lend themselves to examination in a single way. Over time, successions of paradigms were devised, each aimed at shedding new light on the objects. These different paradigms required different measures of the facts observed and different measures of the relationships between the facts. That is the path outlined across this chapter. It is, however, still far from complete.

To begin with, we must absolutely avoid believing that each of these paradigms has outlived its usefulness and has been replaced by a new one. Each actually represents a particular viewpoint on a complex reality. But these points of view have given us an ever fuller vision of the facts and the relationships between them. We can say that (Courgeau, 2009, p. 273):

[. . .] each new paradigm comes as a complement to the preceding one for the purpose of treating cases that lie outside of the latter’s scope, while partly preserving some of the results obtained with its predecessor.

In truth, each paradigm defines its own objects, and we can apply Agazzi’s proposition (1985, p. 51)—formulated for the natural sciences—to the social sciences:

[. . .] scientific progress does not consist in a purely logical relationship between theories, and moreover it is not linear. Yet it exists and may be interpreted as an accumulation of truth, provided we do not forget that every scientific theory is true only *about* its own specific objects.

The measures associated with each of these theories are also specific to their particular objects, while allowing the necessary cumulativeness

thanks to their connection to the broader object of population sciences.

In sum, the approaches and methods used by philosophical hermeneutics and population science seem incompatible. However we can ask if there is a way to link them that would allow progress in the study of life stories? Many authors, including Dilthey himself, proposed advances in this field. We shall examine them after discussing human memory as the source of life stories.

Chapter 8

Autobiographical memory and its critics

Whenever we face a new problem, we recall the similar ones we encountered in the past, so we try to solve it with all the information available to us. Memory therefore serves to reveal our life story. This requires us to take a closer look at how memory plays such a role, and at the scientific methods used to demonstrate it.

While philosophers ever since antiquity have discussed memory and sought to incorporate it into their theories of the world, the first scientific studies on memory date from the nineteenth century.

In *Theaetetus* (ca. 360 B.C.E.), Plato proposes two images to represent memory: the wax tablet and the aviary. He introduces them to try to solve the problem of false judgments. We shall not discuss the arguments that lead him to reject both possible solutions, but we must observe that he never attempts a scientific test of their broader validity. His philosophical approach is of great interest, but we shall set it aside here to focus on the more scientific methods that offer further insights into memory, most notably the psychological approaches.

In his 1879 article on “Psychometric experiments,” Galton paved the way for such scientific study. His work made it possible to develop more satisfactory psychological approaches to the recollection of past events. By contrast, his approach to visual memory (1880) yielded far more questionable results. Examining the various psychological approaches to memory, we show that it was

almost a century later that the cognitive approach to psychology took up these earlier studies to provide information on autobiographical memory. In particular, the problem of memory failures is critical for the use of autobiographical memory in a number of social sciences.

Other approaches are possible, however. They were developed most notably by neuroscience and psychoanalysis, two sharply contrasting disciplines born at nearly the same time.

Modern neuroscience, founded by John Hughlings Jackson in 1884, is based on the axiom that the brain is purely a sensorimotor machine. It defines a rigorous structure for the brain and the mind (Steinberg, 2009). As Jackson (1884, p. 739) clearly states:

I particularly wish to insist that the highest centres—physical basis of mind or consciousness—have this kind of constitution, that they represent innumerable different impressions and movements of all parts of the body, although very indirectly, as certainly as that the lumbar enlargement represents comparatively few of a limited region of the body nearly directly.

Psychoanalysis was founded by Josef Breuer and Sigmund Freud in 1895 with their work *Studien über Hysterie*, which already points to the role of sexuality in hysteria. That same year, Freud drafted *Entwurf einer Psychologie*—not published until 1987—in which he presents the theoretical basis of psychoanalysis, grounded in the recent discovery of neurons by Ramon y Cajal in 1888.

Despite their differences, both approaches are based on the study of nervous diseases. We shall describe their points of convergence and, at the same time, the reasons for their incompatibility.

We conclude with the replication crisis that has confronted psychology more recently and with the means to resolve it.

8.1 Psychology and verification of remembrances

As in the other chapters, our aim is not to give an overview of scientific psychological research on human consciousness, but to discuss more specifically their contribution to the understanding of autobiographical memory.

There are many books with titles such as *A history of modern psychology* (for example Schultz and Schultz, 2011; Saugstad, 2018; and Ludden, 2019). They tend to focus on the major schools—or rather, assumptions—of scientific psychology since its founding by Wilhelm Wundt in 1873. They typically distinguish between structuralism, functionalism, psychoanalysis, behaviorism, cognitive psychology, and evolutionary psychology. This chapter will place special emphasis on psychoanalysis, with a more detailed discussion of the concept of the unconscious in part 7.2. For now, let us turn to the other approaches.

Wundt (1832-1920), the founder of psychological structuralism (not to be confused with the French structuralist school), believed that mental functions such as sensation and perception could only be studied scientifically by introspection. In consequence, the only way to study memory was not through psychological experimentation, but by using methods viewed as non-experimental, such as sociology (Schultz and Schultz, 2011, p. 69).

Despite this, Ebbinghaus, while sharing the basic tenets of Wundt's structuralism, set out to study memory in his 1885 work entitled *Über das Gedächtnis* (*On Memory*). Introspection, which he practiced, made him the only subject of his research. This enabled him, by memorizing lists of syllables, to identify certain features of memory now accepted as standard. For example, he showed that the memorized syllables are forgotten quickly in an initial phase (only 44.2% are still recalled an hour later), and that the forgetting rate slows rapidly thereafter (21.1% are still recalled 31 days later). However, as his study never addressed autobiographical memory, we shall not examine his findings in further detail here. His approach was open to a severe objection: since different experimenters can obtain very different results through introspection, how can they assess the mechanisms of their own thought?

Functionalism freed itself of the analysis of psychological processes by studying the distribution of psychological characteristics in a population through physiological research, mental tests, and objective descriptions of behaviors. These researchers, however, took little interest in autobiographical memory. The exception was Galton—one of the movement’s initiators—who began to conduct surveys on the subject in 1880.

In Chapter 4, we discussed Galton’s eugenicism and critiqued it at length. We now turn to his innovative, experiment-based approach to psychology, and assess the validity of his results.

In 1879, Galton proposed an experimental psychometric approach, particularly for the study of memory, noting (p. 149) that:

[. . .] until the phenomena of any branch of knowledge have been subjected to measurement and number, it cannot assume the status and dignity of a science.

His article describes several experiments conducted—like those of Ebbinghaus—on a single subject: himself.

Galton begins by addressing an important question for further research on memory: are all events in a human life memorized or, on the contrary, are they mostly forgotten? In his own experience, absent constant reminders, these memorizations fade completely. He demonstrates this by trying to recall the dates of memorized events. For example, he lists the associations between ideas that he was able to memorize throughout his earlier life, and certain words chosen to evoke them. He gives the number of these associations. He can thus divide his memories into three periods: childhood, adulthood, and the period comprising very recent events. He was then lead to distinguish between three types of memory: sensory memory, essentially visual, but also linked to sounds and smells; histrionic representational memory; and a more abstract memory. As we shall see, the cognitivists successfully revived this approach nearly a century later. While Galton believed that the results would be different for any other subject than himself, he did not attempt to demonstrate this in his article. How, then, can these experiments be pooled to obtain statistical results?

Galton attempted to do so in his second article, “Statistics of mental imagery,” published in 1880. He asked 100 adults to describe the visual memory of their breakfast table from the very morning of the experiment. For this purpose, he developed a closed but very detailed questionnaire, in which he considered the “Illumination” of the image, the “Definition” of its different objects, and the “Colouring” of each object. He drew the surprising conclusion that scientist are unaware of visual memory (p. 303):

To my astonishment, I found that the great majority of the men of science to whom I first applied, protested that mental imagery was unknown to them, and they looked on me as fanciful and fantastic in supposing that the words “mental imagery” really expressed what I believed everybody supposed them to mean. They had no more notion of its true nature than a colour-blind man who has not discerned his defect has of the nature of colour. They had a mental deficiency of which they were unaware and naturally enough supposed those who were normally endowed, were romancing.

This claim was repeated, without proper discussion, in most of the psychology literature from the nineteenth to the twenty-first centuries, although some authors stated that the finding was not as obvious as it seems. Many later researchers noted the importance of their own visual memory (Brewer and Schommer-Aikins, 2006).

To begin with, Galton himself admitted that his sample was not statistically representative: it consisted of friends, and he only recorded the replies by men. He indicated that of these 100 men, 19 were Fellows of the Royal Society, but he did not give the affiliations of the other scientists. Pearson (1924) published the response by Charles Darwin (Galton’s half-cousin) to the questionnaire (p. 195), which clearly showed that this outstanding scientist was in full possession of visual memory. For example, concerning the “Definition” of objects, Darwin answered:

Some objects quite defined, a slice of cold beef, some grapes and a pear, the state of my plate when I had finished and a few other objects are as distinct as if I had photos before me.

Darwin also stated that he perfectly recalled faces of students whom he had not seen in 60 years, but that at the time of the survey he

could speak to a man for an hour and no longer remember his face one month later.

In the same article, Galton sought to corroborate his results with a larger sample of students (172), which he divided into two groups: group A with the highest grades, group B with the lowest. The result obtained with scientists might lead one to expect that group A would display worse visual memory than group B. On the contrary, Galton concluded the following from his observation (p. 312):

I gather from the foregoing paragraphs that the A and B boys are alike in mental imagery, and that the adult males are not very dissimilar to them[.]

In sum, while the sample of 100 adults was in no way representative, the sample of 172 adolescents did not confirm the result obtained for the scientists.

The finding therefore seems biased by Galton's preconceived idea. Brewer and Schommer-Aikins (2006) believe that he may have been strongly influenced by the replies of the first two scientists whom he surveyed (the astronomer Herschel and the biologist Romanes) out of the thirty- or forty-odd scientists in his sample (Burbridge, 1994). Both reported very few images in their questionnaire. This, it is argued, caused a top-down interpretation of the data.

Another reason for Galton's failure to supply a satisfactory explanation of why the scientists could not answer his questions is given by Schwitzgebel (2009) in his book on *Perplexities of consciousness*, more specifically in his chapter on "Galton's other folly" (p. 52):

Consider also Galton's sceptical scientist who finds fallacy in supposing the existence of a "mind's eye" that sees "images". [...] Maybe, that, the difference between the scientists' and non-scientists' responses to Galton's questions reflects neither differences in their imagery (as Galton supposes) or epistemic failure (as I suggest) but only differences in how strictly they interpret the word "see".

While we may never know the exact nature of Galton's error, we can state today that his reasoning was incorrect, for—as other tests confirm—scientists' visual memory is as good as that of non-scientists (Brewer and Sommer-Aikins, 2006).

Beyond questioning Galton's findings, the functionalists addressed the deeper significance of this subjective measure of the liveliness of images: just what is being measured exactly?

First, Galton's questionnaire concerns short-term memory, since respondents are asked about an event occurring on the day of the survey. One could extend the questionnaire to images further removed in time. That is what the cognitivists attempted, as we shall see later.

Second, many psychologists of the early twentieth century challenged the validity of the approach. For instance, the American psychologist Thorndike (1907) set out to compare the subjective measurement of the liveliness and accuracy of visual imagery to other, more objective measures of the memory of the shape, size, number, and other characteristics of memorized objects. Following Galton's method, he divided his sample of 200 students into two groups: the good and less good "visualizers." He then administered ten standard memory tests concerning objects or persons encountered in everyday life. For example, he asked them how many pillars there were in front of the Columbia University Library. Admittedly, this approach is open to criticism. For example, some students might never have seen the pillars; others might have seen them but did not consider them in any way significant. Despite these objections, the result of the comparison is clear: there is no correlation between the measurement of the liveliness of visual images and memory-test performance. One year later, the British psychologist Winch (1908) tried to correct these flaws by showing his students specific objects and reached the same conclusion as Thorndike: there was no correlation between the two measures.

Despite these findings, Betts developed a "Questionnaire Upon Mental Imagery" (QMI) (1909) more detailed than Galton's, with 150 items. He asked respondents to indicate the degree of clarity of the image evoked by a questionnaire item, for example, a

red apple. The respondent had to rate the image on a scale of seven, ranging from a perfectly clear image to no image at all. These mental images were classified by origin of sensation: visual images, audible images, movement images, tactile images, taste images, and smell images. However, the questionnaire was used by hardly anyone other than Betts himself, for the behaviorist approach completely ignored his work. The test was later reused by the cognitivists, and by Sheehan in a shorter version (1967).

In 1913, Watson published an article entitled “Psychology as the Behaviorist views It,” also known as “The Behaviorist Manifesto.” The text offers an approach to psychology centered exclusively on observable behaviors, which can be described objectively in terms of “stimuli” and “responses.” For Watson, memory consists in establishing a habit (1924, p. 237):

By “memory,” then, we mean nothing except the fact that when we met a stimulus again after an absence, we do the old habitual thing (say the old words and show the old visceral—emotional—behavior) that we learned to do when we were in the presence of that stimulus in the first place.

As his approach is essentially descriptive, he does not address the interaction between stimulus and response. He thus totally rejects his own mental imagery by describing it as (1913, p. 175):

[. . .] a mental luxury (even if it really exists) without any functional significance.

We shall not dwell any further on this behaviorist approach except to note its widespread success, particularly in the United States, during the first half of the twentieth century.

It was the cognitive approach that would focus on memory from 1950. In their 1968 book entitled *Mémoire et Intelligence* (*Memory and Intelligence*), Jean Piaget and Bärbel Inhelder clearly stated why their approach differed from that of their predecessors (pp. 22-23):

Classic studies on memory have been surprisingly positivistic, i.e., confined to the inputs into and outputs from the black box [. . .], making the various factors of the stimulus vary with great

ingenuity, but without going beyond the observables to try to reconstruct the inside of the box.¹³⁹

While their research concerned memory processes in general and not autobiographical memory in particular, their results—obtained for children of different ages—provide a better understanding of the link between memory formation and intelligence.

The authors first show that memory is not acquired at birth but improves with age, a process closely dependent on the development of intelligence. They then emphasize another result that is relevant to the rest of our chapter: there is no intrinsic difference, or difference in content, between a false memory and a true one (p. 468). Lastly, memory is, for the most part, a reconstructive activity: the past is not preserved in a sort of storehouse of imperishable memories; rather, memories are continuously renewed by other experiences.

Atkinson and Shiffrin (1968), taking into account the duration of information preservation, proposed a now classic model of three types of memory. The first, *sensory memory*, has a very brief life span and is barely distinguishable from perception. The second, *short-term memory*, consists in the ability to immediately recall information that has just been perceived. It fades just as rapidly and is lost in 30 seconds, unless it is transferred to long-term memory through control processes. The third type, *long-term memory*, allows the extended preservation of information no longer present in our environment.

Many later studies have led to distinctions between several types of long-term memory, designated by terms that vary from one author to another. Two broad forms of long-term memory introduced by Tulving (1972) deserve mention here. The first, *episodic memory*, concerns specific events that have occurred in a person's life. Also called *autobiographical memory*, it is of the

¹³⁹ French text: Les études classiques sur la mémoire sont demeurées étonnamment positivistes, c'est-à-dire limitées aux entrées et aux sorties de la boîte noire [. . .], en faisant varier avec une grande ingéniosité les divers facteurs du stimulus mais sans dépasser les observables pour chercher à reconstituer l'intérieur de la boîte.

utmost relevance to our discussion. By contrast, *semantic* (or *didactic*) *memory* relies on symbolic and linguistic information. It consists of a set of permanent information not directly related to experienced events.

The volume edited by David Rubin, *Autobiographical memory* (1986), extended this approach to episodic memory by providing a synthesis of the studies on the topic. Autobiographical memory became a research priority again in the early 1950s, and we present the main findings below.

One major theme is the time distribution of autobiographical memories.

In 1974, Crovitz and Schiffman took up the method recommended by Galton in 1879, which we described earlier. They applied it not to themselves (as Galton had), but to a sample of 98 students, whom they asked to associate 20 high-imagery, high-meaningfulness, and high-frequency nouns with a memory that they then had to date. The authors obtained 1,745 dated memories, ranging from one hour to 17 years earlier. They then decided to calculate the number of memories per hour by classifying the 1,745 memories into 60 groups. They obtained a roughly linear curve by plotting the results on a log-log graph, whose slope was estimated at -0.78 . In other words, the frequency of memories declines steadily as a function of their duration.

This remarkable result was later confirmed and refined by many other studies on larger samples. First, in another study of students, but covering a larger number of classes, researchers showed that the curve does not follow the previous slope for childhood memories (before the age of 6 or so) but decreases far more rapidly (for example: Rubin, 1982). This would seem to correspond to the start of the learning period for young children. Second, studies on persons of different ages ranging from 12 to 70 show that, for the period of twenty years prior to the survey, the previous slope is still roughly constant (it varies from -0.88 to -1.03). However, for older persons, there is a reminiscence bump, now observed between ages 10 and 30, often with a peak at ages 21-30 (for example: Fitzgerald and Lawrence, 1984). This period

corresponds to the entry into adulthood, which entails major changes in respondents' lives, such as entry into the workplace, formation of couples and families, and departure from the parental home. Rubin et al. (1986) propose a model that allows for (1) the retention function observed over the 20 most recent years, (2) infantile amnesia, which concerns the first six years of life, and (3) the reminiscence bump, which does not begin to take effect until age 40 and over.

Once they obtained these results, however, researchers could not go back in time to examine the remembered events, i.e., to verify the validity of their findings. These may be influenced by factors such as the choice of words used to stimulate respondents' memories. Rubin supplies the list of stimulus words used in a survey of 20 Duke University students aged on average 19.6 years, and of 20 community-dwelling subjects, aged on average 71.2 years (Rubin et al., 1986, p. 210):

Of the 20 stimulus words (*avenue, baby, board, cat, dawn, coin, cotton, fire, flag, flower, friend, market, mountain, nail, picture, steam, storm, sugar, ticket and window*), only the word *baby* seems to be associated with clear periods of the lifespan for which it might evoke memories.

As we can see, most of the words, except for *baby*, do not clearly evoke major events in respondents' lives such as marriage or partnership, exams, first job, and departure from their parents' home. Arguably, these events, even if they are old, are far more easily recalled than those evoked by the other words.

One way to overcome these drawbacks is to work on diaries kept by persons and to ask them about their memories of the events recorded. The book edited by Rubin contains a chapter by Marigold Linton (1986) offering an initial exploration of the real content of memory.

Drawing inspiration from the earlier-cited study by Ebbinghaus (1885), Linton spent 12 years (1972-1983) recording not syllables but the daily events of her life (at least two per day) that she then tried to freely recall after different lengths of time. One of her first results directly contradicted what Ebbinghaus had shown:

the forgetting of these events followed a totally different curve from that of the forgetting of syllables. After a nearly total recall one year later, she observed a forgetting of approximately 5-6% per year for the subsequent periods. She also showed that the forgetting rate differed substantially with the type of events considered. This prompted her to distinguish events according to a hierarchy of types. The most general level is the *mood tone*, which leads to a distinction between negative and positive memories. Linton then realized that negative events are more often forgotten than positive ones in the years immediately following, but that many negative events remain in memory later on. The next level is the memory's general *theme*. By distinguishing between two broad themes, *professional/work* versus *social/self*, Linton observed that all the memories linked to the first consistently prevail over those linked to the second. The third level comprises what he labeled *extendures* (p.57), which are sets of memories connected to significant life stages such as graduate studies. Their recollection depends on their importance in the remembrance period. The fourth level consists of the specific events occurring over a lifetime. They are fully memorized in the first year, but a growing number are forgotten by the second year. The last two levels, *elements* and *details*, are of lesser interest for us and are very soon forgotten.

As this study covers only a single individual, it is open to the same criticism previously directed at introspection, i.e., that it produces different results depending on the experimenter. Some findings, however, have been confirmed by later studies. The forgetting curve over time, for example, was reproduced by Bradburn et al. (1987), Wagenaar (1986), and others. We may conclude that, depending on the type of memory examined, its recollection may be more or less accurate and the time effect is variable. In particular, can events considered in the social sciences be perfectly remembered after a long period, which would justify the use of retrospective surveys to study them?

For major events in people's lives (marriages, births and deaths of children, changes of residence, changes of employer), some countries keep registers, making it possible to determine the exact dates of the events. One can then question respondents

retrospectively about the dates and compare their answers with the dates supplied by the registers.

For this purpose, we shall rely on the results of a survey conducted in 1988-1989 on a sample of 445 couples by the Demography Department of the Catholic University of Louvain (Belgium) and the French National Institute for Demographic Studies (INED) (an initial survey had been attempted in 1982, but with a sample of only 50 couples). Let us note that few surveys have examined the reliability of data collected in retrospective surveys by comparing them with the data recorded in population registers, for few countries have kept such registers since at least 1930 (the survey covers persons aged 40-59). The survey results were published in two articles (Poulain et al., 1992; Courgeau, 1992), while a later volume gives a more psychological analysis (Auriat, 1996).

The first important point is that the survey was conducted in very special conditions. The husband and wife were first questioned separately about the events of their common life, in order to test for a possible sex effect on memory. They were then questioned together in order to correct the errors made in the first test and to decide on a common reply. The third step was to check the population register in order to compile the dates of the events and assess the reliability of the dates recalled by respondents. Lastly, couples were invited to discuss differences between their answers and the register dates. For example, the register provides the date of the civil marriage, while respondents may have given the date of the religious marriage. Thanks to this final phase, one can avoid recording false errors.

The second notable feature is that the detailed analysis of memories of past demographic events shows that the events are in no way increasingly forgotten over time. First, dating errors by persons under 50 do not differ significantly from those made by respondents aged 50 and over. Second, older events are recalled just as accurately as recent ones. The various types of forgetting curves described above do not apply at all to these demographic events.

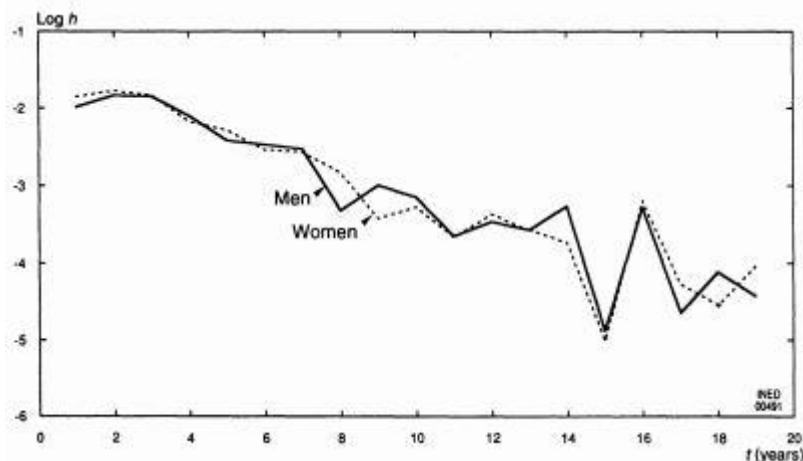
Yet dating errors do indeed occur, and they differ by type of event, ranging from minimal for family events to far greater ones for

migrations. Moreover, they decrease according to the respondent, from a maximum occurrence for the husband to a minimum for the couple. For example, 93.0% of marriage dates given by husbands are accurate to within a month, rising to 98.9% for wives and 99.6% for couples. By contrast, migration dates are accurate to within a month only 61.8% of the time for husbands, 65.2% for wives, and 67.3% for couples. These differences are therefore related to the type of event remembered.

For all the events studied, however, the distributions are relatively symmetrical, indicating the absence of “telescoping” in the data. This phenomenon—widely discussed among psychologists—consists in perceiving past events as having occurred more recently than is actually the case (Auriat, 1996, p. 24).

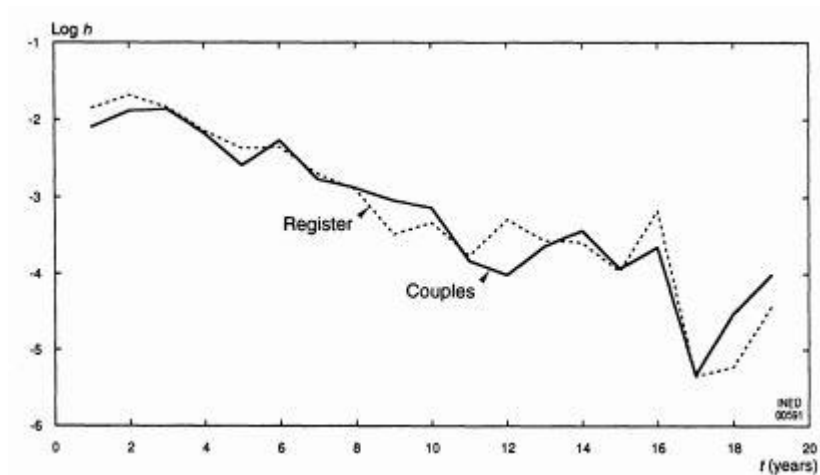
As the highest error rate concerns migration, it is legitimate to ask whether this has a strong impact on the event-history analyses (as described in the previous chapter) of migration.

A simple initial analysis concerns the durations of residences in locations occupied after marriage. We can measure the size of the errors with the instantaneous rates of migration (assumed to be constant for each observation year). Figure 1 compares the logs of the rates, $h(t)$, estimated for men and women over a period t from ages zero to 19; figure 2 compares these logs for couples with register data.



Source: Courgeau, 1992, p.100

Figure 8.1: Natural logarithm of instantaneous rates of migration estimated for men and women



Source: Courgeau, 1992, p. 100

Figure 8.2: Natural logarithm of instantaneous rates of migration estimated for couples and from population register

We see that the curves are not identical, owing to differences in the dating of information obtained for men, women, couples, and population registers. Although different, however, the curves seem to intertwine perfectly: each one is in turn above, below or between the others. All four might belong to the same distribution, the fluctuations being due to low numbers.

We can test this assumption by comparing differences between the moves actually observed in each group and the theoretical number of moves we would observe supposing identical behavior in all groups (Courgeau and Lelièvre, 1992, pp. 75-77).

Taking the 19 years of observation simultaneously, we obtain a chi-square statistic with three degrees of freedom equal to:

$$\chi^2_3 = 1.045$$

which does not contradict the assumption.

Let us now perform a more complex analysis involving a set of characteristics but still focused on post-marriage moves. As figures 1 and 2 show, we may assume that the probability of moving h follows a Gompertz law of parameter ρ ; the characteristics examined Z have a multiplier effect on the probability, yielding the parametric model:

$$h(t; Z, \beta) = \exp(Z\beta + \rho t)$$

where β is a vector of parameters to estimate and t the time elapsed. Taking the probability of moving for a control group as a reference, we measure the effect of a variable by the exponential of the β parameter estimated for this variable. Thus, when the parameter has a value of +0.485 for persons housed by their employer (Table 7.1), their probability of moving is 1.62 ($= \exp(0.485)$) times higher than for the control group (tenants).

The characteristics examined are: (1) duration between marriage and start of residence considered (under a year, 1-4 years, 5-9 years; the control group consists of cases of residences starting ten years or more after marriage) and (2) number of children born before the start of this residence period. We then introduce tenure status to analyze only three sets of survey data (this information was not recorded in the population register); the control group here consists mostly of tenants.

Table 8.1 gives the results of this parametric analysis.

Variables	Men (1,260 residences)		Women (1,310 residences)		Couples (1,314 residences)		Register (1,189 residences)
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1
Constant	-2.955*** (0.174)	-2.322*** (0.193)	-3.009*** (0.179)	-2.391*** (0.193)	-3.062*** (0.183)	-2.264*** (0.192)	-3.118*** (0.187)
Residence starts year of marriage	1.464*** (0.172)	0.438** (0.174)	1.569*** (0.177)	0.574*** (0.178)	1.642*** (0.182)	0.575*** (0.181)	1.564*** (0.186)
Residence starts between 1 and 4 years after marriage	1.117*** (0.160)	0.572*** (0.160)	1.198*** (0.157)	0.622*** (0.158)	1.301*** (0.161)	0.750*** (0.161)	1.199*** (0.166)
Residence starts between 5 and 9 years after marriage	0.641*** (0.164)	0.375** (0.165)	0.559*** (0.162)	0.286* (0.163)	0.684*** (0.164)	0.444*** (0.165)	0.707*** (0.166)
Number of children at start of residence	0.006 (0.040)	-0.016 (0.039)	0.032 (0.042)	0.042 (0.041)	0.051 (0.042)	0.023 (0.042)	0.033 (0.044)
Housed by employer		0.485*** (0.091)		0.480*** (0.090)		0.321*** (0.078)	
Owner-occupier		-2.431*** (0.175)		-2.347*** (0.166)		-2.538*** (0.164)	
Duration of residence	-0.113*** (0.0077)	-0.056*** (0.0076)	-0.116*** (0.0076)	-0.058*** (0.0075)	-0.119*** (0.0077)	-0.064*** (0.0075)	-0.104*** (0.0076)
* Result significant at 10% level. ** Result significant at 5% level. *** Result significant at 1% level.							

Source: Courgeau, 1972, p. 102

Table 8.1: Residential mobility analysis: effect of time since marriage, duration of residence (in years), and tenure status on the probability of moving by data set (parameter estimates with standard deviation in parentheses)

We can then verify that all the characteristics have a similar effect whatever the data source. The only one that has no effect on residence duration is the number of children at the start of residence. All the other characteristics often have a very strong effect, which we cannot distinguish by source from the examination of standard deviations.

Other examples discussed in this article (Courgeau, 1992) lead to the same results and to the following conclusion (p. 109):

Even if errors in the *dating* of past events are frequent, apparently these do not affect their *logical sequence*, or only very slightly so. This sequence is correctly memorized, and the errors only form a kind of background noise, which does not prevent coherent information from being drawn from all sources. Thus memory seems to be reliable where analysis needs it to be.

This result is essential for all analysis of retrospective data. However, for maximum survey reliability, it is useful to collect the information from the wife and if possible with her husband present.

The cognitive approach has also allowed the study of memories of a partly autobiographical nature, which raise various problems.

Concerning visual memory, for example, we have already examined Galton's inconclusive results (1880). After having been completely denied by behaviorists, it eventually attracted renewed interest from cognitivists. They sought, in particular, to identify the relationship between a subjective measure of visual imagery and its objective measure by means of spatial capacity tests, and to analyze that relationship more fully.

In 1967, Sheehan developed a shorter version of Betts' questionnaire (1909), discussed earlier. In 1973, Marks proposed the Vividness of Imagery Questionnaire (VVIQ), adopted by many cognitive psychologists and followed by many other similar tests such as VVIQ₂, Object-Spatial Imagery Questionnaire (OSIQ; Blajenkova et al., 2006), and Vividness of Object and Spatial Imagery (VOSI; Blazhenkova [formerly Blajenkova], 2016). Instead of the items listed by Betts, Marks used color photographs to stimulate visual memory. Psychologists have engaged in extensive discussions on the usefulness and validity of these questionnaires.

To begin with, many studies have tried to determine whether the differences in subjective visual imagery observed for a specific individual were strongly associated with other performances in objective visual perception. What follows is a simplified presentation of these discussions, which are far from settled.

The initial studies on Sheehan's questionnaire (1967) led Sheehan and Neisser (1970) to show that the results obtained on the mental imagery of 32 subjects were barely or not at all correlated with their memory of geometrical drawings. Marks (1973) noted that the mental imagery test used for this study covered seven forms of sensation, as we indicated earlier. He proposed a test more specifically focused on visual imagery, the VVIQ. After conducting it on 74 students, he asked them about certain details of the images

they were shown. The results showed that the good “visualizers” scored higher than the less able ones, and significantly so.

Many other tests, however, disproved the existence of such a connection: Berger and Gaunitz (1977) repeated Marks’ test but showed that the good “visualizers” did not outperform the less able ones. Richardson (1978; 1979) showed the lack of correlation between mental imagery and memory performance. Ernest (1979) found no relationship between a clear visualization of mental images and word recognition, both visual and auditive. Even Paivio (1986), despite his strong defense of the importance of visual imagery, concluded (p. 17) that:

[. . .] self-report measures of imagery tend to be uncorrelated with objective performance tests.

Chara and Hamm (1989) showed that the VVIQ scores are not correlated with any of the “memory tasks” performed later. More recently, Þórudóttir (2020) found no relationship between the results of visual imagery tests and memory accuracy tests.

Only McKelvie’s 1995 quantitative review attempted to assess the contribution of the VVIQ test more positively. However, he found the test to be just a minor component for certain “criterion tasks” and noted that only further research would allow a more definitive assessment. As his bibliography includes nearly 250 articles, his conclusion may seem excessive!

Given such ambiguity about mental imagery tests, it is important to examine in greater detail the deeper psychological theories on which they can be based.

These theories, developed in the 1970s, fall into two broad and opposing categories: propositional theories and imagery theories. While the theories within each category exhibit some differences, their principles are sufficiently clear for our purposes. A detailed presentation will therefore not be useful here. What is important is to see how they justify the use of subjective tests—or not.

Propositional theories were introduced in 1973 in Pylyshyn's article on "What the mind's eye tells the mind's brain: a critique of mental imagery." The author set out to answer the question: what is stored in visual memory? Contemporary psychologists believed that there were only two forms of mental representation: words and images. Pylyshyn refuted this notion and sought to show that, beyond this dual approach, memory is reducible to a single propositional structure. Accordingly, the image's near-perceptive characteristics are merely epiphenomena. Subjective tests of visual vividness thus clearly have no impact on memory.

Imagery theories were introduced by Paivio in 1971 and further developed by Kosslyn in his 1980 work, *Image and mind*. As noted earlier, however, Paivio took a critical stance regarding the correlation between mental imagery and memory performance. Imagery theories rebutted propositional theories point by point, arguing that imagery is not a flawed concept but, on the contrary, a valid concept in psychology. Paivio and Kosslyn proposed a theory according to which our intellectual activities involve two modes of symbolic representation—one visual, the other verbal.

Kosslyn et al. (1978) describe several experiments that, in their view, confirm the existence of visual images in our mental representations. In one experiment, participants are shown a map of an island with various objects. They are asked to memorize the map accurately by copying the positions of the objects on the map, which is then removed from their sight. They then hear the name of one object and asked to visualize it on their memorized map and to concentrate their vision on the object. After five seconds, they hear the name of another object. They are then asked to shift their gaze to this new object and to press a button when they reach it. The time elapsed to reach it is very nearly identical to the time they would have spent in front of the real map. According to the experiment's designers, this result shows that the images are memorized in a nearly pictorial way.

These findings were, however, disputed by many authors in the other camp. Pylyshyn (1981, p.48) believed that Kosslyn and his colleagues were encouraging participants to act as if they were, in

fact, viewing the real map and were then estimating the distance between two points:

The one empirical hypothesis is just this: *When people imagine a scene or an event, what goes on in their minds is in many ways similar to what goes on when they observe the corresponding event actually happening.*

Pylyshyn thus rejected Kosslyn's evidence of the existence of mental images.

The imagery approach gained strength, however, thanks to neuroimaging methods, introduced in the 1990s. In 2015, Pearson and Kosslyn (p. 10.090) felt confident in asserting the end of the imagery debate after an experiment conducted that same year (Naselaris et al., 2015), using “a sensory multifeature-based encoding model” on three subjects. After adjusting their model on perceived data, Naselaris et al. showed that the same model could successfully predict the images recalled by subjects, in the same brain areas.

But is that truly certain? Also in 2015, Zeman et al. clearly identified a group of persons who claimed to have no visual imagery—an absence the authors named “aphantasia.” Some respondents, however, reported an involuntary vision of a mental image. In 2018, Keogh and Pearson showed that persons suffering from “aphantasia” are incapable of activating their visual cortex owing to the lack of a retroactive connection from the frontal cortex. In 2020, Thorudottir et al. described the case of an architect with normal visual perception but altered mental imagery. This disproved the hypothesis that visual perception and mental imagery are governed by the same mechanism.

We may conclude that the problem raised by the subjective measurement of visual memory is still far from having been solved in a fully satisfactory manner. In our view, a subjective questionnaire—such as those of Galton, Betts, Sheehan, Marks, and others—will never allow a clear measurement of visual memory, for it is too complex to be captured by such a simple and reductionist medium. This straightforward observation effectively explains the

difficulties encountered in the use of questionnaires. It shows how important it is for psychology to develop totally different concepts of subjective memory.

Next, we need to examine the cognitivist approach to collective memory. Just as Piaget pioneered the cognitivist approach to individual memory, so did Halbwachs pioneer it for collective memory. While he had already blazed the trail in his earlier studies, his key work on the subject was *La mémoire collective* (*Collective memory*, 1950). Written during World War II, it was published posthumously, as Halbwachs had been deported to Buchenwald, where he died in 1945.

The introduction of collective memory, necessarily linked to individual memory, is equivalent to the shift from the event-history approach to the multilevel approach in the social sciences, discussed in the previous chapter. As Halbwachs clearly stated (1950, pp. 23-24):

Besides, if collective memory draws its strength and duration from being supported by a set of persons, it is, however, individuals who remember, as members of the group.¹⁴⁰

While memory is an activity of individuals who are isolated from one another, these same individuals, as members of social groups, share with the other members a set of cultural tools that make their memory collective as well (Roediger III, Abel, 2015).

Social scientists soon incorporated this theme into their work (Halbwachs being a disciple of Durkheim), but psychologists—the focus of our attention here—responded more slowly. Social scientists were mainly interested in the consequences of collective memory on numerous social and cultural phenomena, but neglected the ways in which these processes are formed.

Cognitivist psychologists, by contrast, sought to transcend social phenomena in order to identify the mechanisms that explain

¹⁴⁰ French text: Au reste si la mémoire collective tire sa force et sa durée de ce qu'elle a pour support un ensemble d'hommes, ce sont cependant des individus qui se souviennent, en tant que membres du groupe.

the formation and persistence of a collective memory (Hirst and Manier, 2008). Despite this desired objective, most methods used so far still belong to the standard field of cognitivist approaches to individual memory. As Hirst et al. (2018, p. 449) note, after presenting and discussing these approaches:

To be sure, a generalized theory of the psychology of collective memory is yet to be proposed, but the different approaches discussed here suggest that the field is rapidly moving forward.

However, one of the paths explored in their article—the bottom-up approach to the formation and preservation of a collective memory—seems sufficiently novel to us to deserve a closer look. Several experiments on different numbers of subjects and networks (Coman et al., 2016; Momennejad, et al., 2019; Vlasceanu et al., 2020) have yielded promising results. These models, based on networks of relationships and conversations between individuals, try to show the conditions in which a collective memory can be formed. They introduce various means of communication between members of a single network or different networks to identify those that produce a collective memory rapidly or, on the contrary, those that prevent or delay its formation.

This psychological research based on relationship networks can also be tied to multilevel research used in epidemiology, demography, sociology, and other disciplines (see previous chapter) but it is in its early stages and would require greater formalization. For the moment, it restricts experimental situations to single networks for each individual, whereas research in the other social sciences shows that the same person is linked to many networks of different kinds and with different goals.

Despite these many problems to solve in the various areas we have explored, we can say that cognitive psychology is still developing. It has the characteristics of a school of thought that has now come into its own, with its journals, laboratories, and international conferences—but also its convictions and assumptions.

Lastly, a word about an approach that has emerged more recently: evolutionary psychology. Based on Darwinian theory, it

aims to show that psychological processes are linked to evolution and determined genetically. In studying the evolution of human memory, it has come up against many difficulties, as Nairne (2010, p. 28) spells out clearly:

As noted, there are no fossilized memory records, the heritability of cognitive processes remains largely unknown, and we can only speculate about the selection pressures that operated in ancestral environments.

While few researchers reject the notion that memory has evolved over the ages (Nairne, Pandeirada, 2016), the empirical bases of such a theory seem too weak to ensure its success. We shall therefore not discuss evolutionary psychology any further, as it contributes little to the study of autobiographical memory.

8.2 From the Freudian unconscious to the neurosciences

As noted at the start of §7.1, psychoanalysis diverged from the other psychological approaches by positing the existence of the unconscious. In this section, we therefore examine it in greater detail by comparing it with the view of the unconscious expressed in today's neurosciences.

Psychoanalysis was developed by Sigmund Freud (1856-1939) outside the current of the functionalist school, which viewed it as an outright heresy. Indeed, psychoanalysis regarded memory not only as a conscious function, but—primarily—as an unconscious one.

In 1895, Freud drafted a *Project for a scientific psychology* (*Entwurf einer Psychologie*), which remained unpublished until 1950, when it appeared as a volume edited by Marie Bonaparte, Anna Freud, and Ernst Kris. The *Project* presents a hypothetical theory of psychology based on the interrelationships between three

types of neurons. As with the other schools, we shall confine our discussion of his approach to the aspects regarding memory.

The late nineteenth century was marked by the first images of neurons, most notably by Ramón y Cajal, who obtained them in 1888 and presented them before the Royal Society of London in 1894. His discovery proved that each nerve cell is a separate entity. For Freud (*Project*, p. 299), this offered the possibility of developing an explanation for memory:

A main characteristic of nervous tissue is memory: that is quite generally, a capacity for being permanently affected by single occurrences—which offers such a striking contrast to the behaviour of a material that permits the passage of a wave-movement and thereafter returns to its former condition. A psychological theory deserving any consideration must furnish an explanation of “memory.”¹⁴¹

The task was to explain these differences between the perceptive system, which receives energy and transmits it to memory, and memory itself, which stores the energy. For this purpose, Freud assumed that memory neurons (ψ) possess contact barriers, whereas perception neurons (ϕ) do not: they merely transmit excitation to the memory neurons and return to their prior state, ready to function again.

This transmission takes place through “facilitation”—the passage of an excitation from one neuron to another—which causes a lasting alteration in the contact barriers of the ψ neurons. Denoting this state of the contact barriers as the degree of facilitation, Freud asserts that “memory is represented by the facilitations existing between the ψ neurones” (p. 300).¹⁴² But the degree of facilitation is

¹⁴¹ German text: Eine Haupteigenschaft des Nervengewebes ist das Gedächtnis, d. h. ganz allgemein die Fähigkeit, durch einmalige Vorgänge dauernd verändert zu werden, was einen so auffälligen Gegensatz gibt zum Verhalten einer Materie, die eine Wellenbewegung durchläßt und darauf in ihren früheren Zustand zurückkehrt. Eine irgendwie beachtenswerte psychologische Theorie muß eine Erklärung des >Gedächtnisses< liefern.

¹⁴² German text: Das Gedächtnis ist dargestellt durch die zwischen den ψ -Neuronen vorhandenen Bahnungen.

not always identical, and will depend on the intensity of the impression of an event.

To explain consciousness, Freud introduces a third type of neurons, called α neurons. We shall not discuss the content of consciousness, which he regards as radically distinct from memory, the focus of our interest here. For Freud, memory can be either conscious or unconscious. The important point for our purposes is that the emerged—i.e., conscious—part of memory is what the other schools of psychology either study (Psychological structuralism, Functionalism or Cognitivism) or reject from their fields for being indescribable in empirical terms (Behaviorism, Evolutionary psychology). Freud, instead, concentrated on the immersed part—and therefore, in his view, the unconscious part—of memory, in order to try to make it conscious through his psychoanalytical work. As we shall see, this immersed part of memory is in fact very short-lived and not outside of time, as Freud believed.

Yet Freud was forced to admit that his distinction between neurons rested on no known evidence, and that the question of the nature of facilitation remained unresolved.

In his letter to Fliess of December 6, 1896 (Freud, 1887-1904, p. 207), Freud argued that several unconscious mnemonic recordings existed:

As you know, I am working on the assumption that our psychic mechanism has come into being by a process of stratification: the material present in the form of memory traces being subjected from time to time to a *rearrangement* in accordance with fresh circumstances—to a *retranscription*. Thus what is essentially new about my theory is the thesis that memory is present not once but several times over, that it is laid down in various kinds of indications [. . .]¹⁴³

¹⁴³ German text: Du weißt, ich arbeite mit der Annahme, daß unser psychischer Mechanismus durch Aufeinanderichtung entstanden ist, indem von Zeit zu Zeit das vorhandene Material von Erinnerungsspuren eine *Umordnung* nach neuen Beziehungen, eine *Umschrift* erfährt. Das wesentlich Neue an meiner Theorie ist also die Behauptung, daß das Gedächtnis nicht an einfach sondern mehrfach vorhanden ist, in verschiedenen Arten von Zeichen niedergelegt.

Again, he did not know how many recordings there were, but believed that there were at least three and probably more. Energy is first captured by perception, which keeps no trace of what has occurred; it then flows to the unconscious (which is inaccessible to consciousness), and onward to preconsciousness, which can become conscious in certain conditions. In the specific case of repression, the communication between the unconscious and preconsciousness does not take place, preventing contents from accessing consciousness. But this memory, inaccessible to consciousness, remains present in unconscious memory and continues to act without being recognized. Ideally, the psychoanalyst should lead the patient to recognize this action and remove the repression by making him or her become conscious of the “forgotten” memory.

It should be noted, however, that after outlining preconsciousness in the *Project* as the seat of that which can be recalled, Freud never described it in detail in his later work.

In fact, Freud never published his theory, no doubt because it lacked a sufficiently robust base and perhaps even because it led to an impasse. The reason is that the classic associationism with which it remained linked had been criticized in the early twentieth century—most notably by Bergson—and was totally discarded in the second half of the twentieth century with the advent of cognitivism. Yet the associationist theory had been developed precisely to explain phenomena specific to memory and to human thought. Its central tenet is that mental life consists of associative chains of elementary facts of consciousness. On these grounds, it seeks to explain how our memory and ideas are produced.

Associationism, which predominated in Freud’s day, was championed by many philosophers and psychologists (such as John Stuart Mill, 1843; Ribot, 1870; Taine, 1878). Ribot (1870, p. 242) described the school’s commanding position in psychology:

When we see Messrs. Stuart Mill, Herbert, Spencer, and Bain in England; physiologists, M. Luys and M. Vulpian in France; in Germany, before them, Herbart and Miller, reduce all our psychological acts to various modes of association between our ideas, feelings, sensations, and desires, we cannot help believing

that this law of association is bound to become dominant in experimental psychology, and to remain—at least for a while—the final way to explain psychic phenomena.¹⁴⁴

While Freud's approach reshaped the notion of association, it remained too dependent on it. As noted above, the advent of the cognitivist era caused associationism to lose much of its appeal: association became a mere chapter of psychology again, but associationism became totally obsolete. We now know that association, far from being a primal fact, always results from a process of information encoding and from the mnestic structure that encodes it. Moreover, Mill's empiricism—with its notion of induction as generalization—had already been rejected back in 1620 by Bacon, who had replaced it with a fully inductive approach (based on Bacon's definition of the term), as described in Chapter 3.

Freud's notion of association turns up in one of the most insightful critiques of his work by the cognitivist Piaget (1965, p. 201):

For Freud, consciousness is a mere lighting-up, an “internal sense organ,” whose only role is to throw light on existing associations resulting from resemblances and contiguities between unconscious memories. This means that he denies to conscious activity what for most contemporary authors is its essential characteristic, i.e., the constitution of thought, which is a real constructive activity. Freudism does not consider the problem of intelligence, which is a great pity, for consideration of the question of awareness in the act of comprehension and of the relationship between unconscious intellectual schemas and conscious “reflection” would certainly have simplified the theory of the affective unconscious.¹⁴⁵

¹⁴⁴ French text: Quand on voit MM. Stuart Mill, Herbert, Spencer et Bain en Angleterre; des physiologistes, M. Luys et M. Vulpian en France, en Allemagne, avant eux, Herbart et Miller, ramener tous nos actes psychologiques à des modes divers d'association entre nos idées, sentiments sensations, désirs, on ne peut s'empêcher de croire que cette loi d'association est destinée à devenir prépondérante dans la psychologie expérimentale, à rester pour quelque temps au moins, le dernier mode d'explication des phénomènes psychiques.

¹⁴⁵ French text: D'une manière générale il conçoit la conscience comme un simple éclairage (un organe des sens interne) dont le rôle est uniquement de projeter sa

In the same period, Ricœur (1965b), in *De l'interprétation. Essai sur Freud*, attempted to incorporate psychoanalysis into hermeneutics. He tried to show that Freud does not seek to “explain” the genesis of the unconscious, but to “comprehend” it in the hermeneutic sense. However, Freud’s analytical approach—discussed in detail below—went against this reductionist interpretation of psychoanalysis as a form of hermeneutics. This was clearly shown by Mi-Kyung Yi (2000, p. 260), in *Herméneutique et psychanalyse, si proches ... si étrangères*, who objected to the reduction:

Let us begin by looking at what psychoanalysis is reduced to: a theoretical system of interpretative codes. Besides the fact that this reduction of psychoanalysis to a theory contradicts the Freudian priority assigned to the analytical method, the latter method is reduced to the application of the comprehension schema. Another, no less important consequence is that the analytical situation becomes a dialogue situation, and the analytical relationship becomes a comprehension relationship.¹⁴⁶

Even if psychoanalysis finds it difficult to systematize itself as a form of scientific knowledge, this can in no way justify a possible attempt by hermeneutics to capture its object.

Freud’s truly original contribution is a new approach that enables him to explore what he calls the unconscious through

lumière sur les associations toutes faites résultant des ressemblances et contiguités entre souvenirs inconscients. Il refuse donc à l’activité consciente ce qui en fait le caractère essentiel pour les auteurs actuels : c’est de constituer la pensée, c’est-à-dire une activité constructrice réelle. Le problème de l’intelligence est en fait absent du freudisme, et c’est grand dommage, car la méditation sur la prise de conscience dans l’acte de compréhension, ainsi que sur les rapports entre schèmes intellectuels inconscients et la “réflexion” consciente, eût certainement simplifié la théorie de l’inconscient affectif.

¹⁴⁶ French text: Commençons par ce à quoi est acculée la psychanalyse: un système théorique de codes interprétatifs. Outre que cette réduction de la psychanalyse à une théorie s’oppose à la priorité freudienne accordée à la méthode analytique, cette dernière se trouve réduite à l’application du schéma de compréhension. , un rapport de compréhension.

circuitous paths. For him, the past is fully preserved in the unconscious, and consciousness simply throws light on the memories stored in the unconscious. To make these unconscious memories rise to the surface, he asks patients to tell him exactly all that came to their minds for an hour, without any intervention on his part. Session after session, patients learn to stop concealing their intimate thoughts, to tell him their dreams, and eventually they take pleasure in talking unrestrictedly as their spontaneous thoughts lead them. Unwittingly, patients will jump from one recollection to another, and recent memories will be interspersed ever more often with older memories, not only of life with their parents but also of old dreams that intermingle with the memory of real events (for more details on this approach see Piaget, 1965, pp. 193-196). The psychoanalyst will then be able to unravel the strands of the unconscious—which will hence become visible—and enable the subject who came for therapy to gradually become aware of the facts leading to his or her current situation.

This approach has been heavily criticized by most psychologists in the other schools except for the cognitivists, who, like Piaget, finally accepted the validity of the study of processes regarded as unconscious. Let us outline the most significant of these criticisms.

First, Freud's research was based on a very small number of cases analyzed, which are in no way representative of the population as a whole. There were only a dozen cases, including himself, and most of his patients were young, single, and highly educated. His results thus seem hard to generalize. Moreover, some cases ended up never being published, prompting Solloway (1992, p. 160) to state:

Some of the cases present such dubious evidence in favor of psychoanalytic theory that one may seriously wonder why Freud even bothered to publish them. Two of the cases were incomplete

and the therapy ineffective. A third case was not actually treated by Freud¹⁴⁷.

Second, there was no control whatsoever of the conditions in which he collected his data. He kept no verbatim record of what his patients told him, but worked on his notes made several hours after the sessions, and he did not archive them. He was therefore at liberty to reinterpret the words, spurred by the desire to find proofs of his theory.

Third, a good number of other theoreticians of psychoanalysis disagreed with many of his hypotheses, most notably concerning the predominant role of biological characteristics—in particular, sex—as the fundamental determinants of psychoanalytical behaviors.

We shall now briefly examine some of these theoreticians before moving on to the neurosciences, which have totally redefined the notion of the unconscious.

While Freud emphasized sexuality as the main driver of psychic problems, the psychoanalysts who extended his approach explored other avenues while preserving the basic elements of his approach.

Adler (1870-1937), for example, broke with Freud in 1911. He believed that human behavior was largely determined by societal rather than sexual forces. Accordingly, he emphasized the conservation instinct and the will to power. For this purpose, he proposed the concept of *social interest*, defined as an innate potential to cooperate with others in order to fulfill one's own destiny. A person's life style, Adler argued, is set by the age of four or five and is hard to change later. He speculated that birth rank has an enormous impact on a person's future. Unfortunately, many later results undermined many of his hypotheses. In any event, most of the objections of a more methodological nature to the Freudian approach also apply to the Adlerian approach.

¹⁴⁷ French text: Une autre conséquence non moins importante, c'est que la situation analytique devient une situation de dialogue et la relation analytique, un rapport de compréhension.

Similarly, Jung (1875-1961)—whom Freud saw as his successor—broke his friendship with Freud in 1914 to establish what he termed *analytical psychology*, which contradicted many of his predecessor's theses. Jung criticized Freud for excessively restricting the unconscious by confining it to patients' past experiences repressed by the patients themselves. Jung replaced this individual unconscious with a collective unconscious, characterized by elements common to all individuals. He undertook a vast survey on the generality of these symbols, inherent in the myths, rituals, and sacred representations of primitive societies, both Western and Eastern. This partly ties in with our discussion of epic in Chapter 6. However, these "hereditary" symbols, which Jung assumed to be present by childhood, are more easily explained by the evolution of infant mentality than by the action of a mysterious heredity (Piaget, 1965, p. 211). In this light, Jung's collective unconscious seems quite useless. Lastly, most of the methodological objections to Freudian methods are valid for the Jungian approach as well.

The evolution of Freudianism was paralleled by the development of the neurosciences. Initially based on the dynamic version of associationism introduced by John Hughlings Jackson (1835-1911), they long remained under the influence of his theories (Jackson, 1884). Before Cajal's discovery of neurons in 1888, Jackson had already constructed a theory that assumed the existence of fibers (axons) serving as mediators between different parts of the nervous system. The theory focused on the study of reflex movements and proposed a hierarchy of nervous centers (p. 649):

The lowest centres are the most simple and most organised centres; each represents some limited region of the body indirectly, but yet most nearly directly; they are representative. The middle motor centres [...] are more complex and less organised, and represent wider regions of the body doubly indirectly; they are re-representative. [...] The highest motor centres are the most complex and least organised centres, and represent widest regions (movements of all parts of the body), triply indirectly; they are re-re-preventative.

Nervous disease was accordingly seen as a regression toward a more archaic form of the nervous system. Conscious mental life therefore

took place at the top level, while unconscious life was situated at the lower levels.

This dynamic associationism, while different from Freud's associationist schema, was no less objectionable for the same reasons noted earlier. In the 1980s, however, the neurosciences turned to the study of information processing and, for this purpose, had to engage in the observation of the processes involved.

They therefore sought to observe with precision the differences between conscious and unconscious thought, which Freud had merely stated to be self-evident without ever trying to observe them before theorizing them. The most salient question was the location of memory. Freud had regarded memory as independent of consciousness, believing it could be located in either the conscious or the unconscious part of the mind.

The neurosciences had to abandon Jackson's model, for it no longer matched the detailed observations made from the 1980s on. First, neuroscientists tried to define unconscious phenomena by observing individual behaviors that offered evidence of cognitive processes of which the individual is not truly aware.

The study of a neurological dissociation between the perception and grasping of objects (Goodale et al., 1991) made it possible to show the existence of unconscious mental processes that are not perceived by the subject but can be located in the higher stages of mental life. Indeed, the authors show (p. 155):

[...] that a person with brain damage may retain the ability to calibrate normal aiming and prehension movements with respect to the orientation and dimension of objects, despite a profound inability to report, either verbally or manually, these same visual properties.

Many other experiments showed that these mental processes are fleeting and disappear from our unconscious in just a few tenths of a second. However, the authors held on to the view that some sectors of the cerebral cortex, which they call the ventral pathway, handle conscious functions while others—the dorsal pathway—handle the unconscious ones (Naccache, 2006, p. 83).

This framework was superseded by the development of fMRI (functional Magnetic Resonance Imagery), which made it possible to show the brain “in action.” In 2000, Rees et al. used fMRI to show that the ventral pathway can be activated unconsciously. This finding—confirmed by other studies—showed that no location in the human brain is specifically devoted to conscious or unconscious functions.

In a more elaborate synthesis of these approaches, Naccache (2006) compared the Freudian unconscious and the neuroscientific unconscious.

The first reason to reject the Freudian conceptions concerns repression, which Freud saw as an unconscious defense mechanism. It stands in total contradiction to the most relevant neuroscientific experimental data and theoretical models. Anderson and Green (2001), for example, show that repression is a fully conscious and voluntary process of elimination of unwanted memories. However, they do raise the question of whether the suppression is total or if the memory can return much later. Other authors, such as Smith and Moynan (2008), observe that these memories are not completely erased but leave a persistent trace in the brain. A more recent study by Wang et al. (2019) shows the need to reconsider the influence of repression on patients’ mental health. They write (p. 90):

Does suppressing intrusive thoughts and memories, even successful, leave remnants of experience in implicit memory that discretely and perniciously influence mental life outside our awareness? To our surprise, and contrary to our own previous conjectures about the lingering influences of suppressed traces [...], the current study and others reported recently [...] suggest that this view is incorrect.

The present research indicates that episodic retrieval suppression inhibits the semantic content underlying episodic traces. We found diminished accessibility of suppressed content measured on a task that participants view as correlated to the original suppression context; that shares no cues with the study episode; that prompts little awareness with the study episode memory; and that clearly could benefit from prior exposure.

Their study manifestly challenges the Freudian theory that ideas suppressed by patients can be made to re-emerge.

The second argument against Freudianism is that all neuroscience experiments support the assertion that the specific characteristic of the unconscious is its extreme evanescence (Naccache, 2006, p. 355):

As exponential decrease and immortality do not go well together, it is clear that the issue of the life expectancy of our unconscious mental representations is a second reason for the definitive abandonment by neuroscientists of the Freudian concept of the unconscious.¹⁴⁸

How, then, can we reconcile this evanescence with the importance that Freud attaches to the unconscious memories of early childhood? As Piaget showed in detail (1945, p. 199):

The memory of a child between two and three years old is still a blend of made-up stories and exact but chaotic reconstructions, and organized memory develops only with the progress of full intelligence.¹⁴⁹

In sum, there is no such thing as early childhood memory, for the child does not yet have an evocation memory capable of organizing these recollections.

For a detailed discussion of all the reasons for the incompatibility between the Freudian unconscious and the neuroscientific unconscious, we refer the interested reader to Naccache (2006).

¹⁴⁸ French text: La décroissance exponentielle et l'immortalité ne faisant pas bon ménage, il apparaît ainsi clairement que la question de l'espérance de vie de nos représentations mentales inconscientes constitue un second motif d'abandon définitif, par les neuroscientifiques, de la conception freudienne d'inconscient.

¹⁴⁹ French text: La mémoire de l'enfant de deux à trois ans est encore un mélange de récits fabulés et de reconstitutions exactes mais chaotiques, et la mémoire organisée ne se développe qu'avec les progrès de l'intelligence entière.

Given the multitude of small brain circuits that continuously produce unconscious mental representations, Naccache (2006, p. 272) defines consciousness as a neural network:

[...] there arguably exists a normal network totally different from these other circuits, whose content corresponds at each instant to the mental representation that we experience consciously. We shall call this unique neural network the “conscious global workspace.”¹⁵⁰

Let us note that this is not an observation but a hypothesis, as indicated by the use of the conditional tense in the French original [rendered here by “arguably”]. An electrophysiological signature of conscious awareness would be needed here (Sergent, 2021). The property of remote cerebral areas to communicate with one another could provide such a signature, but it has not yet been demonstrated.

Many neuroscientists have already recognized this definition of consciousness under the term Global Neuronal Workspace (Dehaene and Changeux, 2011). If we accept it, then Freud, who thought he was analyzing the unconscious, actually revealed the modes of functioning of our consciousness (Naccache, 2006, p. 403):

I credit Freud with having invented a method of treatment—the analytical cure—in which the equipment used for the treatment relies exclusively on the manipulation of the conscious mental attitudes of the patient and the therapist, namely, psychoanalysis. This recognition of the literally vital role of conscious beliefs in the process of healing certain impairments of the mind is revolutionary.¹⁵¹

¹⁵⁰ French text: [...] il existerait un réseau normal absolument différent de ces autres circuits, dont le contenu correspondrait à chaque instant à la représentation mentale dont nous faisons l’expérience consciente. Nous appellerons ce réseau neuronal unique en son genre l’“espace de travail global conscient”.

¹⁵¹ French text: Je crédite Freud d’avoir inventé une méthode de traitement, la cure analytique, dans laquelle le matériel utilisé pour soigner repose exclusivement sur la manipulation des attitudes mentales conscientes du patient et de son soignant, la psychanalyse. Cette reconnaissance du rôle à proprement parler vital des

This renewed appreciation for the technique described in detail above makes up for the partisan squabbles between Freud, Adler, Jung, and others, for all ultimately used the same psychoanalytical approach, albeit with many variants.

However, neuroscience developments continue at a rapid pace. In particular, recent research has revealed the role of glial cells (or glia), which outnumber neurons. The study of their action on memory and many other behaviors is expanding and far from over (Hemonnot-Girard et al., 2021). Similarly, myelin—a form of electrical insulation surrounding neurons—has been shown to play a part in consolidating memory (Steadman et al., 2019). It is still too early to say whether these discoveries will revolutionize the neurosciences of memory.

8.3 Conclusions

We have deliberately refrained from devoting a chapter to parapsychology. The phenomena that it studies—such as telepathy, mesmerism, hypnotism, clairvoyance, apparitions and haunted places—are indeed too specific for our general approach to human life. Despite its intention, from the outset, to be scientific—as claimed by the Society for Psychical Research founded in 1882—it has struggled to establish itself as such.

Yet it is the examination of its methods that led to a more general challenge to the methods used by psychologists of all the schools reviewed here. Many authors had questioned the validity of the statistical results obtained by psychologists, but it was Bem's article (2011) on paranormal phenomena that ignited the controversy. Using psychological methods, Bem showed that eight of the nine experiments on paranormal phenomena proved their existence. In order to avoid protests by many readers, the editors of the *Journal of Personality and Social Psychology*, which had published the article, noted that the studies had been conducted in

croyances conscientes dans le processus de guérison de certaines affections de l'esprit est révolutionnaire.

keeping with standardized scientific practices in the field of experimental psychology, and that it would have seemed inappropriate to apply other practices to parapsychological studies (Judd and Gawronski, 2011). This led to a number of replications of the study in order to verify its results (for example Ritchie et al., 2012, who described three fruitless attempts to reproduce the study).

The episode also led to a challenging of acceptance procedures for more general articles on psychology, as replications of studies in the field are relatively uncommon. An analysis of publications in 100 psychology journals between 1900 and 2012 showed that about 1.6% of articles used the term “replication,” and a more detailed analysis of 500 articles using the term showed that only 68% actually performed a replication, making a total replication rate of 1.07% (Makel et al., 2012, p. 537).

This *Replication Crisis*, as it came to be known, peaked in 2015 with the publication of the *Reproducibility Project: Psychology* (RP:P; Open Science Collaboration, 2015, p. 943) in the prestigious journal *Science*. After replicating 100 experimental studies in psychology, the project found that:

Ninety seven percent of original studies had significant results ($P < .05$). Thirty six percent of replications had significant results; 47% of original effect sizes were in the 95% confidence interval of the replication effect size; 39% of effects were subjectively rated to have replicated the original results; and if no bias in original results are assumed, combining original and replication results left 68% with statistically significant effects.

The authors nevertheless concluded that these figures suggested there was room for improving reproductibility in psychology.

This cold shower triggered a reply in the same journal entitled “Comment on ‘Estimating the reproducibility of psychological science’” from renowned psychologists (Gilbert et al. 2016). They pointed out that the populations to whom replications are applied are very different from the original populations. For instance, an original study measuring the attitude of Americans to African-Americans was replicated on Italians who share none of the stereotypes of Americans. This shows that the effects observed are

conditioned by a large number of “confounders” (potential confusion factors), which need to be factored into comparisons of replication results (Peters and Gruijters, 2017). As a result, the samples to be picked in order to generate equivalent groups are far larger than those specified in the Open Science Collaboration study (Peters and Crutzen, 2021).

The statisticians Hung and Fithian (2020, p. 1084) have also addressed the issue and reached similar conclusions. Moreover, they show that—because of biases due to the selection of significant effects—the Open Science Collaboration study data do not back up the findings set out in the previous quotation:

Our analyses point to several conclusions regarding effect shifts: First, that there are a few studies where we can be confident the effect in the replication study was significantly different than in the original study; second, that in aggregate, when effects do shift, they tend to decline (shift toward zero) in replications rather than increase; and third, that there is insufficient evidence to conclude that the vast majority of experimental effects simply evaporated upon replication.

This crisis can now be said to be over, with a reform of the statistical methods used in psychology.

Moreover, the critique of studies performed on small samples—often just a few dozen persons—has led to a major revision of statistical methods used in scientific publications. For example, the use of the term “statistical significance”—formerly recommended in most scientific journals (particularly in psychology), is now banned there. An entire issue of *The American Statistician* shows the reasons for this move, summarized in the editorial by Wasserstein et al. (2019). Initially regarded as a tool to show that a result could warrant further scrutiny, “statistical significance” had become what the authors call a “tyrant,” i.e. a prerequisite for publishing in a reputable journal. As the editors of *The American Statistician* clearly state:

To move to a world beyond “ $p < 0.05$,” we must recognize afresh that statistical inference is not—and never has been—equivalent to scientific inference.

This distinction is essential for updating publication guidelines in many disciplines, not only psychology.

Lastly, the once commonly accepted notion of objective probability had been increasingly challenged, and the tendency is now to replace it with that of Bayesian epistemic probability. The reader interested in the reasons for the shift will find a fuller discussion of them in our book on *Probability and social science* (2012).

On another side psychology is facing a *Theory Crisis*, may be more fundamental than the *Replication Crisis*. A number of psychologists have called attention to the fact that its theoretical foundations are shaky (Klein, 2014; Fiedler, 2017; Muthukrishna, Henrich, 2019; van Rooij, Baggio 2021; Eronen, Bringmann, 2021; etc.).

In conclusion, while psychology has encountered a range of problems, their resolution has entailed many challenges to existing methods and an ever more systematic evolution toward a more scientific approach. How can we define this scientificity more accurately? That is the question we set out to answer in the next chapter.

General conclusion

Chapter 9

Mechanisms, systems, autonomy, hermeneutics, and understanding human life

As we have seen throughout this work, many if not all social sciences adopt different approaches to human life. None, however, genuinely tries to consider it in its full complexity. Each addresses only some of its aspects. Human life, therefore, appears to loom larger than all the social sciences while constituting one of their key elements.

At the end of Part 1, we outlined the reasons that led to the separation between astrology and astronomy, and between eugenics and genetics. The main reason was the confusion—already noted by Francis Bacon in 1620—between two types of approaches: the first begins by positing axioms, from which it deduces consequences; the second, by contrast, identifies axioms from the observation of the facts studied, in order to deduce the principles of a science. The first type of axiom leads to idols, which are not verified by experiment, as we have seen for astrology and eugenics. The second leads to a true scientific approach as we have seen for astronomy and genetics.

But this scientific approach cannot address the complexity of human life, of which we have sought to provide an overview in the previous chapters. As Frederick Suppe (1989, p. 65) said it cannot deal with phenomena in all of their complexity, but only focus on a

small number of phenomena of human life that can be characterized by a small number of parameters.

In this final chapter, we shall therefore take a closer look at the main approaches used to understand the various aspects of life stories.

We have seen that the notion of mechanism served as the basis for Newton's theory of astronomy (1687), and for the Mendelian theory of heredity in the early twentieth century. In the late twentieth and early twenty-first centuries, biologists and neuroscientists extended the mechanistic approach to their disciplines. In the first volume of the *Methodos Series*, Franck (2002) broadened its scope of application to all the social sciences, showing its initial uses in a number of these disciplines.

More recently, several authors (e.g. Machamer, Darden, and Craver, 2000; Glennan, 2002; Bechtel and Abrahamson, 2005) have offered more precise definitions of such "mechanisms," but we prefer the one given by Glennan and Illari (2018) in *The Routledge handbook of mechanisms and mechanical philosophy* (p. 2):

A mechanism for a phenomenon consists of entities (or parts) whose activities and interactions are organized so as to be responsible for the phenomenon.

Illari and Williamson (2012, p. 119) had already proposed a very similar definition, and we refer the interested reader to their article, which gives the reasons why the definition can apply to different natural, biological, and social sciences.

However, as the mechanistic approach is a causal approach to events, when attempting to explain the concept of aggregation level, we shall need to bring in another approach to explain the concept of emergence of a level.

An alternative (or complementary?) model to mechanistic causal analysis is the systemic approach, developed by Ludwig von Bertalanffy (1901-1972) over his lifetime and presented in his work, *General system theory: Foundations, development, applications* (1969). (It must be remembered that von Bertalanffy, because of his

membership in the Austrian national-socialist party and his role as “biologist of the Third Reich,” had to emigrate at the end of World War II to the United States, where he published his book.) His approach has since been endorsed by many authors including Rapoport, Boulding, and Meadows.

In the “Foreword” to his work (p. vii), von Bertalanffy defined his general systemic approach as follows:

[...] systems theory is a broad view which far transcends technological problems and demands, a reorientation that has become necessary in science in general and in the gamut of disciplines from physics and biology to the behavioral and social sciences and to philosophy.

This led him to view a system as an organized whole with many interrelations between its parts—a whole that is not the sum of its parts. While proponents of the systemic approach direct their attention towards the whole organism and focuses on how it achieves self-maintenance, mechanists direct their attention to how components of a mechanism are organized so that their activities produce a phenomenon (Bitch, Bechtel, 2021).

The systemic approach now extends to a large number of disciplines, including not only social sciences but also biology, psychology, and technology. Examples include Maturana and Varela’s *autonomy theory*, as well as *dynamical system theory*, to be discussed in §§9.3-9.4. Similarly, the *system dynamics model* approach is used to forecast future human population trends.

We shall also examine a third approach: the hermeneutic approach. We have already presented it briefly in the chapters on imaginary and real life stories, showing how the “comprehension” of these lives different from their “explanation” by the social sciences. Our discussion was based on the work of Dilthey (1833-1911). In his wake, many authors such as Heidegger (1889-1976), Gadamer (1900-2002), and Ricœur (1913-2005) developed different forms of hermeneutics, often linked to the phenomenology of Edmund Husserl (1859-1938), under the name of *phenomenological hermeneutics*, as indicated by Grondin’s book entitled *Le tournant*

herméneutique de la phénoménologie (2003). All these studies, however, remained focused on the “comprehension” of human lives. For example, Ricœur (1990, pp. 191-192) writes:

As for the notion of narrative unity of life, one must also view it as an unstable mixture of storytelling and live experience. It is precisely because of the evasive nature of real life that we must resort to fiction in order to organize it retrospectively in the aftermath, even if this means regarding any type of plot-making borrowed from fiction or history as provisional and subject to revision.¹⁵²

Ricœur thus brings imaginary and real life into the same category, recognizing the power of myths for organizing one’s own life story.

Because of its purely philosophical nature, such an approach lies outside of the scope of our book, whose subject is methodology. In §9.3, however, we shall see that the phenomenologist philosopher Merleau-Ponty (1908-1961) supplied the basis for the *autonomy theory* of Maturana and Varela, who developed a new paradigm based not on the metaphor of the computer (see §9.1.1) but on that of living organisms. It is important to see how these enable us to understand a human life.

Rather than contrast the three approaches, our conclusion here will attempt to show how they are complementary in explaining aspects of a human life and what they contribute to understanding them.

9.1 How demographic theories consider human life

¹⁵² French text: Quant à la notion d’unité narrative de la vie, il faut aussi y voir un mixte instable entre fabulation et expérience vive. C’est précisément en raison du caractère évasif de la vie réelle que nous avons besoin du recours à la fiction pour organiser cette dernière rétrospectivement dans l’après-coup, quitte à tenir pour révisable et provisoire toute figure de mise en intrigue empruntée à la fiction ou à l’histoire.

Glennan and Illari (2018) devote fourteen chapters of their book to the application of mechanisms in a variety of disciplines including physics, evolutionary biology, molecular biology, biomedicine, ecology, neuroscience, cognitive science, sociology, history, and economics.

Surprisingly, there is no mention of demography, whose development began in the seventeenth century with Graunt's work (1662). One reason, no doubt, lies in the definition of demography in the IUSSP (International Union for the Scientific Study of Population) *Multilingual Demographic Dictionary* (1982):

[. . .] a science that aims to study human populations by considering their size, their structure, their evolution and their general characteristics, primarily from a quantitative perspective.

The definition leaves out the fact that human populations are characterized by the rules, values, and signs that differentiate them, and that we cannot speak of populations by restricting their study to the physical or material aspects of the societies in which they live. Moreover, the definition avoids citing the study of the disappearance of a human group or a specific population, but only through their evolution.

Jared Diamond's book *Collapse: How societies choose to fail or succeed* (2005) clearly shows—with the aid of abundant information on the foundations of societies both ancient and modern—how these principles and the environment in which populations live allow us to understand their evolution over time, inevitably leading to their disappearance sooner or later. After describing and discussing the problems of our current society, Diamond is forced to conclude (p. 498):

Thus, because we are rapidly advancing along this non-sustainable course, the world's environment problems *will* get resolved, in one way or another, within the lifetimes of the children and young adults alive today. The only question is whether they will become resolved in pleasant ways of our own choice, or in unpleasant ways not of our choice, such as warfare, starvation, disease epidemics, and collapse of societies.

This is a question faced by all human groups, on which their survival or collapse depends. The quantitative approach used by demography does not enable it to answer the question. We must take a closer look at the reasons for this.

Having presented the various paradigms adopted by demography in Chapter 7, we now turn to the theories developed over the centuries to explain and not merely to describe demographic behaviors. A paradigm is a set of assumptions and values that form a way of viewing reality for a community of researchers. A theory applies the paradigm, with additional assumptions, to provide a more general explanation of a population's behavior in a given situation (Courgeau, 2009).

We must therefore pursue our analysis in this broader context. There have been such analyses in the past, and we begin by examining some of the solutions found—as well as some of the failures recorded. Space precludes a detailed examination of the theories, but we can describe the stages of their elaboration.

9.1.1 From the origin of population science to the nineteenth century

In 1760, Euler introduced the concept of what we now call “stable population”—in other words, the notion that if deaths outnumber births, a population will eventually disappear. Euler also realized that extraordinary calamities such as epidemics, wars, and famines disrupt this uniform growth or decline of a population, but he did not discuss their impact, which can be very significant.

Before the nineteenth century, economics and population science were very closely linked, giving rise to two opposing schools. The first, comprising what we can call *populationists*, believed that population growth produces an increase in wealth. This school, however, had few advocates. They notably included William Temple in the seventeenth century and Joseph Strucker and Moheau in the eighteenth. Their far more numerous opponents argued that population growth depended on wealth. Examples include Walter Raleigh and Joshia Child in the seventeenth century and Richard Cantillon and François Quesnay in the eighteenth. Physiocracy,

championed by Quesnay (1694-1774), stated that all increases in population are due to increases in wealth.

Despite their opposition, both theories regarded economics and demography—then known as “political arithmetic”—as two closely tied subjects, whereas they are now very often treated separately. But the disciplines were still in their infancy, and their main concepts were a long way from being defined.

For the reader seeking more information on the two schools, we strongly recommend the reprints and commentaries published in the series *Classiques de l'économie et de la population*, founded by Alfred Sauvy at INED and continued first by Eric Brian, then by Jean-Marc Rohrbasser. Titles include: Cantillon, *Essai sur la nature du commerce en général* (1952), *Œuvres économiques complètes et autres textes*. François Quesnay (2005), and *Recherches et considérations sur la population de la France par M. Moheau* (1994).

In the late eighteenth century, new crucial factors came into play in the analysis of human lives, most notably owing to the French Revolution, which introduced novel concepts.

In 1793, William Godwin published *An enquiry concerning political justice*, in which he examined the effects of most governments, run by monarchs or aristocratic groups, on the populations under their stewardship. He observed that these rulers, forever at war against one another, sacrificed their populations to a perpetual thirst for conquest, with no concern for their aspiration to peace and prosperity. In contrast, he said (vol. 1, p. 11):

[. . .] that perfectibility is one of the most unequivocal characteristic of human species, so that the political, as well as the intellectual state of man, may be presumed to be in a course of progressive improvement.

Godwin made this notion of *perfectibility* the basis for his theory, leading him to propose a type of society that anticipated the political and economic ideas of anarchism as set out by Kropotkin (1910). However, he did not have the courage to stand by his opinions in the

second edition of his work (1796), and he rewrote the chapter on property (vol. 2, book VIII).

In 1794, a year after Condorcet's death, the first edition of his *Esquisse d'un tableau historique des progrès de l'esprit humain* was published in France. The English translation, *Outline of an historical view of the progress of the human mind*, appeared just a year later. The book was merely an initial version of the larger work that he had been preparing since 1772 and had been planning to publish. For details, see the volume edited by Schandeler and Crepel (2004). Like Godwin, Condorcet developed the notion of *perfectibility* of the human species (p. 4, English translation):

Such is the object of the work I have undertaken; the result of which will be to show, from reasoning and from facts, that no bounds have been fixed to the improvement of the human faculties; that the perfectibility of man is absolutely indefinite; that the progress of this perfectibility henceforth above the control of every power, that would impede it, has no other limit than the duration of the globe upon which nature has placed us.¹⁵³

He showed how progress was achieved—at a varying pace—throughout human history. Accordingly, he believed that the average length of human life would increase up to a limit that he could not determine. His theory, however, was not based on Godwin's political concepts, and it led him to view such evolution as a general characteristic of the human species.

In contrast, Thomas Robert Malthus (1766-1834) proposed a theory of population in a philosophical pamphlet published in 1798. In his book of 1803, he developed it into a theological concept, pitting it against the notion of *perfectibility*.

At the very outset of the first essay, he clearly formulated the issue he set out to address (p. 2):

¹⁵³ French text: Tel est le but de l'ouvrage que j'ai entrepris, et dont le résultat sera de montrer par les faits, comme par le raisonnement que la nature n'a marqué aucun terme au perfectionnement des facultés humaines que la perfectibilité de l'homme est réellement indéfinie, que les progrès de cette perfectibilité désormais indépendants de la volonté de ceux qui voudraient les arrêter terme que la durée du globe où la nature nous a jetés.

It has been said, that the great question is now at issue, whether man shall henceforth start forwards with accelerated velocity towards illimitable, and hitherto unconceived improvement; or be condemned to a perpetual oscillation between happiness and misery, and after every effort remain still at an immeasurable distance from the wished-for goal.

Rather than attack the proponents of the first scenario, he began by stating his case for the second. He argued that two factors were involved at the same time: demographic phenomena (above all, the then high fertility rate) and the “subsistence” needed for humanity’s survival (here, mainly the earth’s power to produce food for man). His first and main observation (p. 14) was that:

Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will shew the immensity of the first power in comparison to the second.

From these premises, it followed that if the human population did not act against them, it was bound to disappear sooner or later. Malthus naturally undertook to consolidate his theory by a deeper analysis of the society in which he lived, particularly in his 1803 text.

In the 1798 pamphlet, he went on to offer a lengthy criticism of Condorcet, Godwin, and other authors who defended the *perfectibility* of man. However, in Godwin’s 1820 book entitled *An enquiry concerning the power of increase in the numbers of mankind*, Malthus’ criticism was often considered as baseless and his assertions, such as the one concerning the population growth and subsistence, as resting on false postulates.

Far more significantly, these arguments put forward by a late eighteenth-century Anglican minister are indicative of a religious approach to demographic issues, which prevented him from discerning the major revolutions already under way. The first was the industrial revolution, which began in Great Britain in 1760 with the coal industry and steam energy: Malthus regarded it as secondary with respect to agriculture. The second was the

demographic revolution or rather transition, which began in France in the mid-eighteenth century.

Unlike the flames of the French Revolution, which burned out in a decade with Napoleonic imperialism, the demographic and industrial revolution endured.

9.1.2 The industrial revolution in the nineteenth century: the ascendancy of economics

In the following century, the industrial revolution inspired many theories. By contrast, the demographic revolution did not actually generate new theories until the twentieth century.

We begin with the theories inspired by the industrial revolution in the nineteenth century, which fall into two main categories.

The theory of *industrialism*, developed in the late 1810s, crowned the notion of *perfectibility* of the human species. Its main advocates were Charles Comte (1782-1837) and Charles Dunoyer (1786-1862). The theory stated that society is based on man's mastery of nature through industry, so it analyzed the social foundation of that mastery. For instance, in *L'industrie et la morale considérées dans leurs rapports avec la liberté* (1825), Dunoyer wrote (p. 13):

Industry prepares peoples for collective activity as well as for all the types of activity necessary to the development and conservation of the species. One need only open one's eyes to see that, in our day, the most industrious and most cultured populations are also the liveliest and those with the greatest political capability.¹⁵⁴

Like Jean-Baptiste Say (1803), Dunoyer stressed the importance of property rights as the basis of every industrial society.

¹⁵⁴ French text: L'industrie prépare les peuples à l'activité collective comme à tous les genres d'activité nécessaires au développement et à la conservation de l'espèce. Il ne faut qu'ouvrir les yeux pour voir que, de notre temps, les populations les plus industrieuses et les plus cultivées sont aussi celles qui ont le plus de vie et de capacité politique.

In his *Traité de législation* (1826) and *Traité de la propriété* (1834), Comte advocated a society in which individuals would be entirely free to own and accumulate wealth. He then showed how government interventionism harms industrialism. While recognizing that the classes living off the fruit of their labor were far more populous than property-owners, he believed that in the event of distress (internal disorders or invasion by enemy armies) public aid should not interfere in the way a nation's products were distributed among the population (Comte, 1834, vol. 2, p. 488). The industrialist approach would thus condemn the more populous classes to excessive misery and, as Comte put it, to their "destruction" (id., p. 348). Conversely, if the rich were despoiled to the benefit of the poor, that would entail the "destruction" of the former, with the most dire consequences for the latter (id., p. 487). Lastly, a high fertility among the classes earning their livelihood from their wages alone would spell misery for the families formed with greater restraint, as the children of the former would contend with the latter for their subsistence (id., p. 350). Demographic trends were therefore wholly dependent on social conditions and could lead to the extinction of a class or even of the entire industrial society.

By contrast, Pierre-Joseph Proudhon (1809-1865) followed the path already outlined by Godwin: anarchism. In *Qu'est-ce que la propriété* (1840, p. 21), he proclaimed "*La propriété c'est le vol!*" ("Property is theft!"), but in his posthumous book *Théorie de la propriété* (1866), he noted his distinction between *possession* and *property* (p. 15): "I qualified only the latter as theft." Proudhon also foresaw the functioning of today's mutual insurance companies as early as 1846 in *Système des contradictions économiques, et philosophie de la misère*, in which he proposed (p. 527) "a law of exchange, a theory of MUTUALITY, a system of guarantees that determines the old forms of our civil and commercial societies." Our focus here, however, is on his critique of Malthusian theory. In *Système*, he presents the following calculation (pp. 493-494):

[. . .] with men marrying at the completed age of 28 years, women at 21; with nursemaids no longer used because of equality; with the duration of breastfeeding being reduced to 15 or 18 months; with the period of fertility potentially ranging from 15 to 18 months, it

would be hard for the number of children issued from the same marriage to exceed five.

If we deduce from this number:

Cases of sterility, widowhood, delays in marriage, accidents, interruptions... ...1.5

Deaths before marriageable age (the figure today greatly exceeds 50 p. 100)2.5

Unmarried

persons.....
...0.5

With the population thus increasing by only one-tenth in each period of about 30 years, it would double in three centuries.¹⁵⁵

Sauvy (1959) showed the flaws in this scenario, which would entail the extinction of the French population.

In *Système*, Proudhon also examined the contraception methods available in his day (pp. 450-464)—Fourier system (artificial sterility), Doctor G.'s system (extraction of the fetus, or eradication of seeds), interruption system, three-year breastfeeding system—but he rejected them all because he believed that the problem was unresolved. He did not recognize the decline in fertility due to industrialization and higher living standards (Charbit, 2004), and his outlook ultimately echoed Malthusian pessimism. Many authors of the second half of the nineteenth century clearly noted the decline in fertility among workers. Leroy-Beaulieu (1868, p. 103), for example, recognized that:

¹⁵⁵ French text: ... le mariage ayant lieu pour l'homme à 28 ans révolus, pour la femme à 21 ; l'usage des nourrices disparaissant dans l'égalité ; la durée de l'allaitement étant réduite à 15 ou 18 mois ; la période de fécondité pouvant aller de 15 à 18 mois, le nombre des enfants issus d'un même mariage s'élèverait difficilement au dessus de cinq.

Si l'on déduit de ce nombre :

Cas de stérilité, veuvages, retards dans le mariage, accidents, interruptions.....1.5

Morts avant l'âge nubile (le chiffre dépasse aujourd'hui de beaucoup 50 p. 100)2.5

Célibataires

.....0.5

La population n'augmentant ainsi que d'un dixième par chaque période d'environ 30 ans, le doublement aurait lieu en trois siècles.

[...] as educated and capable workers are systematically childless or have only one or two children, it follows that this class is not increasing, and that it is having the utmost difficulty recruiting [...]¹⁵⁶

In a growing number of European countries, workers had stopped multiplying at the same rate as in the past, but the theory of demographic revolution did not effectively take hold until the twentieth century.

Karl Marx (1818-1881) was very sarcastic in his comparison of Malthus with Frederick Eden, author of *The state of the poor* (1797), in *Das Kapital, Buch I* (1867, p. 603):

If the reader thinks at this point of Malthus, whose *Essay on Population* appeared in 1798, I would remind him that this work in its first form is nothing more than a schoolboyish, superficial plagiarism of Defoe, Sir James Steuart, Townsend, Franklin, Wallace, etc., declaimed in the manner of a sermon, but not containing a single original proposition of Malthus himself. The great sensation this pamphlet caused was due solely to the fact that it corresponded to the interest of a particular party.¹⁵⁷

In essence, Marx was an economist for whom demography can be understood only through economic theory (Charbit, 2005). For him, there was no universal law of population, but rather laws valid for each economic system—here, capitalism. Because of its importance, Marx's theory would require an entire volume. Here, we merely

¹⁵⁶ French text: ... les ouvriers instruits et capables n'ayant par système pas d'enfants, ou en ayant seulement un ou deux, il en résulte que cette classe ne s'augmente pas, que c'est à grand'peine si elle recrute ...

¹⁵⁷ English translation by Samuel Moore and Edward Aveling, edited by Frederick Engels, 1887. German text: Sollte der Leser an Malthus erinnern, dessen „Essay on Population“ 1798 erschien, so erinnere ich, dass diese Schrift in ihrer ersten Form (und die späteren Ausgaben stopften nur Material in das alte Schema und fügten neues, aber nicht von Malthus entdecktes, sondern nur annexirtes zu) nichts als ein schülerhaft oberflächliches und pfäffisch verdeklamirtes Plagiat aus Sir James Steuart, Townsend, Franklin, Wallace u. s. w. ist und nicht einen einzigen selbstgedachten Satz enthält. Nebenbei bemerkt. Obgleich Malthus Pfaffe der englischen Hochkirche, hatte er das Mönchsgelübde des Cölibats abgelegt.

wish to point out its limited connections with demography. However, we may speculate that he would have cursed those who—claiming to follow his ideas—imposed the Soviet or Chinese economy based on a militaristic social organization and a planned economy, more Fascist than Communist at this point..

In sum, theories on the industrial revolution prevailed throughout the nineteenth century. Few authors focused on the concurrent demographic revolution, which did not effectively capture researchers' attention until the twentieth century.

9.1.3 The demographic revolution in the twentieth century: the comeback of demography

Adolphe Landry (1874-1956) was the first to theorize what he called *La révolution démographique* (*The demographic revolution*) in 1934. His book offered a synthesis of his investigations since 1909, most notably including a reprint of his article in *Scientia* entitled “Les trois théories principales de la population.” This text clearly describes the two theories we discussed earlier—populationism and physiocracy—and the emergence of a new theory in late eighteenth-century France (p. 181):

In eighteenth-century France, the population was conditional upon production—in particular, the production of foodstuffs—and it varied, if we confine ourselves to an approximation, in the same way as production. In today's France, population changes seem very largely unrelated to production; population does not vary on account of variations in wealth.¹⁵⁸

In other words, demography seemed to be freeing itself from the grip of economics, and this trend would gradually reach all the other countries at different dates. Landry saw the main cause of this

¹⁵⁸ French text: Dans la France du XVIII^e siècle, la population était conditionnée par la production – par la production des subsistances notamment –, et elle variait, si l'on veut s'en tenir à une approximation, comme la production. Dans la France d'aujourd'hui, les mouvements de la population apparaissent comme indépendants, dans une très grande mesure, de la production ; la population ne varie pas en raison des variations de la richesse.

revolution in the diffusion of the idea of *rationalization* of life (p. 60), adopted first in France, then in other countries. The other possible causes, which he lists, are far from having as great an impact.

While Landry predicted far in advance the depopulation of developed countries (cf. Hungary's negative growth rate since 1981), he failed to foresee the growth of the developing countries, which remains high although it has started to decline.

Today, the demographic revolution theory has turned into a theory of *demographic transition*, but it has become more complex by incorporating ever more numerous factors. We refer readers to Henri Leridon's 2015 presentation, in which he notes (p. 312):

So, we cannot but observe that there is no overarching, generally acknowledged theory of fertility, not even a small number of theories upon which demographers can agree or disagree, and which might serve as a foundation for ongoing debate.

Leridon cites many demographers who share this view, such as the authors of the Princeton study on the transition in Europe (Coale and Watkins, 1986), who confirm that none of the standard indicators can explain the decline in fertility in the countries observed. For our part, we should like to quote Neil Cummins on the French transition (2013), who concludes more specifically as follows (p. 473):

Demographic transition theory, the microeconomic theory of fertility, and the unified growth theory cannot explain why French fertility fell first in Europe because they all predict that fertility should have declined in England before anywhere else. Wrigley's proposition of a neo-Malthusian response cannot be valid as it was the richest terciles who reduced their fertility, and Weir's explanation, again, does not uniquely identify France. [...] The root causes behind the world's first fertility decline are still poorly understood.

It is important to realize that the decline in fertility began in France nearly 100 years before it did in England. For more details, see the arguments presented by Wrigley (1985) and Weir (1984), which Cummins rejects here as unverified.

9.1.4 Three contemporary theories

The application of the systemic approach to demography led Loriaux (1994) to go beyond the causal approach for topics such as the demographic transition, the aging of current populations, and social protection. At the same time, however, he noted the absence of truly systemic methods apart from simulation-based modeling. The latter, for example, led Meadows et al. (1972, 1992, 2004) to develop a “system dynamics model” aimed at forecasting the future of mankind. They concluded that if humanity maintains its economic growth without factoring in environmental and social costs, it will experience a collapse by the mid-twenty-first century. The authors’ simulation model leads to various scenarios depending on the initial assumptions, and the comparison of forecast developments with those observed makes it possible to identify the more plausible outcomes. Despite the many criticisms directed at the model’s assumptions, such as those voiced by the economist Solow (1973), its results have been compared with actual developments. The latest study (Herrington 2021) shows that the simulation’s models, which display little divergence until 2020, predicted with a reasonably good approximation the trend actually observed over 50 years since the first report. But can one regard humanity as a whole when the foundations of the cultures and societies that compose it are so diverse and even contradictory?

Moreover, while Loriaux (1994) argued that—in demography—simulation models were the only possible systemic method, in biometrics, Harvey Goldstein proposed a new approach in 1986: the multilevel approach. The latter developed later in the social sciences, as we saw in Chapter 7; in demography, it was first applied in 1995 by Courgeau, then in 1998 with Baccaïni, and later in 2007 with a book entirely devoted to it. In 1998, Courgeau and Baccaïni wrote:

Is it reasonable to interpret the aggregated characteristics as the reflection of the social organisation in which we live, and the characteristic specific to each individual as the manifestation of individual liberty [. . .]?

The situation is even more complex, for there will always be a difference between the statistical individual and the observed individual.

However, a new theory has developed in the early twenty-first century, offering a very different view of the phenomena experienced by a population: agent-based modelling. Its principle is to deduce the events in a formal system from rules of conduct applied to theoretical agents, and then compare them with behaviors observed in reality (Billari, Prskawetz, 2003). The rules are based on individual behaviors and make it possible—so it is argued—to predict macroscopic regularities. It is thus a bottom-up approach, in which a population's aggregate behaviors emerge from rules applied to autonomous individuals. The important point here is that the approach seeks to “comprehend” human behaviors with the aid of simple individual rules capable of “explaining” macro behaviors. One could thus arrive at a synthesis of philosophical hermeneutics and scientific explanation.

The initial problem with this approach, however, is how to define the rules with precision. Unfortunately, they are defined without a full discussion of their validity, which is often merely deduced by comparing expected behaviors with the aggregate behaviors of populations. This eliminates the need for observed data to explain the phenomenon, for the approach is based on simple rules of individual decision-making that could account for a given real-world phenomenon. As Burch notes (2003, p. 251):

A model explains some real-world phenomenon if a) the model is appropriate to the real-world system [...] and b) if the model logically implies the phenomenon, in other words, if the phenomenon follows logically from the model as specified to fit a particular part of the real world.

But how does one generate macroscopic regularities by using simple individual rules? Conte et al. (2012, p. 340) explicitly describe the difficulties encountered:

First, how to find out the simple local rules? How to avoid *ad hoc* and arbitrary explanations? As already observed, one criterion has

often been used, i.e., choose the conditions that are sufficient to generate a given effect. However, this leads to a great deal of alternative options, all of which are to some extent arbitrary.

Without bringing into play the influence of networks on individual behaviors, it seems hard to obtain a macro behavior merely by aggregating individual ones. To obtain a more satisfactory model, one could introduce decision-making theories. Unfortunately, however, the choice of these theories is influenced by the researcher's discipline and can produce highly divergent results for the same phenomenon studied.

For a more detailed discussion of these theories, we refer the reader to three recent works: Eric Silverman, *Methodological investigations in agent-based modelling* (2018), Thomas Burch, *Model-based demography* (2018), and Jakub Bijak (ed.) *Towards Bayesian model-based demography* (2022).

To conclude this overview of theories, we turn to *viability theory*, developed by the mathematician Jean-Pierre Aubin (1939-) during his entire career. He gave a complete presentation of his theory, including a detailed account of its genesis and impact, in his 2010 book entitled *La mort du devin, l'émergence du démiurge. Essai sur la contingence, la viabilité et l'inertie des systèmes* (the work has not yet been translated in English, but its title would read *The demise of the seer, the rise of the demiurge: essay on contingency, viability, and inertia of systems*). Aubin has also published many books of a more mathematical nature, in English, including *Dynamic economic theory* (1997) and *Viability theory: new directions* (2011). He has promoted multidisciplinary studies on the subject, most notably in demography—the focus of our discussion here—with Noël Bonneuil. We provide a succinct account below.

Viability theory initially relies on what the author calls *régulons* in French, translated as *regulees* in Aubin, 1997, and *regulons* in Aubin et al., 2011. The term simply refers to the rules, values, and signs that structure and regulate all *states* of a given human society. Examples include economic goods in economics,

individual behaviors in sociology, and cognitive states in psychology. Aubin (2010, p. 16) notes:

The difference between *states* and *regulons* resides in this: we know the *actors* who act upon the states; there is no consensus *on the nature of those who govern the evolution of regulons*. I shall use *seer* to denote the prototype of actors acting upon the states of the system, and *demiurge* to denote the entity that represents those mysterious mechanisms “regulating” the evolution with the aid of regulons.¹⁵⁹

Aubin admits that, unlike seers, he can neither name the entity that operates on regulons, nor explain why it does so. However, he shows that, in certain conditions, one can predict how organisms or populations will evolve relative to their environment and one can define their viability constraints.

To do this, Aubin does not use probability calculus, but differential inclusion calculus, which is based on the concept of open directions starting from the present moment. The concept generalizes the notion of differential equation and opens the door to membership of a set (Bonneuil, 2013, p. 73). The approach then tries to describe a given system’s capacity for change by means of one or more differential equations in which the *regulons* are assumed to be proxied by measurable characteristics. In demography, for example, these measurable characteristics may consist of a birth rate, mortality rate, or rate of natural increase; in economics, they may consist of prices or consumption.

This makes it mathematically possible to situate the evolution of the dynamical system studied amid a set of *viable* paths that satisfy certain constraints. The environment’s *viability kernel* relative to the system is the subset of its *states* forming the point of departure for at least one viable evolution (Aubin, 2010, p. 668). This approach would offer a solution to the problem of the

¹⁵⁹ French text: La différence entre *états* et *régulons* réside en ceci : on connaît les *acteurs* qui agissent sur les états, il n’existe pas de consensus *sur la nature de ceux qui régissent l’évolution des régulons*. J’appellerai « *devin* » le prototype des acteurs qui agissent sur les états du système, « *démiurge* » celui qui représente ces mystérieux mécanismes « régulant » l’évolution à l’aide de régulons.

disappearance of societies, described by Diamond above, by avoiding non-viable paths. It is important to anticipate an evolution so as to be able to adapt to it in time.

The application of viability theory to many demographic problems, most notably by Bonneuil, shows that their solution requires us to take demography and economics into account simultaneously. For instance, to explain fertility fluctuations in the late twentieth century, Bonneuil, in a series of articles (1990, 1994, and 2017), proposes an approach using viability theory with two regulons: consumption and population growth. He recognizes (2017, p. 156) that:

[...] the historical trajectories representing the West European countries move in the viability kernel associated with fertility norm n until they reach the boundary of this set. Then, couples must arbitrate between reducing their standard of living while maintaining the same level of fertility, and reducing their fertility to the norm $n-1$ while further increasing their consumption.

This explains these countries' fertility trajectories, which swung from high fertility starting in the mid-1940s (the baby boom) to a major decline in the 1970s (the baby bust).

While offering new perspectives in the social sciences, viability theory sets conditions that may not always seem fully justified. For example, its rejection of the influence of the past on the evolution of a population (Bonneuil, 2013, p. 72) runs counter to many theories that seek to explain that influence on population forecasts (Mazzucco and Keilman, 2020). Similarly, the search for a viability kernel once the model's parameters increase is so complex that only simplified cases can be analyzed (Aubin, 1997, p. 31).

To conclude our discussion on theories, we refer the reader to a recent article by Joel Cohen (2004): "Mathematics is biology's next microscope, only better; biology is mathematics' next physics, only better." His examples, ranging from Euler (1760) to Lotka (1939) and others, give reason for taking all social sciences into consideration rather than biology alone. This opens the possibility that, despite the reservations expressed earlier, viability theory could

provide a new paradigm for social sciences in the future, for its highly mathematical character and its general scope would offer an incentive to do so. Let us recall what we said about paradigms in the conclusion to Chapter 7: each paradigm represents a specific point of view on a complex reality, and this applies equally to the notion of viability.

9.2 How can we explain the complexity of memory and the human brain: from artificial intelligence to neuroscience

In this section, we present a range of sciences of the human mind—most notably artificial intelligence, neuroscience, and nanosciences—all of which seek to explain how our brain and memory work.

9.2.1 The limits of artificial intelligence

In Chapter 8, we saw that Freud tried to introduce neurons into his theory of memory, but he was far from having all the elements needed to do so properly. Yet neurons are the very basis for the functioning of our brain and for our entire memory. Just half a century after their discovery by Ramon y Cajal, McCulloch and Pitts (1943) proposed a mechanistic model of the properties of neurons. For details, we refer the reader to Robert Franck's discussion in the first volume of the *Methodos Series* (2002, pp. 142-144), in which the present book is published: Franck shows that the structure of neural functions proposed by McCulloch and Pitts—without which the neural properties then known would not be what they are—allows the production of all those properties.

The model, coupled with the 1936 implementation of Turing machines (now called computers), with which McCulloch and Pitts were totally familiar, set the stage for artificial intelligence (AI). Its current developments in *Artificial Neural Networks* (ANNs) are increasingly significant. ANNs still perform calculations

consistently with the neuron-based model designed by McCulloch and Pitts: the artificial neurons, now located on different layers, transmit information to neurons on the next layer that enable them to activate themselves or not. While McCulloch and Pitts were not particularly interested in memory issues, their model was adopted by many researchers working on learning and memory, such as Hebb (1949), Brindley (1969), Gardner-Medwin (1969), and Marr (1970).

Although the model largely succeeded in explaining artificial intelligence, it proved unable to explain the functioning of the human brain. As early as 1946, John von Neumann, the creator of the first computer with a recorded program in 1945, started having doubts about the parallels drawn between computers and the human brain. In a letter to Wiener (Masani, 1990, p. 243), he wrote:

[. . .] after the great positive contribution of Turing-cum-Pitts-and-McCulloch is assimilated, the situation is rather worse than better than before.

For von Neumann, the human brain is far more complex than a computer, and equating the two is a serious mistake.

Even McCulloch in 1948, in a lecture on “Cerebral Mechanisms in Behaviour” and a presentation entitled “Why the mind is in the head?,” expressed doubts about applying his approach to the entire cortex (Jeffress, 1951, p. 55):

To understand its (the cerebral cortex) function we need to know what it computes. Its output is some function of its input. As yet we do not know, even for the simplest structure, what that function is. [. . .] Walter Pitts is analyzing them mathematically at the present moment and has yet no very simple answer. There is no chance that we can do even this for the entire complex.

In the ensuing discussion, von Neumann even argued against the possibility that memory could reside in neurons, but no clear response to the argument was provided. We shall see later how the neurosciences addressed the question.

More than seventy years later, Matthew Cobb (2020, p. 285) noted:

[. . .] the failure of the rigid McCulloch and Pitts model of neuronal logic to translate into how real nervous systems function should also be a warning

This clearly shows that the human brain is far more complicated than a machine and operates according to different logical structures than those of binary mathematics, most notably through mechanisms based on analogy.

After 1950, artificial intelligence (AI)—a term definitively adopted at the 1956 Dartmouth seminar—experienced major developments. AI was defined as capable of being simulated by a machine, generally a computer. We shall examine it here with a view to determining whether it can surpass human intelligence (and, if so, in what conditions), or whether, on the contrary, it is of a different nature that prevents computers from thinking like humans.

First, several computer models were introduced to seek a better understanding of human intelligence. In 1958, Oliver Selfridge developed a form recognition model called *Pandemonium*, whose main assumption was that letters are identified by their component lines; that same year, Frank Rosenblatt proposed a similar model called *Perceptron* using parallel processing, which is closer to human intelligence. As he specifically stated in his 1961 report on *Principles of Neurodynamics* (p. 28):

Perceptrons are not introduced to serve as detailed copies of any actual nervous system. They are simplified networks designed to permit the study of lawful relationships between the organization of a nerve net, the organization of its environment and the “psychological” performances of which the network is capable. Perceptrons might actually correspond to parts of more extended networks in biological systems. [. . .] More likely they represent extreme simplifications of the central nervous system, in which some properties are exaggerated, others suppressed.

He thus clearly indicated the major difference between human and artificial intelligence. In 1969, Marvin Minsky and Seymour Papert offered a mathematical analysis showing that this parallel approach was a “dead end,” both for artificial intelligence and for understanding human intelligence.

In his posthumous book *The Computer and the Brain* (1958), von Neumann, whose doubts about artificial intelligence we noted earlier, concluded (p. 83):

Consequently, there exist here different logical structures from the ones we are ordinarily used to in logic and mathematics.

He thus fully recognized the difference between the language used by computers and that used by human biology.

However, in 1965, the mathematician Irving Good saw in the ultra-intelligent machine that “can far surpass all the intellectual activities of any man however clever” (p. 33) an “intelligence explosion” that would leave human intelligence far behind. Yet, nearly sixty years later, we are still waiting for that explosion.

To the contrary, many authors recognize the weaknesses of artificial intelligence. Terry Winograd, for example, despite his ardent defense of AI, has this to say about it in “Thinking machines: Can there be? Are we?” (1990, p. 168):

I will argue that “artificial intelligence” as now conceived is limited to a very particular kind of intelligence: one that can usefully be likened to bureaucracy in its rigidity, obtuseness, and inability to adapt to changing circumstances. The weakness comes not from insufficient development of the technology, but from the inadequacy of the basic tenets.

Similarly, many researchers have argued that “ANN[s] are known ‘blind’, or non-explanatory” (Franck, 2002, p. 127).

Without examining all the rationales and consequences of these models here, we shall try to assess what AI can contribute to the study of human intelligence and memory.

In practice, AI has proved capable of defeating humans in games with fully preset rules. For instance, on May 11, 1997, the world chess champion Kasparov—undefeated since 1985—faced the *Deeper Blue* program for the second time, after an initial victory in 1996. This time, the computer program prevailed with two wins, one loss, and three draws. Likewise, for the game of go, but eighteen years later in October 2015, the AlphaGo program defeated Fan Hui,

the European champion since 2013, winning five out of five matches (Silver et al., 2016). And on March 15, 2016, world champion Lee Sedol was beaten by AlphaGo four games to one.

But human intelligence has proved altogether different in nature from AI when it comes to taking decisions in real life, where rules are generally not predetermined.

In 1990, the book *The foundations of artificial intelligence*, edited by Derek Partridge and Yorick Wilks, sought to provide a fuller view of the differences between the two intelligences. For example, in his article “Thinking machines: Can there be? Are we?,” Terry Winograd is very clear about this (p. 167):

Computers, with their foundations of cold logic, can never be creative or insightful or possess real judgement. No matter how competent they appear, they do not have the genuine intention that is at heart of human understanding. The vain pretensions of those who seek to understand mind as computation can be dismissed as yet another demonstration of the arrogance of modern science.

He notes the parallel between human bureaucracy and AI processes, which reduce human judgment to the systematic application of explicit rules. Similarly, the philosopher Eric Dietrich, in his article “Programs in the search of intelligent machines: The mistaken foundations of AI,” looked for the theoretical foundations of AI. He makes a very interesting comparison between AI in our time and astrology in antiquity. His view of astrology concurs with our assessment in Chapter 3. He shows the predominance of astrology throughout ancient times despite its many failed predictions. The same is true, he states, for AI (p. 229):

Artificial intelligence today is much like astrology was then. As I argued above, AI is based on a mistaken theoretical assumption: the idea that we now know what kind of computing thinking is, which in turn mistakenly draws support from the theory of computation. AI researchers have seemingly reasonable explanations for the shortcomings of their programs: an insufficient number of rules, the wrong heuristics, or not enough processing speed.

Dietrich believes that neuroscience, whose advances we shall discuss later, offer a far better theory of the processes underlying human thought.

In 2012, the World Congress on *Natural Computing/Unconventional computing and its philosophical significance* distinguished between AI and human intelligence and proposed a biological approach to the study of the latter. In the volume of Congress proceedings, Carl Lindley contributed an article on “Neurobiological computation and synthetic intelligence” arguing in favor of a truly biological approach to human intelligence:

An alternative approach in the synthesis of intelligence is to take inspiration more directly from biological nervous systems. Such an approach, however, must go beyond twentieth century models of artificial networks (ANNs), which greatly oversimplify brain and neural functions. The synthesis of intelligence based upon biological foundations must draw upon and become part of the ongoing rapid expansion of the science of biological intelligence.

He thus recognized the inadequacy of AI for explaining human intelligence.

However, Stephen Hawking, while a physicist, went so far as to predict that advances in AI would spell the end of humankind (BBC interview, December 3, 2014):

The primitive forms of artificial intelligence we already have, have proved very useful. But I think the development of full artificial intelligence could spell the end of the human race. Once humans develop artificial intelligence it would take off on its own, and redesign itself at an increasing rate. Humans, who are limited by slow biological evolution, couldn't compete and would be superseded.

Admittedly, the belief that AI can surpass human intelligence seems to be enjoying something of a revival.

For instance, at the 2009 TED Global Conference in Oxford, Henry Markram announced that he was ready to simulate the human

brain and that this could be achieved in ten years. He began his lecture by stating:

Our mission is to build a detailed, realistic computer model of the human brain.

His project was thus indeed driven by AI. In 2011, with thirteen high-ranking researchers, he submitted the Human Brain Project to the European Commission, which awarded him a ten-year grant for the colossal sum of 1.19 billion euros. To win the Commission's approval, he proposed that the project should involve not only AI researchers but also physicians and neuroscientists, for a total 150 research teams from twenty-two countries. Soon, however, the project cut back the role of neuroscience and was contested in 2014 by an open letter to the Commission signed by more than 750 researchers—most of them neurobiologists—as well as an article by Yves Frégnac and Gilles Laurent in *Nature* entitled “Where is the brain in the human brain project?” Among other things, the authors noted (p. 28):

There is no unified format for building functional databases or for annotating data sets that encompass data collected under varying conditions. Most importantly, there are no formulated biological hypotheses for these simulations to test.

As we can see, the project prioritizes the use of Big Data, leaving neuroscience by the wayside. In 2019, a decade after the TED Conference, Ed Yong published an article in *The Atlantic* entitled “The Human Brain Project hasn't lived up to its promise,” in which he observed:

Ten years ago, a neuroscientist said that within a decade he could simulate a human brain. Spoiler: It didn't happen.

Yong thus confirmed what many neuroscientists had thought of the project back in 2014, but this had little impact on Markram's objectives.

Almost at the same time as the European Commission accepted the Human Brain Project, a similar program was set up in

the United States in 2014: Brain Research through Advancing Innovative Neurotechnologies (BRAIN), with an annual budget of 300 million dollars over ten years. The resemblance between the two initiatives is blatant. Both are clearly Big Science projects with no robust neuroscientific basis.

Ali Rahimi, receiving the Test-of-time Award at the 2017 Neural Information Processing (NIPS) Conference, went even further and declared:

We say things like “machine learning is the new electricity.” I’d like to offer another analogy: Machine learning has become alchemy. [. . .] For the physics and chemistry of the 1700s to usher in the sea change in our understanding of the universe that we now experience, scientists had to dismantle 2,000 years worth of alchemical theories. [. . .] I would like to live in a society whose systems are built on top of verifiable, rigorous, thorough knowledge and not on alchemy.

Interestingly, he replaced astrology (which Dietrich cited) with alchemy, but the result is the same: the lack of serious criteria for a clear, unambiguous definition of AI and its subfield, machine learning.

Erik Larson’s 2021 book, *The myth of artificial intelligence: why computers can’t think the way we do*, presents AI as mythical. He shows that AI relies on induction, not in Bacon’s sense (see our Chapter 3.2), but in its traditional meaning of a generalization as defined, for example, by Hume (1739-1740, I, 3, 2, 6):

[. . .] that there can be no demonstrative arguments to prove, that these instances, of which we have had no experience, resemble those, of which we have had experience.

AI functions precisely by using experience to improve its performance. For instance, it can outperform human intelligence in games because their rules are set once and for all (see our earlier discussion). By contrast, when faced with problems such as those encountered in scientific research or, more simply, in many areas of human life, AI is clearly unable to resolve them. Larson gives the example of Google’s “deep learning,” which, having identified

gorillas on a photograph of two U.S. citizens, preferred to remove gorilla images from its system. The rationale given was that, even if Google had tried to improve the system, the risk of confusion would have persisted.

However, by equating human intelligence with abduction as defined by Pierce¹⁶⁰ in various ways over many years (1883-1907), Larson is—in our view—mistaken. While space precludes a detailed discussion of abduction here, we refer the reader to its critical examination by Frankfurt (1958), Kapitan (1990, 1992), and Hoffman (1999), all of whom conclude that the notion is not valid.

We contrast AI with the concept of induction as introduced in 1620 by Bacon, who clearly opposes it to the traditional meaning of the term (*Novum Organon*, I, 105):

For the induction which proceeds by simple enumeration is childish; its conclusions are precarious and exposed to peril from a contradictory instance; and it generally decides on too small number of facts, and on those only which are at hand. But the induction which is to be available for the discovery and demonstration of sciences and arts, [. . .]—which has not yet been done or even attempted, save only by Plato [. . .]

While AI can proceed by means of a simple enumeration, we shall now see that neuroscience prefers to use the second form of induction defined by Bacon.

9.2.2 The contribution of neuroscience to explaining memory

We introduced neuroscience in Chapter 8 in order to compare the Freudian and neuroscientific conceptions of the unconscious. We take our discussion further here by recounting the development of neuroscience from the founding of the International Brain Research

¹⁶⁰ References to Pierce's writings are from the *Collected Papers of Charles Sanders Pierce* (1931-1958), Cambridge: Harvard University Press. For example, he defined abduction in the 1903 *Harvard Lectures on Pragmatism* (Collected Papers, 5, 189) as follows:

(1) The surprising fact, C, is observed;
 But if A were true, C would be a matter of course,
 Hence, there is a reason to suspect that A is true.

Organization in 1961 to that of the Society for Neurosciences in 1969 (<https://www.sfn.org/about>: Mission and Strategic Plan, updated 8/23/2019, p. 2), whose aim was to:

Advance the understanding of the brain and the nervous system by bringing together scientists of diverse backgrounds, by facilitating the integration of research directed at all levels of biological organization and by encouraging translational research and the application of new scientific knowledge to develop improved disease instruments and cures.

As we can see, neuroscience sets out to explore far more diverse fields than psychology.

Regarding AI, we can contrast it with the discovery by Tim Bliss, Terje Lømo, and Tony Gardner-Medwin (in three articles published in 1973) of visual *long-term potentiation*, as a component of a multilevel memory mechanism. Squire and Kandel (2000, pp. 110-111) provide an excellent presentation of this discovery:

[. . .] they attempted to see whether the synapses between neurons in the hippocampus had the capability of storing information. [. . .] They found that a brief high-frequency period of electrical activity (called a tetanus) applied artificially to a hippocampal pathway produced an increase in synaptic strength that lasted for hours in anesthetized animal and would, if repeated, last for days and even weeks in an alert freely moving animal.

The authors describe this *long-term potentiation* not as identical to memory, or as a sort of memory, but rather as part of a more complex memory mechanism.

However, these studies concerned laboratory animals, and it was not until 1996 (Chen et al.) that the first experiments on human visual memory *in vitro*, then in 2005 (Teyler et al.) *in vivo*, made it possible to show the generality of *long-term potentiation* and to develop a coherent paradigm for it.

In his exhaustive analysis of the earlier studies, Craver (2003, pp. 189-190) concludes:

Likewise, a great deal of scientific work remains to be done both to understand what an ideally complete neurobiological explanation of learning or memory would look like and to envision and develop the kinds of experimental techniques that would show convincingly that such explanation had been achieved.

As we shall see, despite many improvements, this mechanistic explanation of memory remains incomplete.

In his book *Explaining the brain* (2007), Craver goes further, stressing the difference between (a) representation and categorization—two customary operations in neuroscience (such as classifying neurons or glial cells into different types, or describing the brain as composed of different spatial areas)—and (b) the causal explanation. In particular, he emphasizes the difference between the hypothetico-deductive approach and the approaches that he refers to as U-models (pp. 40-41):

According to the unification model (henceforth, U-model), explanation is not a matter of deriving the *explanandum phenomenon* from laws but a matter of unifying diverse beliefs under a few simple argument patterns [. . .] The appeal of the U-model derives from the fact that many of the most successful explanations in the history of science (such as Newton's laws, Maxwell equations, and Darwin's theory of evolution by natural selection) encompass large domains of phenomena within the purview of few basic argument patterns.

What is described here is indeed the mechanistic approach, which, for example, will try to explain the genesis of life stories with the aid of a small number of entities and activities.

We shall attempt to see how this approach can be applied not to life stories in all their complexity but to certain more specific elements that characterize them. Before that, however, let us examine in detail what the mechanistic approach means by “entities” and “activities.”

“Entities” are the parts used by the mechanism to perform the various “activities” that the mechanism must explain. “Entities” have properties enabling them to act in a wide variety of “activities.”

In his book *Explaining the Brain: Mechanisms and the Mosaic Unity of Neuroscience* (2007, p. 6), Craver describes the latter as follows:

Activities are the causal components in mechanisms. I use the term “activity” as a filter-term for productive behaviours (such as opening), causal interactions (such as attracting), omissions (as occurs in case of inhibition), preventions (such as blocking), and so on. In saying that these activities are *predictive*, I mean that they are not mere correlations, that they are not mere temporal sequences, and, most fundamentally, that they can be exploited for the purposes of manipulation and control.

This quotation clearly shows that the mechanistic approach is not interested in the correlations that may exist between entities, but seeks to predict how the phenomenon will play out in certain conditions.

The same book highlights another key feature of this approach: its multilevel character. We already pointed out some advantages of the multilevel approach in the social sciences, but Craver attributes a greater importance to it in neuroscience research by stressing the latter’s “mosaic unity.”

For this purpose, he contrasts the McCulloch-Pitts approach with that of Bliss, Lømo, and Gardner-Medwin (2007, pp. 241-243). McCulloch and Pitts clearly aimed at reductionism (1943, pp. 100-101):

The “all-or-none” law of nervous activity is sufficient to insure that the activity of any neuron may be represented as a proposition. Physiological relations existing among nervous activities correspond, of course, to relations among the propositions; and the utility of the representation depends upon the identity of these relations to relations among the propositions. To each reaction of any neuron there is a corresponding assertion of a simple proposition. This, in turn, implies either some other simple proposition or the disjunction or the conjunction, with or without negation, of similar propositions according to the configuration of the synapses upon and the threshold of the neuron in question.

They were thus able to represent the various propositions of Boolean logic as changes in the connecting forces between neurons. A complex psychological phenomenon could therefore be reduced to a phenomenon occurring at neural level.

The approach adopted by Bliss, Lømo, and Gardner-Medwin does not prioritize an analysis at neural level. On the contrary, to flesh out their approach, they propose a top-down or a bottom-up analysis. In the words of Bliss and Lømo (1973, p. 350):

The amplitude of an evoked population potential depends on a number of factors, and it will be helpful to review these before considering the possible mechanism which might be responsible for long-lasting potentiation.

This acknowledgment is followed by a discussion on the various mechanisms that can influence memory.

Indeed, their approach focuses on an intermediate level that we may regard as “electrical synaptic” (Craver, 2002, p. S89), which includes entities such as neurons, synapses, and activities such as the generation and propagation of action potentials. But the memory mechanism is not confined to that level. Craver (2002, p. S91) sees at least four different levels:

To summarize, the mechanism sketch for memory is multilevel; its current description includes mice learning and remembering, hippocampi generating spatial maps, synapses inducing LTP, and macromolecules binding and changing conformation [. . .]

Memory mechanisms must therefore be studied at all these levels in order to obtain a full picture.

The levels listed may be covered by various disciplines. Some have been in existence for a long time, while others have developed more recently within the broader context of neuroscience. For instance, the behavioral level of learning and memorization is studied mainly by general psychology, as discussed in Chapter 8, and biological psychology. The second level is studied mainly by cognitive neuroscience and computational neuroscience. The third

level is studied by cellular neuroscience, the fourth by molecular neuroscience.

In 2007, Craver and Bechtel, in their article on “Top-down causation without top-down causes,” examine this recourse to interlevel causes and clearly show (p. 562) that it is unwarranted:

The interlevel relationship is a relationship of constitution. Where there are mechanistically mediated effects, there is no need for the mysterious metaphysics of interlevel causation at all.

They assume, in particular, that the authors who resort to interlevel causation use a different definition of level than that employed in the mechanistic approach.

Craver (2007) seeks to go further by proposing a fuller analysis of levels. He draws a distinction between mechanism levels (relationships between a whole and its parts), size levels, and natural “merological” levels (from the Greek *μέρος*, “part”) such as elementary particles, atoms, molecules, organisms, and societies. Two or more items belong to the same mechanism level if they are part of the same mechanism. Carver can thus distinguish between “intralevel causal relations” and “interlevel constitutive relations.” If the first are causal, then the second are not. As he clearly states (p. 179):

To view LM (cf.: explanation of spatial memory, commonly said to have four levels) levels as causally related, one must violate the common assumption that causal relationships are contingent and that cause and effect must be wholly distinct.

As a result, there can be no confusion between the levels of a mechanism that involve causal relationships and “interlevel constitutive relations” that involve none. While causality requires a diachronic study, “interlevel constitutive relations” require a synchronic study.

In 2003, Robert Franck went even further, showing that the analysis of the emergence of a level is not an extension of the causal mechanistic approach, but in fact a system analysis of the relationships between the system generated by the new level and the

factors from which it emerges. As noted earlier, this system analysis—which studies the overall functioning of biological systems at different organizational level—was theorized by Ludwig von Bertalanffy in 1968.

This approach contrasts with the then prevailing reductionist theories by viewing a system as a whole, with its relationships and interactions with other systems. Franck relies on this concept of system to state (2003, p. 188):

I will base myself upon the concept of emergence in order to propose a theoretical definition of the notion of a social “level”. Then, I will associate the concept of level with that of system, and try to show how causal analysis and system analysis can be combined, in order to do justice to relations of determination between social levels.

He thus treats the two analyses as totally distinct: the constraints of system analysis are not causal determinations, whereas the mechanistic approach seeks the causes of these mechanisms. Franck takes his argument one step further by pointing out why the emerging entity has properties that its components lack (p. 192):

A system emerges from the combination of its elements. These act upon each other, some in a unidirectional way, other in a reciprocal one, and we call them factors. These are the matter of the system. The system is nothing other than the factors which compose it, except that in a system the action of factors on each other conforms to a definite structure, a structure that we call the form of the system. It is because of this form that the system acquires properties the factors which compose the system don’t have.

Such a constituent relationship between form and matter—which Aristotle called *hylomorphism*, from the ancient Greek *ύλη* (matter) and *μορφή* (form), sets the limits of possible actions for a given system and clarifies the nature of the levels.

This creates a problem for causal mechanistic analysis, for one needs to take into account, at the same time, the organization of the system studied—which is not causal but systemic.

We can conclude that the analysis of a system's functions is as important as causal mechanistic analysis, and that the two should ideally be combined. But how can this be done? We examine the question in greater detail in §9.4.

9.3 Can autonomy theory be associated with hermeneutics?

When we study a small set of events in a person's life (birth, death, and migrations in demography; suicide and marriage in sociology; employment, unemployment, and exit from the workforce in economics, for example), we can develop a social science with its mechanisms. But when we examine a human life in all its complexity, we can no longer elaborate such a science, and we must consider the life in hermeneutical terms as an epic, a tragedy, a comedy, a novel, or another genre.

It is worth asking, however, if the two approaches are truly irreconcilable or if we can build a bridge to connect them.

As our book is concerned with methodology, we shall not describe in detail the philosophical origins of such a relationship—if one exists. We shall only indicate the broad directions followed by the philosophers who established the relationship.

Maurice Merleau-Ponty (1908-1961), in our view, best explained this approach, known as *phenomenology* (or *phenomenological hermeneutics*, if we accept Grondin's argument cited in the introduction to this chapter). Introduced by Edmund Husserl (1859-1938), phenomenology lies on the frontier of psychology, neurology, and sociology. In *La Structure du comportement* (The Structure of Behavior), Merleau-Ponty clearly states that behavior is the main cause of all stimulations, and he notes ([1943] 1963, p. 13):

[...] all the stimulations received by the organism are made possible, in turn, only by its earlier movements, which have ultimately exposed the receptor organ to external influences. As a result, one could also say that behavior is the prime cause of all the

stimulations. The excitant's form is thus *created by* the organism itself, by its specific manner of exposing itself to actions from outside. In order to subsist, it must, no doubt, encounter a certain number of physical and chemical agents in its surroundings. But it is the organism itself—according to the specific nature of its receptors, the thresholds of its nerve centers, and the movements of its organs—that chooses the stimuli in the physical world to which it will be sensitive.¹⁶¹

In other words, a perception is not simply constrained by the outside world, but also contributes to the representation of that world. While Merleau-Ponty relied on contemporary studies in psychology and neurology, his approach is totally philosophical. It expresses the emergence of reason in a contingent world—an endeavor comparable to that of an artist (for the painter's role, see his posthumous book, *L'œil et l'esprit* [The Eye and the Mind], 1964).

The Santiago School of Biology, whose chief exponents were Francisco Varela (1946-2001) and Humberto Maturana (1928-2021), specifically applied this philosophical approach to neuroscience. Varela (1996) even called his approach *neuropsychophenomenology* in order to underscore the connection. Let us examine the School's main features in some detail.

Rather than attempting to characterize biological systems by their components' physical properties, as the mechanistic approach does, the Santiago School looks for the characteristics in the systems' overall organization. This approach, therefore, is completely systemic. It sees the system as a general process whose characteristics are in fact inseparable. The basic concepts applied are *autonomy*, *autopoiesis*, and *adaptation*.

¹⁶¹ French text: ... comme toutes les stimulations que l'organisme reçoit, n'ont à leur tour été possibles que par ses mouvements précédents, qui ont fini par exposer l'organisme récepteur aux influences externes, on pourrait dire aussi que le comportement est la cause première de toutes les stimulations. Ainsi la forme de l'excitant, est créée par l'organisme lui-même, par sa manière propre de s'offrir aux actions du dehors. Sans doute, pour pouvoir subsister, il doit rencontrer autour de lui un certain nombre d'agents physiques ou chimiques. Mais c'est lui, selon la nature propre de ses récepteurs, selon les seuils de ses centres nerveux, selon les mouvements des organes, qui choisit dans le monde physique les stimuli auxquels il sera sensible.

The concept of *autonomy* features in the title of Varela's book, *Principles of biological autonomy* (1979). The Santiago approach defines the term—which can apply to any system, whether biological or not—as the control by a structure of what constitutes the system, and the way in which the structure can handle disturbances from outside, with no need for an external reference for its operations (Varela, 1979, p. xv). Varela accordingly defines an autonomous system as follows (p. 55):

We shall say that autonomous systems are organizationally closed. That is, their organization is characterized by processes such that (1) the processes are related as a network, so that they recursively depend on each other in the generation and realization of the processes themselves, and (2) they constitute the systems as a unity recognizable in the space (domain) in which the processes exist.

This closure does not mean that the system is shut off from the outside world in material and energy terms. That would be impossible. On the contrary, autonomous systems are thermodynamically far from equilibrium, and they exchange energy with their surroundings. The organizational closure refers to the self-referential network that defines the system as a unit.

We can thus see how much this approach owes to the vision of philosophers such as Merleau-Ponty, insofar as the organism both initiates and shapes its environment (Varela et al., 1993, p. 174).

The term *autopoiesis* derives from two Greek roots: αὐτός (“oneself”) and ποιεῖν (“to produce”). This property, identified by Maturana and Varela in 1973, characterizes all living beings, as Varela states more simply (1997, p. 75):

An autopoietic system—the minimal living organization—is one that continuously produces the components that specify it, while at the same time realizing it (the system) as a concrete unity in space and time, which makes the network of production of components possible.

This definition implies that life can be characterized with the aid of the system's dynamics, which depend solely on its organization's

structural composition and remain separate from its physical environment. As soon as the process is interrupted, the system dies.

We can thus define clear criteria for determining whether or not an organization is *autopoietic*: (1) it must have a semi-permeable frontier; (2) its components must be produced by a network of reactions inside that frontier; (3) the two preceding conditions must be interdependent (Thompson, 2007, p. 103). Thus, while a bacterium qualifies as autopoietic because it meets the three criteria, a virus does not, for its molecular components (nucleic acids) are not generated within itself, but in the host cell.

In light of these criteria, we may ask whether certain social systems are *autopoietic* or not (Luhmann, 1986). Mingers (2002) examines this possibility in detail. He shows that, despite major similarities with *autopoietic* theory, the notion of *autopoietic* social systems imposes an incredibly abstract and reductionist view of the social world. In a later work, Mingers (2004) assesses the validity of *autopoiesis* for Bhaskar and Giddens' social theories. Again, he concludes that in these cases it is extremely hard to identify a social system's frontier in empirical terms. These observations are wholly consistent with Varela's on the same topic (1979, pp. 54-55):

[. . .] there have been some proposals suggesting that certain human systems, such as institutions, should be understood as autopoietic [. . .]. From this point of view, I believe that these characterizations are category mistakes: they confuse autopoiesis with autonomy, that we can take the lessons offered by the autonomy of living systems and convert them into an operational characterization of autonomy in general, living and otherwise.

These studies therefore nullify the hypothesis, proposed by certain sociologists, that social systems may be regarded as *autopoietic*. By contrast, social systems lacking a specific frontier may be viewed as *autonomous* (Hooker, 2013, pp. 772-773).

Lastly, *adaptation* is the ability of all living organisms to stay alive. Maturana and Varela (1987, p. 102) define it as follows:

If we turn our attention to the maintenance of the organisms as dynamic systems in their environment, the maintenance will appear

to us as centered on a compatibility of the organisms with their environment which we call adaptation. If at any time, however, we observe a destructive interaction between a living being and its environment, and the former disintegrates as an autopoietic system, we see the disintegrating living system as having lost its adaptation.

While *autopoiesis* enables us to understand how an organism is alive, *adaptation* will allow us to understand how it can die if it ceases to be adapted to its environment. This also offers an explanation for the organism's dysfunctions, stress, fatigue, pathological conditions, the evolution of species, and other phenomena (Di Paolo, 2005, p. 439).

The views of the Santiago School on the evolution of species lie outside the scope of our work. Let us look instead at its working hypothesis (Varela, 1996, p. 343) before describing in greater detail its approach to actual cases:

Phenomenological accounts of the structure of experience and their counterparts in cognitive science relate to each other through reciprocal constraints.

This hypothesis perfectly defines the dual aspect of the School's planned analysis, which begins by classifying the data it will use in three categories.

First-person data are the introspective data collected from personal experience, such as the data obtained through "contemplative meditative traditions." That is what Varela calls *enaction*, as describing the dynamic structure of lived experience. Such data can be considered as purely hermeneutic data, as they constitute interpretations which are inseparable from our bodies, our language and our social history (Varela et al., 1993, p. 149). In fact, he emphasize the affiliation of his ideas to the philosophical school of hermeneutics that show how knowledge depends on being in a world that is inseparable from our bodies, our language and our social history.

Second person data defines an interviewer that collects data from an interviewee. Finally, *Third-person data* use *first-person data* to access physiological processes, which would otherwise

remain opaque. They achieve this with the aid of the variability of responses obtained through scientific methods such as electroencephalograms (Lutz et al., 2002). While the use of the two types of data is not univocal, their relationship is, in fact, dynamic: third-person data can, in some cases, lead researchers to modify the method for collecting first-person data.

Varela (1996, pp. 341-343) describes various kinds of experiments to illustrate this approach, but he clearly notes that these case studies do not constitute a proof of what he is proposing, which thus remains a working hypothesis open to criticism.

This ends our brief presentation of the biological autonomy approach, which has continued to develop in the past twenty years around the principles defined by Maturana and Varela. Let us simply quote from Alvaro Moreno and Matteo Mossio's book entitled *Biological autonomy* (2015), which documents the additions and alterations to the approach. The authors emphasize the central role of autonomy in their work (2015, p. xxix):

The autonomous perspective that we develop here endeavours then to grasp the complexity of biological phenomena, by adequately accounting for their various dimensions, specificities, and relations with the physical and chemical domains.

The focus on autonomy distinguishes their approach from that of Maturana and Varela, who attached greater importance to autopoiesis. We will see that this concept was latter used by Bich and Bechtel (2021), to try to link mechanistic theory to system theory.

Another development worth noting for our purposes is the micro-phenomenological approach (Bitbol, 2018), which gives a new perspective on biographical interviews. These are viewed (Bitbol and Petitmengin, 2017, p. 731) as offering:

[...] a disciplined, explicit "circulation" between first and third person analyses, which is the principle of the neurophenomenological approach to cognitive processes.

The *biological autonomy approach* thus treats biographical interviews in a totally different way from demography. It seeks to conduct a rigorous study of lived experience rather than analyze human lives from an external point of view.

Many authors, however, have hesitated to characterize the *biological autonomy approach* as fully scientific. Podgórski (2010, p. 85), for example, concludes his presentation of the theory as follows:

What is its value? It is certainly a very complicated theory, logically coherent, leaning on complicated language. This theory is not false or verifiable. Transferring it to another scientific discipline, it appears to be more or less adequate in a particular field of research.

Is it worth today investigating the thought of the Chilean biologists? In my humble opinion—it is. Drifting among many of their ideas, expressed in difficult and hermeneutical-like language is challenging.

In the context of our book, devoted to understanding human life, we largely approve Podgórski's conclusion: the hermeneutic approach followed by Maturana, Varela, and others does not really enable us to understand human lives as we described them in Chapters 7 and 8, but it does pave the way for a scientific approach to human life that is entirely worth pursuing and differs greatly from the mechanistic approach discussed in §9.2.

In reality, the two approaches practically ignored each other in the late twentieth and very early twenty-first centuries. The mechanistic approach seeks to show how a mechanism's components are organized so that their activities produce a given phenomenon. The autonomy approach focuses instead on the organism envisaged as a whole, and aims to show how it succeeds in maintaining its integrity. Craver's book: *Explaining the Brain* (2007) totally ignores the autonomy approach, whereas Thompson's book *Mind in Life* (2010) completely ignores the mechanistic approach. However, around 2007, some authors set out to identify their common features.

At this point, therefore, it is worth asking whether we could use the two theories simultaneously to better understand human behaviors.

9.4 How can we associate system biology, mechanisms, and autonomy?

Autonomy theory, discussed in the previous section, is indeed an extension of system analysis, for it aims to treat intelligence and memory as a whole. It is therefore effectively a *biological systems theory*. However, another approach has emerged in the same period: *dynamical system theory*. While similar, in principle, to autonomy theory, we shall point out the major differences between the two.

Dynamical systems theory (DST) developed in the 1990s as a consequence of the Human Genome Project (Ideker et al., 2001), although we can find earlier signs of it. It is open to the systemic interpretation of extensive quantitative data with the aid of mathematical and computer models, but also to an examination of the way in which cognitive phenomena are studied and conceptualized.

DST is presented in detail by Timothy van Gelder and Robert Port in *Mind as motion: explorations in the dynamics of cognition* (1996). They regard it as a new research paradigm (p. 10), for:

[...] dynamical and computational systems are fundamentally different *kinds* of systems, and hence the dynamical and computational approaches to cognition are fundamentally different in their deepest foundations.

DST has since achieved substantial progress in modeling biological and neural systems—ranging from simple neurons to large neural networks—that concern biological populations and complex systems. It is highly mathematized, for it tracks the course of a set of variables interacting with one another over time. Of the many books devoted to it, one of the most recent, *Dynamical systems theory*

(2020) (Awrejcewics and Grzelczyk, eds.), reports the latest mathematical advances in the field.

With its holistic emphasis, DST violently rejects the mechanistic tradition in biology, describing it as “reductionist.” For example, van Regenmortel (2004, p. 1015) writes:

The reductionist method of dissecting biological systems into their constituent parts has been effective in explaining the chemical basis of numerous living processes. However, many biologists realize that this approach has reached its limits. Biological systems are extremely complex and have emergent properties that cannot be explained, or even predicted, by studying their individual parts.

DST proponents therefore consider that, if we want to try to understand human life, we should examine the entire system in which biological phenomena occur. By contrast, the mechanistic approach seeks to understand a complex whole by breaking it down into its components and locating the phenomenon to be analyzed in certain parts of the system.

In 1998, Bechtel—one of the founders of the mechanistic approach, as noted in the introduction to this chapter—responded to the rejection by DST advocates in an article entitled “Representations and cognitive explanations: assessing the dynamicist’s challenge in cognitive science.” The thrust of his rebuttal concerns the validity of the explanatory model that forms the basis of DST. He shows that DST, in fact, is looking for laws and that it follows the *covering law* explanation (Bechtel, 1998, p. 311):

The difference and differential equations in these models are intended to describe patterns of linked change in the values of specified parameters in the course of the system’s evolution over time. The parameters do not correspond to components of the system which interact causally. They are, rather, features in the phenomenon itself (e.g., the motivational value a person assigns to a particular consequence). [...] In this respect, these DST explanations better fit the alternative, covering law model of explanation presented earlier. In order to distinguish explanations from descriptions, proponents of the covering law model argued

that the generalization from which the behavior of the particular instance is to be derived really had to be a law.

The *covering law* explanation claims (Bechtel, 1998, p. 307) “that a phenomenon was explained when a statement describing it was derived from statements specifying one or more laws and relevant initial conditions (Hempel, 1965).” Bechtel argues that the covering law has been largely discredited, most notably for the life sciences (including cognitive science), for which a mechanistic approach seems better suited.

In 2007, Bechtel rehearsed and elaborated some of these arguments in a new article on “Biological mechanisms: organized to maintain autonomy.” He now clearly stated the need to move beyond the mechanistic approach (2007, p. 269):

Mechanistic explanations in biology have continually confronted the challenge that they are insufficient to account for biological phenomena. This challenge is often justified as accounts of biological mechanisms frequently fail to consider the modes of organization required to explain the phenomena of life. [...] Although some theorists would construe such self-organizing and self-repairing systems as beyond the mechanistic perspective, I maintain that they can be accommodated within the framework of mechanistic explanation properly construed.

The article, published in a book on *Systems biology*, clearly presents the two opposing approaches. The first is a systemic holistic approach, whose explanations are supported by the *covering law*. The second is a mechanistic reductionist approach, which breaks down biological systems into their molecular components. To mitigate this extreme reductionism, Bechtel proposes an approach using autonomy theory (see §9.3 above), defended by Maturana and Varela (1987).

Bechtel’s proposal is in fact very similar to what Franck had suggested back in 1995, namely, that part of the solution to biological reductionism can and must be sought in an approach that avoids the dualist opposition between the whole and its parts (Franck, 1995, p. 79):

We leave these two cosmogonies and penetrate into another, and at once the question of reductionism changes meaning, for the aim is no longer to determine if the whole can be reduced to its elementary components, but to determine how the different strata or levels are actually linked—from top to bottom and from bottom to top.¹⁶²

In these conditions, choosing between *holism* and *reductionism* becomes pointless. However, it will be necessary to find out how to incorporate units at a given level into units at a higher level. This approach offers a better solution to the problem posed in §9.2 on how to take the introduction of multilevel analysis into account in the mechanistic approach.

More specifically, Bechtel advocates associating the reductionist mechanistic theory with a holistic approach, which can deal with the gaps encountered by the theory (Bechtel, 2007, p. 297):

Ideas such as negative feedback, self-organizing positive feedback, and cyclic organization are critical to explaining the phenomena exhibited by living organisms. [...] These critical features are nicely captured in Moreno's conception of basic autonomy in which we recognize living systems as so organized to metabolize inputs to extract matter and energy and direct these to building and repairing themselves.

In other words, the combination of autonomy theory and mechanistic theory is indeed what ought to make it possible to explain the phenomena of human life and memory.

This position has since been accepted by most mechanistic theoreticians (Kaplan and Bechtel, 2011; Kaplan and Craver, 2011; Kaplan, 2015; Kaplan, 2018). However, Kaplan concludes his article as follows (2018, p. 278):

¹⁶² French text: Nous quittons ces deux cosmogonies et nous pénétrons dans une autre, et du coup la question du réductionnisme change de sens car il ne s'agit plus de savoir si l'on peut *réduire* le tout à ses composantes élémentaires, mais il s'agit de savoir comment s'articulent véritablement les différents étages ou niveaux, du haut vers le bas et du bas vers le haut.

In addition to the challenge for the mechanistic approach to dynamic explanation identified earlier, more hard work remains for those wishing to defend a mechanistic perspective. For instance, dynamics have also appealed to notions of emergence or downward causation to complex dynamical systems to argue for the limitations of the mechanistic perspective [...]. To date defenders of the mechanistic approach have not sufficiently addressed this challenge.

Indeed, some authors, in their defense of the *covering law* explanation, continue to argue that *Dynamical systems theory* is independent of the mechanistic tradition (Chemero and Silberstein, 2008; Meyer, 2020), but we have seen how this explanation falls short. Nevertheless, the mechanistic approach still faces many difficulties in fully assimilating *autonomy theory*.

For instance, in a very recent article on “Mechanisms, autonomy and biological explanation” (2021), Bich and Bechtel list the many problems still to be resolved before the two theories can be fully integrated. Comparing these theories, they write (p. 2):

The first group espouses explanation in terms of mechanisms, the second in terms of closed networks of constraints that maintain themselves. Although these two philosophical traditions have largely developed independently of each other, we argue that they should be constructively integrated, as each supplies ingredients the other tradition has ignored or not accounted for in sufficient detail.

That way much still needs to be done to achieve integration, but the authors clearly set out the path to follow, which would lead to the successful association between mechanisms and autonomy.

In order, not to oppose the two traditions but to show how they should be constructively integrated, we can say that the recent developments in the autonomy tradition such as those developed by Moreno and Mossio (2015) provide a bridge between these two traditions: they show why mechanistic explanation must be supplemented with other explanatory approaches. Simultaneously, the mechanistic tradition has confronted a number of challenges in specifying the phenomena about which it is applied, and their boundaries: there is a challenge in determining which entities

constitute the mechanism and which are outside it. Also, it fails to try to organize: it may well identify parts of this organization but does not permit to understand how these parts succeed in producing it (Bechtel, 2007, p. 209).

We have now generated all the elements about the three more general traditions, which permit to understand human life: system biology (here mainly the autonomy approach), mechanisms and hermeneutics. In first view, they appeared as largely independent from each other, leading to three different approaches of human life.

However we have seen that very recently there is a growing interest to provide a bridge between the autonomy tradition and the mechanist one. Collaboration from the two approaches appears now as necessary, in order to understand how mechanisms are controlled to serve organisms.

For hermeneutics, we have also seen how Varela et al. (1991) tried to link systemic biology with this approach. For example, in 1996 he uses *first-person data* in order to describe the dynamic structure of lived experience. However, despite the various kinds of experiments, this hypothesis remains a working one open to criticism. While we have not developed here this more philosophical point, Varela et al. (1991) introduce Buddhist thought with the scientific one, in order to understand the embodied mind. This Buddhist thought encounters many common points with relational hermeneutics, as Nicholas Davey (2018) clearly shows. However, Varela never proposes a scientific explanation of Buddhism which, in fact, he opposes to science. Even later, Thompson (2007), who has been co-author of this previous book, gives no more reference to this Buddhist tradition.

As we have already shown a true scientific explanation needs a drastic simplification of the phenomena to be studied (Suppe, 1989). Only a small number of parameters abstracted from those phenomena may figure in this explanation. However, an individual life is too much complex to be explained in this way, and this leads to the notion of *comprehension* as presented by Dilthey. This notion is no more a scientific one, but it permits to understand, in the sense of to comprehend, human lives in all their complexity without any

appeal to explanation which will be too restrictive. If social sciences, like demography, had been able to develop event-history analysis, it is at the price of keeping only in their field three main phenomena: births, deaths and migratory movements (Courgeau, Franck, 2007). To extend their field in order to understand the behaviour of human populations, from individual to society level, would end up embracing everything. Only a comprehensive approach is able to give this view, taking a more ethical, religious and political view of the society in which the individual lives.

References

- Aalen, O.O. (1975). *Statistical inference for a family of counting processes*. Ph.D. Thesis, University of California, Berkeley, iv + 98 p.
- Aalen, O.O. (1978). Nonparametric inference for a family of counting processes. *The Annals of Statistics*, 6 (4), pp. 701-726.
- Aeschylus (472 B.C.). *The Persians*. Translated by Gilbert Murray, London: George Allen & Unwin Ltd.
- Agazzi, E. (1985), « Commensurability, incommensurability, and cumulativity in scientific knowledge », *Erkenntnis*, 22 (1-3), pp. 51-77.
- Amicale de Ravensbrück et Association des déportés et internés de la résistance (1965). *Les Françaises à Ravensbrück*. Paris ; Gallimard.
- Anderson, M.C., Green, C. (2011). Suppressing unwanted memories by executive control. *Nature*, 410, pp. 366-369.
- Angoumois, d', P. (1625). *Les triomphes de l'amour de Dieu en la conversion d'Hermogène. Dédié à Monsieur frère du Roy*. Paris: Nicolas Buon.
- Anouilh, J. (1946). *Nouvelles pièces noires: Jézabel, Antigone, Roméo et Jeannette, Médée*. Paris: La Table Ronde.
- Aristotle (around 330 B.C.). *Politics*. The Internet Classic Archive: translated by Jowett B. <http://classics.mit.edu/Aristotle/politics.html>.
- Aristotle (around 350 B.C.). *Poetics*. The Internet Classic Archive: translated by Butcher S.H. <http://classics.mit.edu/Aristotle/poetics.html>.
- Arnim von J. (1902-1925). *Stoicorum veterum fragmenta*, 4 vol., Leipzig: B.G. Teubner.
- Aschard H., Chen J., Cornelis M., Chibnik L., Karlson E. (2012). Inclusion of gene-gene and gene-environment interactions unlikely to dramatically improve risk prediction for complex diseases, *The American Journal of Human Genetics*, 90, 962-972.
- Ascoli, d', C. (ouvrage non terminé au moment de son exécution en 1327). L'Acerba. Edizione di riferimento, a cura di Crespi, A. (1927) : <http://www.classicitaliani.it/index134.htm>
- Athenaeus of Naucratis (around 223 B.C). *Deipnosophistae*. Translated by Yonge C.D. <http://www.attalus.org/info/athenaeus.html>.
- Atkinson, J.R., Shiffrin, R.M. (1968). Human memory: a proposed system and its control processes. In *The psychology of learning and motivation*, Spense, K.W. ed., pp. 89-195, New York: Academic press.
- Aubigné, d', A. (1630). *Les aventures du baron de Faeneste, Faeneste IV*. Paris: Au Dezert.
- Aubin, J.-P. (1997). *Dynamic economic theory. A viability approach*. Berlin-Heidelberg: Springer Verlag.
- Aubin, J.-P. (2010). *La mort du devin, l'émergence du démiurge. Essai sur la contingence, la viabilité et l'inertie des systèmes*. Paris : Beauchesne Editeur.
- Aubin, J.-P., Bayen, A.M., Saint-Pierre, P. (2011). *Viability theory. New directions*. Heidelberg Dordrecht London New York: Springer.
- Augustine of Hippo (around 387-391). *De libero arbitrio*. Translated by Dods, M., 1955.

http://www.logicmuseum.com/w/index.php?title=Authors/Augustine/De_libero_arbitrio&ol did=13023

- Augustine of Hippo (around 397-400). *Confessiones*. Translated by Pusey, E.S. <http://www.gutenberg.org/files/3296/3296-h/3296-h.htm>
- Augustine of Hippo (around 410-427). *De civitate Dei contra paganos*. Translated by Dods, M., 1955. <http://www.gutenberg.org/files/45304/45304-h/45304-h.htm>
- Auriat, N. (1996). *Les défaillances de la mémoire humaine*. Travaux et Documents, Cahier n° 136, Paris : INED / PUF.
- Avez, P. (2017). *L'envers de la liberté*. Paris: Publications de la Sorbonne.
- Awrejcewics, J., Grzelczyk D. (eds.) (2020). *Dynamical system theory*. London: IntechOpen
- Bacon, F. (1620). *Novum Organon*. London: J. Bill.
- Barrett, J.L. (2000). Exploring the natural foundations of religion. *Trends in cognitive sciences*, 4 (1), pp. 29-34.
- Bateson, M.A. (1902). *Mendel's principles of heredity. A defence*. Cambridge: University Press.
- Batteux, V. (1746). *Les beaux arts réduits à un même principe*. Paris : Durand.
- Bauer, M., Durant, J. (1997). Belief in astrology: a social-psychological analysis. *Culture and Cosmos*, 1(1), pp. 55-71.
- Baumberger, C., Beisbart, C., Brun, G. (2016). What is understanding? An overview of recent debates in epistemology and philosophy of science. In *Explaining, understanding. New perspectives from epistemology on philosophy of science*. Grimm, S., Baumberger, C., Ammon, S. eds., pp. 1-34, New York: Routledge.
- Baur, E., Fischer, E., Lenz, F. (1921). *Grundriß der menschlichen Erblichkeitslehre und Rassenhygiene*. 2 vols. München, J. F. Lehmanns Verlag.
- Bayes, T. R. (1763). An essay towards solving a problem in the doctrine of chances. *Philosophical Transactions of the Royal Society of London*, 53, 370-418.
- Bechtel, W. (1998). Representation and cognitive explanations: assessing the dynamicist's challenge in cognitive science. *Cognitive Science*, 22, pp. 295-318.
- Bechtel, W. (2007). Biological mechanisms: organized to maintain autonomy. In: *System biology. Philosophical foundations*, Boogerd, F.C., Bruggeman, F.J., Hofmeyr, J.-H., Westerhoff, H.J., eds, pp.269-302, Amsterdam Boston Heidelberg London New York Oxford Paris San Diego San Francisco Singapore Sydney Tokyo: Elsevier.
- Bechtel, W., Abrahamson, A. (2005). Explanation: a mechanist alternative. *Studies in the History and Philosophy of Biological and Biomedical Sciences*, 36, pp. 421-441.
- Bechtel, W., Richardson, R.C. (1993). *Discovering complexity. Decomposition and localization as strategies in scientific research*, Princeton: Princeton University Press.
- Bengtsson T., Mineau G. (2008). *Kinship and demographic behavior in the past*. Dordrecht: Springer.
- Berger, G.H., Gaunitz, S.C.B. (1979). Self-rated imagery and encoding strategies in visual memory. *British Journal of Psychology*, 70 (1), pp. 21-24.
- Berggren, J.L., Thomas, R.S.D. (1996). *Euclid's Phaenomena. A translation and study of a Hellenistic treatise in spherical astronomy*. U.S.A: American Mathematical Society.
- Bern, D.J. (2011). Feeling the future: experimental evidence for anomalous retroactive influences on cognition and affect. *Journal of Personality and Social Psychology*, 100 (3), pp. 407-425.

- Bertalanffy, von, L. (1969). *General systems theory. Foundations, development, applications*. New York: George Braziler.
- Bertaux, D. (1974). Mobilité sociale biographique. Une critique de l'approche transversale. *Revue Française de Sociologie*, 15 (3), pp. 329-362.
- Bertaux, D. (1976). *Histoires de vie ou récits pratiques ? Méthodologie de l'approche biographique*. Rapport final, tome 2, Paris : C.O.R.D.E.S.
- Bertho, E. (2016). A quoi pensent les genres littéraires ? Pragmatique de l'énergie dans l'épopée et le roman. *Acta Fabula*, 17 (2), Notes de lecture, URL <http://www.fabula.org/revue/document9717.php>
- Bertillon, J. (1898). La natalité selon le degré d'aisance. Etude à ce point de vue de Paris, Londres, Berlin et Vienne. *Bulletin de l'Institut International de Statistique*, T XI(1), pp. 163-176.
- Bettelheim, B. (1976). *The uses of enchantment. The meaning and importance of fairy tales*. London: Thames & Hudson.
- Betts, G.H. (1909). *The observation and functions of mental imagery*. New York: Teachers College, Columbia?
- Bich, L., Bechtel, W. (2021). Mechanism, autonomy and biological explanation. *Biology & Philosophy*, 36, 53, <https://doi.org/10.1007/s10539-021-09829-8>
- Bijak, J., ed. (2022). *Towards Bayesian model-based demography. Agency, complexity and uncertainty in migration studies*. Methodos Series 17, Cham Switzerland: Springer Nature.
- Billari, F., Prskawetz, A., ed. (2003). *Agent-based computational demography: using simulation to improve our understanding of demographic behaviour*. Heidelberg, New York: Physica-Verlag.
- Binet, A., Simon, T. (1905). Méthodes nouvelles pour le diagnostic du niveau intellectuel d'enfants anormaux. *L'Année Psychologique*, 11, pp. 191-244.
- Birch, J. (2018). Kin selection, group selection, and the varieties of population structures. *British Journal of Philosophical Science*, 69, pp. 1-28.
- Bitbol, M. (2018). La sphère d'intersubjectivité durant l'entretien micro-phénoménologique. *Chroniques phénoménologiques*, 11, pp. 66-71.
- Bitbol, M., Petitmengin, C. (2017). Neurophenomenology and the micro-phenomenological interview. In *The Blackwell companion to consciousness*, Velmans, M., Scheider, S. eds., pp. 726-739, Chichester : Wiley & Sons.
- Blayo, C. 1995. La condition d'homogénéité en analyse démographique et en analyse statistique des biographies, *Population*, 50, pp. 1501-1518.
- Blajenkova, O., Kozhevnikov, M., Moles, M.A. (2006). Object-spatial imagery: A new self-report imagery questionnaire. *Applied Cognitive Psychology*, 20, pp. 239-263.
- Blazhenkova, O. (2016). Vividness of object and spatial imagery. *Perceptual and Motor Skills*, 122 (2), pp. 490-508.
- Bliss, T., Gardner-Medwin, A.R. (1973). Long-lasting potentiation of synaptic transmission in the dentate area of unanaesthetized rabbit following stimulation of the perforant path. *Journal of Physiology*, 232, pp. 357-374.
- Bliss, T., Gardner-Medwin, A.R., Lømo, T. (1973). Synaptic plasticity of the hippocampal formation. In *Macromolecules and behavior*, Ansell, G.B., Bradley, P.B. eds., pp. 193-203, London: MacMillan.

- Bliss, T., Lømo, T. (1973). Long-lasting potentiation of synaptic transmission in the dentate area of the anaesthetised rabbit following stimulation of the perforant path. *Journal of Physiology*, 242, pp. 331-356.
- Bloch, M. (2007). Durkheimian anthropology and religion: going in and out each other's body. In *Religion, anthropology, and cognitive science*, Whitehouse, H., Laidlaw, J. (eds.), Durham: Carolina Academic Press, pp. 63-88.
- Bloch, M. (2008). Why religion is nothing special but is central. *Philosophical Transactions: Biological sciences*, 363 (1499), pp. 2055-2061.
- Bloch, M., Moya, Y., Vienne, de, E. (2016). La double nature du social. Une conversation sur le temps, le transcendantal, la vie, etc. [entretien avec Maurice Bloch]. *Terrain*, 66, pp. 156-171.
- Bobzien, S. (1998). *Determinism and Freedom in Stoic Philosophy*. Oxford, Clarendon Press,
- Bochaca, M. (2013). Un voyage par mer d'Angleterre à Bordeaux et retour en 1442-1443 d'après A *Journal by one of the suite of Thomas Beckington. Annales du Midi*, 125 (283), pp. 371-390.
- Bock, G. (1986). *Zwangsterilisation im Nationalsozialismus. Studien zur Rassenpolitik und Frauenpolitik*. Opladen: Westdeutscher Verlag,
- Bonneuil, N. (1990). Contextual and structural factors in fertility behavior. *Population, English Version*, 45 (2), pp. 69-92.
- Bonneuil, N. (1994). Malthus, Boserup and population viability. *Mathematical Population Studies*, 4 (5), pp. 107-119.
- Bonneuil, N. (2013). Viabilité, probabilité, induction. *Tracés. Revue de Sciences Humaines*, 24, pp. 71-84.
- Bonneuil, N. (2017). Maintain and acquire: the viability principles in population economics. *Revue d'Economie Politique*, 127 (2), pp.153-172.
- Bórudóttir, S. (2020). Does mental imagery vividness predict performance ? [Skoða/Opna](#)
- Botero, C.A., Gardner, B., Kirby, K.R., Bulbulia, J., Gavin, M.C., Gray, R.D. (2014). The ecology of religious beliefs. *PNAS*, 111 (47), pp. 16784-16789.
- Bottéro, J., traduit de l'Akkadien par (1992). *L'épopée de Gilgameš. Le grand homme qui ne voulait pas mourir*. Paris : Gallimard.
- Bouché-Leclercq, A. (1879-1882). *Histoire de la divination dans l'antiquité*. 4 Tomes. Paris : Ernest Leroux.
- Bouché-Leclercq, A. (1899). *L'astrologie grecque*. Paris : Ernest Leroux ?
- Bourcier, E. (1976). *Les Journaux privés en Angleterre de 1600 à 1660*. Paris : Publications de la Sorbonne-Imprimerie Nationale.
- Bourdieu, P. (1986). L'illusion biographique. *Actes de la Recherche en Sciences Sociales*, 62-63, L'illusion biographique, pp. 69-72.
- Boy, D. (2004/2005). The French and parascience: twenty years of surveys. *Revue Française de Sociologie*, 45, pp: 49-59.
- Boy, D., Michelat, G. (1986). Croyances aux parasciences : dimensions sociales et culturelles. *Revue Française de Sociologie*, 27(2), pp. 175-204.
- Boyer, P. (1994). *The naturalness of religious ideas: a cognitive theory of religion*. Berkeley: University of California Press.
- Boyer, P. (2018). *Minds make societies*. New Haven and London: Yale University Press.

- Bradburn, N., Ripps, L., Schevell, S. (1987). Answering autobiographical questions: the impact of memory and inference on surveys. *Science*, 236, pp.157-162.
- Brancacci, A. (2013). Mimesis, poésie et musique. In *Lectures de Platon*, Dissaut, M., Castel-Bouchouchi, A., Kévorkian, G. eds, pp. 201-213, Paris ; Ellipses.
- Bretagnolle, J., Huber-Carol, C. 1988. Effects of omitting covariates in Cox's model for survival data. *Scandinavian Journal of Statistics*, 15, pp. 125-138.
- Breuer, J., Freud, S. (1895). *Studien über Hysterie*. Leipzig und Wien: Franz Deuticke.
- Brewer, W.F., Schommer-Aikins, M. (2006). Scientists are not deficient in mental imagery: Galton revised. *Review of General Psychology*, 10 (2), pp. 130-146.
- Brindley, G.S. (1969). Nerve net models of plausible size that perform many simple learning tasks. *Proceeding of the Royal Society*, B174, pp. 173-191.
- Bronner, G. (2017). Astrologie autoréalisatrice. *Pour la Science*, 479, pp. 24.
- Brouillet, M., Buccheri, A. eds. (2019). Lectures anthropologiques de l'agir dans l'antiquité. *Cahiers "Mondes anciens"*, 12.
- Brousse, J. (1621). *La vie du révérend père, P. Ange de Joyeuse, prédicateur capucin, autrefois duc, pair et maréchal de France, & Gouverneur pour le Roy en Languedoc. Ensemble les vies des RR.PP. P. Benoist Anglois & P. Archange Ecossois du même Ordre*. Paris: Adrian Taupinart et Louis Boulanger.
- Burch, T.K. (2003). Data, models, theory and reality: the structure of demographic knowledge. In F.C. Billari, A. Prskawetz (eds), *Agent-based computational demography*, pages 19-40, Heidelberg New York: Physica Verlag.
- Burbridge, D. (1994). Galton's 100: an exploration of Francis Galton's imagery studies. *British Journal for the History of Science*, 27, pp. 442-463.
- Burnyeat, M., Frede, M. (2015). *The authenticity of Plato's seventh letter*. Oxford: Oxford University Press.
- Caesar, J. (around 51 B.C.). *Commentarii de bello Gallico*. Translated by McDevitte, W.A., Bohn, W.S., (1869), New York: Harper & Brothers.
- Caesar, J. (around 46 B.C.). *Commentarii de bello civili*. Translated by McDevitte, W.A., Bohn, W.S., (1869), New York: Harper & Brothers.
- Caillières de, J. (1662). *Le courtisan prédestiné, ou le duc de Joyeuse capucin*. Paris : Musier et Louis d'Hotelfort.
- Cajal, y, S.R. (1894). La fine structure des centres nerveux. *Proceedings of the Royal Society of London*, 55, pp. 444-468.
- Campbell, J. (2007). An interventionist approach to causation in psychology. In *Causal learning, psychology, philosophy, and computation*, Gopnik, A., Schulz, L., eds., pp. 58-66, Oxford: Oxford University Press.
- Campion, N. (2000). Babylonian astrology: its origin and legacy in Europe. In *Astronomy across cultures. The history of non-western astronomy*, Selin, H., Xiaochun, S (eds.), Dordrecht: Kluwer Academic Publishers, pp. 509-554.
- Campion, N. (2017). How many people actually believe in astrology? *The Conversation, Culture*, 28 avril 2017.
- Cantillon, R. (1755, 1952). *Essai sur la nature du commerce en général*. Classiques de l'Economie et de la Population. Paris: Ined.

- Caplan, A.L., McGee, G., Magnus, D. (1999). What is immoral about eugenics? *BMJ*, 319, pp. 1284-1285.
- Capron C., Vetta A.R., Duyme M., Vetta A. (1999). Misconceptions of biometrical IQists, *Current Psychology of cognition*, 18, 115-160.
- Caquot, A., Leibovici, M. eds. (1968). *La divination*. 2 Tomes. Paris : Presses Universitaires de France.
- Carlson, S. (1985). A double-blind test of astrology. *Nature*, 318, pp. 419-425.
- Carson, R. (1962)). *Silent spring*. Boston: Houghton Mifflin.
- Casetti, V., Conca, A. (2015-2016). Italian psychiatry and fascism: racial laws and life in psychiatric hospitals during World War II. *Evidence-based Psychiatric Care*, 1(3-4), pp. 105-111.
- Cassata, F. (2003). *Il fascismo razionale. Corrado Gini fra scienza e politica*. Roma: Carocci Editore.
- Chara, P.J., Hamm, D.A. (1989). An inquiry into the construct validity of the Vividness of Visual Imagery Questionnaire. *Perceptual and Motor Skills*, 69 (1), pp. 127-136.
- Charbit, Y. (2004). Proudhon et le piège malthusien. *Cahiers Internationaux de Sociologie*, vol. CXVI, pp. 5-34.
- Charbit, Y. (2005). Capitalisme et population: Marx et Engels contre Malthus. *Revue d'Histoire et des Sciences Humaines*, 13, pp. 183-208.
- Charney, E. (2012). Behavior genetics and postgenomics with discussion. *Behavioral and Brain Sciences*, 35, 331-410.
- Chemero, A., Silberstein, M. (2008). After the philosophy of mind: replacing scholasticism with science. *Philosophy of Science*, 75 (1), pp.1-27.
- Chen, W.R., Lee, S., Kato, K., Spencer, D.D., Shepherd, G.M. (1996). Long term modification of synaptic efficacy in the human inferior and middle temporal cortex. *Proceedings of the National Academy of Science*, 93, 8011-8015.
- Christian, P. (1870-1871). *Histoire de la magie du monde surnaturel et de la fatalité à travers le temps et les peuples*. Paris : Furne, Jouvet et C^{ie}.
- Cicero, M.T. (46 B.C.). *Paradoxa Stoicorum*. Translated by Webb, M.O. (1968):
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1010.912&rep=rep1&type=pdf>
- Cicero, M.T. (around 44 B.C.). *De divinatione*. Translated by Falconer W.A, (1923), Cambridge, Mass: Harvard University Press.
- Cicero, M.T. (around 43 B.C.). *De legibus*. Translated by Barham F.
<http://oll.libertyfund.org/titles/545>.
- Clark, V.E. (1961). Experimental astrology. *Search*, 3(1), pp. 102-112.
- Clastres, P. (1974). *La Société contre l'Etat*. Paris: Editions de Minuit (English translation: (1989). *Society against the State*. New York: Zone books).
- Coale, A.J., Watkins, S.C. eds. (1986). *The decline of fertility in Europe*. Princeton: Princeton University Press.
- Cohen, J.E. (2004). Mathematics is biology's next microscope, only better; biology is mathematics' next physics, only better. *PLOS Biology*, 2 (12), pp.2017-2023.
- Coleman, J.S. (1958). Relational analysis: the study of social organizations with survey methods. *Human Organization*, 17, 28-36
- Coman, A., Momennejad, I., Drach, R.D., Geana, A. (2016). Mnemonic convergence in social networks: the emergent properties of cognition at a collective level. *PNAS*, 113 (29), pp. 8171-8176.

- Comte, A. (1835). *Cours de philosophie positive, Tome deuxième*. Paris: Bachelier,
- Comte, C. (1826). *Traité de législation on exposition des lois générales suivant lesquelles les peuples prospèrent, dépérissent ou restent stationnaires*. 2 vol. Paris : Sautet et C^{ie}.
- Comte, C. (1834). *Traité de la propriété*. 2 vol. Paris : Chamerot et Ducollet.
- Condorcet de, N. (1794). *Esquisse d'un tableau historique des progrès de l'esprit humain*. Paris : Chez Agasse. (English translation : (1795). *Outlines of an historical view of the progress of the human life*. 1795, London: J. Johnson).
- Coninck, de, F., Godard, F. (1990). L'approche biographique à l'épreuve de l'interprétation. *Revue Française de Sociologie*, XXXI (1), L'approche biographique, pp. 23-53.
- Connelly, M. (2006). Seeing beyond the state: the population control movement and the problem of sovereignty. *Past and Present*, 193, pp. 197-233.
- Connelly, M. (2008). *Fatal misconception. The struggle to control world population*. Cambridge, London: The Belknap Press of Harvard University Press.
- Constant, B. (1819). De la liberté des anciens compare à celle des modernes. In *Ecrits politiques*, (1997), Gaucher M. ed., pp.594-609, Paris: Gallimard. English translation: The liberty of the ancients compared with that of the moderns, in *Political writings* (1988), Fontana, B. ed., pp. 309-327, Cambridge: Cambridge University Pres.
- Conte, R., Gilbert, N., Bonelli, G., Cioffi-Revilla, C., Deffuant, G., Kertesz, J., Loreto, V., Moat, S., Nadal, J.-P., Sanchez, A., Nowak, A., Flache, A., San Miguel, M., Helbing, D. (2012). Manifesto of computational social science. *The European Physical Journal Special Topics*, 214, 325-346.
- Coob, M. (2020). *The idea of the brain. A history*. London: Profile Books LTD.
- Courgeau, D. (1985). Interaction between spatial mobility, family and career life cycle: A French survey. *European Sociological Review*, 1(2), pp. 139-162.
- Courgeau, D. (1989). Family formation and urbanization, *Population, English Selection n° 1*, 44, pp. 123-146).
- Courgeau, D. (1992). Impact of response error on event history analysis. *Population: An English Selection*, 4, pp. 97-110.
- Courgeau, D. (1995). From the group to the individual: what can be learned from migratory behaviour. *Population: An English Selection*, 7, pp. 145-162.
- Courgeau, D. (2007). *Multilevel synthesis. From the group to the individual*. Dordrecht: Springer,
- Courgeau, D. (2009). Paradigmes démographiques et cumulativité. In *La cumulativité du savoir en sciences sociales*, sous la direction de Walliser, B., Editions de l'EHESS, Paris, pp. 242-325.
- Courgeau, D. (2010). Dispersion of measurements in demography: a historical view. *Electronic Journ@l for History of probability and Statistics*, 6 (1), pp.1-19.
- Courgeau, D. (2012). *Probability and Social sciences. Methodological relationships between the two approaches*. Methodos Series 10, Springer, Dordrecht Heidelberg London New York.
- Courgeau, D. (2013). La mesure dans les sciences de la population. *Cahiers Philosophiques*, 135, pp. 51-74.
- Courgeau, D., Baccaïni, B. (1998). Multilevel analysis in the social sciences. *Population: An English Selection*, 10 (1), pp. 39-71.

- Courgeau, D., Bijak, J., Franck, R., Silverman, E. (2014). Are the four Baconian idols still alive in demography? *Revue Quetelet/Quetelet Journal*, 2 (2), pp. 31-59.
- Courgeau, D., Lefebvre, M. (1978). Zones d'influence migratoire des villes : application à la région de Toulouse. In *Les disparités géographiques régionales*, Editions du CNRS, Paris, pp. 455-472.
- Courgeau, D., Lelièvre, E. (1992). *Event history analysis in demography*, Oxford: Clarendon Press.
- Cournot, A.-A. (1843). *Exposition de la théorie des chances et des probabilités*. Paris: Hachette.
- Cox, D.R. (1972). Regression models and life-tables (with discussion). *Journal of the Royal Statistical Society, Series B*, 34, pp. 187-220.
- Craver, C.F. (2002). Interlevel experiments and multilevel mechanisms in the neuroscience of memory. *Philosophy of Science*, 69, pp. 883-897.
- Craver, C.F. (2003). The making of a memory mechanism. *Journal of the History of Biology*, 36, pp. 153-195.
- Craver, C.F. (2007). *Explaining the brain. Mechanisms and the mosaic unity of neuroscience*. Oxford: Oxford University Press.
- Craver, C.F., Bechtel, W. (2007). Top-down causation without top-down causes. *Biology and Philosophy*, 20, pp. 715-737.
- Cribier, F., Kych, A. (1999). Un ensemble d'enquêtes auprès de deux cohortes de retraités parisiens. In *Biographies d'enquêtes*, Groupe de réflexion sur l'approche biographique, Ined, Paris, pp.74-103.
- Croviitz, H.F. (1970). *Galton's walk*. New York: Harper & Row.
- Croviitz, H.F., Schiffman, H. (1974). Frequencies of episodic memories as a function of their age. *Bulletin of the Psychonomic Society*, 4, pp. 512-518.
- Crusio, W.E. (1990). Estimating Heritabilities in Quantitative Behavior Genetics: A Station Passed. *Behavioral and Brain Sciences* 13, pp.: 127-128.
- Cummins, N. (2013). Marital fertility and wealth during the fertility transition: rural France, 1750-1850. *Economic History Review*, 66 (2), pp. 449-476.
- Cumont, F. (1912). *Astrology and Religion among the Greeks and the Romans*. New York and London: G. P. Putnam's Sons.
- Darbo-Peschanski, C. (2008). Deux acteurs pour un acte. Les personnages de l'Iliade et le modèle de l'acte réparti. In *Le moi et l'intériorité*, Aubry, G., Ildefonse, F. eds., pp : 241-254, Paris : Librairie Philosophique J. Vrin..
- Darwin C. (1859). *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*. London: Murray.
- Darwin, F., Darwin, S. eds. (1903). *More letters of Charles Darwin, a record of his work in a series of hitherto unpublished letters. Vol. 1*. London: John Murray.
- Davenport, C. (1925). Charles Davenport response to Soren Hanson about eugenics. *American Philosophical Society*, <http://www.EugenicsArchive.org/html/eugenics/static/images/443.html>
- Davey, N. (2018). The turning word: relational hermeneutics and aspects of Buddhist thought. In *Relational hermeneutics: Essays in Comparative*

- philosophy*, Fairfield, P., Geniusas, S., eds., pp. 177-192, London: Bloomsbury.
- Dean, G. (2008). Meta-analyses of nearly 300 empirical studies: putting astrology and astrologers to the test. *Astrology and Science*, <http://www.astrology-and-science.com/D-meta2.htm>
- Dean, G., Kelly, J.W. (2003). Is astrology relevant for consciousness and psi? *Journal of Consciousness Studies*, 10(6, 7), pp. 175-198.
- Dean, G., Kelly, J.W. (2017). Explaining levitation by denying gravity. A response to Kenneth McRitchie's article 'Clearing the logjam in astrological research'. *Journal of Consciousness Studies*, 24(7-8), pp. 217-232.
- DeFries, J., Fulker, D. (1985). Multiple regression analysis of twin data, *Behavior Genetics*, 15, pp. 467-473.
- Dehaene, S., Changeux, J.-P. (2011). Experimental and theoretical approaches to conscious processing. *Neuron*, 70, pp. 200-227.
- Dellacherie, C., Meyer, P.-A. 1980. *Probabilités et potentiel. Théorie des martingales*. Hermann, Paris,
- Descartes, R. (1637). *Discours de la méthode pour bien conduire sa raison, & chercher la vérité dans les sciences*. Leyde: Imprimerie de Ian Maire. English translation: Bennett, J. (
- Descartes, R. (1647). *Les méditations métaphysiques touchant la première philosophie, dans les quelles l'existence de Dieu, & la distinction réelle entre l'âme et le corps de l'homme sont démontrées*. Paris: Chez la Veuve Iean Camusat, et Pierre Le Petit.
- Destrée, P., Herrmann, F.-G., eds. (2011). *Plato and the poets*. Leyde: Brill.
- Dewhurst, J. (2016). Computing mechanisms and autopoiesis. In *Computing and philosophy*, Muller, V.C. ed., pp. 17-26, Cham, Switzerland, Springer International Publishing Switzerland.
- Diamond, J. (2005). *Collapse. How societies choose to fail or to succeed*. New York: Viking Penguin.
- Dietrich, E. (1990). Programs in the search for intelligent machines: the mistaken foundations of AI. In *The foundations of artificial intelligence. A source book*; Partridge, D., Wilks, Y., eds., pp. 223-233, Cambridge: Cambridge University Press.
- Dietrich, J. (2019). Liberty, freedom and autonomy in the ancient world: a general introduction and comparison. In *Research on Israel and Aram*, Berlejung, A., and Maeir, A.M. eds., Tübingen: Mohr Siebeck, pp. 3-22.
- Dilthey, W. (1883). *Entleutung in die Geisteswissenschaften*. Leipzig: Verlag von Duncker & Humblot.
- Dilthey, W. (1894). *Ideen über eine beschreibende und zergliedernde Psychologie*. Berlin: Verlag der Königlich Akademie der Wissenschaft zu Berlin.
- Dilthey, W. (1911). Die typen der weltanschauung und ihre ausbildung in den metaphysischen system. In *Weltanschauung*, Frischeisen-Kölher, M. (ed), pp. 2-51, Berlin: Verlag Reichl & Co..
- Diogenes Laertius (around IIIrd century B.C.). *Vitae philosophorum*. III, 20. English translation by Hicks, R.D. Perseus Data:

<http://data.perseus.org/catalog/urn:cts:greekLit:tlg0004.tlg001.perseus-eng1>

- Dodig-Crnkovic, G., Giovagnoli, R. eds. (2012). *Natural computing/unconventional computing and its philosophical significance*. Bath (UK): The Society for the Study of Artificial Intelligence and Simulation Behaviour.
- Doob, J.L. 1953. *Stochastic processes*. New York: John Wiley & Sons,
- Dossier pour la science (2013). *L'hérédité sans gènes. Comment l'environnement rebat les cartes*. Dossier n° 81, Paris : Pour La Science SARL.
- Duchemin, J. (1955). Platon et l'héritage de la poésie. *Revue des Etudes Grecques*, 68 (319-323), pp. 12-37.
- Ducheyne, S. (2005). Bacon's idea and Newton's practice of induction. *Philosophica*, 76, pp. 115–128.
- Dumézil, G. (1968). *Mythe et épopée I, L'idéologie des trois fonctions dans les épopées des peuples Indo-Européens*. Paris : Gallimard.
- Dumézil, G. (1971). *Mythe et épopée II, Types épiques Indo-Européens : un héros, un sorcier, un roi*. Paris : Gallimard.
- Dumézil, G. (1973). *Mythe et épopée III, Histoires romaines*. Paris: Gallimard.
- Durkheim, E. (1895). *Les règles de la méthode sociologique*. Paris: Alcan.
- Durkheim, E. (1897). *Le suicide*. Paris: Alcan.
- Durkheim, E. (1912). *Les formes élémentaires de la vie religieuse: le système totémique en Australie*. Paris : Presses Universitaires de France.
- Ebbinghaus, H. (1885). *Über das Gedächtnis: Untersuchungen zur Experimentellen Psychologie*. Leipzig: Duncker & Humblot.
- Eden, F.M. (1797). *The state of the poor: or an history of the labouring classes in England, from the conquest to the present period*. 3 vol. London: J. Davis.
- Edgeworth, F.Y. (1883). The method of least squares. *Philosophical Magazine*, 5th Series, 16, pp. 360-375.
- Edlund, L., Hongbin, L., Junjian, Y., Junsen, Z. (2007). *Sex ratios and crime: evidence from China's one-child policy*. IZA Discussion paper 3214, Bonn Institute for the Study of Labor.
- Ehrlich, P.R. (1968). *The population bomb*. San Francisco: Sierra Club/New York: Ballantine Books.
- Eig, J. (2014). *The birth of the pill*. New York: W.W. Norton & Company, Inc.
- Ellison, C., Fan, D. (2008). Daily spiritual experiences and psychological well-being among US adults. *Social Indicators Research*, 88 (2), pp. 247-271.
- Ernest, C.H. (1979). Visual imagery ability and the recognition of verbal and non verbal stimuli. *Acta Psychologica*, 43 (4), pp. 253-269.
- Eronen, M.I. (2013). No levels, no problems: downward causation in neuroscience. *Philosophy of Science*, 80 (5), pp. 1042-1052.
- Eronen, M.I., Bringmann, L.F. (2021). The theory crisis in psychology: how to move forward. *Perspectives on Psychological Sciences*, 16 (4), pp. 779-788.

- Estoile, de l', P. (1875-1896). *Mémoires-Journaux de Pierre de l'Etoile. Douze volumes*. Paris : Librairie de Bibliophiles-Lemerre.
- Estoile, de l', P. (1958). *Journal pour le règne de Henri IV (1601-1609)*. Paris: Gallimard.
- Etienne, B. (2006). Islam et liberté: une salutaire complexité. *Actes Sud*, 19 (3), pp. 68-79.
- Euler, L. (1760). Recherches générales sur la mortalité et la multiplication du genre humain. *Bulletin de l'Académie Royale des Sciences et des Belles Lettres de Berlin*, 16, pp. 144-164.
- Evans-Pritchard, E.E. (1937). *Witchcraft, oracles and magic among the Azande*, Oxford: Oxford University Press.
- Eysenck H.J. 1973. *The structure and the measurement of intelligence*. Berlin: Springer-Verlag.
- Eysenck, H.J., Nias, D.K.B. (1982). *Astrology. Science or superstition?* London: Maurice Temple Smith Ltd.
- Fabian, S.B. (2014). *Cecco vs. Dante: correcting the Comedy with applied astrology*. PhD thesis, Columbia University: <https://doi.org/10.7916/D84B2ZFW>
- Faïsse, A. (2008). Epopée biblique entre traduction poétique et commentaire exégétique. *Cahiers d'Etude du religieux*, 4, pp. 1-15.
- Fantoni, C. (2011). Aubigné et frère Ange de Joyeuse: derrière l'homme la rhétorique. *Albineana*, 23, pp. 365-380.
- Fiedler, K. (2017). What constitute strong psychological science? The (neglected) role of diagnosticity and a priori theorizing. *Perspectives on Psychological Science*, 12 (1), pp.46-61.
- Finetti, de, B. (1937). La prévision: ses lois logiques, ses sources subjectives. *Annales de l'Institut Henri Poincaré*, 7 (1), 1-68.
- Finke, J. C. (2003). The Babylonian Texts of Nineveh: Report on the British Museum's 'Ashurbanipal Library Project.' *Archiv Für Orientforschung*, vol. 50, pp. 111-149.
- Fisher, R.A. (1914). Some hopes of a eugenist. *The Eugenic Review*, 5(4), pp. 309-315.
- Fisher R.A. (1918). The Correlation between Relatives on the Supposition of Mendelian Inheritance. *Transactions of the Royal Society of Edinburgh*, 52, pp.: 399-423, Paris: Economica, pp. 303-354.
- Fitzgerald, J.M., Lawrence, R. (1984). Autobiographical memory across the life span. *Journal of Gerontology*, 39, pp. 692-699.
- Flemming, W. (1882). *Zellsubstanz, Kern und Zellteilung*. Leipzig: Verlag von F.C.W. Vogel
- Fognini, M. (2008). Une exploration de l'autre en soi dans le récit mythique de Gilgamesh. *Le Coq-Héron*, 192, pp. 44-56.
- Fouchard, A. (1986). Des « citoyens égaux » en Grèce ancienne. *Dialogues d'Histoire Ancienne*, 12, pp. 147-172.
- Franck, R. (1995). Mosaïques, machines, organismes et sociétés. *Revue Philosophique de Louvain*, 93 (1-2), pp. 67-81.
- Franck, R., ed. (2002). *The explanatory power of models*. Boston/Dordrecht/London: Kluwer Academic Publishers.
- Franck, R. (2003). Causal analysis, systems analysis, and multilevel analysis: philosophy and epistemology. In *Methodology of multilevel analysis*.

- Approaches from different social sciences*, Courgeau, D. ed., pp. 175-198, Dordrecht / Boston / London: Kluwer Academic Publishers:
- Franck, R. (2007). Peut-on accroître le pouvoir des modèles en économie? In *Leçons de philosophie économique*, T. III, Leroux, A., Livet P. eds, pp. 303-384, Paris : Economica.
- Frank, C. (2011). Le fuseau et la quenouille. Personnalités divines et humaines participant à la naissance de l'homme et à sa destinée en Mésopotamie ancienne. *Etudes de Lettres*, 3-4, pp. 37-62.
- Frankfurt, H.G. (1958). Pierce notion of abduction. *The Journal of Philosophy*, 55 (14), pp. 593-597.
- Franz, M.L. (1970). *Interpretation of fairytales*. Zurich: Spring Publications.
- Frégnac, Y., Laurent, G. (2014). Where is the brain in the Human Brain Project? *Nature*, 513, pp. 27-29.
- Freud, S. (1897/1904). *The complete letters of Sigmund Freud to Wilhelm Fliess*, ed. Masson, J.M., 1985, Cambridge, Mass., London: The Belknap Press of Harvard University Press.
- Freud, S. (1895 [1950]). Entwurf einer Psychologie. In *Aus den Anfängen der Psychoanalyse*, Bonaparte, M., Freud, A., Kris, E, Eds., London: Imago Publishing Co., pp. 371-466. (English edition (1954). Project for a scientific psychology. In *The origins of Psycho-analysis*, pp.283-390)
- Frimer-Kensky, T. (1977). The Atrahasis epic and its significance for our understanding of Genesis 1-9. *The Biblical Archaeologist*, 40 (2), pp. 147-155.
- Froggatt, P., Nevin, N.C. (1971). The 'Law of ancestral heredity' and the Mendelian-ancestrian controversy in England 1889-1906. *Journal of Medical Genetics*, 8(1), pp. 1-36.
- Fuller J. L., Thompson W. R. (1960). *Behavior Genetics*. New York: Wiley.
- Galton, D.J., Galton C.J. (1998). Francis Galton: and eugenics today. *Journal of Medical Ethics*, 24, pp. 99-105.
- Galton, F. (1865). Hereditary talent and character. *Macmillan's Magazine*, Vol. 12, pp. 157-166, and pp. 318-327.
- Galton, F. (1869). *Hereditary genius: An inquiry into its laws and consequences*. London: Macmillan. (2nd ed. , 1892).
- Galton, F. (1873). Hereditary improvement. *Frazer's Magazine*, VII(XXXVII), pp. 116-130.
- Galton, F. (1875). Statistics by intercomparison, with remarks on the law of frequency of error. *Philosophical Magazine*, 4th series, 49, pp. 33-46.
- Galton, F. (1879). Psychometric experiments. *Brain*, 2 (2), pp. 149-162.
- Galton, F. (1880). Statistics and mental images. *Mind*, 10, pp. 301-318.
- Galton, F. (1883). *Inquiries into human faculty and its development*. London: Macmillan.
- Galton, F. (1892). Presidential address. *Seventh International Congress of Hygiene and Demography, Division II, Demography, London, August 10-17th, 1891*, London, pp. 7-12.

- Galton, F. (1911). *The eugenic college of Kantsaywhere*. Published in 2011 by London: University College London.
- Gange, F. (2006). *Avant les dieux, la mère universelle*. Monte-Carlo : Alphée
- Gardner-Medwin, A.R. (1969). Modifiable synapses necessary for learning. *Nature*, 223, pp. 916-919.
- Gauquelin, M. (1960). *Les hommes et les astres*. Paris: Denoël.
- Gauquelin, M. (1969). *The scientific basis of astrology. Myth or reality*. New York: Stein & Day Pub.
- Gayon, J. (1992). *Darwin et l'après-Darwin*. Paris: Editions Kimé.
- Gefen, A. (2004). Le récit biographique, à la croisée de l'histoire et de la fiction. In *Histoire et fiction dans les littératures modernes (France, Europe et monde arabe)*, Jacquemond, R. ed., pp. 59-82, Paris : L'Harmattan.
- Gelder, van, T., Port, R. (1996). *Mind as motion: exploration in the dynamics of cognition*. Cambridge, Ma: MIT Press.
- Geller, M.J., ed. (2014). *Melammu. The ancient world in an age of globalisation*. Berlin: Max Planck Institute for the History of Science.
- Gellius, A. (around 150-180). *Noctes Atticae*. Translated in English by Rolfe J.C. 1927. Cambridge: Harvard University Press; London: William Heinemann, Ltd.
<http://data.perseus.org/texts/urn:cts:latinLit:phi1254.phi001>
- Gens, J.-C. (2003). *Heidegger. Les conférences de Cassel (1925) précédées de la correspondance Dilthey-Husserl (1911)*. Paris: Librairie Philosophique J. Vrin.
- George, A., translated by (1999). *The Epic of Gilgamesh*. London: Penguin Press.
- Gertoux, G. (2016). *Absolute chronology of the ancient world from 2840 BCE to 1533 BCE*. Glasstree Academic Publishers.
- Gervais, W.M., Henrich, J. (2010). The Zeus problem: Why representational content biases cannot explain faiths in gods. *Journal of cognition and culture*, 10, pp. 383-389.
- Gervais, W.M., Najle, M.B. (2018). How many atheists are there? *Social Psychology and Personality Science*, 9(1), pp. 3-10.
- Gibson, M. (1993). Nippur, Sacred City of Enlil, supreme god of Sumer and Akkad. *Al-Rafidan*, XIV, pp. 1-18.
- Gilbert, D.T., King, G., Pettigrew, S., Wilson, T.D. (2016). Comments on "Estimating the reproducibility of psychological science". *Science*, 351 (6277), p. 1037 a.-
- Giraudoux, J. (1935). *La guerre de Troie n'aura pas lieu*. Paris, Bernard Grasset.
- Glennan, S. (2002). Rethinking Mechanistic explanation. *Philosophy of Science*, 69, pp. 342-353.
- Glennan, S., Illari, P.M., Eds. (2018). *The Routledge handbook of mechanisms and mechanical philosophy*. London and New York: Routledge.
- Godwin, W. (1793). *An Enquiry concerning political justice and its influence on morals and happiness*. 2 vol. London: Swan Sonnenschein & Co.

- Goldstein, H. (1986). Multilevel mixed linear model analysis using iterative generalised last squares. *Biometrika*, 73, pp. 43-56.
- Good, I.J. (1965). Speculations concerning the first ultraintelligent machine. *Advances in Computers*, 6, pp. 31-88.
- Good, I.J. (1987). Book review of: Birth times: a scientific investigation of the secrets of astrology. *Journal of the American Statistical Association*, 82(398), pp.: 697-698.
- Goodale, M.A., Milner, A.D., Jakobson, L.S., Carey, D.P. (1991). A neurological dissociation between perceiving objects and grasping them. *Nature*, 349, pp. 154-156.
- Gottlieb G. (2001). Genetics and Development. In *International Encyclopedia of the Social and Behavioral Sciences, Genetics, Behavior, and Society*, Smelser N.J., Baltes P.B. eds., New York: Elsevier, 6121-6127.
- Gould, S.J. (1996). *The mismeasure of man*. 2nd Edition. New York: Norton & Company.
- Goyet, F. (2006). *Penser sans concepts: fonction de l'épopée guerrière*. Paris : Champion.
- Graeber, D. (2004). *Fragments of an anarchist anthropology*. Chicago: Prickly Paradigm Press.
- Granet, M. (1934). *La pensée chinoise*. Paris: Albin Michel.
- Granger, G.-G. (1994). *Formes, opérations, objets*. Paris: Vrin.
- Graunt, J. (1662). *Natural and political observations mentioned in a following index, and made upon the bills of mortality*. London. (French translation by Vilquin E., *Observations Naturelles et Politiques répertoriées dans l'index ci-après et faites sur les bulletins de mortalité*. (1977). Paris: Ined.)
- Graves, P.M., ed. (2014). From Sibly to Simmonite: Source texts of the 19th century English astrological revival, 1784-1854. DVD distributed by the AFA: <https://www.astrolearn.com/>
- Greenfield, J.C., Sokoloff, M. (1985). Astrological and related omen texts in Jewish Palestinian Aramaic. *Journal of Near Eastern Studies*, 48(3), pp. 201-214.
- Grenfell, B.P., Hunt, A.S. (1904). *The Oxyrhynchus papyri*. London: Horace Hart.
- Grimal, P. (1959). *Les erreurs de la liberté*. Paris : Les Belles Lettres.
- Grondin, J. (2003). *Le tournant herméneutique de la phénoménologie*. Paris: Presses Universitaires de France.
- Guardia de, J. (2004). La comédie est-elle possible ? Etude générique. *L'Annuaire Théâtral*, 36, pp. 117-140.
- Guenzi, C. (2013). Faculté de prévoir. L'astrologie dans les universités indiennes. *Extrême-Orient Extrême-Occident*, 35, pp. 141-170.
- Guilmoto, C.Z. (2012). Skewed sex ratios at birth and future marriage squeeze in China and India, 2005-2100. *Demography*, 49(1), pp. 77-100.
- Guinan, A.K. (2014). Laws and Omens: Obverse and Inverse. In *Divination in the ancient Near East*, Finke, J.C. ed., Winona Lake, Indiana: Eisenbrauns, pp. 105-120.

- Guthrie, S.E. (1995). *Faces in the clouds: a new theory of religion*. New York: Oxford University Press.
- Hacking, I. (1975). *The emergence of probability*. Cambridge: Cambridge University Press.
- Halbwachs, M. (1950). *La mémoire collective*. Paris: Albin Michel.
- Hallwell, S. (1998). *Aristotle's Poetics*. New York: Bloomsbury.
- Hamilton, H.H. (1922). *Eugenical sterilization in the United States*. Chicago: Psychopathic Laboratory of the Municipal Court.
- Hamilton, W.D. (1964). The genetical evolution of social behaviour. *Journal of Theoretical Biology*, 7, pp. 1-16.
- Hannon, M. (2021). Recent work in the epistemology of understanding. *American Philosophical Quarterly*, forthcoming: <https://philarchive.org/rec/HANRWI-2>
- Hawking, S. (2014). BBC interview from: <https://phys.org/news/2014-12-hawking-ai-human.html>
- Heath, T. (1913). *Aristarchus of Samos. The ancient Copernicus*. Oxford: Clarendon Press.
- Hebb, D.O. (1949). *The organization of behavior*. New York: Wiley.
- Heidegger, M. (1952). *Was Heisst Denken?* Gesamtausgabe. Band 8. Frankfurt Am Main: Vittorio Klostermann.
- Heinich, N. (2010). Pour en finir avec l'« illusion biographique ». *L'Homme*, 195-196, pp. 421-430.
- Hemonnot-Girard, A.-L., Haim, L.B., Escartin, C., Hirbec, H. (2021). De nouvelles techniques pour dévoiler le rôle des cellules gliales du cerveau. *Médecine/Sciences*, 37 (1), pp. 59-67.
- Hempel, C.G. (1942). The function of general laws in history. *Journal of Philosophy*, 39 (2), pp. 35-48.
- Hempel, C.G. (1962). Explanation in science and history. In *Frontiers of science and philosophy*, Colodny, ed., pp. 9-19. Pittsburg: The University of Pittsburg Press.
- Hempel, C.G. (1965). *Aspects of scientific explanation and other essays in the philosophy of science*. New York: The Free Press.
- Hempel, C.G., Oppenheim, P. (1948). Studies in the logic of explanation. *Philosophy of Science*, 15 (2), pp. 135-175.
- Henry, L. 1959. D'un problème fondamental d'analyse démographique, *Population*, 13 (1), pp. 9-32.
- Henry, L. (1966). Analyse et mesure des phénomènes démographiques par cohortes. *Population*, 21 (3), pp. 465-482.
- Henry, L. 1972. *Démographie : analyse et modèles*. Larousse, Paris, 342 p.
- Herodotus, (around 430-424 BCE). *Ιστορίαι*. English translation: G.C. Macaulay, London, New York, Macmillan, 1890.
- Herrington, G. (2021). Update to limits to growth. Comparing World3 model with empirical data. *Journal of Industrial Ecology*, 25 (4), pp. 614-626.
- Herrnstein, R. J., Murray, C. (1994). *The Bell Curve*, London: The Free Press.
- Hewitt J. 1998. Obituary: David William Fulker (1937-1998), executive editor of Behaviour Genetics, *Twin Research*, 1, 165-166.

- Hickok, G. (2009). Eight problems for the mirror neuron theory of action. Understanding in monkeys and humans. *Journal of Cognitive Neuroscience*, 21 (7), pp. 1229-1243.
- Hill W.G. (2010). Understanding and Using Quantitative Genetics. *Philosophical Transactions of the Royal Society B* 365, pp.:73-85.
- Hilprecht, H. (1906). *Mathematical Methodological and Chronological Tablets from the Temple Library of Nippur*, Philadelphia: University of Pennsylvania.
- Hirsch J. (1981). To “unfrock the charlatans”, *SAGE Race Relations Abstracts*, 6, 1-65. (Traduction française (1987). *Défroquer les charlatans*. Paris: Science Libre)
- Hirst, W., Manier, D. (2008). Towards a psychology of collective memory. *Memory*, 16, pp. 183-200.
- Hirst, W., Yamashiro, J.K., Coman, A. (2018). Collective memory from a psychological perspective. *Trends in Cognitive Sciences*, 22 (5), pp. 438-451.
- Hoffmann, M. (1999). Problems with Pierce concept of abduction. *Foundations of Science*, 4, pp. 271-305.
- Homer (around 8th Century B.C.). *Iliad*. English translation by A.T. Murray, 1919, Cambridge: Harvard University Press.
- Homer (around 8th century B.C.). *Odyssey*. English translation by A. Mandelbaum 1990, Oakland, CA: University of California Press.
- Hooker, C. (2013). On the import of constraints in complex dynamical systems. *Foundations of Science*, 18, pp. 757-780.
- Hugo, V. (1828). *Cromwell*. Paris: Ambroise Dupont et C^{ie}.
- Hume, D. (1748). *Philosophical essays concerning human understanding*. London: A; Millar.
- Hung, K., Fithian, W. (2020). Statistical methods for replicability assessment. *Annals of Applied Statistics*, 14 (3), pp. 1063-1087.
- Hunger, H. (2009). The relation of Babylonian astronomy to its culture and society. In *The Role of Astronomy in Society and Culture*, Valls Gabaud D., Boxenbergh A. (eds.), Proceedings IAU Symposium, No. 260, 2009, pp. 62-73.
- Huygens, C. (1657). *De ratiociniis in ludo aleae*. Leyde: Elsevier.
- Ideker, T., Galitski, T, Hood, L. (2001). A new approach to decoding life: System Biology. *Annual Review of Genomic and Human Genetics*, 2, pp.343-372.
- Illari, M.K, Williamson, J. (2012). What is a mechanism? Thinking about mechanisms across the sciences. *Journal for Philosophy of Science*, 2 (1), pp. 119-135.
- Jackson, H. (1884). Evolution and dissolution of the nervous system, Croonian Lectures delivered at the Royal College of Physicians, *The Lancet*, 123 (3161), pp. 555-557, 123 (3163), pp.649-652, 123 (3165), pp.739-743.
- Jacquard, A. (1983). Heritability: One Word, Three Concepts. *Biometrics*, 39, pp.:465-477.
- James, W. (1902). *The varieties of religious experiences. A study of human nature*. New York: Longmans, Green, and Co.

- Jeffress, L. ed. (1951). *Cerebral mechanisms in behavior: the Hixon Symposium*. New York: Wiley; London: Chapman & Hall.
- Jensen, A. (1969). How much can we boost IQ and scholastic achievement? *Harvard Educational Review*, 39, 1-123.
- Jewitt J. 1998. Obituary: David William Fulker (1937-1998), executive editor of Behaviour Genetics, *Twin Research*, 1, 165-166.
- Jinks, J. L. and Fulker D. W. (1970). Comparison of the Biometrical Genetical, MAVA, and Classical Approaches to the Analysis of Human Behaviour. *Psychological Bulletin* 73 (5): pp. 311-349.
- Judd, C.M., Gawronski, B. (2011). Editorial comment. *Journal of Personality and Social Psychology*, 100, p. 406.
- Kahn, C.H. (2015). The pseudo-platonic seventh letter. *Notre Dame Philosophical Reviews*. <https://ndpr.nd.edu/news/the-pseudo-platonic-seventh-letter/>
- Kapitan, T. (1990). In what way is abductive inference creative? *Transactions of the Charles S. Peirce Society*, 26 (4), pp. 499-512.
- Kapitan, T. (1992). Pierce and the autonomy of abductive reasoning. *Erkenntnis*, 37 (1), pp. 1-26.
- Kaplan, D.M. (2015). Moving parts: the natural alliance between dynamical and mechanistic modelling approaches. *Biology and Philosophy*, 36, pp. 757-786.
- Kaplan, D.M. (2018). Mechanisms and dynamical systems. In *The Routledge handbook of mechanisms and mechanical philosophy*, Glennan, S., Illari, P., eds., pp. 267-280, London and New York: Routledge.
- Kaplan, D.M., Bechtel, W. (2011). Dynamical models: an alternative or complement to mechanistic explanation? *Topics in Cognitive Science*, 3 (2), pp. 438-444.
- Kaplan, D.M., Craver, C.F. (2011). The explanatory force of dynamical and mathematical models in neuroscience: a mechanistic perspective. *Philosophy of science*, 78, pp. 601-627.
- Kauffman S.A. (1969). Metabolic stability and epigenesis in randomly constructed genetic nets. *Journal of Theoretical Biology*, 22, 437-467.
- Kellenberger, E. (2004). The evolution of molecular biology: biology's various affairs with holism and reductionism, and their contribution to understanding life at the molecular level. *EMBO Reports*, 5, 547-549.
- Keogh, R., Pearson, J. (2017). The blind mind: no sensory visual imagery in aphantasia. *Cortex*, 105, pp. 1-8.
- King James I, (1616). *The True Law of Free Monarchies or The Reciprocal and Mutual Duty Betwixt a Free King and His Natural Subjects*, Edited by Daniel Fischlin and Mark Fortier.
- Kitcher, P. (1996). *The lives to come. The genetic revolution and human possibilities*. New York: Simon & Schuster.
- Klein, S.B. (2014). What can recent replication failures tell us about the theoretical commitments of psychology? *Theory & Psychology*, 24 (3), pp. 326-338.
- Kohler H.P., Rodgers J.-L., Christensen K. (1999). Is fertility behaviour in our genes? Findings from a Danish twin Study, *Population and Development Review*, 25, 253-288.
- Kosslyn, S.M. (1980). *Image and mind*. Cambridge, Massachusetts, and London, England: Harvard University Press.
- Kosslyn, S.M., Alper, S.N. (1977). On the pictorial properties of visual images: effects of image size on memory for words. *Canadian Journal of Psychology*, 31 (1), pp. 32-40.

- Kosslyn, S.M., Ball, T.M., Reiser, B.J. (1978). Visual image preserve metric spatial information: evidence from studies of image scanning. *Journal of Experimental Psychology: Human Perception and Performance*, 4 (1), pp. 47-60.
- Kropotkin, P. (1910). Anarchism. In *Encyclopaedia Britannica*, 11th edition, vol. 1, pp. 914-919, Cambridge: University Press.
- Kupiec, J.-J., Sonigo, P. (2000). *Ni Dieu ni gène*. Paris: Editions du Seuil.
- LaBouff, J., Rowatt, W.C., Johnson, M.C., Finkle, C. (2012). Differences in attitudes toward outgroups in religious and nonreligious contexts in a multinational sample: a situational context priming study. *International Journal for the Psychology of Religion*, 22 (1), pp. 1-9.
- Lacore, M. (1999). Traces homériques et hésiodiques du mythe d'Œdipe. *Kentron*, 15 (2), pp. 7-26.
- Landry, A. (1934). *La révolution démographique. Études et essais sur les problèmes de la population*. Paris : Sirey.
- Landry, A. (1945). *Traité de démographie*. Paris, Payot.
- Lanoue, G. (2016). Le rêve de Gilgamesh. Les signes du droit de cuissage et de la succession. *Anthropos*, 111 (2), pp. 553-573.
- Laplace, P.S. (1774). Mémoire sur la probabilité des causes par les événements. *Mémoires de l'Académie Royale des Sciences de Paris*, Tome VI, pp. 621-656.
- Laplace, P.S. (1783). Sur les naissances, les mariages et les morts à Paris, depuis 1771 jusqu'à 1784, et dans toute l'étendue de la France, pendant les années 1781 et 1782. *Mémoires de l'Académie Royale des sciences de Paris*, 1786, pp. 693-702.
- Larson, E. (2021). *The myth of artificial intelligence: why computers can't think the way we do*. Cambridge, Massachussets, London: The Belknap Press of Harvard University Press.
- Lavoie, Y., Mayer, F.M. 1984. L'analyse différentielle : outil essentiel à la dynamique bio-culturelle. *Revue Informatique et Statistique dans les Sciences Humaines*, 20 (1-4), pp. 135-147.
- Ledger, R. (1989). *Re-counting Plato: A computer analysis of Plato's style*. Oxford: Oxford University Press.
- Lee, C.-S. (2014). The meaning of romance: rethinking early modern fiction. *Modern Philology*, 112 (2), pp. 287-311.
- Lemaître, N. (2006). Les Livres de Raison en France (fin XIII^e-XIX^e siècles). *Testo e Senso*, 7, 18 p.
- Leridon, H. (2015). The development of fertility theories: a multidisciplinary endeavour. *Population, English Edition*, 70 (2), pp. 309-348.
- Leroy-Beaulieu, P. (1868). *De l'état moral et intellectuel des populations ouvrières et de son influence sur le taux des salaires*. Paris : Librairie Guillaumin et C^{ie}, Editeurs.
- Lesky, A. (1961). *Göttliche und mensliche motivation im homerischen epos*. Heidelberg: Akad.
- Lévêque, P., Vidal-Naquet, P. (1973). *Clisthène l'Athénien*. Paris : Les Belles Lettres.
- Lévy-Bruhl, L. (1931). *Le surnaturel et la nature dans la société primitive*. Paris : Alcan.
- Lévi-Strauss, C. (1958). *Anthropologie structurale*. Paris : Plon.
- Lévi-Strauss, C. (1985). *La potière jalouse*. Paris : Plon.
- Lexis, W. (1879). Über die Theorie der Stabilität statistischer Reihen. *Jahrbücher für Nationalökonomie und Statistik*, 32, pp. 60-98.
- Lindley, C. (2012). Neurobiological computation and synthetic intelligence. In *Natural computing/unconventional computing and its philosophical significance*, Dodig-Crnkovic,

- G., Giovagnoli, R., eds., pp. 21-26, Bath (UK) The Society for the Study of Artificial Intelligence and Simulation Behaviour.
- Linton, M. (1986). Ways of searching and the contents of memory. In *Autobiographical memory*, Rubin, D.C. ed., Cambridge: Cambridge University Press, pp. 50-67.
- Lisdam, du, H. (1619). *Les saintes inconstances de Léopold et de Lindarche*. Paris : Henri Legras.
- Lisdorf, A. (2007). *The dissemination of divination in roman republican times-A cognitive approach*. PhD., University of Copenhagen, DOI: [10.13140/RG.2.1.4724.3368](https://doi.org/10.13140/RG.2.1.4724.3368)
- Loriaux, M. (1994). Des causes aux systèmes. In: *Faut-il chercher aux causes une raison? L'explication causale dans les sciences humaines*, Franck, R. ed., pp. 41-86, Paris-Lyon: Librairie Philosophique Vrin.
- Lotka, A.J. (1939). *Théorie analytique des associations biologiques*. Vol.2. Paris: Herman & C^{ie}, Editeurs.
- Ludden, D.C. (2019). *A History of Modern Psychology*. Newbury Park, Sage Publishing.
- Luhmann, N. (1986). The autopoiesis of social systems. In *Sociocybernetic paradoxes*, Geyer, F., van der Zouwen, J., eds., pp. 174-192, London: Sage Publications.,
- Lush, J.L. (1936). Genetic Aspects of the Danish System of Progeny-testing Swine. *Agricultural Research Bulletin*, 204, pp.:108-195.
- Lush, J.L. (1949). Heritability of Quantitative Characters in Farm Animals. *Hereditas*, 35, pp.:356-375.
- Lutz, A., Lachaux, J.-P., Martinerie, J., Varela, F.J. (2002). Guiding the study of brain dynamics by using first-person data: synchrony patterns correlate with ongoing conscious states during a simple visual task. *Proceedings of the National Academy of Sciences USA*, 99, pp: 1586-1591.
- Machamer, P., Darden, L., Craver, C. (2000). Thinking about mechanisms. *Philosophy of Science*, 67, pp. 1-25.
- Madani, A.H. (2011). Freedom and its concepts in Islam. In *2nd International Conference on Humanities, Historical and Social Sciences*, vol. 17, Singapore: LACSIT Press, pp. 116-120.
- Madison, G.B. (1986). *The logic of liberty*. Westport, Connecticut: Greenwood Press.
- Makdisi, G. (1986). The diary in Islamic historiography. *History and Theory*, 25 (2), pp.173-185.
- Makel, M.C., Plucker, J.A., Hegarty, B. (2012). Replications in psychology research: how often do they occur? *Perspectives on Psychological Science*, 7 (-), pp. 537-542.
- Mallarmé, S. (2019). *Correspondance 1854-1898. Vol. 1*. Paris: Gallimard.
- Malthus, T. (1798). *An essay on the principle of population as it affects the future improvement of society, with remarks on the speculations of Mr. Godwin, M. Condorcet and other writers*. London: Johnson.
- Malthus, T. (1803). *An essay on the principle of population, or, a view of its past and present effects on human happiness, with an inquiry into our prospects respecting its future removal on mitigation of the evils which it occasions*. London: Johnson.
- Manolio T.A. (2013). Bringing genome-wide association finding into clinical use. *Nature Reviews | Genetics*, 14, pp. 549-558.
- Mansfield, D.F., Wildberger, N.J. (2017). Plimpton 322 is Babylonian exact sexagesimal trigonometry. *Historia Mathematica*, 44, pp. 395-419.
- Manson, M. (2004). Platon et les contes de nourrices. In *Les métamorphoses du conte*, Perrot, J. ed., pp. 27-40, Bruxelles : Peter Lang.

- Maraun, M.D., Gabriel, S., Martin, J. (2011). The mythologization of regression towards the mean. *Theory & Psychology*, 21(6), pp. 762-768.
- Markram, H. (2009). *A brain in a supercomputer*. TED Global 2009:
https://www.ted.com/talks/henry_markram_a_brain_in_a_supercomputer
- Markram, H., Meier, K., Lippert, T., Grillner, S., Frackowiak, R., Dehaene, S., Knoll, A., Sompolinsky, H., Verstreken, K., DeFelipe, J., Grant, S., Changeux, J.-P., Saria, A. (2011). Introducing the Human Brain Project. *Procedia Computing Science*, 7, pp. 39-42.
- Marks, D.F. (1973). Visual imagery differences in the recall of pictures. *British Journal of Psychology*, 64, pp. 17-24.
- Marr, D. (1970). A theory for cerebral neocortex. *Proceedings of the Royal Society*, B 176, pp. 161-234.
- Martin, L.H., Wiebe, D. (2012). Religious studies as a scientific discipline: the persistence of a delusion. *Téma*, XX (1), pp. 9-18.
- Marx, K. (1867). *Das Kapital. Kritik der politischen Ökonomie*. Hamburg, Verlag von Otto Meissner. (English translation, (1890). *Capital. A critical analysis of capitalist production*. Engels, F. (ed.), London: Swan Sonnenschein, Lowrey, Co.)
- Masani, P. (1990). *Norbert Wiener 1894-1964*. Basel: Birkhäuser Verlag.
- Maturana, H.R., Varela, F.J. (1973). *Autopoiesis and cognition. The realization of the living*. Boston Studies in the Philosophy of sciences, vol. 42. Dordrecht: D. Reidel.
- Maturana, H.R., Varela, F.J. (1987). *The tree of knowledge. The biological roots of human understanding*. Boston & London: Shambhala.
- Mayo, J., White, O., Eysenck, H.J. (1977). An empirical study of the relation between astrological factors and personality. *Journal of Social Psychology*, 105, pp. 229-236.
- Mazzucco, S., Keilman, N. (eds.) (2020). *Developments in demographic forecasting*. Cham, Switzerland: Springer Nature.
- McCulloch, W.S., Pitts, W.H. (1943). A logical calculus of the ideas immanent in nervous activity. *Bulletin of Mathematical Biophysics*, 5, pp. 115-133.
- McCulloch, W.S. (1951). Why the mind is in the head? In *Cerebral Mechanisms in Behavior*, Jeffress, L.A., ed., pp. 42-57, The Hixon Symposium, New York: John Wiley Publ.
- McGrew, J.H. (1990). A scientific inquiry into the validity of astrology. *Journal of Scientific Explanation*, 4(1), pp. 73-83.
- McKelvie, S.J. (1995). The VVIQ as a psychometric test of individual differences in visual imagery vividness: a critical quantitative review and plea for direction. *Journal of Mental Imagery*, 19, pp. 1-106.
- McRitchie, K. (2014). Cognitive bias in the McGrew and McFall experiment: Review of “a scientific enquiry into the validity of astrology. *ISAR International Astrologer*, 41(3), pp. 31-37.
- McRitchie, K. (2016). Clearing the logjam in astrological research. Commentary article on Geoffrey Dean and Ivan Kelly’s article ‘Is astrology relevant to consciousness and psi?’. *Journal of Consciousness Studies*, 23(9-10), p. 153-179.

- Meadows, D.H., Meadows, D.L., Randers, J., Behrens, W.W. (1972). *The limits to growth. A report for the Club of Rome's projection the predicament of mankind*. New York: Universe Books.
- Meadows, D.H., Meadows, D.L., Randers, J. (1992). *Beyond the limits: confronting global collapse, envisioning a sustainable future*. White River Junction, VT: Chelsea Green Publishing Co.
- Meadows, D.H., Meadows, D.L., Randers, J. (2004). *The limits to growth. The 30-year update*. White River Junction, VT: Chelsea Green Publishing Co.
- Mendel, J.G. (1865). Versuche über pflanzenhybriden. *Verhandlungen des Naturforschenden Vereines, Brünn*, 3, pp. 3-47.
- Merleau-Ponty, M. (1943). *La structure du comportement*. Paris: Gallimard.
- Merleau-Ponty, M. (1964). *L'œil et l'esprit*. Paris: Gallimard.
- Messerli, F.H. (2012). Chocolate, consumption, Cognitive function, and Nobel laureates. *The New England Journal of Medicine*, 367 (16), pp. 1562-1564.
- Mesure, S. (1990). *Dilthey et la fondation des sciences historiques*. Paris: Presses Universitaires de France.
- Meyer, R. (2020). The non-mechanistic option: defending dynamical explanations. *The British Journal for the Philosophy of Science*, 71 (3), pp. 959-985.
- Mikeš, V. (2016). *Le paradoxe stoïcien: liberté de l'action déterminée*. Paris: Librairie Philosophique Vrin.
- Mill, J.S. (1843). *A system of logic, ratiocinate and inductive, being a connected view of the principles of evidence, and the methods of scientific investigation, vol. I*, London: John W. Parker.
- Millet, B. (2006). Novel et Romance. Histoire d'un chassé-croisé générique. *Cercles*, 16 (2), pp. 85-96.
- Mingers, J. (2002). Can social systems be autopoietic? *The Sociological Review*, 50 (2), pp. 278-299.
- Mingers, J. (2004). Can social systems be autopoietic? Bhaskar's and Giddens' social theories. *Journal for the Theory of social behavior*, 34 (4), pp. 403-427.
- Minsky, M., Papert, S. (1969). *Perceptrons: An introduction to computational geometry*. Cambridge, M.A.: MIT Press.
- Moheau, M. (1778, 1994). *Recherches et considérations sur la population de la France*. Classiques de l'Economie et de la Population. Paris : Ined.
- Molet, L. (1979). *La conception malgache du monde surnaturel et de l'homme en Imerina*. 2 Tomes. Paris : L'Harmattan.
- Momennejad, I., Duker, A., Coman, A. (2019). Bridge ties bind collective memories. *Nature Communications*, 1578, pp. 1-8.
- Momigliano, A. (1971). *The development of Greek biography*. Cambridge, Mass.: Harvard University Press.
- Montesquieu (1748). *De l'esprit des lois*. Genève : Chez Barrillot & Fils. English translation by Nugent T. (1750).
- Mordenti, R. (2004). Les livres de famille en Italie. *Annales HSS*, 4, pp. 785-804.

- Moreno, A., Mossio, M. (2015). *Biological autonomy. A philosophical and theoretical enquiry*. Dordrecht Heidelberg New York London: Springer.
- Morin-Chaussé, A. (2014). Public (mis)understanding of news about behavioural genetics research: a survey experiment. *Bioscience*, 64 (12), pp.1170-1177.
- Munnich, A. (2008). Note de lecture. In *Test génétiques. Questions scientifiques, médicales et sociétales*, Amelsen, J.-C., Cambien, F., Dervaux, B., Douay, S., Gaudillière, J.-P., Julian-Regnier, C., Rabeharisoa, V., Roussey, M., Sobol, H., Verstuyft, C. eds., Paris ; INSERM, pp. xxi-xxxii.
- Munoz M., Pong-Wong R., Canela-Xandri O., Rawlik K., Haley C., Tenesa A. (2016). Evaluating the contribution of genetics and familial shared environment to common disease using the UK Biobank. *Nature Genetics* [10.1038/ng.3618](https://doi.org/10.1038/ng.3618).
- Murdock, G.P., White, D.R. (1969). Standard Cross-Cultural Sample. *Ethnology*, 9, pp.329–369.
- Murray, C.J.L., Rosenfeld, L.C., Lim, S.S., Andrews, K.G., Foreman, K.J., Haring, D., Fullman, N., Naghavi, M., Lozano, F., Lopez, A.D. (2012). Global malaria mortality between 1980 and 2010: a systematic analysis. *Lancet*, 379, pp. 413-431.
- Muthukrishna, M., Henrich, J. (2019). A problem in theory. *Nature Human Behaviour*, 3, pp. 221-229.
- Naccache, L. (2006). *Le nouvel inconscient. Freud, le Christophe Colomb des neurosciences*. Paris : Odile Jacob.
- Naddaff, R.A. (2003). *Exiling the poets. The production of censorship in Plato's Republic*. Chicago: Chicago Press.
- Nairne, J.S. (2010). Adaptive memory: evolutionary constraints on remembering. In *The psychology of learning and motivation: advances in research and theory*, Ross, B.H. ed., pp. 1-32, Amsterdam: Elsevier Academic Press.
- Nairne, J.S., Pandeirada, J.N.S. (2016). Adaptive memory: the evolutionary significance of survival processing. *Perspective on Psychological Science*, 11 (4), pp. 496-511
- Nanninga, R. (1996/97). The Astrotest. A though match for astrologers. *Correlation*, 15(2), pp. 14-20.
- Näreaho, L. (2008). The cognitive science of religion: philosophical observations. *Religious Studies*, 44, pp. 83-98.
- Naselaris, T., Olman, C.A., Stansbury, D.E., Ugurbil, K., Gallant, J.L. (2015). A voxel-wise encoding model for early visual areas decodes mental images of remembered scenes. *NeuroImage*, 105, pp. 215-228.
- Neugebauer, O. (1945). The history of ancient astronomy: problems and methods. *Journal of Near-Eastern Studies*, 4, p. 1-38.
- Neugebauer, O., Hoesen, van, H.B. (1959). *Greek horoscopes*. Philadelphia: The American Philosophical Society.
- Neumann, von, J. ((1958). *The Computer and the brain*. New Haven and London: Yale University Press.
- Newsholme, A., Stevenson, T.H.C. (1906). The decline of human fertility in the United Kingdom and other countries as shown by corrected birth-rates. *Journal of the Royal Statistical Society*, 69(1), pp. 34-87.
- Newton, I. (1687). *Philosophiae Naturalis Principia Mathematica*. London: Jussu Societatis Regiae ac Typis Josephi Streater.
- Nietzsche, F. (1882). *Die fröliche Wissenschaft*. Chemnitz: Verlag von Ernst Schmeitzmer. English translation by Dr Oscar Levy.

- Noble D. (2008). Genes and causation, *Philosophical Transactions: Physical and Engineering Sciences*, 336, 3001-3015.
- Norenzayan, A., Sharif, A.F., Gervais, W.M., Willard, A.K., McNamara, R.A., Slingerland, E., Henrich, J. (2016). *Behavioral and Brain Sciences*, 39, doi: 10.1017/S0140525X14001356.
- Nowak, M.A., Tarnita, C.E., Wilson, E.O. (2010). The evolution of eusociality. *Nature*, 466 (26), pp. 1057-1062.
- O'Neill, E. (1931). *Mourning Becomes Electra: A Trilogy*. New York: Liveright.
- Oddo, N. (2002). L'invention du roman français au XVII^e siècle: littérature religieuse et matière romanesque. *XVII^e siècle*, 54 (245), pp. 221-234.
- Oddo, N. (2008). Le duc Henri de Joyeuse devenu 'frère Ange': une héroïsation entre histoire et fiction. *Seizième Siècle*, 4, pp. 237-253.
- Open Science Collaboration (2015). Estimating the reproducibility of psychological research. *Science*, 349 (6251), p. 943, aac4716-1-7.
- Oppenheim, L. (1974). A Babylonian diviner's manual. *Journal of Near Eastern Studies*, 33, pp. 197-220.
- Osborn, F. (1938). The application of measures of quality, in *Congrès International de la Population, Paris, 1937, Vol. IV, Problèmes qualitatifs de la population*. Paris: Hermann et Cie.
- Osborn, F. (1968). *The future of human heredity: An introduction to eugenics in modern society*. New York: Waybright and Talley.
- Ossendrijver, M. (2016). Ancient Babylonian astronomers calculated Jupiter's position's from the area under a time velocity graph. *Science*, 251 (6272), pp. 482-484.
- Paivio, A. (1971). *Imagery and verbal processes: a dual coding approach*. New York: Oxford.
- Paolo, di, E.A. (2005). Autopoiesis, adaptivity, teleology, agency. *Phenomenological and Cognitive Sciences*, 4 (4), pp. 429-452.
- Paquette, J.-M. (1971). Epopée et roman: Continuité ou discontinuité. *Le Roman Médiéval*, 4 (1), pp. 6-38.
- Partridge, D., Wilks, Y. (1990). *The foundations of artificial intelligence. A source book*. Cambridge : Cambridge University Press.
- Pascal, B. (1654a). *Traité du triangle arithmétique, avec quelques autres traités sur le même sujet.* : Guillaume Desprez, Paris.
- Pascal, B. (1654b). *Celeberrimæ mathesos academiae Pariensi*. Paris : Académie Parisienne.
- Pearson, K. (1924). *The life, letters and labours of Francis Galton, vol. 2, Researches of middle life*. London: Cambridge University Press.
- Pearson, K. (1930). *The life, letters and labours of Francis Galton, vol. 3. Correlation, personal identification and eugenics*. London: Cambridge University Press.
- Pearson, J., Kosslyn, S.M. (2015). The heterogeneity of mental representation: ending of the imagery debate. *PNAS*, 113 (33), pp. 10049-10092.
- Pedersøn, O. (1985). *Archives and Libraries in the city of Assur. A Survey of the material from the German Excavations*. Part I, Uppsala: Acta Universitatis Upsaliensis.
- Peirce, B.A. (2012). *Genetics. A conceptual approach*. New York: W.H. Freeman and Company.
- Peirce, C.S. (1931-1958). *Collected Papers of Charles Sanders Pierce*, Hartshome, C., Weiss, P., Burks, A., eds. 8 Volumes; Cambridge: Harvard University Press.

- Peoples, H.C., Duda, P., Marlowe, F.W. (2016). Hunter-gatherers and the origin of religion. *Human Nature*, 27 (3), pp. 261-282.
- Perrin, C. (2013). Une guerre à couteaux tirés. Heidegger et le rationalisme. *Les Etudes Philosophiques*, 106, pp. 397-422.
- Peters, G.-J.Y., Crutzen, R. (2021). Knowing how effective an intervention, treatment, or manipulation is and increasing replication rates: accuracy in parameters estimation as a partial solution to the replication crisis. *Psychology & Health*, 36(1), pp. 59-77.
- Peters, G.-J.Y., Gruijters, S.L.K. (2017). *Why most experiments in psychology failed: sample sizes for randomization to generate equivalent groups as a partial solution to the replication crisis*. Doctoral Dissertation, Maastricht University.
- Pew Forum on Religion & Public life (2009). *Many Americans mix multiple faiths*. Washington: PewResearchCenter.
- Phillips, I. (2014). Lack of imagination: individual differences in mental imagery and the significance of consciousness. In *New Waves in Philosophy of Mind*, Sprevak et al. eds., pp. 278-300, Basingstoke: Palgrave Macmillan.
- Piaget, J. (1945). *La formation du symbole chez l'enfant*. Neuchâtel – Paris: Delachaux & Niestlé S.A.
- Piaget, J., Inhelder, B. (1968). *Mémoire et intelligence*. Paris: Presses Universitaires de France.
- Pincus, G.G. (1955). Some effects of progesterone and related compounds upon reproduction and early developments in mammals, in *Proceedings of the 5th International Conference on Planned Parenthood, I.P.F.F., Tokyo*, London: I.P.F.F., pp. 175-184.
- Pingree, D.E. ed. (1978). *The Yavanajātaka of Sphujidhava*. Cambridge: Harvard University Press.
- Pingree, D.E. ed. (1981). *Jyotihsāstra: astral and mathematical literature*. Wiesbaden:
- Plato (Around 360 B.C.). *Phaedrus*. The Internet Classic Archive: translated by Jowett, B. Website: <http://classics.mit.edu/Plato/phaedrus.html>.
- Plato (Around 360 B.C.). *Republic*. The Internet Classic Archive: translated by Jowett, B. Website: <http://classics.mit.edu/Plato/republic.html>.
- Plato (Around 360 B.C.). *Theaetetus*. The Internet Classic Archive: translated by Jowett, B. Website: <http://classics.mit.edu/Plato/theatu.html>.
- Plato (Around 354 B.C.). *The seventh letter*. The Internet Classic Archive: translated by Harward J. Website: http://classics.mit.edu/Plato/seventh_letter.html
- Plomin R. (2001). Behavioral genetics: psychosocial perspectives. In *International encyclopedia of the social and behavioral sciences*, Smelser, N.J. and Baltes P.B. eds., New York: Elsevier Sciences, pp. 1100-1105.
- Plutarch (around 100-110). *Parallel lives*. Translated by Perrin, B. (1914-1926), *Plutarch's Lives. In eleven Volumes*, London: William Heinemann Ltd, Cambridge: Harvard University Press.
- Podgórski, J.S. (2010). Humberto Maturana's view on the theory of evolution. From autopoiesis to natural drift metaphor. *Ecological Questions*, 13, pp.81-87.
- Poinsot, L., Dupin, C. (1836). Discussion de la « Note sur le calcul des probabilités » de Poisson, *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, 2, 398-399.
- Pollak, M. (1986). La gestion de l'indicible. *Actes de la Recherche en Sciences Sociales*, 62-63, L'illusion biographique, pp. 30-53.
- Pollak, M. (1990). *L'expérience concentrationnaire*. Paris: Editions Métailié.

- Ponsonby, A. (1923). *English diaries. A review of English diaries from the sixteenth to the twentieth century with an introduction in diary writing*. London: Methuen & Co, Ltd.
- Poulain, M., Riandey, B., Firdion, J.-M. (1992). Data from a life history survey and from the Belgian population register. *Population: an English Selection*, 4, pp. 77-96.
- Powell, R., Clarke, S. (2012). Religion as an evolutionary byproduct: a critique of the standard model. *British Journal for the philosophy of science*, 63, pp. 457-486.
- Proudhon, P.-J. (1840). *Qu'est-ce que la propriété ? ou recherche sur le principe du droit et du gouvernement*. Paris : Chez J.-F. Brocard, Editeur.
- Proudhon, P.-J. (1846). *Système des contradictions économiques, ou philosophie de la misère*. Paris : Chez Guillaumin et C^{ie}, Libraires.
- Proudhon, P.-J. (1866). *Théorie de la propriété, suivie du projet d'exposition perpétuelle*. Paris : A. Lacroix, Veboeckoven et C^{ie}, Editeurs.
- Ptolemy, (around 150 A.D.). *Almagest*. Translated by Toomer G.J. (1984). London: Gerald Duckworth & Co. Ltd.
- Ptolemy (around 151 B.C.). *Tetrabiblos*. Translated by Robbins F.E. (1940). Cambridge; Harvard University Press.
- Pylyshyn, Z.W. (1973). What the mind's eye tells the mind's brain: a critique of mental imagery. *Psychological Bulletin*, 80 (1), pp. 1-24.
- Pylyshyn, Z.W. (1981). The imagery debate: analogue media versus tacit knowledge. *Psychological Review*, 88 (1), pp. 16-45.
- Quesnay, F. (1958). *François Quesnay & la physiocratie*. 2 vol. Classiques de l'Economie et de la Population. Paris: Ined.
- Quetelet, A. (1835). *Sur l'homme et le développement de ses facultés, ou Essai de physique sociale*. Tome premier et Tome second. Paris: Bachelier.
- Quetelet, A. (1846). *Lettres à S. A. R. le Duc Régnant de Saxe-Cobourg et Gotha sur la théorie des probabilités, appliquée aux sciences morales et politiques*. Brussels: Hayez.
- Rahimi, A. (2017). *The machine learning has become alchemy*. Test-of-time award speech:
<https://www.youtube.com/watch?v=ORHFOaEzPc>
- Rimbaud, M. (1953). *L'art de la déformation historique dans les commentaires de César*. Paris : Les Belles Lettres.
- Rappaport, R.A. (1999). *Ritual and religion in the making of humanity*. Cambridge: Cambridge University Press.
- Ravenstein, E.G. 1885. The laws of migration. *Journal of the Royal Statistical Society*, 48, pp. 167-235.
- Rawlinson, H.C., assisted by Norris, E., Smith, G and Pinches, T.G. (1861-1884). *The Cuneiform Inscriptions of Western Asia*. 5 vols, London: Trustees of the British Museum.
- Raynal, J. (1759). *Histoire de la ville de Toulouse, avec une notice des hommes illustres, une suite chronique et historique des évêques et archevêques de cette ville et une table générale des Capitouls*. Toulouse: Jean-François Forest.

- Redon R., Ishikawa S., Fitch S., Feuk K.R., Perry G.H., Andrews T.D., Fiegler H., Shapero M.H., Carson A.T., Chen W., Cho E.K., Dallaire S., Freeman J.L., Gonzales J.R., Gratacos M., Huang J., Kalaitzopoulos D., Komura D., MacDonald J.R., Marshall C.R., Mei R., Montgomery L., Nishimura K., Okamura K., Shen F., Somerville M.J., Tchinda J., Valsesia A., Woodwark C., Yang F., Zhang J., Zerjal T., Armengol L., Conrad D.F., Estivill X., Tyler-Smith C., Carter N.P., Aburatani H., Lee C., Jones K.W., Scherer S.W., Hurles M.E. (2006). Global variation in copy number in the human genome. *Nature*, 444, pp 444-454.
- Regenmortel, van, M.V.H. (2004). Reductionism and complexity in molecular biology. *EMBO Reports*, 5, pp. 1016-1020.
- Reiner, E., in collaboration with Pingree, D.E. (1975). *Babylonian planetary omens. I. The Venus Tablet of Ammisaduqa*. Malibu: Udena Publications.
- Ribbe, de, C. (1879). *Le livre de famille*. Tours: Alfred Mame et Fils.
- Ribot, T. (1870). *La psychologie anglaise contemporaine (école expérimentale)*. Paris : Lagrange.
- Richardson, J.T.E. (1978). Mental imagery and memory: coding ability or coding preference? *Mental Imagery*, 2 (1), pp. 101-116.
- Richardson, J.T.E. (1979). Correlations between imagery and memory across stimuli and across subjects. *Bulletin of the Psychometric Society*, 14 (1), pp. 368-370.
- Richardson, J.T.E. (1980). *Mental imagery and human memory*. New York: St. Martin's.
- Rico, C. (2003). Aux sources de l'herméneutique occidentale: les premiers commentaires dans les traditions grecque, juive et chrétienne. *Babel*, 7, pp.7-52.
- Ricœur, P. (1983). *Temps et récit. Tome I*. Paris : Editions du Seuil.
- Ricœur, P. (1984). *Temps et récit. Tome II*. Paris : Editions du Seuil.
- Ricœur, P. (1985a). *Temps et récit. Tome III*. Paris : Editions du Seuil.
- Ricœur, P. (1985b). *De l'interprétation. Essai sur Freud*. Paris : Editions du Seuil.
- Ricœur, P. (1990). *Soi-même comme un autre*. Paris : Editions du Seuil.
- Riley, M. (1957). Theoretical and practical astrology: Ptolemy and his colleagues. *Transactions of the American Philological Association*, 117, pp. 235-256.
- Ritchie, S.J., Wiseman, R., French, C.C. (2012). Failing the future: three unsuccessful attempts to replicate Bem's 'retroactive facilitation of recall' effect. *Plos ONE*, 7 (3), pp. 1-5.
- Robert, L-J-M. (1803). *Nouvel essai sur la mégalanthropogénésie*, 2^{ème} Edition. Paris: Le Normant.
- Roberts, D., Tren, R., Bate, R., Zambone, J. (2010). *The excellent powder. DDT's political and scientific study*. Indianapolis: Dog Ear Publishing.
- Rochberg, F. (1998). *Babylonian horoscopes*. Philadelphia: Philosophical Society.
- Rochberg, F. (2010). "If P, then Q": form and reasoning In *Babylonian divination. In Divination and interpretation of signs in the ancient world*, Shramer, L., Urban, T.G., eds., Ann Arbor: Edwards Brothers, pp.19-28.
- Rochberg-Halton, F. (1984). New evidence for the history of astrology. *Journal of Near Eastern Studies*, 43(2), pp. 115-140.

- Rodgers J.-L., Hughes K., Kohler H.-P., Christensen K., Doughty D., Rowe D., Miller W. (2001). Genetic influence helps explain individual differences in human fertility outcomes: evidence from recent behavioral molecular genetic studies, *Current Directions in Psychological Science*, 10, 184-188.
- Roediger III, H.L., Abel, M. (2015). Collective memory: a new arena of cognitive study. *Trends in Cognitive science*, 19 (7), pp.359-361.
- Roes, F. L., Raymond, M. (2003). Belief in moralizing gods. *Evolution & Human Behavior*, 24, 126-135.
- Romilly de, J. (1989). *La Grèce antique à la découverte de la liberté*. Paris : Editions de Fallois.
- Rooij, van, I., Baggio, G. (2021). Theory before the test. How to build high-verisimilitude explanatory theories in psychological science. *Perspectives on Psychological Science*, 16 (4), pp. 682-697.
- Rosenblatt, F. (1958). The Perceptron: a probabilistic model for information storage and organization in the brain. *Psychological review*, 65 (6), pp. 386-408.
- Rosenblatt, F. (1961). *Principles of Neurodynamics: Perceptrons and the theory of brain mechanisms*. Report n° 1196-G-8, Buffalo: Cornell Aeronautical Laboratory.
- Ross, L.N. (2015). Dynamical models and explanation in neuroscience. *Philosophy of Science*, 82 (1), pp. 32-54.
- Rubin, D.C. (1982). On the retention function for autobiographical memory. *Journal of Verbal Learning and Verbal Behaviour*, 21, pp.21-38.
- Rubin, D.C. ed. (1986). *Autobiographical memory*. Cambridge: Cambridge University Press.
- Rubin, D.C., Baddeley, A. (1989). Telescoping is not time compression: a model for the dating of autobiographical events. *Memory and cognition*, 17 (6), pp. 653-661.
- Rubin, D.C., Wetzler, S.E., Nebes, R.D. (1986). Autobiographical memory across the lifespan. In *Autobiographical memory*, Rubin, D.C. ed., Cambridge: Cambridge University Press, pp. 202-221.
- Sachs, A. (1952). Babylonian horoscopes. *Journal of Cuneiform Studies*, 6, pp. 49-75.
- Saintyves, P. (1907). *Les saints, successeurs des dieux : essais de mythologie chrétienne*, Paris: E. Nourry
- Salmon, G. (2007). Psychologie historique et analyse structurale chez J.-P. Vernant. *Cahiers Philosophiques*, 112 (4), pp. 42-65.
- Sanderson, S.K. (2008). Adaptation, evolution, and religion. *Religion*, 38, pp. 141-156.
- Sanger, M. (1921). Stop perpetuating the unfit by a national policy on limitation of families. *New York American*, Dec. 28, 9. , Margaret Sanger Microfilm c16:167
- Sanger, M. (1925). Editorial. *Birth Control Review*, IX (6), pp. 163-164.
- Sanger, M. (1950). Lasker award address, *Annual meeting of the Planned Parenthood Federation of America*. Margaret Sanger Microfilm S72:0598.

- Sartre, J.-P. (1943). *Les Mouches*. Paris : Editions Gallimard.
- Sartre, J.-P. (1946). *L'existentialisme est un humanisme*. Paris: Nagel. (English translation : (1956). *Existentialism is a humanism*, New York: World Publishing Company.
- Saugstad, P. (2018). *A History of Modern Psychology*. Cambridge. Cambridge University Press.
- Sauvy, A. (1948). Faits et problèmes du jour. *Population*, 3(1), pp. 5-10.
- Sauvy, A. (1952). Trois mondes, une planète. *L'observateur*, 118, p. 14.
- Sauvy, A. (1959). A propos d'un calcul démographique de Proudhon. *Population*, 14 (2), pp. 356-358.
- Say, J.-B. (1803). *Traité d'économie politique, ou simple exposition de la manière dont se forment, se distribuent et se consomment les richesses*. 2 vol., Paris: Deterville.
- Schaeffer, J.M. (1989). *Qu'est-ce qu'un genre littéraire?* Paris: Editions du Seuil.
- Schandeeler, J.-P., Crepel, P. Eds. (2004). *Condorcet. Tableau historique des progrès de l'esprit humain. Projets, esquisse, fragments et notes. (1772-1794)*. Classiques de l'économie et de la population. Paris, Ined.
- Schelling, von, F.W.J. (1914). Briefe über Dogmatismus und Kritizismus. In *Hauptwerke der Philosophie in originalgetreuen Nudruckten*, III, p. 85, Leipzig: Verlag von Felix Reiner.
- Schneider, S.P., Smith, K.B., Hibbing, J.R. (2018). Genetic attribution: sign of intolerance or acceptance. *Journal of Politics*, 80 (3), pp. 1023-1027.
- Schultz, D.P., Schultz, S.E. (2011). *A history of Modern Psychology. Tenth Edition*. Belmont: Wadsworth
- Schuurmans-Steckhoven, J.B. (2013). "As a shepherd divideth his sheep from goats": does the Daily Spiritual Experiences Scale encapsulate separable theistic and civility components? *Social Indicators Research*, 110 (1), pp. 131-146.
- Schuurmans-Steckhoven, J.B. (2019). S – Does religiosity really promote elder well-being? Examining the belief-as-benefit effect among older Japanese. *Archives of Gerontology and Geriatrics*, 81, pp. 129-135.
- Schwarz, W., Reike, D. (2018). Regression away from the mean: theory and examples. *British Journal of Mathematical and Statistical Psychology*, 71, pp. 186-203.
- Schweder, T. 1970. Composable Markov processes, *Journal of Applied Probability*, 7, pp. 400-410.
- Schwitzgebel, E. (2002). How well do we know our own conscious experience? The case of visual imagery. *Journal of Consciousness Studies*, 9 (5-6), pp. 35-53.
- Schwitzgebel, E. (2011). *Perplexities of consciousness*, Cambridge (MA): MIT Press.
- Sciamanna T.C., Vitullo P., Curatolo A., Spadafora C. (2009). Retrotransposons, reverse transcriptase and the genesis of new genetic information, *Gene*, 448, pp. 180-186.
- Selfridge, O.G. (1959). Pandemonium: a paradigm for learning. In *Proceedings of the Symposium on Mechanisation of Thought Process*, Blake, D.V., Uttley, A.M., eds., pp. 511-529, London: Her Majesty's Stationary Office.
- Sergeant, C. (2021). Les bases neurologiques de la conscience: une revue des avancées récentes. In *Les signatures neurobiologiques de la conscience*, Académie Européenne Interdisciplinaires des Sciences, pp. 65-83, Paris : AEIS.

- Severyns, A. (1964). Homère et l'histoire. *L'antiquité Classique*, 33 (2), pp. 325-355.
- Sheehan, P.W. (1967). A shortened form of Betts' questionnaire upon mental imagery. *Journal of Clinical Psychology*, 23, pp. 386-389.
- Sheehan, P.W., Neisser, U. (1969). Some variables affecting the vividness of imagery in recall. *British Journal of Imagery*, 60 (1), pp. 71-80.
- Silberstein, M., Chemero, A. (2013). Constraints on localisation and decomposition as explanatory strategies in biological sciences. *Philosophy of Science*, 80 (5), pp. 958-970.
- Silver, D., Huang, A., Maddison, C.J., Guez, A., Sifre, L., van den Driessche, G., Schrittwieser, J., Antonoglou, I., Panneershelvam, V., Lanctot, M., Dieleman, S., Grewe, D., Nham, J., Kalchbrenner, N., Sutskever, I., Lillicrap, T., Leach, M., Kavukcuoglu, K., Graepel, T., Hassabis, D. (2016). Mastering the game of Go with deep neural networks and tree search. *Nature*, 529, pp. 484-489.
- Simon, G. (2007). Psychologie historique et analyse structurale chez J. -P. Vernant. *Cahiers Philosophiques*, 112 (4), pp. 42-65.
- Smith, S.M., Moynan, S.C. (2008). Forgetting and recovering the unforgettable. *Psychological Science*, 19 (5), pp. 462-468.
- Solloway, F. (1992). *Freud, biologist of the mind: beyond the psychoanalytic legend*. New York: Barnett Books.
- Sophocles, (around 429 BC). *Œdipus The King* (Οἰδίπους Τύραννος). Translated by Fagles (1984): [*The Three Theban Plays: Antigone; Oedipus the King; Oedipus at Colonus*](#). Penguin Classics.
- Sosis, R. (2000). Religion and intragroup cooperation: Preliminary results of a comparative analysis of utopian communities. *Cross-Cultural Research*, 34, pp. 70-87.
- Sosis, R., Bressler, E.R. (2003). Cooperation and commune longevity: A test of the costly signalling theory of religion. *Cross-Cultural Research*, 37 (2), pp. 211-239.
- Sprinkle, R.H. (1994). *Profession of conscience: the making and meaning of life science liberalism*. Princeton: Princeton University Press.
- Squire, L.R., Kandel, E.R. (2000). *Memory*. New York: Scientific American Library.
- Steadman, P.E., Xia, F., Ahmed, M., Steenland, H. W., Mocle, A. J., Penning, A., Geraghty, A. C., Monje, M., Josselyn, S. A., Frankland, P. W. (2019). Disruption of oligodendrogenesis impairs memory consolidation in adult mice. *Neuron*, 105, pp. 1-15.
- Stemmer, B., Whitaker, H.A. eds. (2008). *Handbook of the neuroscience of language*. Amsterdam. Boston. Heidelberg. London. New York. Oxford. Paris. San Diego. San Francisco. Singapore. Sydney. Tokyo: Academic Press, Elsevier Ltd.
- Stigler, S.M. (1986). *The history of statistics. The measurement of uncertainty before 1900*. Cambridge: The Belknap Press of Harvard University Press.
- Suetonius, C. (121). *De Vita XII Caesarum*. Translated by Rolfe J.C., Cambridge (Massachusetts): Loeb Classical Library.

- Suppe, F. (1989). *The semantic conception of theories and scientific realism*. Urbana and Chicago: University of Illinois Press.
- Suppes, P. (2002). *Representation and invariance of scientific structures*. Stanford: Center for the Study of Language and Information.
- Sutton, W.S. (1903). The Chromosomes in heredity. *Biological Bulletin*, 4, pp. 231-251.
- Szondi, P. (1974). *Poetik und Geschichtsphilosophie*. 2 vols. Frankfurt am Main: Suhrkamp Verlag. (French translation (1975) : *Poésie et poétique de l'idéalisme allemand*, transl. Bollack J. et al., Paris, Minuit)
- Szondi, P. (1975). *Einführung in die literarische hermeneutik*. Frankfurt am Main: Suhrkamp Verlag.
- Taine, H. (1878). *De l'intelligence*. 2 vol., Paris: Hachette.
- Tan Q., Christiansen L., von Bornemann Hjelmberg J., Christensen K. (2015). Twin Methodology in epigenetic studies, *The Journal of Experimental Biology*, 218, pp. 134-139.
- Templado C., Vidal F., Estop A. (2011). Aneuploidy in human spermatozoa. *Cytogenetic and Genome Research*, 133, 91-99.
- Terdiman, R. (2010). Memory in Freud. In *Memory*, Radstone, S., Schwarz, B., eds., New York: Fordham University Press, pp. 93-108.
- Terman, L.M. (1916). *The measurement of intelligence*. Cambridge Massachusetts: The Riverside Press.
- Tether, L., McFadyen, J., Eds. (2017). *Handbook of Arthurian romance*. Berlin/Boston: Walter de Gruyter.
- Teyler, T.J., Hamm, J.P., Clapp, W.C., Johnson, B.W., Corballis, M.C., Kirk, I.J. ((2005). Long term potentiation of human visual evoked responses. *European Journal of Neuroscience*, 21 (7), pp. 2045-2050.
- Thomas, W.I., Znaniecki, F. (1918-1920). *The Polish peasant in Europe and America*. 5 vol., Boston: The Gorham Press.
- Thompson, E. (2007). *Mind in life. Biology, phenomenology and the sciences of mind*. Cambridge, MA: Harvard University Press.
- Thorndike, E.L. (1907). On the function of visual images. *Journal of Philosophy, Psychology and Scientific Methods*, 4 (12), pp. 324-327.
- Thorudottir (Þórudóttir), S. (2020). *Does mental imagery vividness predict memory performance?* Master Science Thesis, University of Iceland, website: <http://hdl.handle.net/1946/37119>
- Thorudottir, S., Sigurdardottir, H.M., Rice, G.E., Kerry, S.J., Robotham, R.J., Leff, A.P., Starrfelt, R. (2020). The architect who lost ability to imagine: the cerebral basis of visual imagery. *Brain Sciences*, 10 (2), 59, pp.1-15.
- Tolstoy, L. (1868-1869). *Война и миръ* (War and peace). Moscow: T. Ris.
- Trepanier, L. (2011). Consciousness, memory, and history in Tolstoy's War and Peace. *Perspectives on Political Science*, 41 (1), pp. 35-43.
- Tricard, J. ((2002). Les livres de raison français au regard des livres de famille italiens : pour relancer une enquête. *Revue Historique*, 4, pp. 993-1011.
- Trussel, J. 1992. Introduction. In *Demographic applications of event history analysis*, Trussel, J., Hankinson, R., Tilton J. eds, Clarendon Press, Oxford, pp. 1-7.
- Trussel, J., Richards, T. (1985). Correcting for unmeasured heterogeneity in hazard models using the Heckman-Singer procedure. In *Sociological Methodology*, Tuma, N. ed., Jossey-Bass, San Francisco, pp. 242-249.

- Tulving, E. (1972). Episodic and semantic theory. In *Organization of memory*, Tulving, E., Donaldson W., eds., pp. 302-402, New York: Academic.
- Turing, A.M. (1936). On computable numbers, with an application to the Entscheidungsproblem. *Proceedings of the London Mathematical Society*, 42, pp. 230-265.
- Turing, A.M. (1950). Computing machinery and intelligence. *Mind*, LIX (236), pp. 433-460.
- UIESP (1938). Problèmes qualitatifs. In *Congrès International de la Population, Paris 1937, volume VIII*, Paris: Herman et C^{ie}.
- Valens, V. (around 150-170). *Anthologiarum libri*. Ed. Wilhelm Kroll. Berlin : Weidmanos.
- Vandermonde C-A. (1756). *Essai sur la manière de perfectionner l'espèce humaine*. Paris : Vincent.
- Vandersleyen, C. (1995). *L'Égypte et la vallée du Nil: De la fin de l'Ancien Empire à la fin du Nouvel Empire*, t. 2, Paris : Presses Universitaires de France.
- Van Dongen, J., Slagboom, P.E., Draisma, H.H.M., Martin, N.G., Boomsma, D.I. (2012). The continuing value of twin studies in the omics era. *Nature Reviews Genetics*, 13, 640-653.
- Van Leeuwen, N., van Elk, M. (2018). Seeking the supernatural: the interactive religious experience model. *Religion, Brain & Behaviour*, pp 1-56, DOI: [10.1080/2153599X.2018.1453529](https://doi.org/10.1080/2153599X.2018.1453529).
- Varela, F.J. (1996). Neurophenomenology. A methodological remedy for the hard problem. *Journal of Consciousness Studies*, 3 (4), pp. 330-349.
- Varela, F.J. (1997). Patterns of life: intertwining identity and cognition. *Brain and Cognition*, 34, pp. 72-87.
- Varela, F.J., Thompson, E., Rosch, E. (1991). *The embodied mind*. Cambridge, London: The MIT Press.
- Vernant, J.-P. (1965). *Mythe et pensée chez les Grecs*. Paris : Maspero.
- Vernant, J.-P. (1972). Ebauches de la volonté dans la tragédie grecque. In *Mythe et tragédie en Grèce ancienne*, Vernant, J.-P., Vidal-Naquet, P., pp. 41-74, Paris : Maspero.
- Vernant, J.-P. (1974). *Mythe et société en Grèce ancienne*. Paris : Maspero.
- Vernant, J.P., Vidal-Naquet, P. (1972). *Mythe et tragédie en Grèce ancienne – I*. Paris, Maspero.
- Vetta A. (1976). Corrections to Fisher's correlation between relatives and environmental effects, *Nature*, 263, pp. 316-317.
- Vetta A. (1981). Appendix. In *To unfrock the charlatans*, Hirsh J., London, Sage Race Relations Abstract Publications Ltd., 6 (2).
- Vetta, A., Courgeau, D. (2003). Demographic Behaviour and Behaviour Genetics. *Population-E*, 58, pp.:401-428.
- Vetter, R. (2000). Astrology's paradigm: its main axioms and implications. *Considerations*, XV (4), pp. 84-94.
- Viding E., Price T.S., Jaffee S.R., Trzaskowski M., Davis O.S., Meaburn E.L., Haworth C.M., Plomin R (2013). Genetics of callous-unemotional behavior in children, *Plos One*, 8, e65789.
- Vinclair, P. (2015). *De l'épopée et du roman. Essai d'énergétique comparée*. Rennes : Presses Universitaires de Rennes.
- Vinclair, P. (2016). Le roman fait l'épopée. *Le Recueil Ouvert*, URL : <http://ouvrage-litt-arts.univ-grenoble-alpes.fr/revues/projet-epopee/166-le-roman-fait-l-epopee>

- Visscher, P.M., William G.H., Naomi T.W. (2008). Heritability in the Genomic Era - Concepts and Misconceptions. *Nature Reviews Genetics*, 9, pp.:255-266.
- Vlasceanu, M., Morais, M.J., Duker, A., Coman, A. (2020). The synchronisation of collective beliefs: from dyadic interactions to network convergence. *Journal of Experimental Psychology: Applied*, 26 (3), pp. 453-464.
- Wachsmuth, A., Wilkinson, L., Dallal, G. (2003). Galton's Bend: A Previously Undiscovered Nonlinearity in Galton's Family Stature Regression Data. *The American Statistician*, 57 (3), pp.190-192.
- Wagenaar, W. (1986). My memory: a study of biographical memory over six years. *Cognitive Psychology*, 18, pp. 225-252.
- Wang, Y., Luppi, A., Fawcett, J., Anderson, M.C. (2019). Reconsidering unconscious persistence: Suppressing unwanted memories reduces their indirect expression in later thoughts. *Cognition*, 187, pp.78-94.
- Wasserstein, R.I., Schirm, A.L., Lazar, N.A. (2019). Moving to a world beyond "p < 0.05". *The American Statistician*, 73 (Sup 1), pp. 1-19.
- Watson, J.B. (1913). Psychology as the Behaviorist views it. *Psychological Review*, 101 (2), pp.: 248-253.
- Watson, J.B. (1924). *Behaviorism*. New York: The People's Institute Pub. Co.
- Watson, J.D., Crick, F.H.C. (1953). Molecular Structure of Nucleic Acids. A Structure for Deoxyribose Nucleic Acid. *Nature*, 171, pp.:737-738.
- Weaver I., Cervoni, N., Champagne, F.A., Alesio, d', A.C., Sharma S., Seckl J.R. (2004). Epigenetic programming by maternal behaviour. *Nature Neuroscience*, 7, 847-854.
- Wedel, T.O. (1920). *The mediæval attitude towards astrology, particularly in England*. New Haven: Yale University Press.
- Wees van, H. (2001). Demetrius and Draco Athen's property classes and population in and before 317 BC. *Journal of Hellenic Studies*, 131, pp. 95-114.
- Weir, D.R. (1984). Life under pressure: France and England, 1670-1870- *Journal of Economic History*, 44, pp. 27-47.
- Weiss S.F. (2005). « The sword of our science » as a foreign policy weapon. The political function of German geneticists in the international arena during the Third Reich. In *Ergebnisse, Vorabdrucke aus dem Forschungsprogramm, 'Geschichte der 'Kaiser-Wilhelm-Gesellschaft im Nationalsozialismus' Der Präsidentenkommision der Max-Planck-Gessellschaft*, Berlin: Max-Planck-Gessellschaft.
- Weiss S.F. (2010). *The Nazi symbiosis*. Chicago, London: The University of Chicago Press.
- Weldon, W.F.R. (1902). Mendel's laws of alternative inheritance in peas. *Biometrika*, 1(2), pp. 228-254.
- Wengrow, D. (2015). *Cities before the State in early Eurasia*. Max Planck Institute for Social Anthropology. Goody lecture: https://www.eth.mpg.de/4091237/Goody_Lecture_2015.pdf
- Westerhoff, H.V., Alberghina, L. eds. (2005). *Systems Biology*. Berlin Heidelberg: Springer-Verlag.
- Whitehouse, H., François, P., Savage, P.E., Currie, T.E., Feeney, K.C., Cloni, E., Purcell, R., Ross, R.M., Larson, J., Baines, J., Haar, ter, B., Covey, A., Turchin, P. (2019). Complex societies precede moralizing gods throughout world history. *Nature*, 568, pp. 226-229.

- WHO (2006). WHO gives indoor use of DDT clean bill of health for controlling malaria. Sept. 15, 2006, <http://www.who.int/mediacentre/news/releases/2006/pr50/en/index.html>
- Wiebe, D. (1983). Theory in the study of religion. *Religion*, 13, pp. 283-239.
- Wiener, N. (1948). *Cybernetics or control and communication to the animal and the machine*. New York: Technology Press.
- Winch, M.H. (1908). The function of images. *Journal of Philosophy, Psychology and Scientific Methods*, 5 (13), pp. 337-352.
- WIN-Gallup International (2012). *Global index of religiosity and atheism*.
<http://www.wingia.com/web/files/news/14/file/14.pdf>
- Winograd, T. (1990). Thinking machines: Can there be? Are we? In *The foundations of artificial intelligence*, Partridge, D., Wilks, Y., eds, pp. 167-189, Cambridge: Cambridge University Press.,
- Wood, C., Shaver, J.H. (2018). Religion, evolution, and the basis of institutions. *Evolutionary Studies in Imaginative Culture*, 2 (2), pp. 1-20.
- Woodward, J. (2003). *Making things happen: a theory of causal explanation*. Oxford: Oxford University Press.
- Wrigley, E.A. (1985). The fall of marital fertility in nineteenth century France: exemplar or exception? (Part I). *European Journal of Population*, 1, pp. 31-60.
- Wundt, W. (1874). *Grundzüge der Pysiologischen Psychologie*. Leizig: W. Egelman.
- Wundt, W. (around 370 B.C.). *Anabasis*. Translated by Dakyns, H.G.:
<https://www.gutenberg.org/files/1170/1170-h/1170-h.htm>
- Xenophon (around 370 B.C.). *Cyropaedia*. Translated by Dakyns, H.G.:
<https://www.gutenberg.org/files/2085/2085-h/2085-h.htm>
- Yarkoni, T. (2020). The generalizability crisis. *Behavioral and Brain Sciences*, 1-37. doi:10.1017/S0140525X20001685
- Yi, M.-K. (2000). *Herméneutique et psychanalyse, si proches ... et si étrangères*. Paris: Presses Universitaires de France.
- Yong, E. (2019). The human Brain Project hasn't lived up to its promise. *The Atlantic: July 22, 2019*.
- Yule, U. (1897). On the theory of correlation. *Journal of the Royal Statistical Society*, 60, pp. 812-854.
- Yule, U. (1902). Mendel's laws and their probable relations to intra-racial heredity. *The New Phytologist*, 1(9), pp.193-207 and pp. 222-238.
- Zeman, A., Devar, M., Della Sala, S. (2015). Lives without imagery – Congenital aphasia. *Cortex*, 73, pp. 378-380.
- Zmigrod, L., Garrison, J.R., Carr, J., Simons, J.S. (2016). The neural mechanisms of hallucinations: A quantitative meta-analysis of neuroimaging studies, *Neuroscience and Biobehavioral Reviews*, 69, pp. 113-123.

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Back cover's promotional text:

This book addresses the challenge of understanding human life. It compares our life experience with the attempts to grasp it by astrologers, eugenicists, psychologists, neuroscientists, social scientists, and philosophers. The main opposition among these specialties lies between understanding and misunderstanding. We also address the central methodological difficulty of capturing a human life.

First, we examine how certain approaches may lead to a misunderstanding of human life. We contrast the example of astrology—an accepted practice in ancient civilizations, but now classified among the pseudosciences—with astronomy, a full-fledged science since Galileo's time. Another, more recent approach regards human life as predetermined by genes: the methods used by eugenicists, and later by political regimes under the name of hereditarianism, came to compete with genetics. A broader analysis will show how astrology and eugenicism are not truly scientific approaches.

Next, we look at the ways of capturing an imaginary or real human life story. A comprehensive approach will try to fully understand their complexity, while a more explanatory approach will consider only certain specific phenomena of human life. For example, demography studies only births, deaths, and migration. Another crucial factor in the collection of life histories is memory and its transmission. Psychology and psychoanalysis have developed different schools to try to explain them.

We conclude with a detailed discussion of the concepts and tools that have been proposed in more recent times for understanding the various aspects of life stories: mechanisms, systems, hermeneutics, and autonomy.