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# Bone Geopolitics: Bone Age and the Racialization of Growth in UK and US Pediatrics (1940-1980)

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► **To cite this version:**

Ingrid Voléry, Marie-Pierre Julien. Bone Geopolitics: Bone Age and the Racialization of Growth in UK and US Pediatrics (1940-1980). Ingrid Voléry; Marie-Pierre Julien. In Voléry I., Julien M-P. (Eds.). From measuring rods to DNA sequencing: assessing the human. New-York. Palgrave-MacMillan, Palgrave Macmillan, pp.175-203, 2020. hal-02956991

**HAL Id: hal-02956991**

**<https://hal.science/hal-02956991v1>**

Submitted on 21 Aug 2024

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## **Chapter 7. Bone Geopolitics. Bone Age and the Racialization of Growth in UK and US Pediatrics (1940-1980).**

Ingrid Voléry and Marie-Pierre Julien

In recent years, European migration policies have brought under the attention of the media a type measurement at the intersection of anthropometry, radiography, biology, pediatrics and forensic medicine: bone age assessment. Practiced in several European countries (France, Italy, UK) to evaluate whether unaccompanied foreign youths were minors or adults, this type of measurement resorts to abacuses that have been elaborated in the mid-twentieth century in a very different context and for very different purposes. Intense debates were raised by these measurements of age: critics pointed at their symbolic violence, at disparities in their implementation, at their unreliability and at the unequal socio-administrative treatment of children that can derive from them. In particular, issues were raised as to the applicability of abacuses that have been elaborated on “Caucasian” children to “immigrant adolescents of Moroccan origin”, whose chronological age, when measured according to Greulich and Pyle’s atlas (1959), was overestimated by up to three years (Jacques 2009; Chariot 2019: 4). From an “indicator of development” constructed in the late nineteenth century by hygienist medicine (see Chapter 2 of this book), bone age has become a tool for “measuring” the age of adolescents, characterized according to fuzzy ethno-national or racial categories (“of Moroccan origin”, “Caucasian”, etc.). In what historical contexts and social spaces did this shift occur? What children was it applied to, and what controversies did it raise? At what point did “Caucasian” come to being used as a category? What does this category refer to? Does it indicate a “racialization” of bone age, overwriting the “ageization” of bone that had been introduced at the turn of the twentieth century?

### **Ethnicity, race and bone age in research and reports on child growth**

This chapter follows a socio-historical perspective on the categorizations and measurements of human bodies, whose foundations were set by major figures of philosophy, sociology, and history of science (Foucault 1966, Knorr-Cetina 1999, Hacking 2005, Doron 2016). However, instead of postulating the existence of major *épistémès* or reasoning styles underpinning the measurement of bone age, we chose to go down a pragmatic route: we consider that the actions based upon measurement activities, but also the context in which these activities are implemented and used, can dramatically alter their meaning and effects (Desrosières 1995; Hartigan 2009). From this perspective, to quote Doron and Lallemand-Stempak’s approach on race (2014), we will attempt to examine “the whole complex task of defining objects and aligning categories used with other pre-existing categories; the task of designing software and technologies involved, and highlighting the hypotheses they include and their limitations; and the task of enshrining values and ethico-political choices, which determine the researchers’ interests and method of presenting their results” (Doron & Lallemand-Stempak 2014). To analyze these alignments and discontinuities, we conducted a study of generalist and specialist databases (Scholar, PubMed and Medline), using as keywords: “racial”, “ethnic”, “skeletal age”, “bone age”, “children”, “adolescent” and “forensics”, and working our way back to the 1940s when the abacuses used today for the measurement of bone maturity in children and young migrants were designed (Todd 1937; Greulich & Pyle 1959). In analyzing this corpus,<sup>1</sup> we paid specific attention to the types of publications and to the disciplinary affiliations of their authors. While earlier articles were published in journals on child health and human development (*Child Development*, *American Journal of Diseases of Children*, *Human Growth*, *Human Biology*) the most recent appeared in international publications on pediatrics (*Pediatrics international*), radiology (*Radiology*) or forensic medicine, in connection with current events

involving “unaccompanied foreign minors” and politico-legal procedures that placed forensic medicine at the heart of public debates. For each article identified, we then considered the way in which children are referred to (with reference to their city of origin, nationality, regional or social origin? In terms of “White” vs. “Caucasian”? As “Afro-American” or “negro”?), as well as the arguments upon which these classifications are based, and the ways in which biological and social determinants are formalized (in terms of ethnicity, race, “gene pools”, “growth patterns”, etc.). In addition, we studied the ways in which the climatic, geographic, socio-economic, and biological dimensions are articulated in the authors’ arguments. Our analysis also focused on the devices used to measure and establish comparisons: who are these children compared to? How are measurements performed, and to which end? Is the purpose to produce a set of standards of human growth? Is it to detect diseases? Is it to test the applicability of an abacus? Or, is it to characterize pre-determined “racial” groups”? Finally, in what political contexts did these measurements and classifications emerge? We complemented the first corpus, comprising of journals, with an in-depth study of books reflecting discontinuities in the categorizations and uses of bone age measurement standards.

We thus identified three distinct periods. Initially used in the aftermath of World War Two to explore class differences in the US and UK, bone age assessment shifted from the field of clinical and social pediatrics, and was integrated into a large-scale project aimed at standardizing knowledge on human maturation – nationally at first, and later internationally. In this particular new context, under the influence of international pediatrics, population genetics and international medical aid, bone measurement came to be used to reveal geneticized development patterns, which went along with the de-racialization of European populations and the racialization of African populations.

### **1960s: honing the measurement of human growth and capturing class variations**

While the notion of bone age appeared in forensic medicine in the late nineteenth century (see Voléry, Chapter 2), the first abacuses for its measurement were not formalized until the mid-twentieth century: in 1937, British orthodontist Thomas Wingate Todd conducted a first study on the skeletal age of Cleveland children for the Brush Foundation; in 1959, in Boston, Greulich and Pyle (anatomy professor and research assistant) complemented their measurements with a radiographic tool for additional measurement and data figuration. They performed thirty standard radiographs for each sex, each representing a particular bone age, based on a relatively small number of well-off Euro-American children born in the 1930s, and associated an “average” X-ray with each chronological age for each sex.<sup>ii</sup>

**INSERT Figure 6.5—X-Rays plate, Greulich & Pyle Atlas (1959)**

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Recent meta-analyses of the applicability of Greulich and Pyle’s abacuses to “ethnicized” populations (Alshamrani, Messina & Offiah 2019) categorize these 1950s studies as conducted on “White” subjects. However, these early studies were more interested with the social background of children and the degree of industrialization of the city where they were surveyed. The populations studied were then not defined according to “ethnic” criteria. In Philadelphia, Cleveland, Boston and London, pediatricians, dentists and anatomists measured degrees of bone maturation in children who were healthy but exposed to varying socio-economic conditions: all these studies considered first and foremost the effects of living environments on child development and aimed to capture growth delays caused by poverty.

Conducted in community health centers or school medicine settings, these researches formed part of what David Armstrong refers to as a new regime of truth deployed after the war due to

the dissemination of the survey method: “The survey was part of a ‘new regime of truth’ which, in its focus on the social rather than the individual body, introduced a new direction and imperative in medical investigation” (Armstrong 1983: 76). The child’s body is no longer considered in isolation, but in relation to other bodies in its community: “Pre-war, the child was essentially constituted by analysis of discrete bodies and problems were located *within* the child; post-war, the child was increasingly constituted by its social mapping in the community and its problems were located *around* the child [...]” (Armstrong 1983: 59). Concurrently, normality itself was redefined: it no longer referred to a discrete condition but rather to a space within the “range of normal variation” or the “continuous distribution curve of health” (Armstrong 1983: 90). Research into child diseases gave way to investigations of the normal child (Illingworth 1953): “The break with the panoptic vision of clinico-pathological medicine was to replace the question: ‘Has this patient a disease?’ with: ‘Is the child growing normally?’”(Armstrong 1983: 59). Normality and abnormality were thus derived from the spatial and temporal variations of child growth and maturation in the space of the community.<sup>iii</sup> In this context, social pediatrics set averages as well as standardized indicators to monitor child growth, and in particular growth delays caused by poverty, which were targeted by US and UK governments post-war and in the 1960s (see the “Great Society” program launched in 1964 by Lyndon Johnson in the USA, or the policies engaged by Wilson’s Labour government around the same period in the UK).

### *Setting growth scores*

James M. Tanner is one of the key medical figures who contributed to the elaboration of growth scores. This London pediatrician studied three fundamental indicators of child growth: pubertary maturation in the 1950s (see Vinel, Chapter 7 of this book); bone maturation, in collaboration with Whitehouse in 1959; and dental calcification with Demirjian in the 1970s. Tanner researched the growth of middle-class children, working from the medical center where he practiced (Child Health Center in London). In contrast with Greulich and Pyle’s protocol elaborated around the radiography of a single ossification point, Tanner and Whitehouse established a more complex procedure “based on a large random sample of not very well-off British children”, considering 20 hand and wrist bones examined separately to standardize 8 or 9 development stages (Tanner 1975). Like Greulich and Pyle, these pediatricians establish a necessary difference of sex between their scales but do not mention any “ethnic” or “racial” dimensions. While Tanner is very critical of the possibility of using skeletal age to extrapolate an individual’s chronological age (Eveleth & Tanner 1976: 14),<sup>iv</sup> he does also regard that skeletal age as a good indicator of maturation, due to its statistical connection with the menarche and chronological age.

Skeletal age thus becomes a benchmark: it even provides a conceptual and metrological framework for other development standards formalized throughout the 1970s. The method for the measurement of calcification elaborate to assess bone age is later transposed to teeth, which also go through a calcification process that can be captured using similar radiographic tools (Demirjian, Goldstein & Tanner 1973). It is then applied to the measurement of pubertary development, to which bone age is eventually integrated. In each of these cases, measurement readings are used to calculate averages by age group, to which X-rays are associated to support the pediatrician’s observations.

Tanner’s early works thus form part of a broader movement of elaboration of maturation indicators, at the intersection of research and community health. These universal indexes, easily reproducible in school medicine settings and child health centers, were regarded as tools that could be used to map out bodies within social space, thus opening up a new topographic approach to disease and development: “The survey had shown certain forms of illness to be

intimately related to the social body” (Armstrong 1983: 81). This perspective based on close and continual monitoring soon raised practical issues, involving for instance the ergonomics of measuring tools and the speed of execution of metrological readings in medical practices.

### *Standardizing scores and rectifying variations*

In the late 1950s, abacuses were no longer used solely to document the living world. They equipped the eye and judgement of professionals operating in new institutional and political spaces (Daston & Galison 2007) where growth assessment was mainstreamed on a finer topographical scale, looking not just at cities but also at their districts. The scores thus obtained needed to be standardized.

First, this standardization required cancelling out the “noise” in the data – i.e. variations observed between individuals. An excellent example is provided by US anthropologist Johnston, who is frequently cited in pediatrics. In 1963, Johnston conducted surveys on the skeletal age of 120 white children in Philadelphia, characterized according to their sex (62 girls, 58 boys) and living environments. All of them were assessed as clinically normal and monitored throughout their education by the Philadelphia Center for Research in Child Growth where Johnston worked. In addition to weight measurements from the ages of 7 to 17, Johnston had access to 976 radiographs, which he interpreted according to Greulich and Pyle’s standards (Johnston 1963: 193). Then, the measurement of skeletal age was compared to chronological age, and the discrepancies were interpreted in terms of precocity or delay with respect to a standard chronological age. At the age of 7, boys from Philadelphia were thus described as late developers in comparison with the Cleveland boys studied by Todd (Johnston 1963: 201); they grew faster until 10 when they became more precocious. Johnston then compared Philadelphia children with Boston children (studied by Greulich and Pyle) whose skeletal age and chronological age were equal in both sexes (Johnston 1963: 201). From this comparison between cities and social backgrounds, Johnston drew three structuring conclusions.

First of all, he observed a gap between children born in the 1920s and 1930s as studied by Todd and Greulich & Pyle, and those born in the 1950s and 1960s. According to him, better living conditions (food, access to healthcare) are a cause of faster growth. However, while Johnston observed the influence of the socio-economic environment on maturation, he does not acknowledge the flexibility of bone age, which is on the contrary regarded as a linear maturational standard: “The concept of skeletal age has become an accepted technique in the assessment of the maturational status of children, whether considered individually or collectively. The assignment of a development age [...] permits the rapid placement of a given child along a graduated scale, the end points of which are fixed biological entities” (Johnston 1963: 192).

Secondly, former studies highlighted a great variability in the age at which ossification points appear (in 1937, Todd even mentioned the possibility of changing these thresholds depending on the group of children being studied). In contrast, Johnston used his measurements to support the hypothesis that constant sequences could be observed in normal individuals, making it possible to calculate growth curves with a margin of error only due to the samples used for the calculation of the initial growth rates. Initially regarded as flexible and susceptible to social conditions of existence (hence the comparisons between cities and districts), bone age was gradually reified in the early 1970s. This seems to be due to the practical demands of public health policies (reproducibility of results, speed of execution, etc.): the priority was no longer to explore the statistical variations of the living world, but to create stabilized metrologies and convert them into public health monitoring technologies.

Finally, while some references to skin color (“white”) can be found in earlier studies as a complement to other information on socioeconomic conditions of existence,<sup>v</sup> Johnson’s work

reveals a change of perspective by introducing the hypothesis of ethnic background, in keeping with the approaches of biological anthropology: “It is felt that Philadelphia and Cleveland children may, in general, be equated environmentally. However, the Brush series probably represents a somewhat higher socioeconomic level. Ethnic backgrounds are similar, both being largely north-central European. The groups do not represent breeding isolates which would tend to limit genetic differences at population levels” (Johnston 1963: 198-199). The ethnic dimension is used here to refer to “genetic” differences, which are distinguished from social background and divide the national space into sub-groups (the north-central European background in Philadelphia and Cleveland). However, in contrast with later studies, ethnicity is not used as a pre-established criterion of classification: rather, it is a control variable that can help interpret stature discrepancies within a given social class. In a way, this variable introduces difference within difference. Furthermore, these “ethnic” divisions do not reproduce the raciological classifications inherited from late eighteenth century biological anthropology. For example, the term “north-central European” is preferred to “Caucasian” which came into prominence in the 1990s, in particular in contemporary medico-legal spaces where the influence of physical anthropology is greater than in pediatrics, where biology and endocrinology are more influential.

We will now examine the contexts in which this research into social class-related bone maturation discrepancies was gradually reorganized around new categories based on ethno-national and later bio-racial specificities.

### **From class to nation: the dissemination of US and UK standards and bottom-up ethnicization**

A second use of bone age appeared at the turn of the 1970s: no longer used to document social inequalities in child growth, it became a standard expressing a fictional national body (the American child) to which other countries could compare themselves. This marks a first phase in “bone geopolitics”, and more widely in the measurement of child growth.

#### *Monitoring public health or positioning countries within an international metrologic space*

In the 1970s, child growth standards were disseminated beyond their countries of origins. These indicators and abacuses were used in Northern European countries and beyond. Their purpose was no longer necessarily clinical or public health-related: the aim became that of engaging with an increasingly international field of knowledge production on human growth, from which researchers derived their international scientific rankings. Of course, anthropometric data had been circulating for decades, and most intensely in the seventeenth and eighteenth century (Bancel *et al.* 2014). Merchants were trading data collected in faraway colonies, which was then processed by European savants for the purpose of describing the plurality of humanity or othering alien bodies (see Chapter 1 of this book). However, the political and institutional context of the production of science – and in particular, the importance of knowledge on human growth – changed dramatically in the early 1970s.

First of all, there was a transformation in the political use of data on human growth: the search for variety in faraway countries gave way to an exploration of the variability of what is near – first by considering social conditions of existence, and later by embracing global demographic and economic concerns. While Foucault associates these measurements of the human with the emergence of biopolitics from the eighteenth to the twentieth century, this specific form of biopolitics went through contrasting historical moments. In the early 1970s, the gaze of powerful countries in the North turned to social health inequalities. Their objective was to maximize their population’s health, but also to imprint modernity, social progress and national

greatness in their children's bodies. Funding was channeled into the alleviation of these social health inequalities while a market developed for expertise and intervention, nationally at first and later internationally. This benefitted the researchers who worked on human growth: see for example the Bolton-Brush Growth Study Center founded by Todd in 1926 to investigate normal human mental and physical growth and development by collecting "the world's most extensive source of longitudinal human growth data".<sup>vi</sup>

Secondly, the very organization of the scientific world was transformed: measurement was revalued and placed at the heart of the production of research findings. In the pediatric spaces that form the object of this study, "measurers" were required to display medical knowledge and to be trained in performing measurements. Tanner explains at length his method for measuring height, with the subject sitting down and standing up, with photographs showing correct postures and instruments (Eveleth & Tanner 1976: 9). He is also highly reflexive as to the biases induced by these methods (associated with different ways of measuring, standardizing data, etc.). In 1975, USA pediatrician Alexander F. Roche who specialized in community health, backed his research with a major training program for his "assessors", in order to control intra- and inter-measurer variations. As pointed out by Daston and Galison (2007) concerning "trained judgement", a particularly prominent model in clinical research, the objectivity of pediatric science is closely associated with measurement practices: a good researcher must conduct his measurements him or herself. This can also be explained by the fact that a scientific niche was being built at the time around human metrologies – with dedicated journals, disciplinary specialisms, specific professional applications, potential fields of expertise associated with these metrologies, and the development of collections whose economic and scientific exchange value depends on measurement methods.

Finally, science as an *institutional field* also underwent major changes: the dissemination of knowledge became concentrated and standardized, partly because of the structuring of reference journals whose boards are based in certain Western countries, and which impose a number of normalized methodological standards for submissions to be accepted in their pages (Merton 1973 [1942]). In this context, the use of internationalized measurement scales became a structuring condition for accessing legitimate publications, which gave rise to specific geopolitical scientific issues, such as being able to demonstrate that the abacus can be applied to a given population.

#### *"Nationalizing" abacuses: bottom-up ethnicization*

The question of whether human maturation measurement standards can be applied to local populations became crucial for scientists, as well as for medical practitioners who used these standards in their clinical or medico-legal practice. This question arose as scientists attempted to produce research data that could be assessed as adequate, i.e that could be compared with other available data and resorted to existing metrologies. It also emerged in a context where the measurement of the living world became a priority in medical and political agendas. These factors brought the question of the applicability of abacuses to the forefront – a question that today forms the object of a large proportion of publications on bone age assessment in children. For example, in 1971, biological anthropologist E. Andersen (1971) applied both Greulich and Pyle's (GP) and Tanner and Whitehouse's (TW) methods to Danish children between 7 and 18 and concluded that the latter was more reliable, but more susceptible to variations in measurement, less user-friendly and less adaptable to older children. Andersen also recommended some adjustments that could be brought to both methods (by 6 months for GP and 2 months for TW), thus focusing on these studies' essentially practical aspects. In doing so, Andersen also argued that there was such a thing as "Danish" measurements – in contrast with earlier studies which investigated potential growth delays caused by poverty in the 1940-

1950s and captured variations on the finer topographical scale of a socioeconomic space (city/district), rather than that of a nation.<sup>vii</sup> From the early 1990s onward, multiple studies have addressed the applicability of abacuses in forensic medicine, radiology, orthodontics and human biology.<sup>viii</sup> After Denmark, researchers investigated standards in Austria (Wenzel & *al.* 1984), Sweden (Kullman 1995), the Netherlands (Van Rijn & *al.* 2001), Morocco (Garamendi *et al.* 2005), Germany (Schmidt & *al.* 2007), Italy (Santoro & *al.* 2012), Scotland (Hackman & Black 2013) and France (Zabet & *al.* 2015). Turkey was the object of five studies from 2007 to 2015 (Büken & *al.* 2007; Büken & *al.* 2009; Gungor & *al.* 2015; Oztürk & *al.* 2016), China of four studies between 1990 and 2007 (So & Yen 1990; So & Yen 1991; Chiang & *al.* 2005; Griffith & *al.* 2007), and India of five studies between 2012 and 2015 (Patil & *al.* 2012; Shilpa & *al.* 2013; Rai & *al.* 2014; Mohammed & *al.* 2015; Patel & *al.* 2015). Other researchers investigated the perspectives opened up by Johnston by focusing on sub-national groups, often characterized in an inconsistent and inexplicit manner: some studies refer to skin color – for instance, Dembetembe and Morris (2012) refer to South-Africans of African biological origin as “Blacks” – while others like Roche (1975) resort to the notion of racial geographic area, combining social (nutrition, access to healthcare), environmental (climate) and biopolitical factors (the “white” vs. “negro” opposition in American society):

These various studies all highlighted the practical implications of using measurement tools that had been built between the 1950s and 1970s, pointing at discrepancies, convergences and statistical corrections, or at necessary interpretative precautions. However, there was no attempt to *explain* these “ethnicity” variations. Measurement was ethnicized “from the bottom up” according to practical considerations rather than theoretical ones,<sup>ix</sup> as shown by the fluctuating uses of the term “Caucasian”, or by the multiple connections established between nationalities and ethnicities. For instance, Turks, classified as “Caucasians”, are described by some authors as perfectly aligned with Western abacuses (Catekin & *al.* 2012), while others describe them as non-aligned due to geographic and socio-economical specificities (Oztürk & *al.* 2016). Similarly, Italians are categorized as “Caucasian” – although they present “ethnic differences” from European Americans (Santoro & *al.*, 2012) – because the Greulich and Pyle abacus is rated as “reliable for the sample analyzed”.

This ethnicization of bone age and child growth standards reflects the rising “nationalization” of measurement. The social space where bodies are interpreted is no longer associated with class but gradually reconfigured along the borders of the nation-States – this shift is mostly unnoticed by Armstrong in his analysis of the changes introduced by the survey method in pediatrics, psychiatry, general medicine and geriatrics. However, this nationalization of measurement is not so much related to the rise of racial or nationalist doctrines – manipulating growth data to support the notion of a national people – but rather to the global scientific agenda, organized around North American and British standards. Ethnicity is thus constructed by default: it fills the gaps between measurement instruments and measured bodies, in conjunction with social factors that were still considered at the time. The third type of use of bone age emerged around the same period (mid-1970s) in a different branch of pediatrics and followed a very different perspective.

### **Bone age and development patterns in mid-1970s international pediatrics**

In the mid-1970s, a third use of bone age was formalized outside of social pediatrics, in a branch of pediatrics influenced by genetics and by the increasingly globalized biopolitical context. No longer practiced in school medicine settings only, research was encouraged by global health and development institutions. During this period, the differential measurement of health in children of different classes and the practical interrogations as to the applicability of abacuses gave way to a measurement of growth according to a global perspective.



### *The internationalization of biopolitics and the geneticization of pediatrics*

The emergence of a global perspective on growth measurement can be explained by a twofold context. From a geopolitical point of view, this period saw the constitution of major international aid and development agencies. In addition, global demographic growth and the need to regulate it became an issue of interest in Northern countries, as shown by the influence of the Club of Rome and the dissemination of its views in medical, activist, economic and environmentalist circles (Randers & Meadows 1972).

During the same period, pediatrics underwent institutional and scientific transformations. The foundations that supported research into growth and social class changed their strategies and focused on data collection to map growth on a global scale. In addition, some foundations supported the creation of the first “ethnicized” databases, looking at specific pathologies at first and later at wider issues (Epstein 2007; Braun 2014).<sup>x</sup> Concurrently, clinical and social pediatrics were losing their prestige: as the medical field reorganized, research was increasingly separated from clinical activities<sup>xi</sup> while biological and genetic knowledge acquired a growing influence (on these topics, see Déchaux, Chapter 4 in this book). Along with geriatrics (Faya-Robles 2018), pediatrics was symbolically rehabilitated by its alliance with genetics and in particular population genetics, which was establishing itself as a distinct field from lab-based genetics (Rabinow 2000). This particular context fostered the geneticization of bone age and its parallel use as a marker of racialization.

### *Worldwide Variation in Human Growth: mapping genetic growth patterns to tailor global development policies*

This context finds an illustration in the research program “Worldwide Variation in Human Growth”, led in 1976 by Phyllis B. Eveleth (a biological anthropologist who supported a genetic and ethnic interpretation of growth) in collaboration with Tanner, an eminent figure in early pediatric studies on growth and social inequality. The project “Worldwide Variation in Human Growth” was developed under the “human adaptability” topic, as part of the International Biological Program launched in 1964 by the World Health Organization (WHO), UNICEF and the International Council of Scientific Unions. In a context of strong population growth that required, according to the NGOs involved, to rethink the management of natural resources,<sup>xii</sup> this program aimed to collect data on child growth and physical maturation from a medical and anthropological angle, by comparing European populations (which continued to be held up as a standard) with others.

The program draws from two theoretical perspectives. The first is the notion of human ecology as developed by Tanner. The environment is integrated into the study in a very particular manner: the purpose is not just to investigate variations in human biology under environmental pressure, but also to prove that geographic proximity induces biological proximity. Tanner applies the very spatialized approach of social pediatrics that associates living places, living conditions and maturational status. The second perspective, championed by Eveleth, is influenced by Cavalli-Sforza’s genetic geography (Cavalli-Sforza & Bodmer 1971).<sup>xiii</sup> Phyllis Eveleth follows a similar analytical framework: against nutritional interpretations of growth, she supports the idea that genetic factors are determinant (Eveleth 1975, Eveleth & Tanner 1976: 214). Both Tanner and Eveleth do not just interpret the body according to a *social* space, understood as statistical distance from other bodies that form part of a given class or national community. The body is also interpreted in relation to a *physical* space, according to which genetic similarities and differences are postulated and integrated into the analysis (Rajagopalan & Fujimura 2011). In particular, one of the authors’ objectives is to determine the respective

impacts on growth of heredity and the environment, in order to assess the “possibilities for improvement in growth in large areas of the world”. The study concludes that all populations do not have the same potential for growth, due to pure heredity or to this factor’s interplay with the social environment (in particular nutrition and healthcare): genetic patterns of growth can therefore be detected. The monitoring of child development (measured through child mortality and growth rates) is associated with the objective of determining the genetic potential of “bioethnies”, to which public health policies must be tailored.

*Reconsidering global child growth data through the ethnical background hypothesis*

For this purpose, the program proposes to collate existing studies conducted according to diverse research approaches. Eveleth and Tanner use measurements collected through 340 studies conducted in 42 countries on different scales. They choose to aggregate this data into five groups: Sub-Saharan African populations and their descendants in the Americas; Asian populations including Chinese, Japanese, Amerindians and Southeast Asians to the exclusion of Indians and Bengalis (although these populations were categorized as Asians in mid-1970s British statistics); Australian Aborigines and Pacific island peoples; and Indo-Mediterranean peoples of the Near East, North Africa and India. When considering African populations, the authors also introduce sparse data on “tribal groups” – the data in question was collected in rural villages in Africa, where Eveleth and Tanner postulate that genetical patterns have been preserved due to lower migration<sup>xiv</sup> and to a greater distance from Western lifestyle and consumption standards. African populations are thus subdivided into “ethnic groups” (Eveleth & Tanner 1976: 75): Nilotes and Nilo-Hamites, Bantu, Sudanese, Khoisan and related peoples (Bushmen, Hottentots) and Pygmies. These groups are characterized using second-hand data which had originally been produced by country and living place (rural vs. urban), and not by ethnicity: these studies cover Jamaica (rural areas vs. Kingston); the poor city of Santo Domingo; California, the city of Dakar in Senegal and the village of Imesi in Nigeria. From this angle, “Worldwide Variation in Growth” is an example of a re-interpretation process through which these maturational data are not just interpreted differently but undergo a deep transformation.

First of all, the measurements are converted: while they occupied a secondary place in their initial studies, they are now used as criteria for the stratification of populations.<sup>xv</sup> The data figuration models are also transformed. The tables showing measurements, previously sorted by country, place or living standard, are replaced by tables organized according to particular “bio-ethnic” subgroups. Eveleth and Tanner encounter great difficulties in defining clearly delimited subgroups, except for the European group which they regard as genetically homogeneous. However, the authors do not consider this as an indication of the fragility of their interpretative model, but rather as the consequence of social variations that blur the underlying genetic substrates they are seeking to uncover. The ethnic factor is not regarded as a variable among others, within a multi-modal analysis that takes in socio-economic and environmental data, as Johnston and Roche did in respectively 1971 and 1975. Instead, it becomes a principle of categorization that presides over the initial break-down of measured bodies and of the data on growth thus produced. From a statistical variable, ethnic categories become a homogeneous biological entity. Eveleth and Tanner even back these categories with specific measurements selected to highlight their distinctive qualities: they examine the selected populations’ genetic makeup, physical shape, nutritional status, tolerance to climate, physical makeup, growth and development measured through weight-to-height ratio, skin-fold thickness, limb circumference and skeletal diameters, as well as maturational status defined through the triptych (bones, teeth, puberty) established by Tanner in 1960s’ United Kingdom and used very differently in this case. In addition to the geneticization of growth, this project thus introduces new divides and

hierarchies (Fujimura 2018), chiefly of which the racialization of African populations and the de-racialization of Europeans to whom the others are perpetually compared.

### *Beneath social class: the racial growth pattern of African populations*

For instance, Chapter 4 is dedicated to Africans in Africa and America. While the authors observe size discrepancies to do with living conditions, in particular in children for whom the genome is not regarded as fully expressive (Eveleth & Tanner 1976: 104), Eveleth and Tanner note other phenotypical particularities that they regard as genomic markers, in particular when they persist into adulthood. Those include muscles, skin folds and leg length:<sup>xvi</sup> “The triceps skinfolds of Africans are less than those of Europeans due to ethnic rather than to nutritional influences” (*ibid.*: 112) or “the longer legs of African groups is believed to be a genetic characteristic” (*ibid.*: 111).

Furthermore, skeletal age occupies a crucial place in this process of racialization as it is used to extrapolate different genetic patterns (*ibid.*: 199-206) even if the racialization of skeletal development is based on incomplete data (7 ossification centers out of 30, for which selection criteria remain undisclosed) and deduced from proximities in measurements of Africans in America and Europe, who are exposed to presumptively similar living and healthcare conditions (*ibid.*: 204): “African children under good nutritional and environmental circumstances are more advanced than Europeans in skeletal development from birth to adolescence” (*ibid.*: 206). The skeletal development speed of African children placed in Western living conditions supports the argument of a genetic specificity, proving the existence of a “racial” tempo of growth – which remains dormant in Africa when children are subjected to difficult living conditions, but is activated in the West. Difference thus moves in beyond the barrier of the skin. A profound otherness is constructed both in growth tempos than in nature: “There may also be differences between different parts of the hand skeleton” (*ibid.*: 206). The bones of African skeletons are thus described as denser than the bones of Europeans (*ibid.*: 236). Similarly, when observing teeth, Tanner choses to only consider permanent teeth to reinforce the differences between “ethnic groups”, which are not as apparent during prime infancy: “whereas there are no clear differences between ethnic groups in the age of eruption of deciduous teeth” (*ibid.*: 210).

Finally, the causal role of social determinants is underplayed in African populations<sup>xvii</sup> and restricted to specific bodily features (head circumference for example (*ibid.*: 110)). While highlighting the specificities of the social conditions of existence experienced by these groups (malnutrition, measles, pertussis, vulnerable living conditions of mothers), the authors support the idea of a shared genetic heritage, which becomes apparent when comparing Africans in North America with well-fed European children and “tribal Africans”, because “the combination of the effects of malnutrition and diseases masks the underlying genetic growth pattern” (*ibid.*: 75). Far from nuancing the genetic interpretation of growth, the comparison between social classes serves an argument that defines race as something people share in common beyond social class. Concurrently, African children are systematically compared to European children who are on the contrary de-racialized.

### *Variations between social classes: the de-racialization of Europeans*

The second chapter of the book, dedicated to Europeans in Europe, characterizes tempos of growth by using available growth data.

In this section, shoulder and hip widths, chest, arm and calf circumferences, skinfold thickness and head circumference are used to measure child development, and not as a marker of race (contrary to Diasio’s findings concerning the mid-nineteenth century, see Chapter 1). In

addition, the authors stress the heterogeneity of available data – as much in the construction of samples of children as in measurement methods, in the standardization of measurements (Eveleth & Tanner 1976: 19) and in the geographical areas surveyed. As a consequence, they refuse to calculate a national average for these groups, highlighting the variable degrees of maturation observed per “occupational category” (*ibid.*: 34). The focus is placed on socio-economic variations of growth and on the assertion of this group’s genetic and auxologic homogeneity – in spite of significant variations in the measurements: “Europe also has the advantage that the population is relatively homogeneous from a genetical point of view” (*ibid.*: 15). Finally, when Europeans are compared with other African and Asian populations, this is done with the purpose of deducting universal standards of growth or medical risk,<sup>xviii</sup> or that of identifying racial patterns of growth. For example, leg length is mentioned in this section when the authors stress that European populations meet certain standards in their conformation (like the African’s, the European’s leg is about half the total height of their body) whereas in the chapter dedicated to the characterization of an African growth pattern, longer legs and arms are described as specific biological traits found in populations of African descent.

This third period in the interpretation of bone age is thus marked by a racialized medical reading of human growth, which stems from a distinctive type of genetic knowledge. Otherness is denoted not so much by conformation or by the measurement of orifices (see Chapter 1) as by maturation tempos. As it transforms into a chronological process, race paradoxically becomes a more rigid notion. It is not understood as an encounter between an organism situated within a given maturational phase and a particular socio-economic environment at a given point in time. Instead, it is regarded as a degree of expressiveness of an initial “genetic map”, a program whose deployment can be attenuated or optimized under certain living conditions at certain ages: childhood is seen as a phase of plasticity, puberty as the awakening of a pattern, adult age as the period of its full expression. This view, which was formalized in the late 1970s, occupies a key place in pediatric and endocrino-pediatric research (Mora & *al.* 2001), as studied in the chapter 7, and even converges with the mainstreaming of genetic bio-ancestry measurement tests (Guo & *al.* 2014; Doron 2016).

## Conclusion

This chapter shows how bone age, initially regarded as a marker of age, became an ethno-national and later a racial marker: the study of models used for the categorization of age can thus shed light on previously undetected processes of racialization. Our study also highlighted the emergence of a new form of racialization based on chronology, which seems to have appeared in a particular branch of late 1970s pediatrics, and which is also addressed by Vinel in her study of the menarche (Chapter 7). Genetics occupies a complex role in this process. Whereas in certain spaces, this discipline contributed to the deconstruction of race, in others on the contrary (human biology and “inter-cultural” pediatrics), it re-constructed this notion by paradoxically tapping into social data.<sup>xix</sup> Race thus becomes what cannot be explained by class conditions: this redefinition shows that considering the social environment does not necessarily imply a de-racialized interpretation of human measurement.

This study of the very particular case of the racialization of bone measurements also reveals a transformation of the medical gaze as noted by Armstrong (1983), and more specifically of the medical field’s spatial economy and associated categorizations. This shift modified the scale of the communities produced by researchers, and the interpretations of the reference groups thus constructed (M’charek, Schramm & Skinner 2014). In the wake of World War Two, the community of reference was a local social space defined by shared social living conditions, with people living on the poor or wealthy side of town. In contrast, from the 1970s onwards, the interpretation of standards of growth spans across more distant spaces: “national”

differences, immutable “tribal groups” versus “mixed” or “homogeneous but non-tribal” groups (such as European populations according to Eveleth and Tanner). This social space is used no longer to situate bodies within a metered continuum, but rather to infer their sameness based on presumed shared genes. Regardless of social distance, physical proximity becomes an indicator of ontological kinship – another occurrence of the *epistémè* of resemblance described by Diasio in her study of the nineteenth century (Chapter 1).

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<sup>i</sup> The corpus initially comprised 5,889 entries. By reading the abstracts, we were able to filter out papers addressing bone maturation in children with specific pathologies and restrict ourselves to studies aimed at determining age in relation to “ethnicity” or “race”. Working from this narrower second corpus (191 entries), we carried out a double analysis – first by considering each document individually, then by comparing them. We were thus able to extract the three main categories of uses of bone age presented in this article. We then selected a number of “typical” contributions, which formed the focus of our argument. The selection was based on these contributions’ line of argument and on the understanding of bone age they conveyed, but also on the position occupied by their authors in the field of bone maturation studies. This perspective, which places the emphasis on authors rather than on lexemes, allowed us to reveal shifts in the positioning of major figures in this field, thus highlighting the weight of historical, scientific and political contexts on these changes. For instance, Tanner “exported” his vision, initially developed in the context of social pediatrics, into late 1970s genetics-inspired pediatrics.

<sup>ii</sup> An analysis of the sexualization of bone and of the construction of bone maturation measurement tables establishing a rigid distinction between sex groups remains to be conducted – according to the same model followed by anthropologists who studied how bone was gradually constructed as a marker of sex. On this question, see for instance Evelyne Peyre (2015) and Judith Bouhallier (2015). This question exceeds the scope of our study, which focuses on the ethno-nationalization and racialization of bone.

<sup>iii</sup> The notion of community in Armstrong’s works is close to that of population in Foucault’s. It does not imply a subjective identification or a type of tie, but refers to the collective in which children’s bodies are aggregated (for instance a city), and based on which deviations from the norm are assessed: “The new body is not a disciplined object constituted by a medical gaze which traverses it, but a body fabricated by a gaze which surrounds it: the new body is one held in constant juxtaposition to other bodies, a body constituted by its social relationships and relative mental functioning, a body, of necessity, of a subject rather than an object” (Armstrong 1983:102).

<sup>iv</sup> In particular when is missing a random control survey comprising of children with contrasting health statuses and whose measurements would be likely to meet normal standards. This is an important condition which allows the use of the abacus (this precaution is taken by Quételet when using averages). Here, Tanner refers to families who falsify their children’s age in Southern countries with a “male predominant culture” in order to have boys in education at an earlier age and girls at a later age. For these ages, Tanner suggests using primary teeth, which are less susceptible to the environment, to determine children of school age (5/6 years old). Very different markers were later used in France to determine whether unaccompanied foreign minors were 18 or more. This reflects the impact of social issues on the selection of relevant biological markers (Chapter 2).

<sup>v</sup> This term appears to have been misunderstood in French translations of Greulich and Pyle where the authors are often presumed to support the notion of a “white race” (Jacques 2009). In these early works, skin color does not express the author’s belief in the existence of a biologically distinct group but rather a quite fuzzy dimension: this phenotype is politically associated with class position, as individuals who are “labelled” as black find themselves circumscribed in disqualified social spaces.

<sup>vi</sup> <https://case.edu/dental/departments-programs/bolton-brush-growth-study-center>. In 1970, the foundation expanded its collection of international maturation measurements with over 200,000 radiographs of the head (lateral and frontal views) and the main joints of the body (shoulder, elbow, wrist/hand, pelvis, knee and



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ankle/foot). This website actively promotes these collections, which clearly act a marker of the foundation's position in the field and market of medical measurements.

<sup>vii</sup> This, in spite of the fact that these studies were conducted on sometimes narrow samples – from 190 (Zabet, 2015) to 1,0009 individuals (Andersen 1971) – with a particular social profile: students described as “healthy”, living in “average” sanitary conditions.

<sup>viii</sup> It should be stressed that most forensic medicine studies cover Northern countries or strategically placed neighboring countries located along migratory routes (between Morocco and Italy for example) – i.e. places in which forensic assessments of bone age or postmortem identification can involve a guesswork estimation of age.

<sup>ix</sup> See for instance Braun's study (2014) on the introduction of racial standards into spirometers.

<sup>x</sup> This trend was widely supported by public health institutes: see for instance the surveys conducted by the NCHS and the University of Texas School of Public Health under whose impulse the first ethnicized databased were introduced, in particular on cardiovascular diseases (in Louisiana, Philadelphia and Pennsylvania). This “racialization” was present well before 2000 and the introduction of the BiDil as studied by Khan (2013): see Jones' study (2013) of pharmacogenetics in the 1950s.

<sup>xi</sup> This shift goes along with the transformation of the role of measurement in the symbolic economy of research tasks (clinical measurers vs modelers from research institutions) and methodologies (where individual clinical studies were discredited in favor of statistics, deemed to provide a higher level of proof).

<sup>xii</sup> This biology, based on the diversity of humanity, seeks to measure its potential of change under environmental pressure. It is supported by the World Health Organization and the International Biological Programme (see J.S. Weiner, international convener of the Human Adaptability program, in the acknowledgements (Eveleth and Tanner 1976: XIV).

<sup>xiii</sup> See in particular the *Human Genome Diversity Project* (HGDP), launched in parallel with the Human Genome Project to identify and preserve intra-human genetic biodiversity by drawing samples from isolated populations with common geographic, cultural and linguistic features.

<sup>xiv</sup> This perspective underestimate the intensity of internal migrations within the African continent and Southern countries.

<sup>xv</sup> Studies on Afro-Americans in the USA did not include blood tests to compare genomic and statural measurements. The authors used the presence of a particular blood factor that was absent in “tribal groups” but present in “American Africans” to deduct their “mix” and support the idea that 1/5 to 1/4 of USA Afro-Americans were descendants of Europeans. For a critique of these methods, see Doron 2016.

<sup>xvi</sup> The menarche, whose racialization is studied by Vinel in this book, has a particular status in this study. The “precocious” menarche in girls is mentioned, but it does not function as a factor of racialization. Instead, it marks the beginning of a phase in which variations between measurements intensify, requiring additional methodological precautions. It is also described as subjected to major environmental influences – diet, but also the influence of the tropical climate (Eveleth and Tanner 1976: 219) – and is rarely associated with clear genetic determinants that could make it possible to distinguish between populations. This explains why this factor takes on a secondary role in Eveleth and Tanner's study.

<sup>xvii</sup> The analysis follows a different perspective regarding “Asiatics in Asia and America”, for whom nutritional differences and measurement biases are more widely considered: “There is great diversity in adult Asiatic populations, reflected in the growth of the children” (Eveleth and Tanner 1976: 118) due to “differences in nutritional or racial background, or possibly even to some unknown differences in measuring techniques” (*ibid.*: 153).

<sup>xviii</sup> See the focus on the increase of body fat in children in developed countries, where obesity is presented as a medical and social hazard (Eveleth & Tanner 1976).

<sup>xix</sup> Bliss (2012) refers to this thinking as “the sociogenomic paradigm of race” in contemporary genetics research.