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Joëlle Proust

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The cultural evolution of information seeking

Joëlle Proust

Institut Jean-Nicod, ENS, Paris

joelle.proust@gmail.com

Abstract

The mechanisms of selection, assimilation and transmission at work in cultural accumulation need to include evaluative processes for detecting informational lacunae and repair mechanisms. Novelty, interest, learnability of alternative concepts and practices need to be permanently monitored at the individual and at the group level. It is proposed that the evaluative mechanisms that control cultural accumulation are themselves subject to cultural evolution. This article outlines a plausible sequence of evolutionary steps from curiosity-based exploration to inquisitive communication and to collective epistemic deliberation. Procedural metacognition, based on affective monitoring, regulates curiosity and early forms of inquisitive communication. Explicit metacognition, based on transmitted concepts, rules and practices regulates collective epistemic deliberation. It successively expands across cultures the epistemic sensitivity to a range of distinct norms such as evidentiality, consistency, explanatory power and consensuality.

Keywords: Cultural accumulation, curiosity, inquisitive communication, epistemic deliberation, procedural metacognition, explicit metacognition, epistemic norms.

Introduction

Human culture depends on the *selection, assimilation and transmission* of predictive information about the physical and the social environment (including values, know-hows and emotional management). These three functions are supported by a superposition of metacognitive and socio-cognitive mechanisms. This article explores how the metacognitive processes underlying information seeking have evolved from individual error detection and learnability assessment to inquisitive behaviour and epistemic cooperation.

Defining metacognition

The definition to be used in this paper focuses on the *homeostatic regulative structure* of informational processing (Nelson & Narens, 1990) (cf Fig. 1).

Metacognition is the set of abilities whose function is to control and monitor likely efficiency of one's ongoing cognitive activities.

In virtue of this definition, an organism has metacognition if it is able to predictively assess its likely ability to discriminate, remember, or acquire information in a cognitive action, and to guide its decision on this basis (e.g., attempting to remember). This definition contrasts a primary cognitive task (e.g., attempting to discriminate) with a secondary metacognitive evaluation (assessing one's own likely efficiency in discriminating).

Metacognitive mechanisms

Two main types of mechanisms have been used, in the course of evolution, to perform the functions defined above.¹ *Procedural metacognition (PM)* – a self-evaluative ability present in rodents, birds and primates – is implemented by nonconscious predictive heuristics and comparators and their affective outputs (metacognitive feelings). *Explicit metacognition (ExM)* is a human mode of evaluation that complements and hierarchically controls procedural metacognition. In association with episodic memories, beliefs and theories about an on-going task, agents judge what they are up to: "this task is easy", "one cannot learn in a noisy place", "females are no good in maths". ExM may either accept or resist PM-based evaluations.

Goal of this article

This article concentrates on the *evolution of informational search* from PM to ExM. It means to explore the role of language in cumulative cultural learning and to clarify the interplay between individual and collective aspects of epistemic decision-making.² While the transitions involved are relatively well-documented in developmental research,³ they are much less studied from an evolutionary viewpoint. The present proposal outlines a plausible sequence in the evolution of evaluative mechanisms in the primate lineage.

Comparators

Information seeking is one of the oldest forms of cognitive action across phyla. Curiosity is the metacognitive feeling that regulates individuals' trade-off between exploring information and exploiting it. Inquisitive communication refers to ways of obtaining

¹ See Koriat & Levy-Sadot (1999).

² Processes of decision-making are *sociocognitive* when social considerations, including institutional rules, hierarchically control the output of information-based mechanisms. Mercier & Boyer (2021), Poirier & al. (2021).

³ For a review, see Goupil & Proust, (submitted).

information from cooperative others. In these and other forms of cognitive actions, a similar regulative scheme monitors progress to goal at three functional junctures

- Before an action is selected, in order to determine its feasibility;
- During action performance, in order to detect discrepancies between expected and observed feedback;
- After the action is completed (in order to compare the expected and the observed outcome)

In each action segment, a comparator monitors ongoing activity (see Figure 1). Comparators are based on nonconscious stored predictive cues and heuristics. Their output consists in a conscious metacognitive feeling, whose gradient of valence and intensity modulates predictive confidence in a given action type⁴ and guides further decision-making (see Table 1).

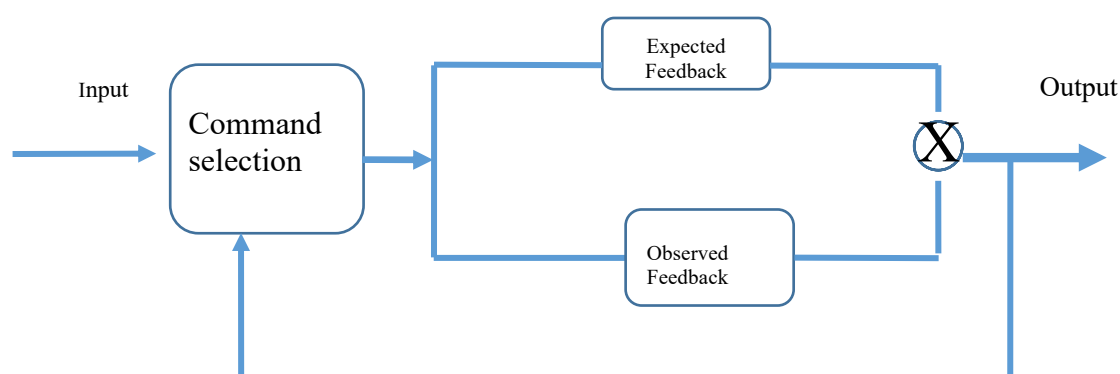


Figure 1. The homeostatic structure of action regulation is based on comparators, whose output – a metacognitive feeling – further guides decision-making.

⁴ See Koriat & Levy-Sadot, (1999), Proust (2013).

Goal-related predictive feelings	Process-related evaluative feelings	Result-related evaluative feelings
Feelings of curiosity	Feelings of error	Feeling of being right/wrong
Feelings of familiarity	Feelings of incomprehension	Feeling that one learned ("judgement of learning")
Feelings of knowing	Feelings of incoherence	Eureka feeling
Feelings of prospective confidence	Feelings of interest/boredom	Feelings of retrospective confidence
Tip-of-the tongue	Feelings of confusion	

Table 1. Taxonomy of metacognitive feelings based on activity segments being assessed (reproduced from Goupil and Proust, submitted).

Exploratory cognitive actions across cultural evolution

On the view defended here, three kinds of exploratory action develop sequentially in cultural accumulation through a hierarchical expansion.

1. curiosity-based exploration
2. inquisitive behavior
3. group-level epistemic action.

Different cognitive mechanisms are involved in each case.

I - From curiosity to exploration

a) Before exploring

Curiosity depends on two metacognitive comparators that automatically detect

- lack of knowledge in a given context.⁵
- learning potential in this context.⁶

Curiosity occurs when two informational properties lie above a stored statistical threshold:

- i. An informational gap is detected: in a given context, the agent feels unable to arbitrate among alternative predictions based on her prior beliefs. An incipient drive to collect additional information arises.⁷
- ii When a learning affordance is sensed,⁸ an exploratory behaviour is triggered.⁹

b) During exploration: additional metacognitive comparators step in. A *progress rate* comparator induces engagement, persistence or disengagement until curiosity is satiated.¹⁰ Exploration duration is subject to a contextual trade-off between information-seeking and expected reward.

c) After exploration: the known best option is assessed and selected for exploitation purposes.

II - The case of inquisitive communication.

⁵ Loewenstein, (1994).

⁶ Luciw et al., (2013).

⁷ Golman & Loewenstein, (2018)

⁸ See Pezzulo & Cisek, (2016). About cognitive affordance sensings, see Proust (2016); about their evolution: Cisek (2021).

⁹ See also Vygotsky's "zone of proximal learning" in Vygotsky & Cole, (1978).

¹⁰ See Ten et al., (2021).

The step from curiosity to inquisitive behavior involves the ability to request information from another agent or to respond to such a request. Questioning and responding practices might have evolved in a context of information reciprocation among kins in late Pleistocene, possibly within a gesture-based referential protolanguage.¹¹

Definition. An inquisitive behaviour (from now on: IB) is initiated by a sender S in order to reduce her subjective uncertainty about a given topic. In IB, S questions R because *she wants to learn something* from R (curiosity-driven, epistemic questions), not primarily because *she wants to obtain something from R* (utility-driven questions).

Semantic structure Epistemic questions (verbal or nonverbal) have a semantic structure¹² that may or not systematically organize early forms of curiosity.¹³ A question has a *focus*, such as a new object in the environment; it also represents a *topic*: a range of options to be narrowed down concerning the focus (for example, how to name this object, how to play with it). Adequately answering a question, then, requires identifying its focus along with the set of relevant topical alternatives – the "contrastive topics" - that the questioner has in mind. A plausible conjecture is that the underlying representational ability is shaped by caregivers' communication to pre-linguistic infants. Curiosity-based questioning detects the existence of alternative informational pathways (i.e. sets of cognitive affordances). Questioning relies on this primary detection, but selects, in addition, a subdomain of alternatives, (e.g. name, function, place, time.)

¹¹ Sterelny (2016). On the evolution of teaching, see Laland, (2017).

¹² Roberts, (2012).

¹³ See Wilson et al., (2022).

Developmental evidence for the semantics of inquisitives – At the end of their first year, infants start producing curiosity-driven pointing gestures¹⁴, having a specific focus, manifested in ostensive gestures, as well as a specific topic. Declarative pointings communicate a *focused desire to share* with another person the perception of an object of interest.¹⁵ Inquisitive pointings are successively used by infants to learn the name and the function of an object.¹⁶

Verbal children keep on asking questions until they receive an explanation.¹⁷ This persistence shows that inquisitive behaviour relies on the comparators involved in curiosity monitoring. Thanks to shared linguistic and pragmatic practices, IB can take advantage of a diversity of cognitive affordances and the associated cognitive tools such as:

- informer availability and resource value.
- Focus-topics contrasts – an opportunity to compress information in memory.

Story telling practices prepare children's sensitivity to cognitive affordances, a sensitivity further developed by formal teaching.¹⁸

Types of questioning – What can questions be about? Based on information gap detection and cognitive affordance detection, a sender S is able to verbally express the kind of interrogation corresponding to her intended repair. Interrogative words have a double role: 1) they *express a specific need*. 2) They *control* both the sender's sustained attention to a response, and the receiver's attention to the selected focus. In the response provided, the lacuna-tracking interrogative word is filled-in by a word, a phrase or a sentence. For example

¹⁴ Begus & Southgate, (2012); Tomasello et al., (2007)

¹⁵ Lucca, 2020; Tomasello et al., (2007)

¹⁶ Lucca & Wilbourn, (2019)

¹⁷ Frazier et al. (2009)

¹⁸ Caregivers scaffold not only language acquisition, but infants' uncertainty detection and willingness to communicate in order to repair it (Begus & Southgate, 2012). Infants learn better the function and names of objects they have previously pointed towards (Begus, Gliga, & Southgate, 2014).

the name of a person is to be provided (who ?, whose ?), of an event type (what?), of a place (where?) or a time (when?) etc.

How is a form of questioning socially stabilized? At first impulsively produced, non-verbal inquisitive pointing and curious verbal questioning are differentially reinforced across cultures, as a function of rearing practices, caregivers' cooperative responses,¹⁹ and teaching methods.²⁰ On the view defended here, three questioning types correspond to distinctive informational needs associated with distinct stages of cultural activities.

- i. Routine questions have a basic informational goal: they target first-order *environmental and social affordances* (the location, name or function of objects or persons, physical or social events to be expected, ways of doing).
- ii. Clarification questions are posed in response to mishearing or misunderstanding a word, a word, a sentence, a gesture. They emerge between 20 and 30 months in non-sentential queries (“what?”) or reprise fragments.²¹
- iii. Explanatory questions aim at enriching one's own inferential potential by exposing causal relations between focal elements (e.g., successive events). They emerge around 3 years of age.²²

As emphasized by Bayesian approaches, asking a question and answering it can target event and resources predictability ("hidden state information"), the computational vehicle (clarity) or the "parametric structure" of the environment (explanatory power).²³ Because error-detection-and-repair is a basic mechanism cumulatively re-deployed in the hierarchy of

¹⁹ Once the metacognitive structure of ostensive questioning is stabilized, language acquisition enables children to use it in flexible and strategic ways, alternating the roles of sender and receiver in a variety of interrogative modalities. See Goupil & Proust (submitted), Proust (2015).

²⁰ Karabenick (2004), Kim et al. (2018).

²¹ Ginzburg & Kolliakou (2018)

²² Chouinard et al., 2007. Causal-explanatory questions include teleological questions (regarding object functions).

²³ Friston et al., (2017); Schwartenbeck et al., (2019).

inquisitive actions, a similar sequence of questioning should be found across individual development and social practices:

- i. basic questioning relies on the exploration/exploitation trade-off (sensitivity to *informativeness*)
- ii. dyadic communication secures alignment on focus and referential idiom (norm is *expressive clarity*).
- iii. group decision-making, (see next section) requires participants to explicitly share informational-explanatory goals and communication rules (norms are *explanatory power* and *argumentative clarity*)

Questioning across cultures –A comparative study indicates that 3- to 5-year-old children from Belize, Nepal, Kenya and Samoa ask as many information-seeking questions but less explanatory questions than their US counterparts. These differences manifest the impact of socio-cognitive rules on IB.²⁴

- i. Children's respect toward adults – a traditional, not a Western social rule –, is often associated with a command not to request explanations from adults.
- ii. In Western societies, adults prepare their children to formal school education by encouraging them to ask or to respond to explanatory questions.²⁵ In traditional societies, children are expected to cooperate with adults in carrying out community tasks. They are encouraged to learn by observation the parametric structure of their physical and social environment.²⁶

The socio-cognitive dimension of *epistemic autonomy* might thus differentially impact informational mining across human societies.²⁷ Words such as "why", as well as turn taking

²⁴ Gauvain & Munroe, (2020).

²⁵ Ochs & Schieffelin, (1982/2001)

²⁶ Gaskins & Paradise, (2010). For example, Maya children are allowed to play with knives.

²⁷ Kim et al., (2018).

and response monitoring, however, are universal metacognitive tools, whose function is to control and monitor epistemic agency in self and others. As suggested above, *metacognitive tools are transmitted ways of controlling the detection and exploitation of metacognitive affordances*. They are advertised as recommended strategies for selecting the adaptive trade-off between effort consumed and successful information acquisition (e.g. "teaching", "learning", "paying attention").²⁸

Inquisitive behaviour and mindreading ability - It has been proposed that questioning presupposes an ability to conceptually represent the contrast between one's present ignorance and a specific knowledge goal.²⁹ Does inquisitive communication – and the corresponding forms of cultural accumulation – require a capacity to metarepresent knowledge and ignorance?³⁰ Current studies suggest that inquisitive communication *does not* presuppose a *conceptual understanding of knowledge*.³¹ Questions and answers might only involve concept-based metarepresentations when they specifically (rather than rhetorically) focus on mental states (compare: "do you know where John is going"? with "Are you sure to know where John is going?").

A recent study explores children and adults' answers to ambiguous questions – where the referent of the question needs to be inferred from what the questioner allegedly knows or ignores about a situation as a function of her perceptual access.³² When interpreting epistemic questions, both adults and children readily consider what the questioners can or cannot see, but not necessarily what they know or do not know. Furthermore, children's ability to

²⁸ On teaching as a metacognitive tool, see Zawidzki (2021), Qiu & Moll (this volume).

²⁹ Bromberger, (1988).

³⁰ This question raises the more general issue of whether mindreading has to be involved in meta-communication (the ability to interpret the meaning of a signal or of a verbal utterance). In contrast to Origgi & Sperber, (2000), Proust (2016) proposes that basic metacommunication depends on PM.

³¹ Carruthers (2020).

³² Aguirre et al., (2022).

interpret questions that have an ambiguous focus *does not* correlate with their performances in second-order false-belief tasks.

One might object that the epistemic vigilance manifested in children's inquisitive behaviour is evidence for mindreading: 2-yr olds can already recognize informants as potentially benevolent or malevolent; 3-yr olds progressively learn to distinguish correct from incorrect testimony;³³ 6-yr olds are able to learn a name from a *single* reliable informer over three unreliable but consensual informers.³⁴ *There is no consensus, however, that such a sensitivity to others' epistemic competence and trustworthiness is enabled by mindreading.* Comparative psychologists report that nonhumans can detect trustworthy co-operators and reliable signallers in the absence of an ability to read others' minds.³⁵ Epistemic vigilance in young children might similarly depend on the detection of cognitive affordances, i.e. on procedural metacognition rather than on mental reasoning.

In conclusion, detecting an informational gap or a learning affordance and representing a domain of alternative options belong to PM mechanisms. Questioning might only involve mindreading in strategic cognitive actions – with high informational stakes, marked epistemic asymmetry between senders and receivers, – or in collective decision-making (see section 3).³⁶ This suggests again that cultural accumulation has opportunistically depended on a variety of partly independent cognitive and socio-cognitive mechanisms.

III - Group-level epistemic decision-making

It is generally accepted that ExM optimizes decision-making by appealing to epistemic group expertise. Its suprapersonal function of *cognitive control*, shaped by biological and cultural

³³ Corriveau & Harris, (2009).

³⁴ Bernard et al. (2015).

³⁵ Byrne, (1999); for the view that any form of intentional communication requires mindreading, see Baron-Cohen, (1999).

³⁶ See Proust, (2018).

evolution,³⁷ is associated with specific forms of monitoring, such as the extraction and integration of individual participants' evaluative feedback about a proposal. From a crosscultural viewpoint, a striking feature of ExM is its variability across time and space. Local division of cognitive labour, background knowledge, salient epistemic norms, in conjunction with social values and socio-cognitive considerations, together shape collective decisions in medical, legal, political or scientific contexts.³⁸

Defining epistemic group agency - Epistemic group decision-making is

a social process aiming to form common epistemic attitudes based on distributed information and deliberation about relevant informational or explanatory issues, and to plan future cognitive or instrumental actions on their basis.³⁹

As defended elsewhere,⁴⁰ groups as such do not have beliefs. Striving to reach a decision by reasoning on the basis of the information distributed in the participants' minds, groups as such can only form acceptances under consensus.⁴¹ Each epistemic goal (e.g. informational, clarificatory, explanatory goals) activates *e-norms*, i.e. specific standards to be met while processing information (for example: evidentiality, consistency, inferential power).

Epistemic efficiency in collective actions again depends on three types of action feedback being collected and used:

Before: 1) Markov blankets⁴² enabling e-efficiency in a domain must⁴³ be identified as available (epistemic affordances). 2) division of labour must be organized as a function of the

³⁷ Shea et al., (2014).

³⁸ Kim et al. (2018).

³⁹ Pettit (2003), Proust (2018).

⁴⁰ Proust, (2018).

⁴¹ Collective decision-making integrates truth-evaluations by participants: their potential divergence makes consensus a proxy for truth.

⁴² A Markov blanket is an independent domain of probabilistic predictions (and the associated neural activity), as automatically partitioned through the interactions of an organism and its environment. See Poirier et al., (2021), Hipólito et al., (2021).

⁴³ "Must" here is associated with factivity: when requirements fail to be met, evaluations fail to deliver a predictive indicator. A requirement, however, is relative to a specific e-goal.

relevant e-norm(s).⁴⁴

On the way: Individual subjective uncertainty concerning evidence reports crucially needs to be collected and integrated.⁴⁵ Quality of cognitive exchange needs to be monitored by adversarial arguments.

Final step: retrospective collective evaluations are expressed in consensual acceptances; if no sufficient consensus is obtained, additional expertise and deliberative work are in order.

The role of mindreading in group epistemic agency

As we saw above, questioning and responding typically depend on representing first-level situations, rather than on metarepresenting the questioner's or the responder's knowledge.

Mindreading, in contrast, is a necessary ingredient of collective e-agency, and might have co-evolved with it within an inclusive socio-cognitive niche.⁴⁶

- Group deliberation is centred on arguments, not on their individual sources. However, it is functionally essential for efficient deliberators to remember who said what.
- In order to detect possible interest-based coalitions,⁴⁷ they need to infer privately comparative trustworthiness, expertise and disinterested e-engagement.
- Metarepresenting co-participants' beliefs and intentions enables individual participants to make sense of the collective consensual acceptances as distinct from their own beliefs.⁴⁸

ExM and cultural evolution

⁴⁴ See for example the rules of deliberation discussed by List and Pettit, (2011).

⁴⁵ Fusaroli et al., (2012).

⁴⁶ Whiten & Erdal, (2012).

⁴⁷ Mercier & Boyer, (2020).

⁴⁸ See Proust, (2018).

Granting that ExM controls and monitors collective e-agency, its evolution can be driven either

- as a *control mechanism*: new goals are pursued, engaging different e-norms, e-methods and e-tools;
- as a *monitoring mechanism*: new types of feedback are found necessary to evaluate efficiency.

A general hypothesis in the philosophy of science and technology is that an ExM *control change* is first triggered by a *monitoring crisis*. In Larry Laudan's definition,

An epistemic crisis occurs when a group or community finds itself with reasons to question the correctness of the rules and structures it has been using for fixing beliefs. (Laudan, 2001, p. 273).

In other terms, an e-crisis is generated when the *e-decision rules* themselves are found unable to produce *consensus-based acceptances*: poor evidential methods, biased expertise, prejudiced inferences or poorly managed debates can be blamed. A control crisis is resolved when a new set of presumably more reliable control and monitoring epistemic practices are consensually accepted, resulting, for example, in a scientific revolution⁴⁹, or in Civil law supplanting Common law.⁵⁰ Given our three-tier evaluative structure, revisions can target goal, process and final evaluation. For example, the Ptolemaic geocentric model was overthrown by the Copernican heliocentric model, based on mathematical arguments, naked eye observation, and telescopic evidence. Selecting alternative e-norms, such as evidential quality and consistency with astronomic findings (rather than reliance on naïve phenomenology or on consistency with Scriptures) presupposes both doubts concerning *prior*

⁴⁹ Kuhn, (1962).

⁵⁰ Poirier et al., (2021).

metacognitive tools and a sensitivity to more promising alternative *metacognitive affordances* (i.e. Markov Blanket-sensitivity).

Studies in the history of science and of legal systems show how epistemic collectives dynamically change in division of labour, goal selection and associated e-norms. As will be seen below, however, former belief systems may survive in local cognitive niches, including cultural institutions whose explicit goal is to keep traditional ways of thinking alive (religion, art, philosophy).⁵¹ This kind of inertia demonstrates the impact of *control mechanisms* in cultural accumulation.

ExM internalized – Granting the deliberative structure of group decision-making, how can it be internalized? The response is that adversarial deliberation, as well as other cognitive actions, once trained, become individual habits of control: individual minds are shaped to respond to a number of epistemic norms and social rules as a function of context.⁵²

"Intrapersonal" informational goals, then, only differ from suprapersonal ones by the direct, unmediated access agents have to PM monitoring at each monitoring step. PM monitoring, however, is now itself under the control of epistemic norms and metacognitive strategies, whose function is to resist the guidance provided by metacognitive feelings, when it is appropriate.⁵³ Experimental evidence shows that individual thinkers are indeed able to resist the verdict of procedural metacognition, when explicitly provided reasons to doubt it. Under higher cognitive load, however, they can no longer resist it.⁵⁴ In this case, fluency-dependent responses prevail over effortful ways of integrating all the information available.

⁵¹ Legare & Shtulman, (2018).

⁵² Zawidzki, (2021).

⁵³ Heyes et al. (2020) mention the controlled character of ExM, and its dependence on working memory. This dependence, however, describes rather than explains the transition from collective to individual self-evaluation.

⁵⁴ Nussinson & Koriat, (2008).

In summary, as seen in the flowchart in Fig. 2, the evolution of information seeking across cultural accumulation involves a hierarchy of control and monitoring steps.

- As a first step, lacuna detection and learnability assessment trigger curiosity-based exploration.
- Inquisitive behavior conjoins curiosity with an ability to solicit and receive relevant information through gestural and verbal semantic exchanges.
- A higher-order epistemic awareness (which flows back into inquisitive behaviour) occurs when epistemic norms are made explicit, and used in division of labour and decision-making (ExM). Mindreading interacts with ExM to allow co-operators to reflectively reason about the deliberative processes and their conditions of correction.

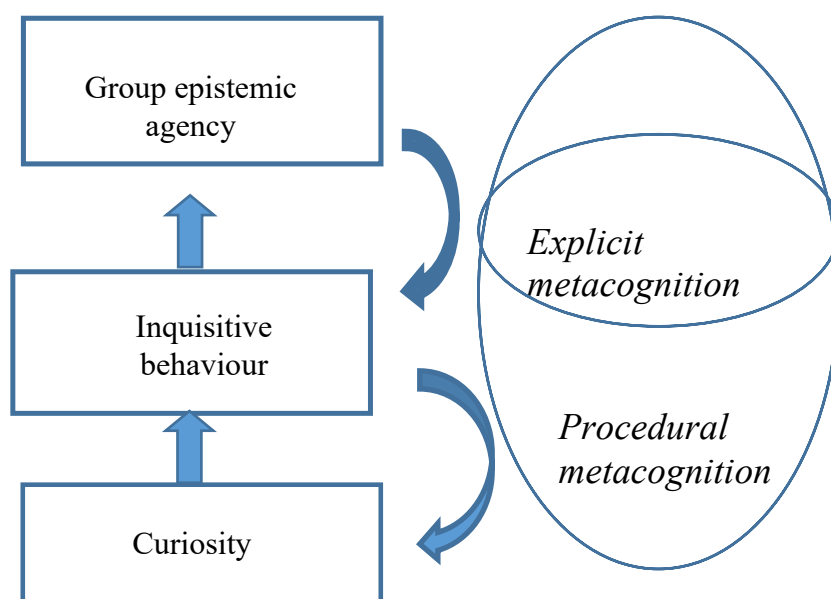


Figure 2. Successive steps in the cultural evolution of information seeking

Suboptimal collective agency – From the viewpoint of the evolution of cumulative culture, group acceptances such as creationism, flat-earth or conspiracy theories and the use of post-

truth as a norm of justification question the view that suprapersonal epistemic control tends to optimize cognitive output. What is fascinating in such cultural e-variants is that they are widely replicated in cultures where alternative variants are available. Should one take them to be by-products of biased transmission of information, attempts of restoring coherence within belief systems, or cultural adaptations connected to specific socio-ecological niches?

A viewpoint common to evolutionary theorists and cognitive scientists is that optimality depends on functional equilibria in the trade-off resource-benefit that applies to action selection: impulsive, routine, and strategic decision-making can all be contextually adaptive.⁵⁵ This hypothesis has been applied to conspiracy theories.⁵⁶ It might have paid earlier in human evolution to detect hostile coalitions to collectively take action against them. The detect-and-repair mechanism involved in these impulsive cognitive actions are part of our innate biological endowment. Such actions have a low cost: they are fluently performed and easily shared when the relevant cues are detected. A number of revisionist belief systems – such as flat earth – might draw on conspiracy theory to restore coherence with phenomenology and tradition.⁵⁷

In contrast, the post-truth phenomenon defines *a new norm of acceptance* – accepting as "my own" truth – whose role is to pre-empt adversarial argumentation. It builds on a social equity bias that tends to supplant epistemic requirements at the expense of group efficiency.⁵⁸

Conclusion

Successive forms of epistemic self-evaluation have co-evolved with cumulative culture,⁵⁹ from curiosity-based exploration to inquisitive communication, and finally to collective e-

⁵⁵ See Proust, (2015, 2021).

⁵⁶ van Prooijen & Van Vugt, (2018).

⁵⁷ On cultural conservatism, see Morin (this volume).

⁵⁸ On the equity bias, see Bahrami, (2018), Fusaroli, (2012). On post-truth, see Proust (2021).

⁵⁹ See Dunstone & Caldwell (2019), Heyes et al., (2020), Shea et al. (2014)

decision-making. The cultural evolution of ExM has extended the potential quality and power of informational evaluation in collective agents. It has controlled and aligned individual and collective epistemic assessment. However, it has also created new opportunities for manipulating informational value (of content) and trust (in sources) and for resisting such manipulation. From this Machiavellian arms race between informational and instrumental interests, explicit e-norms emerged as kind of metacognitive weaponry.

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