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Introduction

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What can metacognition teach us about the evolution of communication?

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It is often emphasized that the study of language evolution requires a cooperation between researchers working on different aspects of the problem.[1] In the rapidly growing literature about the origin and development of language, *Evolutionary Linguistic Theory* stands out for its strong emphasis on interdisciplinary approaches to language. The present issue pools resources from neuroscience, comparative and developmental psychology, paleoanthropology and the philosophy of mind to review the metacognitive properties of nonhuman signallings with human language-based communication. In the literature on the evolution of communication, continuity has been defended through game-theoretic structure[2], functional reference[3], cognitive mechanisms of understanding, including mirror neurons for action[4], shared emotions[5], shared affordances[6], and context-based signal interpretation[7]. Discontinuity has been inferred from the contrast between competitive versus cooperative dispositions[8], imperative versus declarative contents,[9] lexicon size and rapid word learning[10], absence or presence of symbolic artefacts[11], complex recursion[12], joint attention[13] and of mindreading[14]. The present volume considers a comparative dimension that has been rarely explored until now: how does nonhuman communication compare with

[1] See, for example, Kirby, 2007, p.679.
[2] See Skyrms, 2010
[3] Seafarth & Cheney, 2003.
[4] See Fogassi et al., 2005
[5] Jablonka et al., 2012
[6] Proust, 2023, Wheeler & Fischer, 2012
[7] Christiansen et al. 2011, Seyfarth & Cheney, 2003.
[8] Tomasello, 2008

its human counterpart from the viewpoint of the *metacognitive* mechanisms respectively engaged? This foreword will summarize the distinction between procedural and explicit metacognition, its potential relevance to the evolution of communication, the methodology to be followed and the research questions that will be focused upon.

Distinguishing two forms of metacognition

Metacognition refers to all the forms of control and monitoring of cognitive activities.[15] This wide definition applies to two distinctive types of processes, possibly reflecting two stages in the evolution of metacognition, based respectively on procedural predictions and on conceptual reasoning. *Procedural metacognition* is not uniquely human, and is not specialized in communication. It allows agents to predict or evaluate their success in their various *cognitive* actions (for example trying to learn, to discriminate, to solve a problem, or to understand). *Conceptual (or explicit) metacognition*, in contrast, is both uniquely human and language-dependent, but apparently not specialized in communication. To the extent that humans reason about what to do when subjectively uncertain, however, they share their explicit metacognitive judgments with others, to improve collective efficacy in decision-making, or to justify their own decisions. Because of these important communicative functions, a plausible hypothesis is that a form of specialized metacognition emerged, that controls and monitors human communication, both on line, e.g., in speech, and offline, e.g., in writing. The procedural and explicit processes involved begin to be systematically studied (Bang et al 2014 , Proust, 2022, Thorne et al. 2022).

What about the respective roles, in the evolution of communication, of procedural and explicit *metacognition*? For clarification, it is useful to compare this question with the discussion of the respective roles of affect reading and mindreading as a *cognitive* basis for the evolution of communication. This debate concerns the *content* of communication. Expressivism is the view that affects are *needed* to *directly* grasp the significance of a call or of a message.[16] Expressives, on this view, bypass the need of inferences to access message content. Dorit Bar-on (2013), for example, claims that expressive communication

through their facial gestures, bodily movements and behaviors.[17] Communicators converge on the intended meaning merely because it is emotionally expressed.

Procedural metacognition, applied to communication, also relies on affects, but its function is a more general one: it does not select contents, it regulates communication based on its processing demands. Metacognitive affects (called "metacognitive feelings") are an internal predictive guidance system that, in the case of communication, allows producers and receivers to select optimally efficient signals or messages in a given context. Feelings of fluency (ease of processing), of interest (expansion of neural activity), and of understanding (reaching a threshold for decision-making) have as their function to optimize message production and reception. Just as expressives do not require mindreading to access message contents, metacognitive feelings do not require mindreading to regulate communication. This does not mean, however, that inferences about others' mental states and intentions cannot be useful to enhance one's communication potential.

Explicit metacognition has it own role to play in human communication, when additional constraints apply, for example when collective decision-making is required by the circumstances. Senders have complex goals, from information to self-promotion and manipulation; receivers need to read senders' overt and covert intentions. In such contexts, explicit metacognition is needed to communicate about one'own informational goals, justify one's claims, and publicly express one's level of confidence in them. Mindreading is needed, in addition, to scrutinize communicators' sincerity and reactivity.[18]

Multiple ways of reasoning about evolution

How are we to reconstruct the role of metacognition in the evolution of communication? There are several ways in which this evolution can be described, depending on one's background theory. On *dual-inheritance* theories, culture and biology are parts of one interacting system, with feedbacks going both ways.[19] From this viewpoint, cultural traditions might influence, as well as be influenced, by the genes presiding to oral communication. On a *cultural epidemiology* view, in contrast, cultural processes have their

perspective, however, either memetic processes[20] and high-fidelity imitation, on the one hand, or creative reconstruction of a target input[21], on the other hand, have been taken to causally underlie cultural accumulation. A third view recently emerged: primates are able to use non-reflective forms of social learning to select their models, while humans are able to evaluate models' reliability when selecting whom to copy or learn from, thanks to explicit metacognition, seen as a form of mindreading.[22]

Concerning a possible co-evolution of metacognition and communication, however, endorsing a specific evolutionary theory requires having a sufficiently wide and detailed comparative evidence, allowing us to analyze the functional structure and underlying neuro-anatomical elaboration of the basic components of metacognitive control of communication across phyla. An example of such an achievement in a related domain is given by the reconstruction of the evolution of behavioral control in the primate lineage, from chordates to humans. This reconstruction provides insights on how competition between parallel control systems guides species-typical actions, as a function of the environmental challenges encountered.[23] Because the evidence is still limited about how the control of communication evolved, the present volume has a more limited aim. It explores in which ways metacognitive tools may have been adaptive in the evolution of communication.

Research questions pursued in this volume

The present issue explores three foundational research questions:

1. What types of competition among parallel control systems are engaged in the control of communication systems in non-humans?
2. What additional forms of control and monitoring are to be found in human communication?
3. What are the metacognitive mechanisms that allow humans to evaluate which concepts to select, retain, or relinquish on the basis of their communicative interactions?

The first research question is explored by Joëlle Proust. Her hypothesis is that, granting the evidence for nonhumans' ability to control and monitor their perception and their memory, they might have applied their control abilities to the domain of communication. Why should metacognition be useful to regulate efficient signalling? Because the latter requires a sensitivity to the trade-offs that are contextually adaptive. For example, producers must select optimally informative calls, with a minimal processing effort, an optimal clarity, and prioritize urgent components in the information to be transmitted. Receivers must attend to the signals *in proportion of* their informational value and pragmatic significance. They must also adapt their behavioral responses *to the context as they know it*. How do signallers manage to handle these various decision trade-offs?

Against a metacognitive account, one might conjecture that the trade-offs are built into a genetic program for signalling. Observations of intentional signalling, however, are not easily reconcilable with a hard-wired mechanism. In many species, signallings can be inhibited, addressed to specific recipients, be repeated or interrupted as a function of receivers' responses. Moreover, laboratory and field data show that, in many species, producers learn what, when and how to adaptively signal; they also learn to detect and repair inefficient signallings, and when to stop signalling.

Granting the evidence that mammals and birds are individually able to control and monitor their perception or their memory, Proust proposes that a specialized form of procedural metacognition, which she takes to be a first step in the evolution of "metacommunication",[24] evolved to regulate signal production and reception. She offers evidence that many signalling species select and fine-tune strategies and trade-offs that, with repeated external feedback, enhance their signalling efficiency. Assuming that procedural metacommunication does not depend on language use, one can speculate that Grice's conversational maxims, or Sperber & Wilson's presumption of relevance, incorporate the control and monitoring mechanisms available to primates. On this hypothesis, reasoning about what others know – explicit metacognition -- might have led to a differentiation beetween different ways of accepting an information – finding it true, coherent, plausible,

new, etc. The variety of acceptances reflected in language use, however, still partly relies on procedural metacognition.

Ronald Planer's article tackles the second of our research issues. How different is human communication from nonhuman signalling? To address this question, the author discusses the theoretical literature about metacognition and its relations to other-directed mindreading. Observing that turning mindreading inward to one's own mind requires a reorganization of the mental architecture, he proposes that specific selective pressures must have driven it. Assuming, which seems plausible, that communication and mindreading co-evolved via a positive feedback loop (the better you mindread, the better you communicate, and reciprocally), what are the relevant selective pressures for a higher efficiency in both? Planer builds upon the "interaction engine hypothesis" developed by Stephen Levinson and his colleagues to address this question. Communication efficiency can be explained by the joint activation, inside a communication niche, of various independent capacities, such as turn-taking, repair procedures, sequence organization, that somehow were present in the communication of great apes, but never reached the intensity and universality displayed in human conversation.[25] Other characteristics of human communication, notes Planer, are higher inferential demands, more cooperative give-and-take processes, more systematic and swifter turn-taking. A number of metacommunicative elements, however, suggest that metacognition must have played its control and monitoring role: errors and misunderstandings are detected (or anticipated), repairs are performed, clarifications are requested, comprehension is checked, common ground is tracked. What, then, is the role of procedural metacognition in this process? The author suggests that early hominins might have relied upon feelings of understanding.[26] When confronted with new challenges, higher needs of cooperation and cooperation led to the selection or an increased role (an issue on which Planer remains agnostic), of a mindreading capacity. From the author's viewpoint, the most significant advantages of mindreading would be, not only to allow communicators to fine-tune the inferential content of theirs messages, but also to conceptually identify their specific

mindreading (predicting others' mental states) and explicit metacognition (judging and broadcasting the precision of one's own cognitive performances). In the latter case, the relevant cues might include tracking others' perspectives in order to categorize one's own in conceptual terms.

Nicholas Shea deals with our third research issue, concerning the relevance of concept metacognition to the evolution of language and communication. That concepts play a fundamental role in cognition has been emphasized by a number of philosophers, logicians and psychologists. Conceptual terms are the sentential constituents that structure deductive reasoning and help us form inductive expectations about the environment. However, until Shea (2020) raised this issue, it has been rarely realized that concepts must themselves be selected and regulated, i.e. be themselves subjected to a specific form of metacognition. In this first article, as in the subsequent project that was deployed in collaboration with the psychologist James Hampton (Thorne et al., 2021, 2022), the metacognitive properties of concepts responsible for their selection and re-use (or disuse), such as reliability, inferential power and intelligibility, have started being scrutinized.

In the present article, Shea studies concept metacognition under a different angle, by focusing on a proposal made by Ruth Millikan in her 1987 *Language, Thought and other Biological Categories,* and later elaborated in relation to reference tracking in *Beyond Concept* (2017) *:* a certain type of mechanism, "consistency testers", might help cognitive agents check the soundness of the concepts they use. Millikan hypothesizes that a specialized system automatically puts a consistency tester into operation when activating concepts, ensuring that they do not deliver inappropriate contrary judgments. If Millikan is right, consistency testers are crucial for explaining cultural accumulation: the ability of receivers to appreciate concept dependability, and to use their assessment as a criterion for re-use and dissemination predicts that human culture is epistemically adaptive in a critical dimension.

principle of contradiction. Other issues to be empirically explored consists in determining the nature of the internal epistemic signal used. Existing evidence concerning consistency detection includes proposals such as Koriat's self-consistency[27], Sperber's epistemic vigilance,[28] incongruence detection in predictive coding, work on intuitive reasoning, or research on category learning. These proposals do offer evidence for a sensitivity of thinkers to inconsistency, but provide little evidence of the downstream epistemic effects of this sensitivity – an essential feature with respect to its role in cultural evolution. The experimental work already conducted by Shea and his group, however, suggests that a higher confidence in the validity of a concept raises the probability that it will be selected in performing inductions.[29] This result makes it plausible that a full demonstration of Millikan's hypothesis is in view.

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References

Bang, D., Fusaroli, R., Tylén, K., Olsen, K., Latham, P. E., Lau, J. Y., ... & Bahrami, B. (2014). Does interaction matter? Testing whether a confidence heuristic can replace interaction in collective decision-making. *Consciousness and cognition*, *26*, 13-23

Bar-on, D. (2013). Origins of meaning: Must we 'go Gricean'? *Mind & Language*, *28*(3), 342-375.

Bickerton, D. (2007). Language evolution: A brief guide for linguists. *Lingua*, *117*(3), 510-526.

Boyd, R., & Richerson, P. J. (1985). *Culture and the evolutionary process*. University of Chicago press.

Cisek, P. (2022). Evolution of behavioural control from chordates to primates. *Philosophical Transactions of the Royal Society B*, *377*(1844), 20200522.

Fitch, W. T., Hauser, M. D., & Chomsky, N. (2005). The evolution of the language faculty: Clarifications and implications. *Cognition*, *97*(2), 179-210.

Fogassi, L., Ferrari, P. F., Gesierich, B., Rozzi, S., Chersi, F., & Rizzolatti, G. (2005). Parietal

Fröhlich, M., & van Schaik, C. P. (2022). Social tolerance and interactional opportunities as drivers of gestural redoings in orang-utans. *Philosophical Transactions of the Royal Society B*, *377*(1859), 20210106.
Gong, T., & Shuai, L. (2012). Modelling the coevolution of joint attention and language. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1747), 4643-4651.
Grice, P. (1989). *Studies in the Way of Words*. Harvard University Press.
Heesen, R., Fröhlich, M., Sievers, C., Woensdregt, M., & Dingemanse, M. (2022). Coordinating social action: a primer for the cross-species investigation of communicative repair. Philosophical Transactions of the Royal Society B, 377(1859), 20210110.
Heyes, C. (2018). Enquire within: Cultural evolution and cognitive science. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1743), 20170051
Heyes, C., Bang, D., Shea, N., Frith, C. D., & Fleming, S. M. (2020). Knowing ourselves together: The cultural origins of metacognition. *Trends in Cognitive Sciences*, *24*(5), 349-362.
Jablonka, E., & Lamb, M. J. (2007). Précis of evolution in four dimensions. *Behavioral and brain sciences*, *30*(4), 353-365.
Jablonka, E., Ginsburg, S., & Dor, D. (2012). The co-evolution of language and emotions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1599), 2152-2159.
Koriat, A. (2012). The self-consistency model of subjective confidence. *Psychological review*, *119*(1), 80-113.
Kirby, S. (2007). The evolution of language. In R.I.M. Dunbar and L. Barrett, *Oxford handbook of evolutionary psychology*, Oxford University Press, 669-681.
Levinson, S. C. (2020). On the human" interaction engine". In S. C. Levinson, & N. J. Enfield, (Eds.).*Roots of human sociality* (pp. 39-69). Routledge.
Millikan, R. G. (1987). *Language, thought, and other biological categories: New foundations for realism*. MIT press.
Millikan, R. G. (2017). *Beyond concepts: Unicepts, language, and natural information*. Oxford University Press.
Moore, R. (2018). Gricean communication, language development, and animal minds. *Philosophy Compass*, 13(12), e12550.
Nelson, T. O. & Narens L. (1990). Metamemory: A theoretical framework and new findings. In *Psychology of learning and motivation* (Vol. 26, pp. 125-173). Academic Press; reproduced in T.O. Nelson, (Ed.). (1992). *Metacognition: Core Readings, 117-130.*
Oakhill, J. (2020). Four decades of research into children's reading comprehension: A personal review. *Discourse Processes*, *57*(5-6), 402-419.
Origgi, G., & Sperber, D. (2000). Evolution, communication and the proper function of language. *Evolution and the human mind: Language, modularity and social cognition*, 140-169.
Pinker, S., & Jackendoff, R. (2005). The faculty of language: what's special about it? *Cognition*, *95*(2), 201-236.
Planer, R. J. (2017a). Protolanguage might have evolved before ostensive communication. *Biological Theory*, 12(2), 72-84.

Proust, J. (2022), The cultural evolution of information seeking, *Journal of Cognition and Culture, 22*(5), 467-484.
Proust, J. (2023). A semantics for affordances. *Philosophical Psychology*.
Saussure (de), L., & Wharton, T. (2020). Relevance, effects and affect. *International Review of Pragmatics*, *12*(2), 183-205.
Seyfarth, R. M., & Cheney, D. L. (2003). Signallers and recipients in animal communication. *Annual review of psychology*, *54*(1), 145-173.
Shea, N. (2020). Concept-metacognition. *Mind & Language*, *35*(5), 565-582.
Shea, N., Boldt, A., Bang, D., Yeung, N., Heyes, C., & Frith, C. D. (2014). Supra-personal cognitive control and metacognition. *Trends in cognitive sciences*, *18*(4), 186-193.
Skyrms, B. (2010). *Signals: Evolution, learning, and information*. OUP Oxford.
Sperber, D., Clément, F., Heintz, C., Mascaro, O., Mercier, H., Origgi, G., & Wilson, D. (2010). Epistemic vigilance. *Mind & language*, *25*(4), 359-393.
Sperber, D., & Hirschfeld, L. A. (2004). The cognitive foundations of cultural stability and diversity. *Trends in cognitive sciences*, *8*(1), 40-46.
Sperber, D., & Wilson, D. (1986/1995). *Relevance: Communication and cognition* (Vol. 142). Cambridge, MA: Harvard University Press Thorne, S. R., Smortchkova, J., Quilty-Dunn, J., Thorne, S. R., Quilty-Dunn, J., Smortchkova, J., Shea, N., & Hampton, J. A. (2021). Concept appraisal. *Cognitive Science*, *45*(5), e12978.
Thorne, S. R., Smortchkova, J., Quilty-Dunn, J., Shea, N., & Hampton, J. A. (2022). Is concept appraisal modulated by procedural or declarative manipulations?. *Frontiers in psychology*, *13*.
Tomasello, M. (2008). *The cultural origins of human cognition*. Harvard University press.
Tomasello, M., & Camaioni, L. (1997). A comparison of the gestural communication of apes and human infants. *Human Development*, *40*(1), 7-24.
Wheeler, B. C., & Fischer, J. (2012). Functionally referential signals: a promising paradigm whose time has passed. *Evolutionary Anthropology: Issues, News, and Reviews*, *21*(5), 195-205.
Wheeler, B.C.,. Searcy, W.A, Christiansen, M.H.,. Corballis, M.C., Fischer, J., Grüter, C., Margoliash, D., Owren,M.J., Price,T., Seyfarth,R. & Wild,M .(2011), Communication, in R. Menzel & J. Fischer (eds). *Animal Thinking: Contemporary Issues in Comparative Cognition*, *ch. 13,* Cambridge, Mass: MIT Press, 187-205.