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The multimodal origins of linguistic communication

Abstract

Why is language unique? How and why did it emerge? Such questions are emblematic of the Western intellectual tradition, and while some even today see them as intractable, a majority consider the problem of language origins as difficult but possible to address scientifically: "the hardest problem in science". Such questions are the domain of *language evolution*: an interdisciplinary and inclusive research area unified by a common goal: to explain the emergence and subsequent development of the species-specific human ability to acquire and use language. In this brief introduction, we describe the transition of the field from mostly theoretical "grand questions" to mostly empirical research focused on narrowly defined puzzles. Increasingly many such specific, empirically addressable puzzles revolve around the motif of *sensory modality*, which – we argue – is as central to determining the origins of linguistic communication as to understanding its present nature.

1. Language evolution

Researchers in language evolution see their challenges as inferring the baseline cognitive and communicative capacities of our non-linguistic ancestors as well as reconstructing the evolutionary mechanisms and sequence of steps that transformed this baseline into language: getting from there to here. However, recent advances in the field bring an unexpected realisation: the difficulties do not stop at inferring the "there" and the path. Describing the "here" turns out to be no less problematic. One of the most striking insights afforded by the 25 or so years of modern language evolution research is that the "view from phylogeny" leads to a reassessment not only of the initial but also the end state: language as we know it today.

What is (modern) language evolution research? It is an inherently interdisciplinary and inclusive research area unified by the goal of explaining the emergence and development of the human ability to use language. Although the relevant questions have millennia of intellectual tradition behind them, researchers are now inclined to draw a symbolic line (around the early 1990s) between the glossogenetic philosophising of the past and modern *language evolution* as a research field[1]. The current *empirical* focus makes a qualitative difference thanks to which today's research in this field can, at last, aspire to being truly *scientific*: to solve "the hardest problem in *science*" (Christiansen & Kirby, 2003a; emphasis ours]).

This empiricism is twofold. Its bedrock is existing empirical data, synthesised from a broad range of disciplines to corroborate or falsify various language-origins scenarios.

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[1] Many articles offer introductions to the field: see e.g. Dediu and De Boer (2016) in the recently established *Journal of Language Evolution Studies*. A testimony to the field's maturation is the publication of tertiary literature in the form of synthetic monographs (Johansson, 2005; Fitch, 2010; Hurford 2014) and handbooks (ed. Tallerman & Gibson, 2012), increasingly in languages other than English (e.g., Italian: Ferretti, 2010; Polish: Żywiczyński & Wacewicz, 2015).

However, an increasingly important aspect of this empirical nature consists in an effort – where possible – to collect data first hand.

1.1. Interdisciplinarity

Regarding sources of data, language evolution research has always been a thoroughly multidisciplinary enterprise (see Christiansen & Kirby, 2003a, 2003b for early overviews). The most important and long-standing elements of its disciplinary matrix include *linguistics*, with special focus on syntax (e.g., Heine & Kuteva, 2007) and phonology (e.g., MacNeilage, 2008); *primatology*: especially primate communication (including recent interest in primate multimodal communication: e.g., Liebal et al., 2014); *genetics*, mainly in relation to the genetic foundations of language (such as the role of the FOXP2 gene in deficits of language and orofacial praxis: e.g., Lai et al., 2001); *paleoanthropology* (e.g., attempts to deduce gross cortical structures in hominins from fossil braincases: Holloway, 1983); *archaeology,* including cognitive archaeology (e.g., d'Errico et al., 2005); *neuroscience* in general and *neurolinguistics* in particular (e.g., the problem of lateralization and language: Gazzaniga, 2000); and *simulations*, especially in the tradition of *iterated learning* (Kirby, 2001), which has developed into a successful laboratory paradigm of psychological experimentation (Kirby et al., 2008).

These areas have formed the interdisciplinary core of language evolution; however, the range of relevant topics has gradually expanded. The boundaries have been pushed by the increasing presence of neuroscience (e.g., research on the mirror neuron system: Rizzolatti et al., 1996) and by new experimental trends (especially *experimental semiotics* studies involving human subjects communicating without the use of language or other symbols: Galantucci & Garrod, 2011). Within linguistics itself, a much wider range of topics have come to be seen as relevant to language evolution: gesturology and sign linguistics (Goldin Meadow, 2003; Senghas et al., 2004), semantics (e.g., Hurford, 2007), pragmatics (e.g., Moore, 2016), conversational structure (e.g., Levinson, 2006) – even linguistic politeness (e.g., Żywiczyński, 2012; Wacewicz et al., 2014; Pleyer & Pleyer, 2016). Likewise, there is a wider scope of methods being employed, with more emphasis on quantitative analysis of large databases and making connections to other disciplines (e.g. correlating linguistic and genetic variation; Dediu and Ladd, 2007). The range of comparative studies of interest has also significantly widened: today, language evolution researchers look not only at communication and cognition in non-human primates but in many other taxa: e.g., marine mammals, dogs, or even birds (Fitch, 2010).

One of the most vivid illustrations of how such diverse data can come together to inform higher-order questions concerns the question of Neanderthal language. A conviction still widespread among linguists – mostly, it seems, due to the early study by Lieberman and Crelin (1971) that found its way into influential linguistic textbooks – is that Neanderthals lacked recognisably modern capacities for speech and language. Contrary to this view, several lines of evidence – in particular, the most recent – converge on a picture of Neanderthals as cognitively sophisticated and, most likely, articulate creatures. Neanderthals shared with us the same two derived mutations of the FOXP2 gene (Krause et al., 2007), their anatomy related to speech production and perception appears to fall within the range of modern human variation (as reviewed e.g. by Dediu & Levinson, 2013), and the record of

their material culture does not differ substantially from that of contemporaneous *Homo sapiens* populations (e.g., Villa & Roebroeks, 2014) with whom they interbred. In short, paleoanthropology, archaeology and genetics systematically point to similarities rather than differences between *neanderthalensis* and *sapiens* (Johansson, 2013). Furthermore, advances in anthropology have resulted in a revised view of behavioural modernity, in a more complete picture of the full range of variation in the material culture of anatomically modern *Homo sapiens*, and in a better understanding of the dynamics of cultural evolution (revealing e.g. cases of the loss of cultural/technological complexity in human populations despite the presence of fully fledged language [Henrich, 2004]): all compatible with Neanderthals being language users.

At the least, the collective weight of converging interdisciplinary evidence supports changing the null hypothesis, from assuming difference to assuming similarity (Johansson, 2014). But did Neanderthals actually have language? The answer is as much a matter of the available definition of language as it is the available data (Barceló Coblijn & Benítez Burraco, 2013). Dediu, Janssen and Moisik (this issue) comment that "such an encompassing view of language, using a sort of Bayesian view of science where all the evidence available is rationally weighted against explicit prior assumptions resulting in probabilistic conclusions, allows us to consider the possibility that language and speech are very old… and that other forms of humanity such as the Neandertals and Denisovans also probably had recognizably modern (but of course not identical to our own) speech and language". Such a view of language − and of *science* − is a matter of near-consensus in present-day language evolution research.[2]

1.2. Data collection

The other defining aspect of modern language evolution research is the steady transition from necessarily more theoretical "grand questions" to the smaller − therefore more empirical − puzzles of Kuhnian normal science. At the turn of the millennium, the field was captivated by the old glossogenetic motif of creating *scenarios* of language emergence. By "scenario", we mean a holistic account outlining a skeletal structure of transitions from the languageless *Pan-Homo* last common ancestor (LCA), through a series of stages, to the fully fledged language found in present-day *Homo sapiens*. The transitions form a more or less coherent story whose highlights are frequently the selection pressures − evolutionary "reasons" − precipitating the shift from one stage to another. The most influential scenarios include those offered by Robin Dunbar (1996), whereby language arose from vocal grooming, originally for purposes of gossip; and Derek Bickerton (1990, 1998; later abandoned in favour of a gradualist account: Bickerton, 2009), whereby language emerged through a macro-mutation, affecting brain connectivity, that endowed lexical protolanguage with syntax. Mithen's (2005) scenario avoids reducing the problem of language origins to a single pressure while representing one of the most detailed − if necessarily speculative − accounts of language evolution. Perhaps less naively, Donald (1991, 2001) and Arbib (2012) account for language emergence in terms of our ancestors' growing cognitive-representational capacities. Efforts

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[2] But not unanimous: see e.g. Hauser et al., 2014.

towards providing a complete scenario – of very different types – can be found in Deacon (1997), Gärdenfors (2003), MacNeilage (2008) and Falk (2009).

Scenarios continue to have an important role to play by setting out frameworks and canalising research efforts even as the nature of the evidence that fills in the details of those frameworks has changed. Language evolution researchers no longer stop at being consumers of empirical data, but rather aim at being providers as well, acquiring data by experimentation, observation, or simulation (and a steadily increasing proportion of these results then feed back into more general discussions on the nature of language – see Section 3). The maturation of language evolution research has been marked by a steady growth in the proportion of empirical ("new data") research relative to theoretical (synthetic) argumentation. The scale of the shift is nicely captured by examining the proceedings of EVOLANG: the field's most important conference. In the volume that grew out of the first EVOLANG conference in 1996 (Hurford et al., 1998), all 24 contributions have a decidedly theoretical (synthesising) character, whereas the proceedings of the most recent conference (Roberts et al., 2016) are dominated by empirical research: 123 contributions, as opposed to 25 theoretical. With four empirical contributions, one empirical overview and two theoretical papers, the present issue reflects the same trend.

2. Sensory modality in language evolution

A classic point of departure for comparisons between language and other communication systems is Charles Hockett's set of *design features* (1959, 1960)[3]. Linguistics still shows a strong tendency to use this definitional framework, particularly with regard to the channel-dependent nature of language: "the signals used in any language consist… of patterns of sounds, produced by motions of the respiratory and upper alimentary tract" (Hockett 1960, p. 126). The vocal-auditory character of language quickly becomes problematic though when addressing its evolutionary origins; the consequent debates over the original modality of ancient protolinguistic communication gave rise to one of the most important axes of disagreement in language evolution research: the speech-first/gesture-first controversy.

That particular debate had an obvious favourite, at least on intuitive grounds: the present-day dominance of speech in language acquisition and face-to-face communication – as reflected in Hockett's system – constitutes a powerful argument that language must always have existed in the vocal-auditory modality (e.g., Dunbar, 1996; Burling, 2005; MacNeilage, 2008). Other arguments include the scale of anatomical and neural adaptations for speech: primarily the descended larynx in humans (Lieberman, 2001; *contra* Fitch, 2000), which enabled the appearance of the double-resonator system (Nishimura et al., 2003), the large-scale rewiring of the cortical neurons responsible for tongue movements (Deacon, 1997) and an increase in the innervation of the thorax muscles (MacLarnon & Hewitt, 1999; see also research on the loss of airs sacs: De Boer, 2012). Anatomical considerations aside, many speech-first theorists have sought to justify the prehistoric functionality of vocalisation before it acquired a strictly linguistic character. The most influential line of reasoning points to the bonding function of non-linguistic vocalisation, of increasing importance for larger groups

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[3] See Wacewicz et al., 2016b; also Wacewicz & Żywiczyński, 2015 for the apology of the historical value of Hockett's system but scepticism regarding its utility in modern language evolution research).

(Dunbar, 1996). Meanwhile, the weak point of speech-first accounts traditionally was the alleged rigidity of ape vocalisations – a point that is currently under serious reconsideration (see See, 2014; Clay & Zuberbühler, 2014).

Since the inception of modern language evolution research in the 1990's, gesture-first views have remained a strong contender. Initially, proponents of gesture-first scenarios divided their efforts between finding new lines of evidence supporting their position and combating traditional arguments against it, even if presented in new guise. One of the most important sources of new evidence – the one that persuaded Hewes (1977) to put forward a gesture-first view of his own – was the success teaching sign-based communication systems to non-human apes (Gardner & Gardner, 1969; Premack, 1970). This was complemented by arguments pertaining to handedness and lateralisation (Hewes, 1973; Corballis, 2003). In more recent years, the broadly construed gesture-first position gained two influential advocates in Tomasello (2008) and Arbib (2012), whose pantomimic scenarios underscore the ability of gesture and whole-body pantomime to support advanced, open-ended semantics without reliance on conventional signs. The natural expressive power of manual signals, and in particular their potential for iconicity, was also used as a gesture-first argument by sign language researchers (Armstrong & Wilcox, 2007).

However, the appreciation of sign language as language proper – with all the lexical, syntactic and communicative complexity found in spoken language – brings home the criticism common to gesture-first accounts, already articulated by Hewes: the "transition problem" (1973, *cf*. Kendon, 2011). It can be summarised as follows. If language first emerged as a gestural/manual system, and if "gestural" systems such as sign language are just as expressive as spoken language, why should language have assumed the vocal-auditory form dominant today? Although there are ways to mitigate the problem (to say e.g. that manual gestures became coupled with orofacial gestures that then gave rise to vocal signals: Corballis, 2003), commentators agree that no satisfactory solution exists (see Fitch, 2010). The persistence of the problem, together with new sources of empirical data (Section 3, below), was a powerful motivation for language evolution researchers to look to the multimodal alternatives whereby, from the start, the evolutionary emergence of language involved an intimate connection and interplay between the vocal-auditory and motor-visual modalities (e.g., Kendon, 2011; McNeill, 2012; Collins, 2013; Sandler, 2013; Zlatev, 2014).

3. The multimodal origins of linguistic communication

It is tempting to see this multimodal alternative as an easy fix, where the increase in explanatory power comes at the price of a corresponding decrease in predictive power and falsifiability (*cf*. Wacewicz et al., 2016a). However, we argue that the rise of multimodal scenarios *is a natural consequence of the progression from theoretical to empirical work*, outlined in Section 2. In other words, closer inspection of the available data is a natural ally of multimodal approaches. It is impossible to overstate the observation that such approaches work from a vision – of animal communication in general, and human communication in particular – that is better grounded in empirical data, which results in a more realistic assessment of both the starting point and end state for language evolution.

As for the starting point, recent comparative data show non-human primate communication to be multimodal to a much greater extent than previously acknowledged.

Until recently, language evolution research paid disproportionate attention to monkey vocal signalling (especially vervet alarm calls: Cheney & Seyfarth, 1990). Recent research into great ape communication (e.g., Slocombe et al., 2010; Schel et al., 2013) undermines the long-held conviction that apes' vocal signalling is involuntary and therefore inflexible. More importantly, careful observation has revealed that communicative interactions usually take the form of multimodal complexes: not only vocal-manual, but incorporating other semiotic resources, such as facial expression and haptic gesture (Slocombe et al., 2011; Liebal et al., 2014). This happens in displays, where multiple modalities are brought together for maximum effect (e.g., Pollick & de Waal, 2007; *cf*. Tanner & Perlman, this issue), and in close social interaction including play and grooming: e.g., wild chimpanzees apparently use lip smacking – "a distinct multimodal oral gesture" – to coordinate bouts of grooming (Fedurek et al., 2015). Wild chimpanzees use vocal-auditory signals for attracting attention but switch to the visual modality when secrecy is needed: e.g., in sexual signalling (Hobaiter & Byrne 2012). Of captive chimpanzees, Leavens et al. (2010: 39) note that "the ability to exercise choice over modality of communication and to tactically vary the display of signals within a context-appropriate modality emerges... in the complete absence of any explicit training to do so". Captive chimpanzees also combine visual and vocal signalling depending on communicative context (Taglialatela et al., 2015). Some studies purport to offer more direct support to the multimodal scenario: e.g. Taglialatela et al.'s (2011) finding that captive chimpanzees' manual gesturing causes selective activation of their homologue to Broca's area but only when accompanied by attention-getting calls.

Concerning the end state, there is growing realisation that face-to-face interaction represents "the core ecological niche for language" (Torreira et al., 2015). Such a view has thoroughgoing methodological consequences beginning with the definition of language: language is part and parcel of the interactional processes that exploit not just vocal-auditory signals[4] but gestural, postural and prosodic resources (e.g., Vigliocco et al., 2014; Bavelas & Chovil, 2000; *cf*. Perea et al., this issue), leading naturally to the idea of language as "multi-modalic orchestration" (Kendon, 2011). This incorporative vision of language first emerged in gesturology: notably, through exploration of Kendon's foundational motif of how the organisation and synchronisation of body movement and speech contribute to the essentially interactional process of *languaging* (e.g., 1972, 2004, 2011). The most influential theoretical paradigm for studying the relation between utterances and hand movements comes from McNeill, for whom the *growth point* – the minimal psychological unit of language expressed by both speech and gesture – constitutes the basic unit for analysing language, construed dynamically as meaning-making activity (1992, 2012). Goldin-Meadow's research – including her influential research on language acquisition (2003, 2011) – provides strong empirical grounding for the view that speech, gesture and thought form an interactional unity. A growing number of recent accounts explain linguistic communication not by appeal just to

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[4] In a trivial sense, even speech production is inherently multimodal: speaking is coordinated not only by auditory feedback (see "total feedback" in Hockett, 1960), but also via the orosensory feedback loop, which consists of kinaesthetic feedback, based on proprioception from the speech muscles, and tactile feedback, mainly from the tongue and lips (see e.g. Guenther & Perkell, 2004; Markides, 1983). Hence, speech production is serviced by multimodal feedback – auditory as well as proprioceptive and tactile, and can even be further enhanced by visual feedback (in the articulation non-native speech sounds, Katz & Mehta, 2015).

sensory modalities, but to a broad range of multimodal semiotic resources including dance, song and pantomime (Lewis, 2014; Zlatev, 2014; Żywiczyński et al., 2016).

4. The multimodal origins of linguistic communication: A snaphot

The present issue is intent on giving voice to the new, inclusive perspective on language described here, and on showing the continuity between language and other semiotic resources – in different modalities, as pivotal elements of language and its evolutionary trajectory. All seven papers exemplify the trend in mature language evolution research (see Section 1.2) whereby the "big questions" have been progressively transformed into well-defined puzzles, open to systematic empirical investigation. Within the broader multimodal perspective, the seven contributions offer a fascinating slice of the research field, exploring many of the most current, hotly discussed themes in language evolution research: storytelling (Sibierska); the roots of cooperative information sharing: the "central puzzle in language evolution"[5] (Perea, Ehlers & Tylén; Żywiczyński, Orzechowski & Wacewicz); iconicity as a candidate bootstrapping mechanism for language (de Carolis, Marsico & Coupé); and biases imposed by the environment on communicative modalities (Dediu, Janssen & Moisik). At the same time, the contributions reflect the methodological pluralism of language evolution research: from phenomenological philosophy (Parthemore) to literary/semiotic analysis (Sibierska) to ethology (Tanner & Perlman) to laboratory experimentation (de Carolis et al.; Perea et al.; Żywiczyński et al.) to synthesis of experimental results (Dediu et al.).

The last text in particular demonstrates how viewing language from an evolutionary perspective requires an inclusive rather than isolationist approach. "Firmly anchoring language in its wider environment [social, physical, biological – SW, PŻ] is essential for a proper science (or a set of sciences) of language that fits seamlessly in the larger scientific landscape". Dan Dediu et al. focus their review on vocal-tract anatomy and its variation "within the normal range". Whereas mainstream linguistics is predicated on ignoring differences between individual speakers in pursuit of idealised patterns, such minor variation is precisely a target for selection: that is to say, if small differences in e.g. the shape of the alveolar ridge have a genetic basis and result in articulatory consequences which translate into differences in biological fitness, they will become subject to natural selection (whose effects are open to further amplification by cultural filters).

It is worth noting that all seven papers appeal to the visual modality in one way or another, including the two papers focussing on speech, which nevertheless begin with signed languages as exemplification of key target phenomena. For Dediu et al., this is the feedback loop between cultural and biological evolution, the (social utility of a sign language translating into biological-reproductive success of its deaf users), whereas Léa de Carolis et al. mention sign language in the context of non-arbitrary meaning and form correspondence. The authors then provide an extensive review of sound symbolism and its potential role in ontogenetic as well as phylogenetic language development, and report the results of three empirical studies of their own. An analysis of French words for animal kinds did not reveal the expected sound-symbolic associations, and of the two experiments with French pseudo-words, only the more explicit and orthographic version revealed sound-symbolic effects.

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[5] Fitch, 2010.

Sound symbolism turns out to be an intricate phenomenon whose manifestation may depend on the specifics of a language, rather than being universal. It is dependent as well on types of units and their interactions: individual phonemes versus larger complexes; as well as on the level of cognitive processing.

Cognitively, most sound symbolism requires assembling cross-modal links between representations. Joel Parthemore points out that exactly the opposite appears to be true of the actual, subjective first-person experience: "phenomenologically speaking, human beings experience a consciousness that is, from the onset, unified. Initially undifferentiated experience gets progressively broken down into more and more fine-grained conceptual categories of e.g. sensory modalities, motor actions, 'inputs', 'outputs', thoughts, etc." Unlike the underlying mechanics, our experience of experience – linguistic, semiotic and otherwise – does not get assembled bottom up from various modalities but rather presents itself in already integrated form, only then do the "different modalities" arise as a matter of *post factum* analysis. (Consider the McGurk effect, in which it is next to impossible to separate out consciously the influence of visual information – by just watching the speaker's mouth – on what phoneme is heard.) Parthemore calls this the *unbinding problem*, and argues that addressing it – as well as other fundamental problems in the origin of semiosis – is essential to telling anything like the full story of language origins. His take-home message is that a phenomenologically well-informed approach starts with a different set of starting assumptions, constructs the empirical studies differently, and interprets the resulting data differently.

Marta Sibierska challenges researchers to push the interdisciplinary envelope of language evolution studies further when she applies the tools of literary and semiotic analysis to storytelling: a recently popular subject in the language evolution literature. Sibierska shows that it is possible to "tell" stories without language. She illustrates this point with examples of visual communication involving both pictorial and gestural semiotic resources. The central claim is grounded in meticulous conceptual work that lays out the definition of, and minimal criteria for, storytelling. In the process, Sibierska identifies the *play frame* – a non-serious "as-if" aspect – as a central element of storytelling.

Play is likewise crucial to Joanne Tanner and Marcus Perlman's text on sequences of gestures in gorillas. The traditional perspective on "gestures" as "vectors of meaning" aimed at inferring function or meaning from immediate behavioural effect, is shown to be insufficient to adequately address the target behaviours. Based on their analysis of seven video examples of structurally complex behavioural sequences in captive gorillas, Tanner and Perlman distinguish two types of gesture sequences, each having a different function and produced in different contexts. Some sequences performed during play are close range, highly interactive, often with tactile contact implying force that may be mechanically effective or ineffective (thus interpretable as iconic). Other sequences take place at longer range between participants and often include an auditory component, such as percussive sound. These are performed during displays as well as in solitary or social play. Tanner and Perlman conclude that "some gesture sequences of gorillas are better understood as playful, multimodal displays, rather than as communication to achieve a particular goal."

The final two contributions describe experimental studies on the prototypical context of language use: face-to-face interaction. Juan Olvido Perea García et al. are interested in the

origins of triadic communication, involving referents that are external to the communicative dyad but co-present to both interactants. They investigate multimodal referentiality: specifically, the role that ocular (gaze) cues play in both partners properly identifying the target referent in their peripersonal space, a mechanism that would have been essential to supporting collaborative activities in pre-linguistic hominins. They report that when gaze cues are blocked, spatial reference becomes ambiguous, frequently resulting in misunderstanding (which in turn can be partly – but not fully – compensated for using explicit, verbal repair strategies).

Przemysław Żywiczyński at al. build on Levinson's idea of a human-species-specific "interaction engine". Their study grows out of concerns with the evolution of perceptual systems and – more specifically – the impact that third-party perception could have exerted on the evolution of face-to-face interaction. Grounded in the *social brain hypothesis*, their study investigates how self-centred adaptive behaviours, such as self-touches, come to be interpreted as causally related. This leads to speculations about the bootstrapping mechanisms for low-level non-verbal coordination in the evolutionary emergence of the infrastructure for face-to-face conversation.

Conclusion

The beginnings of language evolution research, in its present form, are often dated to the early 1990s, when the field became visibly and qualitatively different from earlier, more speculative approaches. Over the last 25 years, language evolution research has solidified into a broadly interdisciplinary field whose research problems are increasingly seen as empirically addressable; many of them revolve around questions of the role of sensory modality in communication. The seven contributions to this issue work out different features of multimodal communication – from the most foundational philosophical aspects to narrowly defined experimental questions – with results informative not only about the origins of linguistic communication but also its present nature.

Acknowledgements

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