Unreviewed article presented by Pablo Bernabeu at the 10th LangUE Conference (2015, Essex, UK).
This is a corrected version from the original proceedings published on the Conference's website.

Language evolution: Current status and future directions

Pablo Bernabeu[1,2]
Paul Vogt[2]

[1]Radboud University, Netherlands.
[2]Tilburg Center for Cognition and Communication. Tilburg University, Netherlands.

The topic of language evolution is characterised by the scarcity of records, but also by a large flow of research produced within multiple subtopics and perspectives. Over the past few decades, significant advancement has been made on the geographical and temporal origins of language, while current work is rather devoted to the underpinnings of language, in brain, genes, body, and culture of humans. Much of this literature is polarized over the crucial dichotomy of nativism versus emergentism. Our state of affairs report also confirms a high degree of speculation, albeit with a decrease for modelling. To tackle the speculation and the large research flow, we propose a more impersonal kind of review, focused on the topic's questions rather than on particular accounts. Another observation is that novel perspectives are on the rise. One of these highlights the importance of perceptual cognition, often dubbed 'embodiment,' in the earlier evolution of language. In following this lead, we adapted a previous experiment which had investigated the correspondence between certain perceptual features of events, and different grammatical orders arising as participants acted out those events. That design made a perfect basis for us to put in an additional variable, namely the contrast between body-based communication (gestures), and more disembodied communication (symbol matching). Albeit tentative, the results of this pilot experiment reveal a greater effect of the embodiment variable on the grammatical preferences, which we see as inviting further exploration of embodied cognition in language evolution.

1 Introduction

Evolutionary linguistics encompasses the origins of language, the change within and across different languages, and the acquisition of language and languages by children and adults (Gong, Shuai, & Zhang, 2014). Arguably, the origins are the ultimate, most crucial question in this triad, to the extent that the origins determine the evolution and the acquisition in turn. For that reason, greater attention will be paid the origins in this paper. We shall start framing this voyage by looking back two centuries. In the mid-19th, many of the theories on language origins seem to have displayed considerable 'imagination' (Aitchison, 2008: 17; see for instance Grimm 1851/1905, in German), which did stir some scepticism on this study (Whitney, 1873). Indeed, by 1866 the question had become so blurred in the eyes of the Societé Linguistique de Paris (a French authority in linguistic research at the time) that they decided to protect the topic by banning it altogether.[1] The sequence of events around the great ban is ceaselessly recounted (Deacon, 1998; Christiansen & Kirby, 2003b; Tallerman & Gibson, 2012), but it usually stops at that. In trying to probe further, we will next consider an extract *on language evolution* from the time:

> The further argument for the possession of language by mammals and birds, at least, is that they readily learn to respond to a name given them. To what extent that sense can be cultivated is shown in Sir John Lubbock's dog, which brings out a card with "o-u-t" on it when he wants to take a walk. (Jastrow, 1886: 556)

Published in *Science* two decades into the French ban, Jastrow's account betrays lacunas in general cognition as well as on language proper. First, a basic symbol-stimulus connection on the part of the dog is interpreted as language use, no less. That reveals the under-definition of language. Another important lacuna is that of direct evidence: early language had left no trace for scholars to analyse (only long after the appearance of language did writing develop). As a general result, the accounts of the mid-19th century could not be judged against any preeminent theory, which may have allowed for the more facile explanations. Certainly, speculation was a major factor in the mid-19th century crisis (Deacon, 1998). Yet, arguably, it has also been an integral part of science for a long time, even if we have grown more factual of late. It might

[1]Articles from before the ban are highly elusive online. As regards censorship around science, notice current examples in areas such as evolution (against creationism, see Press Association, 2014), and environment (against the denial of global-warming, see Pnewell, 2008).

simply be problematic in great quantity, so how much is there at present? According to some scientists, speculation in the area of language evolution is still abundant:

— In this admittedly speculative essay... (Deacon, 2003: 138)
— Theory and speculation are simply not empirically comparable. (Smolensky & Dupoux, 2009: 468)
— The absence of direct evidence does not, of course, prevent speculation, hypothesizing and inferencing, and in the ever-growing literature on language evolution we see all. (Pavlenko, 2014: 26)

We will aim at a more quantitative measure by comparing the speculation in the LE area with that in others, on the basis of a repository survey. As such, we calculated a rough measure of the *acknowledgment about* speculation in several areas, as reflected in publications from 1994 to 2014. Specifically, the 'speculation ratios' in Table 1 were obtained by dividing the number of hits with the term 'speculation' by the total hits, i.e. with and without the term.

1 **language evolution** speculation (32)
÷ language evolution (7,584)
= 0.004219

2 **language origins** speculation (20)
÷ language origins (6,891)
= 0.002902

3 **language comprehension** speculation (14)
÷ language comprehension (17,067)
= 0.000820

4 **language disorders** speculation (28)
÷ language disorders (36,831)
= 0.000760

5 **language teaching** speculation (6)
÷ language teaching (12,465)
= 0.000481

6 **hadron collider** speculation (2)
÷ hadron collider (6,096)
= 0.000328

Table 1. Speculation ratios ordered from the highest rank, LE, through other areas of language research, down to a topic from the so-called exact sciences.[2]

According to this index search, LE ranks high in the contingency of speculation. Because this is a relatively novel, perhaps even unorthodox, method of analysis, we decided to include a topic from the hardcore sciences among our queries—the (Large) Hadron Collider, a recent advancement in physics—, and as predicted it came out with the lowest ratio of speculation. Also importantly, alternative forms of the term 'speculation' were used, such as 'speculating' and 'speculative,' on which LE did not shift its rank. The figures stand to reason, considering the lacunas on LE described above. The same holds for the current lacks in subfields relevant

[2]Every term in each entry is present in every hit (e.g., +language +evolution +speculation). Time range: 1994-2014. All other parameters as default. Conducted 20th September, 2014 on the Thomson Reuters' *Web of Science™* (http://wokinfo.com/). Institutional hosting is required.

to LE, such as genetics and neuroscience (Marcus, Marblestone & Freeman, 2014). It is in such a context that Hauser et al. (2014) questioned the feasibility of the LE enterprise. In fact they concluded with a rather pessimistic forecast, which they would revise only after crucial knowledge has been attained in the areas that inform LE research (similarly, see Wu, 2014). Moreover, the great acceleration of data coming from various disciplines makes it hard to attain any desirable synthesis: in other words, it is hard to draw general conclusions from the stream of individual findings (Fitch, 2014). Yet, for a more optimistic state of affairs, we could highlight the greater scientific rigour that was attained after the ban—to start by thinking of the pioneers, Chomsky (1968), or Pinker and Bloom (1990). What is more , this positive trend has extended to date, as evident from a wealth of current studies ranging from linguistic features (Evans & Levinson, 2009) to language genes (Fisher & Scharff, 2009) through evolutionary correlates (Tomasello, Call, & Gluckman, 1997). Achieving a more conclusive 'checkup' constitutes one major goal for this paper, and with that aim we will review much of the research produced after the ban. We will tackle the more secured bases as well as the harder question of what language is indeed.

2 Coordinates traced

In spite of historical lacunas, substantial findings have been made with regard to the spatial coordinates of language origins. Most of the evidence from archaeology, historical demography and computational modelling has rendered wide acceptance of the monogenesis of languages from Africa (Tallerman & Gibson, 2012; Levinson & Holler, 2014), contra earlier theories such as polygenesis (Nichols, 2011) and macromutation (Chomsky, 1968). As for the time of origin, estimates range from 2.6M years ago (Semaw, 2000; Stutz, 2014), through 1.4M (Levinson & Holler, 2014), on to about 70k years (Bolhuis, Tattersall, Chomsky, & Berwick, 2014; Chomsky, 2011). First off, we should not bypass the marvel behind these estimations: their mere existence tells of ever more precise tools, both archaeological and analytical-computational. Still, the divergences as for time are too large: are these scholars even thinking of Language in the same way? Likely not. To illustrate, if the language one has in mind is fundamentally linked to the processing of syntactic units in communication (Bolhuis et al., 2014), the date of origin will be set much more recent than if we think of language as more importantly linked to broader factors not specific to language, to know, social structuration, mass migrations, or cultural production (Stutz, 2014). In the long run, therefore, it remains a

necessity to address the core nature of language. However, that is the hardest nut to crack. In sum, under-defined language, and the lack of direct evidence that is inherent to LE have left us to search for the fundamental support(s) of language in its origin, evolution and acquisition. In words of Hurford (2003: 40), we are left 'with the material (anatomical, neural, biochemical) bases of language in humans, related phenomena in less evolved creatures, and the dynamics of populations and cultural transmission.'

3 Underpinnings of language

3.1 In the mind

The mind, as a constructed proxy for brain, has been understandably more accessible in LE research. The majority of accounts fall over two ballparks: language-specific or not.

3.1.1 A language-specific system

In the late 1960s, Chomsky (1968) touched upon LE as he posited an innate language faculty for humans. Thus, hardwired on the human brain through the 'Universal Grammar' (UG), language would be supported by a 'Language Acquisition Device'—a correlate of the non-generativist 'critical period' (Hurford, 1989). Chomsky's early-cognitive theory appeared in the midst of reigning formalism, which surely must have contributed to its broad impact in and out of the linguistic field. It is also relevant to remark, yet, that Chomsky seldom addresses the origins or evolution of language; he regards those as irrelevant because the language faculty would have mutated, rather than evolved.

The cognitive era in LE started to set in with the 1975 conference on 'Origins and Evolution of Language and Speech'—the first major LE meeting after 200 years—according to Harnad, Steklis, and Lancaster (1976). The authors also report a sizeable representation of accounts in within the conference. The sections included 'history of language-origins theory; formulating the target; protolanguages and universals: perceptual and cognitive substrates; artificial intelligence; paleobiological approaches; the fossil record and neural organization; behavioral parallels and continuities; gestural origin theories; linguistic competence of apes; perception

and production of speech; neural parallels and continuities; and language and the human brain'. It might surprise the reader to see gestural origin theories listed there, as one may have the feeling at present that this is *cutting-edge* (e.g., Tomasello, 2008). Fifteen years later, another landmark was set with a target article by Pinker and Bloom (1990).[3] The authors coincided with Chomsky's 1968 stand on the evolutionary discontinuity, as they too posited a fundamental gap between the communicative system of modern humans and that of our closest ancestors (Pinker, 1994; see also Jackendoff, 2002).[4] But aside from support, Chomsky's UG has attracted much dissent, especially with regard to its emergence. Contra Chomsky's proposal of 'macromutation,' Pinker has posited natural selection, famously likening the evolution of UG to that of vision (Pinker, 1994; in turn against that, see Sampson, 2005). Also, contrary to Chomsky's UG for internal thought (Fitch, Hauser & Chomsky, 2005), Pinker's 'language instinct' is rather an adaptation for communication (Jackendoff & Pinker, 2005).

3.1.2 A general cognitive system

Some scholars see no need for innate, language-dedicated devices. Indeed, the emergentist approach (also dubbed empiricist or functionalist) points to general cognitive structures in the modern human brain as the fundamental support for language (Enfield, 2013). General cognitive systems of two types have emerged within this paradigm:

Complex-structure cognition. This account underscores the importance of cognitive developments for LE (as accompanied by a sheer increase in brain size). In this vein, Christiansen and Kirby (2003b) remark on the ability to process complex linguistic relations and hierarchies as a prime essential of the language capacity. Comparable accounts have looked at complex thought more generally (Richardson, 2007; Evans and Levinson, 2009), now labelled as 'supra-regular computation' (Bickel, 2014), now as 'a propensity by our species to infer tree structures from sequential data' (Fitch, 2014: 329). According to Vogt (2006a: 177), language would thus be 'a complex communication system that is—among other things—

[3]The paper that is available online unfortunately lacks the peer commentary. Yet, the full version can be ordered from the Harvard repository.

[4]To date, most construals of innate specialized devices seem to have been replaced by theories with holistic, learning-based devices (cf. Kant's 'a priori' systems; Friedman, 1994; Palmquist, 1987).

symbolic, learnt, compositional and recursive, whereas all other species' communication systems typically lack these properties.'

Complex social cognition. What really made a difference for LE may have been high-level social cognition. Tomasello (2009)—'Universal Grammar is Dead'—argues that any and all so-claimed linguistic universals are the result of more general biases in human thought. For instance, semantic roles across languages would be explained by the natural tendency of humans to think in categories. Tomasello (2008) also underlines 'shared intentionality' and 'joint attention' as fundamental in the acquisition of cultural forms, e.g. language. This is supported by the great chasm spanning from primate selfishness to human collaboration. Indeed, Rivas (2005) observed that, as primates address humans by signs, their communicative intentions were 98% requests. On the phylogeny of language, Tomasello (2008: 320) concludes that 'the road to human cooperative communication begins with great ape intentional communication'—though he refines, 'especially as manifest in gestures,' acknowledging a modality break in the continuum. In a similar vein, but focused on the ontogeny of language (i.e. in the child), Vogt and Lieven (2010) have argued that language emergence in evolution could be parallel to first language acquisition, both advancing through a continuum (see also Chater & Christiansen, 2010).

3.2 In the genes

Fisher et al.'s (1998) report on the relationship between an inherited language impairment and the mutation of a gene was hailed by nativists as the discovery of the 'language gene' (Pinker & Jackendoff, 2005; but see also Vernes et al., 2008). However, the emergence of that protein, the FoxP2, has been dated back to evolutionary stages prior to language (Krause et al., 2007). For this reason, nativist takes on the FoxP2 have met criticism for the sidestepping of genetic conditions such as 'disfunctionality,' 'nonuniqueness' and 'functionlessness' (Botha, 2002; see also Sampson, 2005). Also, the human exclusivity of this trait has been annulled, as it is highly relevant in the communicative systems of other animals (Wohlgemuth, Adam & Scharff, 2014). Hence, the FoxP2 would support not language but rather communication more generally (perhaps the faculty of language in a broad sense, as in Fitch, Hauser & Chomsky, 2005). Summing it, Christiansen and Chater (2008: 489) said that 'language constitutes a "moving

target" both over time and across different human populations, and, hence, cannot provide a stable environment to which language genes could have adapted.'

3.3 In the body

LE is crucially linked to certain anatomical developments (Pavlenko, 2014, ch. 1). We know of an enlargement of the cranium, as well as the appearance of thoracic anatomical features that are unique to later hominids. The latter include the supralaryngeal tract and the lowered larynx, as well as vertebral-neural connections for breathing control (de Boer, 2009; Fitch, 2000; Levinson & Holler, 2014). These are crucial for the articulation of precise language sounds, as well as for singing and for running, yet some also give us a risk of choking. In this welter of factors, there exist three main lines of explanation about the relation between such anatomical changes and LE (for more detail, see de Boer, 2009, 2012; Fitch, 2000; de Boer & Fitch, 2010): (a) preadaptations for language (Kay et al., 1998), (b) interactive language-biology shifts (Corballis, 2003; Levinson & Dediu, 2009), and (c) processes independent of language (Chomsky, 2011).

3.4 In culture

The cultural factor is informed from language fieldwork and archaeology, each tackled below.

3.4.1 Universals *vs* diversity of language

On this point as in others, the schism between nativism and emergentism is such that evidence against one is often proof for the other. Thus came the dispute about recursion. Hailed by some as a design feature of the linguistic faculty (Hauser, Chomsky & Fitch, 2002), when Everett (1986; 2007) reported it as *absent* from the Pirahã language, any alleged universality of this language feature started to be questioned. In echoing this from a cognitive standpoint, Tomasello (2008) enumerated some recursive, common human activities. Yet, a broader sort of universals is also possible: functionalist universals are construed as 'both unique to the human

mind and sufficient for language, yet not specifically evolved for language' (Enfield, 2013: 158), unlike the specificity of formal universals (Greenberg, 1963).

Proposals about an innate language faculty have come with design constraints (Jackendoff & Pinker, 2005)—when not categorical principles (Greenberg, 1963). It would follow, then, that every language should share significant properties. It was that very connection that led to a long quest for linguistic universals, now via fieldwork on isolated languages, now via language acquisition studies (for a comprehensive discussion, see Evans and Levinson, 2009, and commentary therein). Among other findings, 'constituency'—[[which] [allows] [for [[the [connection] [of [structures]]]]] [in [a systematic [guise]]]]—is present in an overwhelming majority of the known languages (Evans & Levinson, 2009). On the other hand, more recently, the rarer indigenous languages—mostly in Oceania and South America—have become the strongest case against universals. Below, Greenbergian, formal universals are listed which have been refuted to date (adapted from Evans & Levinson, 2009).[5]

— **Phonetics:** The possibility of sounds in a language is virtually infinite, for all we know.
— **Phonology:** Pattern CV > V > VC is not universal.
— **Morphology:** Isolating languages are no less functional than polysynthetic ones.
— **Lexicon:** The Big Four (nouns, verbs, adjectives and adverbs) are not all universal.
— **Syntax:** Subject and Object categories are not universal; nor is recursion.
— **Semantics:** Space, quantity, colour, etc. are not universally articulated as in English.
— **Discursive:** Conditionals are not always expressed via isolated morphemes.

3.4.2 Culture as a gateway to language

The evolution of cultural practices has been explored via comparative studies with chimpanzees, on the one hand, and via archaeological explorations of early cultural products (Davidson, 2003). In the comparative tradition, Tennie, Call and Tomasello (2009) investigated the interaction between process-oriented social learning, and increasing group cooperation, finally coining the 'ratchet' effect—i.e., accumulation of cultural practices (cf. the social cognition factor, in section 3.1.2; see also Tomasello, 2014; van Leeuwen, Cronin, & Haun,

[5]The map of diversity resulting from such fieldwork has invited revision of the traditional 'shoehorning' custom, by which any so-called 'exotic' language would be subsumed onto Latin grammatical principles (Tomasello, 2008; Haspelmath, 2010).

2014; Dean, Vale, Laland, Flynn, & Kendal, 2014). In the case of archaeological explorations, two main types can be distinguished: semiotic references, as painted on vases or walls (Chazan & Horwitz, 2009), and tools, furniture and shelter (Stout, Toth, Schick, & Chaminade, 2008). Based on these cultural products, scholars ellucidate what mental mechanisms must have been necessary for their production (Pavlenko, 2014, Ch. 1). In the same vein, Uomini and Meyer (2013) investigated the relationship between the neural demand for language use and that for a prehistoric practice like stone knapping, finding a correlation between the two. The cultural factor, as studied in the empiricist paradigm, is considered subsequent to the cognition factor, and parallel to the biological factor (Tomasello, 2008; Enfield, 2013). That is, evolution of (social) cognitive skills would have set the mind ready for increasing linguistic elaboration, which in turn would have allowed the other two factors to co-shape protolanguage, then languages. Focused on earliest stage, Steels (2012) modelled the emergence of mirror behaviour and its role for body language. Modelling also serves to trace the often obscure course of grammaticalization. Interestingly, while this used to be modelled backwards, starting with the resulting form, to then tackle the proto-form—e.g., 'give' deriving from 'other-have'—, recent computational techniques have allowed for simulations in the natural direction, starting with the proto-form, through the gradual addition of conventionalized patterns (Vogt, 2006b). In all, modelling is a method on the rise in LE research. Furthermore, it is linked to less speculation, as Table 2 shows.

language evolution modelling speculation (3)
÷ language evolution modelling (2,026)
= 0.001481

Table 2. Ratio of speculation for LE with modelling (cf. Table 1; calculated as there).

Modelling is a viable method, so long as we acknowledge its limitations (Hurford, 2003; Perfors, 2014). For instance, it may be necessary to post-test these models in behavioural experiments (e.g., Vogt & Mastin, 2013; see also greater possibilities of modelling in Franks, Griffiths, & Jhumka, 2013). Aside from computational simulations, there is another type of simulation in LE, of a behavioural nature, conducted with human participants. For instance, this is useful in experimental semiotics—the study of novel communicative forms—, enabling the reproduction of behaviour such as compositionality (Galantucci and Garrod, 2011). Behavioural simulation generally offers less control but greater ecological validity.

Taken in toto, the LE literature reveals that language is fundamentally linked to various systems in mind, body and culture. In this, traditional methods coexist with the latest computational tricks which are applied to the modelling of varied LE phenomena. Yet beyond that, there is the causality of such evolvements: how fundamental is each? This has preoccupied several colleagues, of late (Wu, 2014; Hauser et al., 2014). And it is a circular question: we would need more fundamental data on LE to commonly settle for one definition of language, and we would also need a definition of language to know what to focus on, and what to place second, within the mass of data. This brings us to a possibly relevant prescription: different reviews. As it seems, extant reviews are most commonly centred (particular) theories (e.g., Christiansen & Kirby, 2003), or on (particular) methods (e.g., Vogt, 2009). Far from denying the great service of such reviews, we find that such as massive topic as this, in terms of inherent perspectives and hence of research production too, does necessitate a different approach to its reviews. Indeed the new kind of review would be more directly centred on the questions themselves which drive our enquiry, e.g. what are the underpinnings of language at different levels. One could argue that this is already done in effect, but what we propose is actually scaffolding the review up to these questions, right from the headings in the article. This would imply in turn that the author of such a kind of review would aim for objectivity from the first letter, not foregrounding their own work but rather trying to capture as much as possible of the relevant, general buzz.

The last major conclusion from this review is the increasing importance of non-classic perspectives. To be sure, this connects to the speculation we analysed above, facing us with the elephant in the room. There is a trade-off in today's science between the need to honour the facts and only the facts, and, on the other pole, the drive to explore new avenues. In LE research, there will always be the alibi that we lack data, and need extra digging for it. Exemplifying the extra digging, some of the current new perspectives are centred on extra-cognitive biological evolvements (Munro & Verhaegen, 2011); others on extra-linguistic cognition (Stout, Toth, Schick, & Chaminade, 2008); others on language-internal factors (Heine & Kuteva, 2007; Progovac, 2015), and yet others on the junction of general cognition and language (Steels, 2012). We have addressed the latter sort by way of an experiment.

4 Role of embodied cognition in LE

In the wake of new advances in linguistics and the cognitive sciences, LE researchers start to embrace the state-of-the-art, and integrate it with older schemas—however tentatively at first. Since the time of Structuralism, through the cognitive revolution of the late 20th century, up until the early 2000s, research on the ability for language had been dominated by a linguocentric perspective. The speaker, if acknowledged at all, would be ancillary to the system (e.g., Chomsky, 1968; for a review, see Levelt, 2013). Language would be honoured an exclusive region in the brain, with no fundamental interaction onto other networks (Fodor, 1983). Only recently, with the advent of a functionalist view of language (Darnell, Moravcsik, Noonan, Newmeyer, & Wheatley, 1999), the celebration of cross-linguistic diversity (Evans, & Levinson, 2009), and the expansion of brain imaging (Carreiras, & Clifton, 2004), the spotlight has moved onto the speakers and their environments. Now, non-verbal communication is acknowledged as an essential component of language (Macedonia, 2014; Willems, Özyurek, & Hagoort, 2007), with some evidence suggesting that gestures precede verbal language in ontogeny and phylogeny (Tomasello, 2003, 2008). Relatedly, Bouchard (2013) argued for the human ability to image concepts offline—without direct perception—as a driver of language (see also Adornetti & Ferretti, 2015). Only on that soil, the author argues, did symbol recursion and grammar arise. Such findings have contributed to the study of language as 'embodied,' or embedded in *ecologies* both internal and external to the speaker (Shapiro, 2014). Further, it has recently been argued that embodiment may have been crucial for the emergence of private and social semiotic structuration, and hence of language (Stutz, 2014; for a related take on music, see Perlovsky, 2015). In toto, much in the same way as functionalism had shown that the 'visible language'—the system—is not all there is to language, embodiment theory has shown that neuronal connections are not all there is to cognition.[6] It is in the context of such linguistic and cognitive paradigm shifts that we approach language evolution hereby—namely through an experiment designed to simulate the influence of human embodied cognition on the evolution of language.

Has embodiment affected the evolution of language and languages, much as it now affects language use? Logical though it may seem, this study is actually a first, to our knowledge. There

[6]Notions comparable to 'embodiment' include 'situated' and 'grounded' cognition (see Shapiro, 2014). Also note that embodiment could as well be fundamentally distinguished from functionalism, in that the former is an advancement ahead of the latter in chronological, and perhaps scientific, terms.

has been some research on when, why and how embodied thinking takes place, for instance, as reflected in the use of gestures (Pouw, De Nooijer, Van Gog, Zwaan and Paas, 2014). But there is little if any data on how embodied cognition may have influenced the development of forms of cognition such as language. As a gateway into this puzzle, we will analyze the emergence of word order preferences in two different conditions.

Research on word order has mostly centered on the sequencing of verb, subject and object in transitive clauses across languages. As an illustration of word orders, an event such as *a pirate throwing a guitar* is recounted differently across languages: where Dutch speakers say 'the pirate' (subject, S) 'threw' (verb, V), 'the guitar' (object, O) (Dutch=SVO language), Turkish speakers say 'the pirate the guitar threw' (Turkish=SOV language).[7] Related research off the language-typological scope has focused on word order *preferences*.[8] For instance, Schouwstra and de Swart (2011; henceforth, SdS) conducted a non-linguistic experiment wherein Turkish and Dutch participants gestured to represent drawings of simple events. Crucially, some were *extensional* events—i.e., with a tangent action and object, like *throw a guitar*—, while others were *intensional* events—i.e., with a more imaginary quality, like *think of a guitar.* On their non-linguistic representations, Turkish and Dutch participants alike tended to represent extensional events as SOV, and intensional events as SVO.

To test our critical question on the role of embodied cognition in LE, we replicated SdS's manipulation of event types, and crucially added an extra variable: bodily versus symbolic communication. Indeed, on one task, participants represented the pictures by gesturing, as they did in SdS (embodied task); yet on the other task, participants conveyed the pictures by way of written codes (disembodied task). The aim of the gesturing task was to instill in the participants a sense of bodily involvement and perceptual iconicity, thus tapping into the modal cognitive system, whereas the coding task, in contrast, is more deprived of perception and thus should engage the more abstract mental systems (cf. Paivio's 1971 dual code). Our hypothesis on the critical role of embodied cognition in LE would be tentatively confirmed so long as the cognitive system manipulation overrode the event type manipulation.

[7]If less common, other languages have other patterns, such as VSO and VOS (Dryer, 2011).
[8]In fact, 'word' in 'word order preference' is a proxy for *entity*, or *semantic role*, aside from language typological distinctions. After all, one general conclusion from Schouwstra and de Swart is that the SOV/SVO typological contrast may be explained by cognitive constraints of meaning.

4.1 Method

4.1.1 Participants

Eight Tilburg University students, two males and six females, participated for no reward. Their native languages were Dutch (5), Chinese (1), Portuguese (1), and Serbian (1), all SVO in nature—regardless, as SdS showed, the native language is not crucial in this question.

4.1.2 Materials

The set of stimuli, borrowed from SdS, consisted of 20 pictures of extensional events, and another 20 of intensional events, each event characterized by three crucial semantic roles: action, agent, and patient.

Figure 1. Stimuli taken from SdS. Extensional events are above; intensional below.

In the disembodied condition, participants were provided with a pool of symbols of three categories--numbers, letters and shapes--, along with a board with empty slots on which they would have to code the events, i.e., as summarized in three key constituents of their choice.

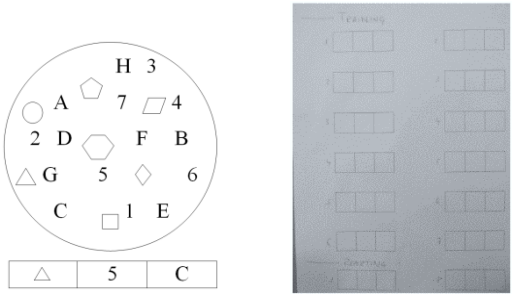

Figure 2. Symbol pool, left, empty symbol boxes, right, and an example of the boxes filled.

4.1.3 Design

Along with the contrast of embodied/disembodied tasks, we distinguished between extensional and intensional actions, both variables being distributed within one single group (Table 3). All participants saw all items, but two different versions of the design were distributed 50:50, with the cognitive system tasks in opposite orders, in order to control for any primacy effect in favour of either cognitive system. In other words, for the embodied-first group, the gesturing task was followed by the symbol-referent pairing task, and this order was reversed for the disembodied-first group.

Embodied (Gestures)	Extensional event
	Intensional event
Disembodied (Symbols)	Extensional event
	Intensional event

Table 4. Two-by-two design of the experiment.

4.1.4 Procedure

The instructions were identical across the counterbalanced groups. In the gesturing task, the procedure was followed as in SdS, whereby participants were shown pictures which they had to represent through iconic gestures (pantomiming). Figure 3 illustrates it.

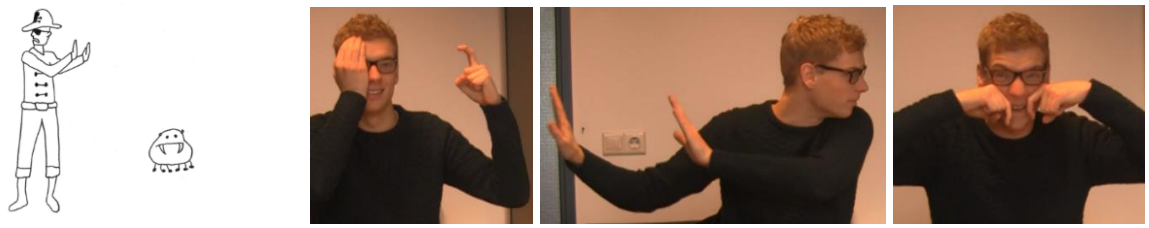

Figure 3. A participant in the embodied condition represents the event on the left, intensional, which results in an SVO order, in accord with SdS's results.

Their gestures were recorded, and supposedly (only to render a communicative feeling to the task) this was 'to be broadcast to a remote partner with no access to the pictures, who should be able to understand the events on the basis of the participants' gestures.' Participants were

not permitted to use speech, but could produce upper and lower body movements, as well as nonverbal sounds, without any constraints, stopping at any time they thought the meaning had been fully conveyed. Note, however, that some participants were advised to focus on three key parts to each event, whereas others were not (see Criticism below). The coding task was equipped with a symbol pool with three different categories, namely letters, numbers, and geometric shapes. Participants were first trained in matching the symbols provided onto the semantic roles of the event on screen. Four examples were provided with no conventional alphabetic or ordinal sequencing that might be used to bypass a new structuration of events. The experimenters did warn the participant in case the representation lacked clarity. After the training, the experimental trials ensued. Here, the experiment unfolded similarly to the set-up in SdS, and no significant feedback was provided.

4.2 Results

In our design, we had 176 total, trials, made up of 128 experimental trials and 48 training trials. The results of this first exploratory experiment were not quite as expected, with a 45% of invalid trials; accordingly, it was decided to include the training trials, too, in the final analysis, which conveniently increased the valid data. We considered valid trials only those with preferences SOV or SVO, in line with the findings of our basis study, SdS. Trials declared invalid included patterns such as OVS, OSV, and VOS, as well as trials missing one of the crucial event components, e.g., SSV, VV, VO… One further remark on our method is in order: sometimes participants would refer to the same item (S, V or O) over again at different points; in such cases, only the first three different constituents were taken into consideration. Table 4 provides the results.

		176 total trials			
Cognitive System	Event type	SOV	SVO	**Ratio**	Other
Embodied (Gestures)	**Extensional**	13	15	**1.15**	79
	Intensional	9	13	**1.44**	
Disembodied (Symbols)	**Extensional**	5	23	**4.60**	
	Intensional	3	16	**5.33**	

Table 4. Results. The ‘ratio’ is the result of dividing SVO by SOV.

We had wondered whether, in the symbolic task, we would find some systematic assignment of symbols to event roles. There was no such consistency in the data of any participant. Aside from that, there is an apparent consistency of word order preferences through both of our variables. Indeed, SVO is always more common than SOV, in both cognitive system conditions, and in both event type conditions. Yet it is cognitive systems that seem to drive our figures, as numbers vary dramatically and consistently between the embodied condition and the disembodied one. In comparison, the event type distinction fares more weakly, with very slight differences between extensional and intensional events. A comparison of variances could further help us decide on this, and so we have calculated ratios that limit the SVO/SVO contrast to one number per condition. If we compare the ratios for each cognitive system, we get 2.6 versus 9.9, namely a difference of 7.3. For the event type ratios across cognitive systems, we get 5.8 and 6.8, hence a difference of 1 point. Thus, it is clear that the effect of the cognitive system manipulation is larger than the event type manipulation, and this tentatively confirms the hypothesis that embodied cognition would have played a critical role in LE.

The findings reported in SdS – the correlation of extensional events with SOV patterns, and intensional events with SVO – is not altogether mirrored by our results, yet we cannot conclude a total refutation either. Firstly, part of our results are in fact at one with the said correlations, as is the case of intensional events in each of the communicative conditions. Secondly, the fact that we cannot apply statistics with such a small sample stops us from testing the significance of the event type variable.

Our results are in opposition with a bulk of evidence for the predominance of SOV across the World's languages (Gell-Mann & Ruhler, 2011). Likewise, it counters the cognitive 'naturalness' hypothesis about that order preference (Goldin-Meadow, So, Özyurek, & Mylander, 2008). What we found was a sheer prevalence of the SVO pattern, with 67 trials presenting SVO, dwarfing the 30 trials with SOV. In this, to the extent that our event type contrast may have overridden the alleged SOV prevalence, our results would concur with SdS.

Criticism. From this coarse approach, it permeates that embodied cognition might actually have played a major role in the evolution of word order preferences, and so perhaps on other common semantic phenomena. However, our experimental set-up was not perfectly rigorous, and our results are not clearly contestable for one particular hypothesis. There were flaws in our experimental design, as well as minor conducting mistakes. To start with the former, we had

distinguished a perceptual iconicity task based on pantomiming, and an abstract, symbolic task based on coding. The latter has sometimes failed, however, with participants drawing relations between the symbols and the referents that were not purely arbitrary but, in fact, rooted in the real world, as heard in the verbal descriptions posterior to the written coding of the disembodied condition. Script-based examples included: 'A for witch-made Art,' 'B for Beautiful princess,' 'C for Creepy witch,' 'D for Delicious stew,' and 'A for Anastasia, the princess,' so christened by one participant. Other perceptual relations for coding the scenes included 3, for a bent moustache, and □ for a table. Far from our expectations, too, participants matched some of the symbols to 'adjuncts' such as locatives, instruments and end states. Such unexpected behaviour betrays our major flaw: loose ends in the instructions.

Because participants did not know just what to make of the written instructions on screen, we could but support them verbally off the record—and that is where an experiment will go off science. Problematically, the experimenter's knowledge about the experimental design—with its target and filler components—is likely to go off into such clarifications, in which target components may predominate, potentially biasing the responses thereafter. This could have happened with some of our participants whom we helped by highlighting the target components in the stimulus, namely, agent, action and patient. The same applied to the actual word orders, though we did care not to pronounce any of our target orders, SVO, SOV. In this kind of experiments, and in most for that matter, instructions are to be *engraved* a priori, and not amended in any way. Our participants should all have been commended to describe the pictures in full, highlighting 'in full.' Thus, representations would have lasted relatively longer, with participants going through many a filler, with no indication to the contrary. As in SdS, this would have ensured that the target components of pictures were noticed and expressed naturally and completely, thus decreasing incomplete trials (e.g. VV, SVV, VO…).

Feedback on training trials is to be avoided. It is best to have fixed, clear instructions (previously tested in a pilot), and do away with any interaction on-the-fly between the conductor and the participant. We also had smaller procedural mistakes. One of these regarded the interface: in the disembodied condition, our participants had to shift between a computer screen and a sheet, on which they coded the elements of the scene on the PC. This is to be avoided, as we have checked it led one participant to confusion, and that in turn led to the very bad off-the-record interaction. There is yet one more general remark in order concerning our theoretical background. The two studies anchoring this experiment—on the one hand Stutz's hypothesis

on embodiment and language evolution, and, on the other, SdS's look at extensional and intensional events in the preference for SOV and SVO word orders—are both fairly recent, and neither appears to have been further addressed (i.e., there are no citations of either article to date). This circumstance made this experiment very exciting to us, but at the same time it did pose a major challenge.

5 Summary and discussion

Inquiry into the origins of language—a major part of the current LE inquiry—was muted for one century due to an overflow of speculative theories. Years after the start of the ban, in the mid-19th century, linguist William D. Whitney (1873: 279) labelled the topic as 'mere windy talk.' Nearly 150 years later, Richardson (2007: 144) opined that 'an answer advanced in the absence of knowledge of the details is a hypothesis without foundation. It is but speculation.' Along with a renewed scientific drive, the post-ban inquiry into LE presents influence of Darwin (1859), as evident in the widespread construal of *continuism*—i.e., gradual, phylogenetic evolution from our ancestors' communicative practices (Pinker, 2003; Tomasello, 2008; but see Chomsky, 2011).

At present, the LE inquiry is a complex pursuit formed by (1) multiple *subtopics*—origins, change and acquisition—, (2) multiple *questions*—what evolved, how, why, where and when—, (3) multiple *disciplines*—linguistics, anthropology, psychology, genetics, neurology and archaeology, and multiple methods, and (4) multiple *methods*—theoretical, comparative and simulative. Currently, most research probes into the systems underpinning language, which appear at numerous levels: mental, genetic, anatomical and cultural. Which system is fundamental for language is one key question. The other major question is, why did such systems come to be: for language, because of it, or independently? LE has a vivid production, evident in its breadth of perspectives. First, fieldwork has seen a myriad languages catalogued the World over. Psychology and cognitive science have been equally prominent perspectives; whilst Chomsky (1968) pioneered on these, the definitive cognitive turn was marked by Pinker and Bloom (1990). Archaeology is another discipline of major relevance; even though rarely carried out directly for LE, it is key in dating and locating the start of language (Perreault, Mathew, & Petraglia, 2012). In fact, much of this draws on theoretical and experimental analyses that do not address LE directly (see overviews, e.g., Tallerman & Gibson, 2012).

On most fronts, this inquiry appears divided over the nativist-empiricist dichotomy. While earlier times were dominated by nativist, UG-aligned views such as Pinker and Jackendoff's (2005), the past two decades have seen a surge of publications on language acquisition (Pye, Pfeiler, de León, Brown, & Mateo, 2007) and on linguistic diversity (Evans and Levinson, 2009). In spite of the recent 'pendulum swing' (Enfield, 2013: 155) the inquiry is taking long to reach quorum over its central dilemmas. Surely this is caused in part by the schism over nativism and emergentism. It is such a crucial question, and yet it is rather circular, too. Some researchers long to leave the dispute behind; but how? As we try, it may be fitting to rethink over our reviews. The multiplicity of factors and approaches that characterizes LE calls for an all-encompassing approach on reviewing work. Thus, aside from the more traditional reviews centred on methods and theories, a new kind of overview, broader in scope, may help to keep the field up to its fast research production. In addition, we find reason to give new methods a chance. Promising new methods include 'neuroarchaeology' (Uomini & Meyer, 2013), where stone knapping (more relevant than it would seem!) is analysed for its cognitive demands, as well as the better-known computational modelling. The latter have enabled us to control known factors, and test potential ones. In the midst of a possible deadlock blocking the ultimate questions of LE, modelling can help to connect similar views across disciplines, as well as compare different or opposite views. For instance, in a recent statistical approach to animal communication systems, Kershenbaum et al. (2014) refuted the traditional idea that animals communicate in predictable sequences. Novel and eclectic perspectives may well bring the right new explanations.

The speaker appears to be as important to language and its evolution as body and environment are important to cognition. There is already considerable evidence on those premises, so in our embodiment study we wanted to go further. Putting those two premises in interaction, we have tested whether bodily-situated cognition should have influenced the evolution of language. We adapted a previous experiment on word order preferences by adding a new distinction: embodied and disembodied tasks. Our results tentatively confirm the hypothesis, as manipulation of bodily involvement in the experimental tasks (gestures/codes) influenced the semantic preferences of participants (SOV/SVO) more systematically than previously-reported semantic biases (extensional/intensional events). This exploratory approach demonstrates its own feasibility in a broad sense, even though there is room for improvement of theory and method.

Acknowledgments

We received valuable advice from Vinicius Macuch (Radboud University), Sean Roberts, and Luis Miguel Berscia (both Max Planck Institute for Psycholinguistics). We also appreciate the help of our participants from the Tilburg School of Humanities.

References

Adornetti, I., & Ferretti, F. (2015). The pragmatic foundations of communication: An action-oriented model of the origin of language. *Theoria Et Historia Scientiarum, 11*, 63.

Aitchison, J. (2008). Lifting the veil: Uncovering language origin. In P. van Sterkenburg (Ed.), *Unity and diversity of languages* (pp. 17-25). Amsterdam: John Benjamins.

Bickel, B. (2014). Linguistic diversity and universals. In Enfield, Kockelman, & Sidnell (Eds,), *The Cambridge Handbook of Linguistic Anthropology*. Cambridge: Cambridge University Press, 101-124.

Bolhuis, J.J., Tattersall, I., Chomsky, N., Berwick, R.C. (2014). How could language have evolved? PLoS Biol 12, 8: e1001934.

Botha, R. P. (2002). Did language evolve like the vertebrate eye? *Language and Communication*, *22*, 2, 131-158.

Bouchard, D. (2013). Arbitrary signs and the emergence of language. In Lefebvre, C., Comrie, B., & Cohen, H. (Eds.). New perspectives on the origins of language. Amsterdam: John Benjamins.

Calvin, W. H., & Bickerton, D. (2000). *Lingua ex machina: Reconciling Darwin and Chomsky with the human brain*. Cambridge, MA: MIT Press

Carreiras, M., & Clifton, C. (2004). On the on-line study of language comprehension. In Carreiras, M. & Clifton, C. (Eds.). *The on-line study of sentence comprehension: Eyetracking, ERP, and beyond*. London: Psychology Press.

Chater, N. & Christiansen, M. H. (2010). Language acquisition meets language evolution. *Cognitive Science, 34*, 1131-57.

Chazan, M., & Horwitz, L. K. (2009). Milestones in the development of symbolic behaviour: a case study from Wonderwerk Cave, South Africa. *World Archaeology, 41*, 4, 521-539.

Chomsky, N. (1968). *Language and Mind*. New York, NY: Harcourt Brace.

Chomsky, N. (2011). Language and Other Cognitive Systems. What Is Special About Language? *Language Learning and Development, 7*, 4, 263-278.

Christiansen M. H., & Kirby, S. (Eds.). (2003a). *Language evolution*. Oxford: OUP.

Christiansen M. H., & Kirby, S. (2003b). The hardest problem in science? In Christiansen, M. H. & Kirby, S. (Eds.), *Language evolution* (pp. 1-15). Oxford: OUP

Christiansen, M. H. & Chater, N. (2008). Language as shaped by the brain. *Behavioral and Brain Sciences, 31*, 5, 489-509.

Corballis, M. (2003). From Hand to Mouth: The Gestural Origins of Language. In Christiansen, M. H. & Kirby, S. (Eds.), *Language evolution* (pp. 201-218). Oxford, UK: OUP

Darnell, M., Moravcsik, E. A., Noonan, M., Newmeyer, F. J., & Wheatley, K. (Eds.). (1999). *Functionalism and Formalism in Linguistics: Volume II*. Amsterdam: John Benjamins.

Darwin, C. R. (1859). *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. London: Clowes and sons.

Davidson, I. (2003). The archaeological evidence of language origins: states of art. In Christiansen, M. H. & Kirby, S. *Language evolution*. Oxford: OUP.

Deacon, T. W. (1997). *The symbolic species: the coevolution of language and the brain.* New York, NY: W. W. Norton.

Dean, L. G., Vale, G. L., Laland, K. N., Flynn, E., & Kendal, R. L. (2014). Human cumulative culture: a comparative perspective. *Biological Reviews, 89*, 2, 284-301.

De Boer, B. (2009). Acoustic analysis of primate air sacs and their effect on vocalization. *The Journal of the Acoustical Society of America, 126*, 6, 3329.

De Boer, B. (2012). Loss of air sacs improved hominin speech abilities. *Journal of Human Evolution, 62*, 1, 1-6.

De Boer, B., & Fitch, W. T. (2010). Computer models of vocal tract evolution: An overview and critique. *Adaptive Behavior, 18*, 36–47.

Dryer, M. S. (2011). The evidence for word order correlations: a response to Dunn, Greenhill, Levinson and Gray's paper in Nature. *Linguistic Typology, 15*, 335-380.

Enfield, N. J. (2013). Language, culture, and mind: Trends and standards in the latest pendulum swing. Journal of the Royal Anthropological Institute, 19, 155-169.

Evans, N. & Levinson, S. C. (2009). The myth of language universals: Language diversity and its importance for cognitive science. *Behavioral and Brain Sciences, 32*, 429-492.

Everett, D. L. (1986). Pirahã. In D. Derbyshire and S. G. Pullum (Eds.), *Handbook of Amazonian languages, vol. 1* (pp. 200-326). Berlin: Mouton de Gruyter.

Everett, D. L. (2007). Challenging Chomskyan Linguistics: The Case of Pirahã. *Human Development 50*, 297-299.

Fisher, S. E. & Scharff, C. (2009). FOXP2 as a molecular window into speech and language [Review article]. *Trends in Genetics, 25*, 166-177.

Fisher, S. E., Vargha-Khadem, F., Watkins, K. E., Monaco, A. P., & Pembrey, M. E. (1998). Localisation of a gene implicated in a severe speech and language disorder. *Nat Genet, 18*, 168-170

Fitch, W. T. (2000). The evolution of speech: a comparative re-view. *Trends in Cognitive Sciences, 4*, 7, 258-267.

Fitch, W. T. (2010). *The evolution of language.* Cambridge: Cambridge University Press.

Fitch, W. T. (2011). The evolution of syntax: An exaptationist perspective. *Frontiers in Evolutionary Neuroscience, 3*, 9.

Fitch, W. T. (2014). Toward a computational framework for cognitive biology: Unifying approaches from cognitive neuroscience and comparative cognition. *Physics of Life Reviews, 11*, 3, 329-364.

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

Fodor, J. A. (1983). *Modularity of Mind: An Essay on Faculty Psychology*. Cambridge, Mass.: MIT Press.

Franks, H., Griffiths, N., & Jhumka, A. (2013). Manipulating convention emergence using influencer agents. *Autonomous Agents and Multi-Agent Systems, 26*, 3, 315-353.

Friedman, M. (1994). *Kant and the Exact Sciences*. Cambridge, MA: Harvard University Press.

Galantucci, B., & Garrod, S. (2011). Experimental semiotics: a review. *Front. Hum. Neurosci., 5*, 11.

Gell-Mann, M., & Ruhlen, M. (2011). The origin and evolution of word order. *PNAS, 108, 42*, 17290-17295.

Goldin-Meadow, S., So, W. C., Özyurek, A., & Mylander, C. (2008). The natural order of events: How speakers of different languages represent events nonverbally. *PNAS, 105*, 27, 9163–9168.

Gong, T., Shuai, L., & Zhang, M. (2013). Modelling language evolution: Examples and predictions. *Physics of Life Reviews, 11*, 2, 313-314.

Greenberg, J. H. (1963). *Universals of Language*. London: MIT Press.

Grimm, J. (1851/1905). Über den Ursprung der Sprache. *Auswahl aus den kleinen Schriften*, 162-246. Hamburg: Im Gutenberg-Verlag Dr. Ernst Schultze.

Harnad, S. R., Steklis, H. D., & Lancaster, J. (Eds.). (1976). *Origins and evolution of language and speech: Annals of the New York Academy of Sciences, Vol. 280*. New York: New York Academy of Sciences.

Hauser, M. D., Chomsky, N., & Fitch, W. T. (2002). The faculty of language: What is it, who has it and how did it evolve? *Science 298*, 5598, 1569-79.

Hauser, M. D., Yang, C., Berwick, R. C., Tattersall, I., Ryan M. J., Watumull J., ... Lewontin R. C. (2014) The mystery of language evolution. *Front. Psychol., 5*, 401.

Haspelmath, M. (2010). Comparative concepts and descriptive categories in cross-linguistic studies. *Language* 86, 3, 663-687.

Heine, B., & Kuteva, T. (2007). *The genesis of grammar: A reconstruction*. Oxford: Oxford University Press.

Hurford, J. (1989). Biological evolution of the Saussurean sign as a component of the language acquisition device. *Lingua, 77*, 2, 187-222. Oxford: OUP.

Hurford, J. (2003). The language mosaic and its evolution. In Christiansen, M. & Kirby, S. (Eds.), *Language Evolution*, pp. 38-57.

Jackendoff, R. (2002). *Foundations of language: Brain, meaning, grammar, evolution*. Oxford: Oxford University Press.

Jackendoff, R., & Pinker, S. (2005). The nature of the language faculty and its implications for evolution of language (Reply to Fitch, Hauser, & Chomsky). *Cognition, 97*, 2, 211-225.

Jastrow, J. (1886). The evolution of language. *Science 7*, 176, 555-7

Kershenbaum, A., Bowles, A. E., Freeberg, T. M., Jin, D. Z., Lameira, A. R., & Bohn, K. (2014). Animal vocal sequences: not the Markov chains we thought they were. *Proceedings of the Royal Society B: Biological Sciences, 281*, 1792, 20141370.

Kirby, S. (2002). Natural language from artificial life. *Artificial Life, 8*, 3, 185-215.

Krause, J., Lalueza-Fox, C., Orlando, L., Enard, W., Green, R.E., Burbano, H.A., ... Pääbo, S. (2007). The Derived FOXP2 Variant of Modern Humans Was Shared with Neandertals. *Current Biology, 17*, 21, 1908-1912.

Levelt, W. J. M. (2013). *A history of psycholinguistics: The pre-Chomskyan era*. Oxford: Oxford University Press.

Levinson, S. C., & Holler, J. (2014). The origin of human multi-modal communication. *Phil Trans R Soc B, 369*, 20130302.

Macedonia, M. (2014). Bringing back the body into the mind: gestures enhance word learning in foreign language. *Front. Psychol., 5*, 1467.

Marcus, G., Marblestone, A., & Freeman, J. (2014 November 12). How to Study the Brain. *The Chronicle of Higher Education*. Retrieved from

http://chronicle.com/article/How-to-Study-the-Brain/149945/

Munro, S., & Verhaegen, M. (2011). Seafood, Diving, Song and Speech. In M. Vaneechoutte, A. Kuliukas & M. Verhaegen (Eds.), *Was Man More Aquatic in the Past? Fifty Years after Alister Hardy: Waterside Hypotheses of Human Evolution* (pp.181-9). eBook, Bentham Sci. Publ.

Nichols, J. (2011). Monogenesis or polygenesis: a single ancestral language for all humanity? In Tallerman and Gibson (Eds.), *Handbook of language evolution* (pp. 558-572). Oxford: OUP

Palmquist, S. A. (1987). A Priori Knowledge in Perspective: (I) Mathematics, Method and Pure Intuition. *The Review of Metaphysics, 41*, 1, 3-22.

Pavlenko, A. (2014). The bilingual mind: And what it tells us about language and thought. Cambridge: Cambridge University Press.

Perfors, A. (2014). Representations, approximations, and limitations within a computational framework for cognitive science. Comment on "Toward a computational framework for cognitive biology: Unifying approaches from cognitive neuroscience and comparative cognition" by W. Tecumseh Fitch. *Physics of Life Reviews, 11*, 3, 369-70.

Perlovsky, L. (2015). Origin of music and embodied cognition. *Frontiers in Psychology, 6*.

Perreault, C., Mathew, S., & Petraglia, M. D. (2012). Dating the Origin of Language Using Phonemic Diversity. *PLOS One, 7*, 4.

Pinker, S. (1994). *The Language Instinct: How the Mind Creates Language*. New York, NY: William Morrow and Company.

Pinker, S., & Bloom, P. (1990). Natural language and natural selection. *Behavioral and Brain Sciences, 13*, 707–84.

Pinker, S. & Jackendoff, R. (2005). The faculty of language: What's special about it? *Cognition, 95*, 2, 201-236.

Pnewell (2008, May 7). Reddit's science forum banned climate deniers. Why don't all newspapers do the same? [Web log comment]. Retrieved 2014 September 1 from http://www.spring.org.uk/the1sttransport

Pouw, W. T., De Nooijer, J. A., Van Gog, T., Zwaan, R. A., & Paas, F. (2014). Towards a more embedded/extended perspective on the cognitive function of gestures. *Front. Psychol., 5*, 359.

Press Association (2014, January 17). Ban the teaching of creationism in science lessons, says Alice Roberts. *The Guardian* (online). Retrieved 2014 Sept. 1 from http://www.theguardian.com

Progovac, L. (2015). *Evolutionary Syntax.* Oxford: Oxford University Press

Pye, C., Pfeiler, B., de León, L., Brown, P. & Mateo, P. (2007). Roots or edges? Explaining variation in children's early verb forms across five Mayan languages. In B. Blaha Pfeiler (Ed.), *Learning indigenous languages: Child language acquisition in Mesoamerica and among the Basques* (pp. 15-46). Berlin: Mouton de Gruyter.

Richardson, R. C. (2007). *Evolutionary Psychology as Maladapted Psychology*. London: MIT Press.

Rivas, E. (2005). Recent use of signs by chimpanzees (*Pan Troglodytes*) in interactions with humans. *Journal of Comparative Psychology*, 119, 4, 404-417.

Sampson, G. R. (2005). *The "Language Instinct" Debate.* New York, NY: Continuum.

Schouwstra, M., & de Swart, H. (2014). The semantic origins of word order. *Cognition, 131,* 3, 431-6.

Semaw, S. (2000). The World's oldest stone artefacts from Gona, Ethiopia: their implications for understanding stone technology and patterns of human evolution between 2·6-1·5 million years ago. *J.Archaeol.Sci., 27,* 1197-1214.

Shapiro, L. K. (2014). *The Routledge Handbook of Embodied Cognition*. London: Routledge.

Shu, W., Cho, J. Y., Jiang, Y., Zhang, M., Weisz, D., Elder, G. A., … & Buxbaum, J. D. (2005). Altered ultrasonic vocalization in mice with a disruption in the FoxP2 gene. *PNAS, 102,* 9643–9648.

Smolensky, P., & Dupoux, E. (2009). Universals in cognitive theories of language. *Behavioral and Brain Sciences, 32,* 468-469.

Steels, L. (2012). Emergent mirror systems for body language. In Steels, L. (Ed.), *Experiments in Cultural Language Evolution*. Amsterdam: John Benjamins

Stout, D., Toth, N., Schick, K., and Chaminade, T. (2008). Neural correlates of Early Stone Age toolmaking: technology, language and cognition in human evolution. *Phil Trans R Soc B, 363,* 1499, 1939-1949.

Stutz, A. J. (2014). Embodied niche construction in the hominin lineage: semiotic structure and sustained attention in human embodied cognition. *Frontiers in Psychology, 5*, 834.

Tallerman, M., & Gibson, K. R. (Eds.) (2012). *The Oxford handbook of language evolution*. Oxford: Oxford University Press.

Tennie, C., Call, J., & Tomasello, M. (2009). Ratcheting up the ratchet: on the evolution of cumulative culture. *Phil Trans R Soc, B, 364,* 1528, 2405-15.

Tomasello, M. (2008). *The origins of human communication*. Massachusetts, MA: MIT Press.

Tomasello, M. (2009). Universal Grammar is dead. In N. Evans, & S. C. Levinson, The myth of language universals: Language diversity and its importance for cognitive science (pp. 470-471). *Behavioral and brain sciences, 32.*

Tomasello, M., Call, J., & Gluckman, A. (1997). Comprehension of Novel Communicative Signs by Apes and Human Children. *Child Development, 68*, 6, 1067-1080.

Uomini N. T., Meyer G. F. (2013) Shared Brain Lateralization Patterns in Language and Acheulean Stone Tool Production: A Functional Transcranial Doppler Ultrasound Study. *PLoS ONE 8*, 8, e72693.

Van Leeuwen, E. J. C., Cronin, K. A., & Haun, D. B. M. (2014). A group-specific arbitrary tradition in chimpanzees (Pan Troglodytes). *Animal Cognition, 17*, 1421-1425.

Vernes, S. C., Newbury, D. F., Abrahams, B. S., Winchester, L., Nicod, J., Groszer, M., ... Fisher, S. E. (2008). A functional genetic link between distinct developmental language disorders. *New England Journal of Medicine*, 359, 22, 2337-2345.

Vogt, P. (2006a). Language evolution and robotics: Issues in symbol grounding and language acquisition. In A. Loula, R. Gudwin, & J. Queiroz (Eds.), *Artificial Cognition Systems* (pp. 176-209). Hershey, PA.: Idea Group.

Vogt, P. (2006b). Overextensions and the emergence of compositionality. In A. Cangelosi, A. D. Smith and K. Smith (Eds.) *Proceedings of Evolang 6 (World Scientific Publishing).*

Vogt, P. (2009). Modeling Interactions between Language Evolution and Demography. *Human Biology, 81*, 237-258.

Vogt, P., & Lieven, E. (2010). Verifying theories of language acquisition using computer models of language evolution. *Adaptive Behavior, 18*, 21-35.

Vogt, P., & Mastin, J. D. (2013). Anchoring social symbol grounding in children's interactions. *Künstliche Intelligenz* 27, 2, 145-151.

Whitney, W. D. (1873). *Oriental and Linguistic Studies, vol. 1*. New York, NY: Charles Scribner's Sons.

Willems, R. M., Özyürek, A., & Hagoort, P. (2007). When language meets action: The neural integration of gesture and speech. *Cerebral Cortex, 17*(10) 2322-2333.

Wohlgemuth, S., Adam, I., Scharff, C. (2014). FoxP2 in songbirds. *Current Opinion in Neurobiology, 28*, 86-93.

Wu, Y. (2014). Understanding the origins of language: An interactive stance: Comment on "Modelling language evolution: Examples and predictions" by Gong, Shuai and Zhang. *Physics of Life Reviews, 11*, 2, 305-306.