

★ FORUM ★

# Disentangling the Neanderthal Net: A Comment on Johansson (2013)

Lluís Barceló-Coblijn &amp; Antonio Benítez-Burraco

## 1. Johansson's approach to Neanderthal language

Sverker Johansson provided a very useful piece of work in which he skillfully reviews most aspects and scientific areas that have dealt with the Neanderthal language issue, including (but not limited to) genetics, archaeology, linguistics and modeling. Johansson's main conclusion is that *Homo neanderthalensis* had some form of language, at the very least, a proto-language, which he understands as "a system possessing lexical semantics but not syntax" (Johansson 2013: 6). At the same time, he notes that many aspects are still obscure, and that the data reported until now is still not conclusive. In particular, "whether they had syntactic language can be neither confirmed nor refuted" (p. 23).

We agree with Johansson when he says that Neanderthals had to count on some form of language. The amount of evidence he has reviewed points in this direction without doubt. We also agree with him in conceding Neanderthals a much more sophisticated capacity for oral production than as sometimes been depicted in the past. Nevertheless, we think that the real, productive debate is whether or not Neanderthals had the *same* faculty of language that anatomically modern humans (henceforth, AMHs) have. The author distances himself from this debate and, at the end, he does not take a stance. According to Johansson, the main reasons for not taking any clear position in this regard are related to an inherent problem of the sources of evidence and of the methodology:

- (A) The data are few and not always trustworthy.
- (B) Some conclusions imply difficult, even illicit inferential steps from the data.

Our criticism to Johansson's position is double. First, although we entirely agree with Johansson regarding the additional difficulty incorporated by an extinct species, we think that we actually can proceed with a null hypothesis: In our opinion, current evidence supports that the Neanderthal language was not like

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AMH's because it lacked *modern* syntax (and *only* because of this). This is a plausible conclusion that can be reached from the very data reviewed by Johansson. Second, some aspects of Johansson's approach, both related to the evidence and the methodology need to be improved. Plausibly, it is this circumstance that hinders him from reaching any firm conclusion about this issue.

## 2. Some remarks on (the interpretation of) evidence

### 2.1. *The nature of language*

Johansson's definition of language is as follows: "Language is a symbolic communication system that is not fixed; extensibility is an integral part of the system. This amounts to the presence of something like lexical semantics, flexibly and learnably mapping forms to meanings" (Johansson 2013: 6). He further states that "a system that has units that are combined in syntax-like patterns, but that lacks a mapping to meanings, such as birdsong, is likewise not language. A system possessing lexical semantics but not syntax, I would call a protolanguage" (p. 6). Johansson has pointed out that *lexical semantics* is something one could attribute to Neanderthals. In turn, "there is no real evidence one way or the other concerning syntactic abilities [among them] [...]. This means that Neanderthals had at least a spoken proto-language; whether they had syntactic language can be neither confirmed nor refuted" (p. 23).

Consequently, Johansson has focused his attention on (1) *lexical semantics* as the core property with which language (or protolanguage) is endowed; (2) *syntax* as the property that distinguishes protolanguages from modern language; and (3) *communication* as the function that language fulfills (and plausibly evolved for). All these assumptions can be eventually problematic, particularly if some of these concepts are used loosely, as sometimes seems to be the case.

For instance, lexical semantics in frameworks like Hale & Keyser's (1995), Mateu's (2002), Borer's (2005a, 2005b), or Acedo's (2010) does not separate syntax from the meaning of the lexicon. It is still an important open debate whether lexical items are or can be detachable from syntax.

Moreover, exactly what does *extensibility* (or even "flexibly and learnably mapping forms to meanings") mean or imply? And what is the ultimate source of such extensibility or flexibility? After all, semantic extension allows for such expansion of meaning and for flexibly mapping forms to (new) meanings. However, this ability has been attested in great apes reared in captivity (Gardner *et al.* 1989; Savage-Rumbaugh & Lewin 1994; Savage-Rumbaugh *et al.* 1998). The other source of semantic extensibility is, crucially, that of semantic compositionality. But this kind of compositionality relies heavily on syntax: new meanings emerge when the same words are combined in a different fashion.

Additionally, it is important to always make clear in which case one is referring to modern, complex syntax, or instead is using the term *syntax* loosely (perhaps in the etymological sense of 'to put in order' or even 'to arrange'). For example, Johansson's dismissal of Piattelli-Palmarini's rejection of a language without syntax obviates that Piattelli-Palmarini is referring to the former type. More importantly, different kinds of grammars have been actually hypothesized within the very Chomskyan paradigm. Syntax is not an all-or-nothing question

within this framework. But neither is it a continuum.<sup>1</sup> Ultimately, when we look at “animal communication” through a “syntactic” lens, we actually find “grammar” among extant species (see Hurford 2011: 3–99). Hence, ape strings of lexigrams or signs, such as those performed by Washoe, Kanzi, or Sarah, were not syntax-free. On the contrary, they are the output of a system that can be described by means of a regular grammar. Allegedly, some species (such as Gentner’s *et al.* 2006 starlings) might have access to recursive grammars, though once again in experimental conditions only.<sup>2</sup> Perhaps all hominin proto-languages were the output of systems akin to regular grammars (such as apes’ ‘languages’) or perhaps to recursive grammars. In fact, it is our contention that the available data do not support non-AMH hominin ‘languages’ being syntactically structured like AMH languages are.

On another front, Johansson argues that Pirahã (if it actually lacked recursion) or pidgins are functional communication systems with lexical and propositional semantics. He further states that, although they “lack one or more components of full modern human language [...], these systems also deserve the label ‘language’” (p. 6). This can plausibly be the case, according to his own characterization of *language* (see above). But once again, this entails placing structurally different linguistic objects under the cover term of *language*, obviating the fact that they rely on grammars endowed with different (formal) properties. In the end, one always can argue that the string of symbols productively generated by Washoe or Sarah were also endowed with lexical and propositional semantics, and allowed them to communicate with their caregivers. The suppression of boundaries between systems (i.e. gradualism) places apes’ performance in an ambiguous position, becoming able to be classified under the pidgin umbrella as well. Notice also that, behind a pidgin there is always an AMH brain. A pidgin is never entirely independent from the influence of a prototypical, non-simplified/reduced adult language (these systems have been simplified by adult AMHs who already spoke a full modern language). Ultimately, it seems to us that what is really worth characterizing is the proto-typical AMH language, and then to determine whether or not Neanderthals could have developed something like this.

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<sup>1</sup> In fact, Johansson mentions the controversy about a partial Merge, and specifically about a gradual evolution of Merge with precursor stages. However, fifty years earlier, Noam Chomsky himself postulated as well different classes of grammars according to the type of set of strings of symbols (= formal languages) that can be generated under certain general admissibility conditions (Chomsky 1956, 1959). Cross-serial dependencies (i.e. dependencies among nodes in a hierarchy that are not expressible as hierarchical nodes) suggest that natural languages could be characterized as Type 1, or context-sensitive languages within his hierarchy. Nonetheless, both Type 2 (context-free) and Type 3 (regular) grammars were also hypothesized to exist. Notice that context-free grammars are also able to generate sets of strings recursively. Eventually, regular grammars generate strings of symbols as well, although they are arranged in a linear fashion without any internal structuring. Currently, different subtypes of both regular grammars (‘first-order Markov grammars’ and ‘state chain grammars’), and context-sensitive grammars (‘mildly context-sensitive’ and ‘context sensitive [*stricto sensu*]’) are postulated. It is true that formal grammars could not properly apprehend the complexities inherent to natural languages (Pullum & Rogers 2011), but they help to understand some of their basic properties. As a consequence, it seems justified to rely on them to gain a clearer insight on some basic properties of hominin [proto] languages.

<sup>2</sup> This is a well-known open debate. See Gentner *et al.* (2006), van Heijningen *et al.* (2009), or Berwick *et al.* (2011).

Lastly, one should avoid conflating *language* with one of the functions it fulfills, namely *communication*. As discussed above, different types of (formal) languages (including proto-languages), all endowed with lexical and propositional semantics, can effectively function as communication devices. As a consequence, it is the structural properties of languages that matter — and, more specifically, how linguistic structures are generated. In fact, modern biology heavily supports this view, given that only biological structures along with their activities evolve, but not functions (see Love 2007 for discussion).<sup>3</sup> This clarification is important also for correctly addressing the *form-function* problem that Johansson has repeatedly come into and has extensively reviewed. Admittedly, modern functions cannot be automatically inferred from human-like, language-related biological structures (the descended larynx, the mirror neurons, etc.). Conversely, modern functions can exist even if some human-like, language-related biological structure is absent (e.g., sign languages and speech-hearing organs). Nonetheless, biological structures *do* exhibit a measurable degree of evolutionary continuity that allows making justified inferences from them regarding language evolution.<sup>4</sup>

## 2.2. *The substratum of the language faculty: Neural connections and the brain*

We completely agree with the way in which Johansson has reviewed the fossil evidence of speech and hearing organs. However, we have some concerns regarding the way in which he has discussed the neuronal substrate of language. Concerning the neural wiring, Johansson only mentions nerves that control tongue movements and breathing, plausibly because some of their properties can be confidently inferred from the fossilized nerve canals. But this is informative only with regard to speech. Although brain nerve tracts do not fossilize, we are not here in total darkness. For instance, as brains become larger, structural changes in the form of internal reorganization do occur. Typically, we observe a connective invasion of disjointed areas, thus plausibly allowing different cognitive systems to interface. Brain allometry is another interesting source of evidence. Different brain morphologies plausibly imply different brain interconnection patterns. Whereas Neanderthal and AMH skulls (and brains) are quite similar at birth, they differ progressively across development (Gunz *et al.* 2010, 2012). Importantly, it is after birth when essential changes in the wiring of the brain take place under the influence of environment and, when fully functional,

<sup>3</sup> According to Love (2007), *functions* can be construed as the uses given to biological structures because of their connections with other structures, but also because of the relationships existing between the organism and the environment.

<sup>4</sup> For instance, we have contended elsewhere (Balari *et al.* 2011) that the Chomsky Hierarchy has a neurobiological correlate that can illuminate how human language evolved. Hence, the automaton in the Chomsky Hierarchy equates with a computational device relying on a pattern generator (or sequencer) and a memory 'stack'. Simply put, more memory resources allow the automaton to generate more complex structures. Following Lieberman (2000) or Ullman (2001), a plausible neural substrate for the sequencer is the basal ganglia (see section 2.5). Working memory plausibly relies on the activity performed by diverse cortical structures. Our point was, then, that the evolutionary trajectory of this computational device is more informative regarding the evolution of language than that of the functions it fulfills or of the functions fulfilled by language (communication, symbolic behavior, modern behavior, and the like).

computational devices eventually appear (Balaban 2006; Ramus 2006; Petanjek *et al.* 2011). For instance, according to Boeckx (2012), it is the more globular configuration of adult AMH brains that allowed modern syntax to emerge. Such a configuration would offer the possibility of more efficient connections and information exchanges and, eventually, of computational efficiency. In sum, the different skull developmental trajectories plausibly do reflect real differences between these two hominins at the neurobiological level.

On the other hand, we consider that the importance given by Johansson to lateralization should be reduced. There is only a weak correlation in our species between general verbal skill and precociousness of language development on the one hand, and the degree of lateralization in hand use, on the other — in general, between lateralization and cognitive abilities, including language (Nettle 2003). Additionally, language seems not to depend so much on a specific pattern of structural and functional lateralization of the brain, but on specific interconnections between neuronal populations that link them functionally. For instance, language integrity is not substantially affected, either qualitatively (patterns or types of linguistic structures) or quantitatively (number of utterances, size of the lexicon, etc.) when language is transferred to the right hemisphere in some pathological conditions or in some left-handed people (Liégeois *et al.* 2008). Moreover, at the genetic level, Lambert *et al.* (2011), in their study of the expression of genes in human fetal cerebral cortex, have found no significant differences in gene expression patterns between left and right neurons from Broca and Wernicke language areas.<sup>5</sup> Lastly, fossil evidence of brain structural and functional asymmetries predates the evidence for (modern) right-handedness among hominins (Kyriacou & Bruner 2011). In fact, functional (or even structural) brain lateralization is an archaic feature among mammals.<sup>6</sup>

### 2.3. *On the role of genes, the environment and development*

We have some major concerns regarding the way in which Johansson reviews the genetic evidence.

First, it is true that “there is no such thing as *the* gene for a complex trait” (Johansson 2013: 16). However, this does not automatically preclude that a “single genetic change conferr[ed] language” (p. 15). This mutation can affect a master or hub gene (see for example, Seo *et al.* 2009). These genes establish connections with many other elements in the genome/proteome. A single mutation or change will plausibly affect the relations with the rest of elements within its interactome,<sup>7</sup> thus provoking many downstream changes. More importantly, when one speculates about *the* mutation that yielded language (e.g., Chomsky, cited by the author [p. 16]), one does not normally think about a

<sup>5</sup> Importantly, they also concluded that “cortical evolution in different mammalian species may be driven in part by species-specific changes in the regulation of the same genes and pathways, which are potentially important in brain patterning in many species” (Lambert *et al.* 2011: 10).

<sup>6</sup> Proven in gorillas and chimps (Cantalupo & Hopkins 2001; Hopkins & Cantalupo 2004; Hopkins *et al.* 2007), but also in many other vertebrates (Rogers 1989).

<sup>7</sup> That is, the whole set of molecular interactions in cells. *Genome*: the whole set of genes; *proteome*: the whole set of proteins.

mutation that gave rise to *all* components of language from scratch. This mutation could just help to functionally interconnect the diverse, previously evolved, elements of language. Or it could just optimize some specific component (such as syntax?) that was already connected to all the remaining, important-for-language pieces? For more on this, see section 4 below.

Another aspect that should not cause confusion is that of *the function* of a gene. In fact, this is related to the dual sense that *function* has in biology (see also section 2.1). Hence, it is true that *FOXP2* has a very well preserved expression pattern and plays practically the same physiological role in all mammals (and perhaps in all vertebrates). Nonetheless, this does not preclude that the brain circuitry *FOXP2* contributes to fulfill different functions in different organisms — i.e. support different behaviors like ultrasound generation, song learning and performance, or language. The possibility that this gene contributed to a different function in Neanderthals is neither implausible nor non-parsimonious (e.g., vocalizations related to some musical behavior, as suggested by Mithen 2006).

In the third place, the differences between Neanderthals and AMHs at the genetic level are real. There are differences in genes involved in brain development and, more significantly, in genes related to language disorders. For instance, Neanderthals exhibit the ancestral allele in some positions of the gene *MCPH1*, which controls neuronal proliferation and whose mutation gives rise to microcephaly (Green *et al.* 2010). A similar case is the gene *CNTNAP2*, one of *FOXP2* targets and a candidate for specific language impairment and autism. This gene shows a fixed single nucleotide change in Denisovans, the closest hominin to Neanderthals (Meyer *et al.* 2012). Finally, Maricic *et al.* (2013) found an AMH-specific substitution within a regulatory region of *FOXP2* that is likely to alter its expression.

Furthermore, it seems to us that Johansson has, to some extent, oversimplified the role of genes in relation to the environment and in development. He wisely takes into account West-Eberhard's (2003) book. However, it is West-Eberhard who has shown us that the same genotype can develop different phenotypes in different environments. Neanderthals and AMHs actually evolved and lived in different environments (Finlayson 2005; Carrión *et al.* 2011). Consequently, even if they were endowed with the same 'linguistic genotype' (though, remember, this is not the case), we cannot automatically rule out the possibility that the former had a different faculty of language. In fact, as we pointed out above, it has been recently proved that their skull ontogenies (and, hence, brain development) diverge at some point after birth. Ultimately, evolutionary innovations can arise in the absence of genetic modifications (i.e. in neutral conditions) because of the very dynamics and generative properties of developmental systems (Müller & Newman 2005; West-Eberhard 2005). These considerations substantially minimize the role of genes both in development and evolution.

Last but not least (and related to our latter concern), genes are less important during the last steps of development, when the definitive wiring of the brain takes place and cognitive abilities finally emerge in response to environmental stimuli.

#### 2.4. *Effects of introgression*

In section 5 of his article, Johansson rightly distinguishes between *hybridization* and *introgression*. Introgression is a case of partial hybridization between species; it is “an invasion of the genome”, in Mallet’s (2005) terms, something that happens quite often in nature, and therefore it is not an anomaly (Mallet 2008); within European mammals, 10% hybridize. Mallet observes that “introgression can be highly selective, *affecting only some parts of the genome*, whereas other genomic regions strongly affected by divergent selection remain virtually isolated” (Mallet 2005: 6; our emphasis). Neanderthals and AMHs interbred.<sup>8</sup> But so did Denisovans and AMHs (Meyer *et al.* 2012).

Interestingly, Johansson concludes that “evidence of successful interbreeding would [...] add some modest weight to the case for Neanderthal language [...] But it is not clear what form of language is supported”. In essence, his argument goes as follows:

- (1) Neanderthals could not be reproductively successful (within an AMH reproductive group) if they had lacked language.
- (2) Therefore, they most likely had “a functioning language faculty” (Johansson 2013: 17).
- (3) “A genetic endowment heterozygous<sup>9</sup> for the relevant genes [was] sufficient [for language]” (idem) — perhaps with the exception of *FOXP2*.

Notice, however, that:

- (A) Communication was not out of range of Neanderthals, and a proto-language should have been sufficient for communication.
- (B) Hence, one cannot take for granted that Neanderthals automatically had full language. Mallet’s words caution against quick conclusions. This is important if we take into account the differences in development (see sections 2.2 and 2.3 above).
- (C) Certainly, an AMH interacting with other AHMs by means of a pidginized version of the group language (or of her own language) resembles the scenario posited by Johansson quite closely. However, we do not derive from this that they are endowed with a different faculty of language or that there are cognitive differences between them.
- (D) *FOXP2* is perhaps more the rule than the exception concerning the effect of heterozygosity on language abilities. In fact, many cognitive disorders in which language is impaired are caused by changes in gene dosage. For

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<sup>8</sup> Johansson says that Africans do not have Neanderthal genes. This is technically inaccurate (Green *et al.* 2010 say *Sub-Saharians*), though we attribute this generalization to the recency of the paper published by Sánchez-Quinto *et al.* (2012), who show that North-Africans do have Neanderthal genes.

<sup>9</sup> That is, endowed with different alleles of the same gene; in this case, with only one copy of the language-ready genome.

instance, the duplication of a small fragment within the chromosomal region 7q11.23 gives rise to a mild to severe language impairment (Somerville *et al.* 2005; Berg *et al.* 2007). Conversely, language is more preserved (but still disordered) in hemizygotic people — the disease is known as Williams-Beuren syndrome —, while the visuo-spatial abilities are substantially impaired (Mervis & Becerra 2007; Martens *et al.* 2008).

However, our main criticism against any relevant role of the interbreeding fact in granting Neanderthals a modern faculty of language is of quite a different nature. For the sake of argument, we will leave aside the circumstance that current DNA analyses have only proved a gene flow from Neanderthals to AMHs, but not vice versa (Green *et al.* 2010). Obviously, we will obviate as well that evidence of modern language in Neanderthals is at least controversial, as Johansson himself discusses. To begin with, it seems that the introgression event did not prompt any significant cultural change among Neanderthals, in spite of the role commonly granted to (modern) language in dynamizing cultures. Hence, according to Green *et al.* (2010), the admixture took place  $\approx$  50–100kya BP, but the Châtelperronian and other modern-like techno-complexes only emerged  $\approx$  40kya BP (d’Errico *et al.* 1998; Langley *et al.* 2008).<sup>10</sup> Moreover, the introgressed DNA should have contained all the AMH-specific variants of the ‘language genes’ and of the corresponding regulatory mechanisms of gene expression. Importantly, these genes are scattered throughout the genome (Smith 2007; Benítez-Burraco 2012). However, we have direct evidence that Neanderthals exhibit the ancestral alleles in some cases (see above). Finally, if we could attest that the introgression event actually provided Neanderthals with the whole AMH-specific molecular machinery needed for language, an AMH faculty of language can still not be taken for granted. As we discussed at the end of the previous section, there is no direct link between the genotype and the phenotype.

## 2.5. *Archaeological evidence*

As he did before with other sources of data, Johansson has proficiently reviewed the extant evidence of symbolism and of ‘modern behavior’ among Neanderthals. However, we think that his analysis would benefit from a change of focus. To begin with, it is not symbolism or symbolic behavior *per se* which is at stake. From a semiotic perspective, human languages are certainly ‘codes’. But natural languages are more than codes. As we discussed in section 2.1, linguistic meaning is compositional by nature (see also Hurford 2011). Modern, human-like language is a system of representation (and ultimately, of communication) that combines symbols — both hierarchically and recursively — to generate complex structures that include different sorts of dependencies between distal constituents (Chomsky 1965, 1980; Baker 2001; Hauser *et al.* 2002). What matters in our opinion is, above all, how linguistic structures are generated. Moreover, even if we found evidence of a symbolic culture among Neanderthals, we could not

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<sup>10</sup> Some authors (*e.g.*, Bar-Yosef & Bordes 2010) even cast serious doubts on a possible Neanderthal authorship of the Châtelperronian industry.



automatically infer that they were endowed with a modern faculty of language. Symbolic cultures are opaque by nature (Eco 1976), whereas linguistic meaning is open, productive by nature. Ultimately, as we have already argued, other extant primates can learn and use symbols (Premack 1971; Savage-Rumbaugh 1986; Gardner *et al.* 1989; Savage-Rumbaugh & Lewin 1994).

Conversely, Johansson has just taken a quick look at archaeological evidence of syntax as originally posited by Uriagereka & Camps (2006). Johansson merely points out that these pieces of evidence are considered controversial or uninformative, according to some other authors (e.g., Lobina 2012). However, two lines of evidence suggest that this piece could be more informative than currently assumed:

First, under this fresh hypothesis, the computational system of language is thought to be functionally unspecific by nature. The functions to which it contributes depend on the systems with which it interfaces.<sup>11</sup> In fact, this is what ultimately qualifies knots as a proxy for syntactic abilities (Barceló-Coblijn & Gomila 2012). Motor behavior will help us to prove this:

- The field of motor disorders is familiar with the idea that voluntary motor actions are decomposable into motor primitives or ‘movemes’ (Del Vecchio *et al.* 2003). Movemes combine in diverse fashions according to specific combinatorial or syntactic rules (Flash & Hochner 2005). Moreover, the brain seems to rely on basic neural ‘binding mechanisms’ (like cortical synfire chains) to generate any kind of composite objects at the representational level. As Flash & Hochner also remark, “activities in synfire chains might bind and form a hierarchy of representations as required for language, [but] they might also offer a unique neural mechanism for compositionality of motor elements” (p. 663).
- There is also ample evidence suggesting that movements are controlled by a ‘central’ device, with peripheral, biomechanical factors playing a subsidiary role (Dipietro *et al.* 2009). fMRI studies suggest that motor processing activates cortical and subcortical areas that greatly match those involved in language processing. Significantly, the signal of two relevant components of that network (the bilateral ventral premotor area and the right posterior inferior temporal cortex) is transmitted via the arcuate fasciculus, which also plays a relevant role in language processing (see Makuuchi 2010 for a review).
- Lastly, there is ample evidence as well of the comorbidity between motor and language disorders. In most cases, this is due to the affectedness of the same specific brain areas, which probably perform some basic computation relevant for both language and motor planning. For instance, specific language impairment positively correlates with fine and gross motor deficits affecting limb movements (but not with rhythmic timing skills) (Zelaznik & Goffman 2010). In the same vein, dyslexia can be comorbid with drawing deficits. It has been argued that dyslexics suffer from a visuo-

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<sup>11</sup> This idea goes back to the seminal paper by Hauser *et al.* (2002).

constructive deficit (Eden *et al.* 2003; Lipowska *et al.* 2011). Probably, they specifically suffer from a deficit in the rule abstraction mechanism inherent to sequential learning, which can simultaneously impair visuo-motor and linguistic tasks.<sup>12</sup> Similarly, Huntington disease is a neurodegenerative condition caused by the atrophy of the basal ganglia.<sup>13</sup> In this condition, both linguistic and motor deficits are observed (Teichmann *et al.* 2005; 2008; Robins Wahlin *et al.* 2010). Interestingly, knock-in mice expressing the human pathogenic *HD* gene exhibit abnormal prefrontal and cortico-striatal functions, which impair rule learning abilities, and ultimately, give rise both to visuo-spatial and motor deficits (Trueman *et al.* 2009).

A second line of evidence supporting the knotting hypothesis is that of cultural dynamism among hominins, which we have introduced in section 2.4. Contrary to the emergence of modern behavior within our clade — a ‘classic’ proxy in the field of language evolution, which Johansson has greatly clarified in his paper —, the controversy around cultural stasis *versus* cultural dynamism in Neanderthals and AMHs is not so frequently addressed. Johansson marginally mentions this: “[T]hroughout most of their existence, Neanderthals used Mousterian tools” (Johansson 2013: 20). The important point is not merely that complex language seems a key requirement for cultural dynamism in AMHs. It is that static and non-static cultures plausibly entail different organizations of mind, and particularly, different working memory capacities (Coolidge & Wynn 2005). Ultimately, more working memory resources could allow more complex linguistic structures to be generated (see the discussion in fn. 4). Consequently, if only AMH cultures are non-static, some important (for language) cortical reconfiguration plausibly occurred only in *Homo sapiens*, allowing full-fledged language to emerge (see Balari *et al.* 2011 and Balari & Lorenzo 2012 for details).

### 3. Some remarks on the methodology

Johansson has postulated a concept of ‘proxy’ for language (see his section 2.3). The advantage of this conceptual tool is that it is well defined and it constrains the possibilities. According to the author, for something to be qualified as a proxy for language:

- It has to be uniquely human: “[A] feature that is shared between humans and language-less non-humans is not a useful proxy for language” (Johansson 2013: 7).
- The absence of the proxy should ideally entail the absence of language: “Preferably, the entailment should be two-sided, so that the absence of the proxy likewise entails the absence of language” (Johansson, 2013: 7).

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<sup>12</sup> It would impair visuo-motor tasks demanding implicit learning of sequential stimuli along with generating complex motor patterns, such as drawing (Vicari *et al.* 2005), but also the ability for implicit learning of modified artificial grammars (Pavlidou *et al.* 2010).

<sup>13</sup> This subcortical area implements a sequencer device in some models of language processing (see Lieberman 2000; Ullman 2001; Balari *et al.* 2011; see also fn. 4).

Johansson correctly advocates as well not relying on just one single proxy for inferring either the presence or the absence of language in other species: “Instead of relying on any single one, a more prudent approach is to see if there is a common pattern to be found among multiple proxy-candidates” (p. 19).

That said, we think that Johansson has not followed his own advice till the very end. On the one hand, sometimes, we do not see any profound difference between his approach and the common search for something that is uniquely human and unique in AMH language, like the famous FLN/FLB distinction (Hauser *et al.* 2002).<sup>14</sup> But this approach ultimately entails that an AMH language is just a hominin language with an extra component. On the other hand, each of these proxies, when examined one by one, seemed essentially inconclusive to Johansson. Nonetheless, it is important to see the picture that emerges when *all* are simultaneously considered. If we consider language as a complex feature, then all the elements that play a role therein are important. Paraphrasing Gould & Lewontin (1979: 585) language does not seem to be “a collection of discrete objects” — in which one of them represents the kernel of language and a completely independent entity —, rather “an integrated entity”.

Let us illustrate this with an example. From the continued discussion about the Neanderthal vocal tract between Philip Lieberman and Louis-Jean Boë,<sup>15</sup> we can extract at least a relevant aspect from each side:

- a. Cavities and shape of the vocal tract are not enough, but the precise control of the organs, such as, for example, the jaw, lips, and tongue.
- b. The neural substratum for the control and execution of speech is very particular in AMHs, involving cortical and subcortical areas, the basal ganglia in particular, although similar (i.e., homologue) circuitries are observed in other, non-related species (e.g., song birds).

Both (a) and (b) are connected, and hence both describe part of the reality. A modern vocal tract certainly does not entail *per se* modern language, but neither does a human-like neural circuitry. However, a modern vocal tract controlled by a human-like circuitry is plausibly suggestive of modern *speech*.

Summing up, because language is a complex feature intervened by many factors, we need to consider *all* small details in order to enhance our knowledge. Ultimately, it is not so much a matter of when *a* component of language appeared, but, above all, of when *all* the components were put together (i.e. functionally interconnected). And of course, we should also consider the possibility that some properties of language are emergent by nature. In other words, they

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<sup>14</sup> Fitch, one of the proponents of the FLB/FLN distinction, has recently said:

Given the fact that human cultural capacities themselves rest upon a unique biological basis, the debate actually hinges on a distinction between ‘general cognitive’ and ‘specifically linguistic’ neural mechanisms in our species. I suggest that, from a biological viewpoint, this distinction is unproductive and misleading, and that the debates surrounding it have led cognitive science down a blind alley.

(Fitch 2011: 383).

<sup>15</sup> For example, Lieberman & Crelin (1971), Boë *et al.* (1999), Boë *et al.* (2002), Lieberman (2007), Boë *et al.* (2007), and Lieberman (2012); see also Barney *et al.* (2012).

cannot be predicted from the nature and the interplay of their components at a particular level of analysis (see Deacon 2005).

#### 4. A stringent biolinguistic approach to Neanderthal language

We think that a stringent biolinguistic approach to Neanderthal language is actually possible. An outline of this could be as follows. If our hypothesis is correct, all hominin proto-languages (including Neanderthals') could have been endowed with regular-like grammars (like apes' 'languages') or perhaps with context-free-like grammars. Conversely, a fully-fledged modern syntax (which is mildly context-sensitive) would have only emerged along with our own species. This entails that the Neanderthal-AMH divide would basically consist of a brain reconfiguration that improved the computational abilities of the latter. Perhaps, it enhanced their working memory, or alternatively, it allowed more efficient information exchanges (see Balari & Lorenzo 2012 and Boeckx 2012, respectively, for details). But it was this reconfiguration that eventually facilitated the advent of modern syntax.

In turn, most components of speech were very probably shared both by Neanderthals and AHMs — allowing for minor differences.<sup>16</sup> The Neanderthal interface between this audio-vocal (exteriorizing/interiorizing) system and a conceptual system (responsible for thought) could have been firmly established as well. As a consequence, an oral, “symbolic communication system that is not fixed” (Johansson 2013: 6) in Neanderthals is granted; at the same time, the grammar of this language (or protolanguage) would almost certainly have been different from that of AHMs' languages.

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<sup>16</sup> The hypothesis that orality replaced gestuality sometime after the split from extant apes is conceivable, though a scenario of co-evolution and co-intervention is also plausible. Eventually, the latter, in particular, would explain why sign languages and oral languages co-exist in modern humans and obey the same neural pattern regarding the centers of comprehension and production, although they obey different peripheral paths of input and output.

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Lluís Barceló-Coblijn  
 Universitat de les Illes Balears  
 Departament de Psicologia  
 Carretera de Valldemossa km 7,5  
 E-07122 Palma (Mallorca)  
 Spain  
[lluís.barcelo@uib.cat](mailto:lluís.barcelo@uib.cat)

Antonio Benítez-Burraco  
 Universidad de Huelva  
 Departamento de Filología Española y sus Didácticas  
 Campus el Carmen  
 E-21071 Huelva  
 Spain  
[antonio.benitez@dfesp.uhu.es](mailto:antonio.benitez@dfesp.uhu.es)