

Ice age mentalists: debating neurological and behavioural perspectives on the Neandertal and modern mind

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Reconstructions of the evolution of human cognition and the interaction between cognition and behaviour in extinct hominins suffer from two problems. One is the pervasive use of double standards when it comes to judging behavioural evidence from *Homo sapiens* and extinct hominins, notably Neandertals (Roebroeks & Corbey, 2001). The other one is the continued and pervasive use in palaeoanthropology of an outdated linear view of evolution for the evolution of cognition (Langbroek, 2012). Unlike in other domains of biology, the evolution of cognition is still universally approached by means of a scalar ladder model rather than a diverse branching tree. As a result, there is a strong focus on defining behaviours exclusive to *Homo sapiens* and arguing that the lack of these in extinct hominins points to an inferior cognition (Langbroek, 2012; Trinkaus *et al.*, 2001). The existence and significance of well-developed uniquely derived modes of cognition and behaviour in extinct hominins is seldom given a thought (Langbroek, 2001, 2012). When expressed in *Homo sapiens*, unique traits are always presented as evolutionary advantages over other hominins. Unique traits in extinct hominins in turn, if discussed at all, are usually quickly mitigated by turning them into evidence for 'deficiencies'. An example is the recent study by Pearce *et al.* (2013). Pearce *et al.* argue that superior Neandertal vision as implied by their large occipital lobes and large orbits was really a *deficiency* because it was achieved, they assume, at the expense of brain capacity for higher social cognitive functions. Pearce *et al.* tellingly never use the word 'superior' to

describe Neandertal visual capacities: that word is exclusively used in connection to *Homo sapiens* in their study.

Bruner & Lozano's thought-provoking study (this volume) on parietal lobe evolution and the implication of cutmarks on Neandertal teeth for visuo-spatial system integration is in danger of stepping into a similar pitfall. Nevertheless, Bruner and Lozano do probe fertile behavioural and paleoneurological grounds that are food for thought. In this contribution I will take their observations but provide an alternative explanation. I will treat Neandertal brain structure and visuo-spatial cognition as representing a distinctly separate evolutionary path from *Homo sapiens*, in line with earlier work by Bruner (Bruner *et al.*, 2003), rather than an incomplete evolutionary path to a modern mind (Bruner and Lozano, this volume).

From the ubiquitous presence of cutmarks on Neandertal tooth enamel, Bruner and Lozano map the combination of stone tools use with the use of the mouth as a 'third hand' as a behavioural idiosyncrasy of Neandertals and *Homo heidelbergensis*, pointing out that this behaviour is much less common in Anatomically Modern Humans and early Pleistocene hominins. This is an interesting observation, for here they appear to have identified a uniquely derived behavioural trait of the Neandertal lineage, one that might point (and does, I will argue) to uniquely derived aspects of Neandertal cognition (Langbroek, 2012).

Bruner & Lorenzo tie their observation about cutmarks on Neandertal tooth enamel to observations on the structural and functional evolution of

the brain. They point out that the parietal lobes show an evolutionary process of lateral widening in Neandertals, in contrast to volume expansion in *Homo sapiens* (Bruner *et al.*, 2003; Bruner, 2010; Bruner & Lozano, this volume). The parietal lobes and notably the upper parietal cortex are areas believed to have important functions in visuo-spatial data integration (Bruner, 2010), which in turn “has a major role in human-specific cognitive processes like simulation and self-representation” (Bruner & Lozano, this volume; see also Kyriacou & Bruner (2011)). The parietal lobes therefore play a role in capacities for an extended mind and an extended self-awareness in relation to the surrounding environment.

While Bruner & Lozano do not deny Neandertals these traits completely, they do try to argue that these traits were less developed in Neandertals. They interpret the marked use of the mouth as evidence for the necessity of enlisting “an additional, third interface between brain and material culture”, and argue that this behaviour points to “an incomplete brain-environment body interface and limits in visuo-spatial integration ability” with regard to “the corresponding level of material complexity” of Neandertals (Bruner & Lozano, this volume).

I disagree and instead of seeing evidence for an incomplete visuo-spatial integration ability, I will turn the tables and suggest that we have a case here of an advanced cognitive trait better developed in Neandertals than in *Homo sapiens*. I will argue that the separate evolutionary paths of the Neandertal and modern brain (Bruner *et al.*, 2003; Bruner & Lozano, this volume) led Neandertals on a path that *Homo sapiens* never took, and that they developed a unique cognitive capacity for spatial virtualization which *Homo sapiens* never had.

When using stone tools for cutting tasks without the involvement of the mouth as an ‘extra’ interface, such as *Homo sapiens* predominantly does, visual clues take a strong precedence: one can see what one is doing, with direct visual feedback to the brain guiding motorics. This is relatively straightforward, and evidence suggests it involves the parietal areas and cerebellum (Stout *et al.*, 2000), two parts of the

brain particularly well developed in *Homo sapiens* (Weaver, 2005; Bruner *et al.*, 2003; Bruner, 2010; Bruner & Lozano, this volume). It does not need a high level of virtualization, as much of it is direct visual observation. By contrast, when using the mouth as an extra device to manipulate materials in combination with sharp stone tools such as Neandertals frequently did, *visibility is very poor*. This is easy to demonstrate: try to get a clear view of a stone tool and its interaction with a material when manipulating something clenched between the teeth, in close proximity to the mouth. You will quickly find out that the mouth generally is out of clear and direct visual range (and generally outside of focus range of the human eye as well). For Neandertals this will have been even more so, as their big noses obscured a direct view of the mouth even more.

Therefore, it is manipulation of this kind which to a very large degree relies not on direct visual input, but instead on *clear capacities for abstract model representation* in connection to fine motoric skill. It is a strong pointer to a well-developed capacity for simulation and self-representation, as it involves the virtual and three-dimensional spatial visualization of both the object, the tool and multiple body parts (hands, mouth) in the absence of direct view. It needs a sophisticated virtual model of the manipulated object and the cutting tool involved, in relation to a strong spatial virtualization of the body as bodyparts that are not visible are in need of a very fine degree of control while they are engaged in a risky manipulation involving very sharp stone tools. These capacities have to be well developed to perform these tasks: otherwise the risk is large, as Bruner & Lozano themselves also point out, endangering crucial elements of the body (lips, tongue, gums) which are vital for survival as feeding depends on them. Room for error is very small.

In contrast to Bruner & Lozano, I therefore would argue that the use of a third interface (the mouth) in combination with sharp tool use by Neandertals actually points to *a very high degree* of visuo-spatial integration, one where strongly developed capacities for *visual virtualization*

guide spatial motorics and where direct visual feedback is not mandatory. This argues against their hypothesis of inefficiencies in the visuo-spatial integration system. In many ways, this is behaviour cognitively more complex than using the hands with direct visual feedback.

This has implications for *Homo sapiens* as much as for Neandertals. In addition to behavioural observations (the general lack of cutmarks on teeth) there are neurological arguments that underline the stronger emphasis on direct eye-hand coordination, signalling a lack of virtualization skills, which I infer for *Homo sapiens*. Brain elements enhanced in *Homo sapiens* such as the intra-parietal sulcus and precuneus are notably elements involved in *direct* eye-hand coordination (Bruner & Lozano, this volume). This reinforces the apparent importance of direct vision for *Homo sapiens* when it comes to visuo-spatial information integration.

PET studies by Stout *et al.*, (2000) have shown that when *Homo sapiens* is knapping stone (direct hand-eye coordination), the parietal lobes and cerebellum are notably activated. They also show that when *imagining* the act of stone knapping, which enlists capacities for model representation and virtualization more strongly, the same brain regions are involved *but* in addition the occipital lobes get involved. This shows that the occipital lobes play a role in model representation and object/action virtualization. It suggests that without direct visual input the cerebellum (which is involved in internal body model representation in modern humans (Imamizu *et al.*, 2000)) and parietal lobes cannot fulfil this task on their own, requiring recruitment of the occipital lobes. Interestingly, the occipital lobes are better developed in Neandertals (Pearce *et al.*, 2013), which again suggests that their capacity for model representation and virtualization in the absence of direct visual input might have been better than in *Homo sapiens*. Neandertals might not only have had superior vision (Pearce *et al.*, 2013): they might in addition have used their large occipital lobes for complex mental visualizations.

If one is willing to look for it, many aspects of behaviour and cognition typically associated

with *Homo sapiens* appear to rely heavily on direct visual anchors, suggesting inefficiencies in mental virtualization skills, perhaps because of their smaller occipital lobes. A clear need for direct visual input in order to cognitively connect the inner and outer environment and create model representations in the mind might explain the increased use of visual symbols which develops as a behaviour in *Homo sapiens* during the Late Pleistocene (e.g. Henshilwood *et al.*, 2002; Texier *et al.*, 2010). I observe that several behaviours that paleoanthropologists generally include in *modern behaviour* involve such direct visual input. Mobile and parietal art are clear examples, but also the use of material culture (tools, ornaments and clothing) and body manipulations to visualize and visually encode social structures. The division of space into specific activity areas (a direct visually expressed structuring of the surrounding environment), is another example.

Many of the traditional elements of “modern behaviour” (see Henshilwood & Marean, 2003; Langley *et al.*, 2008; Wynn & Coolidge, 2009; McBrearty & Brooks, 2000) hence appear to be very physical and visual ways of defining oneself in relation to the surrounding physical and social environment. *Homo sapiens* apparently needs these physical, visualized anchors to cognitively relate itself to its surroundings. Similar to yellow post-it notes on an office wall, they act as cognitive anchors when mentally structuring the surrounding physical, spatio-temporal and social environment and the place of the self in all of this.

The way Neandertals structured their world and imaged their place in it seemed to have relied less on such visualized, physical anchors. Expressions of personal space and social structure in Neandertals might be so elusive in the archaeological record because they structured their surroundings in a highly virtual way, with less need for permanent visual anchors and definitions permanently embodied in the external world. This strongly fits models for Neandertal spatial structuring such as proposed by Kolen (1999) and explains why Neandertal living spaces are structured modestly, fluidly and centered on their own bodies for example.

Could art, the deliberate visual structuring of space and deliberate visual structuring of social connections be the result of a *deficiency* in the spatial virtualization system of the brain of *Homo sapiens*, when compared to Neandertals? Could a stronger reliance on visual symbols be their solution to an incomplete cognitive ability to mentally model connections?

If this is true, it has profound implications in other behavioural and cognitive domains. Notable implications for Neandertals involve the transfer of knowledge. With regard to tool technologies, a capacity for complex conceptual virtualizations in the mind of Neandertals strongly argues in favour of the existence of complex mental templates in tool technologies (Gowlett, 1984, 1986; Wynn & Coolidge, 2004). When such capacities are used in tool technologies, communication is necessary to pass these mental templates on to other generations. A primary vehicle to express such mental virtualizations would be language. From genetic information we have on Neandertals (the presence of the FOXP2 gene (Krause *et al.*, 2007)) and recent investigations of their hyoid bone (D'Anastasio *et al.*, 2013), little precludes language capacities in Neandertals. Language in turn is a good virtual vehicle to express social structure, and the need to virtually structure social space indeed might have been the origins of language (Dunbar, 1993, 1996; Aiello & Dunbar, 1993). Neandertals, while lousy painters, therefore might have been excellent storytellers given their skills for virtualizing situations in their minds. Such a trait is beneficial for long term survival in harsh, risky, erratic environments such as those of glacial Eurasia, as stories can encode and pass on vital information on how to deal with subsistence crisis over generations (see Minc, 1986). Interestingly, the study by Minc also indicates that there are benefits (for modern humans) when visual rituals are included in this storytelling, again pointing to *Homo sapiens'* cognitive need for direct visual anchors to structure and virtualize their world and information on the outer world that is crucial for survival).

This alternative interpretation of the evidence provided by Bruner & Lozano is something

one needs to let sink in. It yields breath-taking potential for the way we interpret the Neandertal archaeological record and Neandertal spatial cognition in relation to that of *Homo sapiens*, as well as the archaeological record of *Homo sapiens* itself. From parietal art to long distance ornament trade to the appearance of writing: they could all signify that *Homo sapiens* needs visual cognitive anchors when mentally structuring the surrounding physical and social environment and the place of the self in all of this, from a limited cognitive ability to mentally model without such direct visual input and anchors. These behaviours are largely absent in Neandertals, because their better cognitive ability to mentally model (perhaps as a result of their larger occipital lobes) meant that they didn't need these to effectively relate their inner selves to the physical, spatio-temporal and social environment surrounding them.

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