Things to think with: words and objects as material symbols

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This paper integrates archaeology, anthropology and functional brain imaging in an examination of the cognition of words and objects. Based on a review of recent brain imaging experiments, it is argued that in cognition and action, material symbols may be the link between internal representations and objects and words in the world. This principle is applied to the sapient paradox, the slow development of material innovation at the advent of the anatomically modern human. This translates the paradox into a long-term build-up of extended and distributed cognition supported by development in the complexity of material symbols.

Keywords: archaeology; symbols; extended mind; anthropology; brain imaging; meaning

1. INTRODUCTION

The intersection between archaeology and neuroscience examined in this special issue presents a somewhat personal challenge. Trained mainly in social anthropology, I am affiliated with an institute that also includes three departments of archaeology, and it is here I find some of my closest collaborators. I spend much of my research time in an interdisciplinary brain imaging unit, where we place most of our discussions, experiments and analyses in a neurocognitive framework. This publication therefore presents me with an opportunity to reflect on the different styles of thinking (Fleck 1979; Hacking 1992; Crombie 1994; Roepstorff 2001) inherent in those disciplines and in the social anthropology I feel most at home in. I shall argue, in parallel with many other contributors to this special issue, that some version of an ‘extended mind’ hypothesis is a good candidate for a conceptual meeting point between the disciplines of archaeology, neuroscience and anthropology. However, crucial to this is a notion of ‘symbols’—or more generally ‘signs’ to those semiotically inclined. For some, notion of signs or symbols appear to be central in linking up the work that objects do with the type of processes that goes on in brains.

This will set the scene for explorations

- (i) of some brain imaging studies of how symbols work in brains,
- (ii) of a particular study, conducted in our group, of what happens when objects become signs of ‘something’, and
- (iii) of Colin Renfrew’s *sapient paradox*.

2. NEUROSCIENCE AND ARCHAEOLOGY: AN ANTHROPOLOGICAL PERSPECTIVE

It has been forcefully argued by Chris Gosden that archaeologists generally show a preoccupation with ‘things’, in all their specific materiality. To outsiders, this fascination with the particularities of objects, their style, manufacture, use, history, migration, etc. may, at times, appear almost idiosyncratic. However, it rests on a fundamental insight, namely that the apparent thingness of things, the fact that they appear just to be there as given in some way, is an end product of a long chain of transformations, which changes the material into concrete objects. The underlying argument appears to be that mapping this chain of transformation in all its cumbersome details is key to understanding the type of society in which the object was produced, and—at least since the turn towards a cognitive archaeology (Renfrew & Zubrow 1994)—also the mindset of the people who made it. There is in this insistence on the importance of things a very important lesson to be learned for the rest of the humanities and social sciences: things are not only representatives of some broad understanding of ‘material culture’ which again is part of a larger notion of ‘culture’. Rather, objects in themselves do work in very particular ways. They are not only additions to the social or emergent properties of the social, but they are indeed the very stuff from which human society is built. In archaeology, this understanding parallels and indeed pre-dates the recent discovery of the importance of things in versions of social theory such as actor–network theory (Latour 1996, 2005) and post-modern ethnography (Henare *et al.* 2006). This very brief and cursory analysis of the thought style of archaeology just says that if anything, archaeology is about things.

But what about neuroscience, then? It is almost trivial to say that neuroscientists have a certain preoccupation with brains in all their complexities. Whether it is through the study of anatomical structure, haemodynamic couplings between blood

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flow, metabolism and activity, patterns in neuronal firing or release of transmitter substances into tiny clefts and crevices, the 'brain', both as a concrete entity and as a metaphysical framing, forms the reference point for neuroscience. This latent brain-centrism has obvious consequences the moment tools from neuroscience are used to address issues that used to be almost exclusively in the domain of psychology, economics, philosophy and other disciplines of the social sciences and humanities. What the new neurosciences, i.e. social (Cacioppo 2002), cognitive (Gazzaniga 2000), affective (Panksepp 1998), etc., bring to the fields of intellectual discourse is to relate these processes, the social, the cognitive, the affective, etc., to the brain. This is a laudable, promising and highly interesting approach. However, there is an accompanying risk that, partly lured by the style of argumentation and reasoning, the phenomena studied may become trapped in the brain. It is as if 'brains' do all the work, and the person, the surroundings, the others, the experience, mind, etc. are at best scaffoldings for the workings of the brain. And this is, of course, a very different story.

If archaeology is preoccupied with things, and neuroscience with brains, what, then, is anthropology preoccupied with, what can it bring to an interdisciplinary smorgasbord? Arguably, one of the most important developments in anthropological theory in the last decades has been the reflexive turn, first, perhaps, brought out in the seminal realization that the prime activity of anthropologists is to write (Clifford & Marcus 1986; see also Sangren 2007). One reading of this development is that a prime concern of anthropologists is anthropology. The slightly more friendly version is a preoccupation with how stories and facts come about and an attempt at using one's own trajectory and tradition as an exemplary case for understanding this. This can be seen in the recent drive towards ethnographies and anthropologies of knowledge (Agrawal 1995; Roepstorff 2001; Barth 2002). Obviously, this paper is written very much within such a perspective, although implications of the inherent social reflexivity for what brains do are hardly touched upon here (see Petersen *et al.* in press). However, for the present discussion, two other things stand out as a prime concern for anthropologists: symbols (Turner 1967) and exchange (Mauss 1954). The notion that the social is inherently about reciprocity and exchange and that 'the cultural', a loaded term these days, involves particular ways of establishing symbols and significations appears to be something that most anthropologists would agree on, in spite of any other theoretical disagreement they may have.

3. THE CHALLENGE

This very cursory description of the three perspectives on 'the human' leaves us with an epistemological question and a very concrete challenge. First, the question: should one treat the different approaches as inherently arbitrary and conventional, and hence able to be replaced with other styles of thinking, or is there something in the topic studied that appears to afford

a particular style of thinking? To cut a long story short, I will argue for a realist position: there is something at stake in each perspective. The challenge, then, becomes to relate and superimpose the preoccupations of the archaeologist, the anthropologist and the neuroscientist into one framework, which is if not entirely coherent then at least productive. This would, very concretely, translate into something like: say something sensible about how things in the outer world come to do something to brains by way of symbols and 'exchange'. A critical issue here is how to mediate between inside and outside, between things in a pure form, and 'mind' as it emerges out of and constrains processes in the brain. This story, if we take the symbolic notion seriously, becomes a story not only of physical objects and physical neurons, but also about other thing-like entities, about words, symbols, meanings and those chains of transformations they undergo.

There are multiple strains of thinking that explore such models. Today, they are usually found in and around the hypotheses of distributed cognition (Hutchins 1995) and extended mind (Clark & Chalmers 1998). But it is worth noting that there is a very long and twisted story of such theorizing, which involves important foci outside of the Anglo-American world, e.g. in post-revolutionary Russia (Voloshinov 1986; Vygotsky 1986) and structuralist Paris (Lévi-Strauss 1988). I will in this paper only examine a version of this, found in a recent paper by Andy Clark on 'Material symbols' (Clark 2006b). It almost seems to fit hand-in-glove the type of framework I called for above, as it attempts to link processes in the mind, and I think ultimately in the brain, with the environment through material symbols, which at the same time are very concrete and tangible.

4. MATERIAL SYMBOLS

Clark (2006a) develops his idea of material symbols through an examination of language. He has previously argued that language is the ultimate artefact (Clark 1997), like other objects it is part of an extended and augmented repertoire for cognition and action. In his recent work, he does not discuss exhaustively other forms of material symbols such as images, representations and things in general, but there is little in the analysis to suggest that words are unique in this respect. Rather, they appear as a special case of a much more general understanding of how the material also becomes symbolic. Let us see what is at stake in his own words:

The idea on offer, then, is that the symbolic environment (very broadly construed) can sometimes impact thought and learning *not* by some process of full-translation, in which the meanings of symbolic objects are exhaustively translated into an inner code, a mentalese, or even a Churchland-style neuralese, but by something closer to coordination. On the coordination model, the symbolic environment impacts thought by activating such other resources (the usual suspects [e.g. attention, memory AR]) *and* by using either the objects themselves (or inner image-like internal representations of the objects) as additional

fulcrums of attention, memory and control. In the maximum strength version, these symbolic objects quite literally appear as elements in representationally hybrid thoughts.

(Clark 2006b, p. 300)

This 'hybrid' model of language caches in on a *complementary* action of 'actual material symbols (and image like encodings of such symbols) and more biologically basic models of internal representation' (op. cit. 304). In other words, people do not think in a generalized, abstract internal language of representation, instead they think through concrete things, with words being a special case. The strength of this approach, Clark argues (Clark 2006b), is that it concurs several possibilities on cognition.

- (i) Otherwise inaccessible contents can be learnt and grasped by agents skilled in the use of perceptually simple tokens that reify complex ideas.
- (ii) The presence of material symbols (or images thereof) can productively alter the fulcrums of attention, perception and action.
- (iii) Material symbols (or their shallow imagistic encodings) can coordinate the fulcrums of attention, perception and action.

This leads Clark to conclude that 'minds like ours are indeed transformed by the web of material symbols and epistemic artefacts' (op. cit.).

5. THE FUNCTIONAL NEUROIMAGING OF SYMBOLS

Andy Clark's notion of material symbols appears to sketch a model where the beloved things of the archaeologist through symbolic processes, which the anthropologist cherishes, may impact on the mind by creating coordinated reverberations in the neuronal networks of the neuroscientist. This may appear to deliver the kind of framework asked for. But how does it hold up against empirical evidence? There is surprisingly little work done in brain imaging on the cognitive effects of symbols and objects *per se*, but a number of studies, particularly of language, throw some light on how words, as a particular class of symbols, work on the brain.

6. WORDS AND SENTENCES IN THE BRAIN

Inspired by lesion findings, a long range of studies have examined whether different forms of words carry different localizations in the brain. Starting out from highly imprecise categories, these studies have become increasingly sophisticated, and there is now strong converging evidence that the semantics of particular a word category is accompanied by a particular neuronal signature, such that words, depending on their meaning, tie in with brain regions that are not dedicated to language. In recent experiments, it has, for example, been demonstrated that colour words and form words activate specific, relevant networks (Pulvermüller & Hauk 2006) while action verbs related to different body parts (e.g. lick, kick, pick) appear to be able to link in with the neuronal representation of these body parts (Pulvermüller 2005).

The story becomes more complicated once words are embedded in sentences rather than when presented as free-standing units. The problem is that the meaning of any particular word is highly confined and constrained by the context of the other words (Gennari *et al.* 2007).

A recent highly elegant experiment took the elements of narratives and presented them as either isolated words, single sentences or small narratives. They could demonstrate that as words became embedded in an increasingly complex context, there was a recruitment of an increasingly extended network of brain regions. For single words, this included Wernicke's area (a classic low-level 'language area'), sentences further evoked Broca's area in the inferior frontal gyrus (another classic language area), while narratives also evoked the medial prefrontal cortex and the temporoparietal cortex, areas not typically associated with linguistic processing (Xu *et al.* 2005). We have shown (Wallentin *et al.* 2005a) that motion verbs increase activity in typical 'motion' areas of the brain (in the left posterior middle temporal cortex), even in sentences with static semantics (e.g. 'the road goes into the forest') when compared with sentences with static verbs (e.g. 'the road is in the forest'). In other sentences with motion verbs, changing the target of the sentence from concrete (e.g. 'the man goes into the house') to abstract (e.g. 'the man goes into politics') radically shifts the contrastive brain activation from a typical bilateral posterior temporoparietal 'spatial navigation' pattern to a typical 'language-like' left-lateralized inferior-frontal pattern (Wallentin *et al.* 2005b).

All these experiments suggest, not surprisingly, that the specific activity evoked by words is strongly constrained by the context they occur in, and that the overall neuronal resonance created by words interacts with non-linguistic brain areas involved in representing processes that the words represent. This hypothesis is supported by a set of experiments where we studied the difference between accessing a scenario that had been presented visually and linguistically. Depending on the type of information accessed, there were consistent overlaps in the activity of relevant regions, such as precuneus and hippocampus, irrespective of whether the stimuli had been presented as visual displays or as sentences describing the scenario (Wallentin *et al.* 2006, 2007). How do these findings play themselves out against the material symbol hypothesis outlined above? There appears to be some evidence that once a set of words, as a special case of symbols, is perceived and understood, it comes to stand for that which it represents. That is, it may activate, draw on, coordinate and resonate with, depending on the choice of metaphors, brain areas associated with that which the symbol stands for. This is apparently a circular argument but in the process it ties the fluffy symbolic in with the material, in the sense that once words are understood by a person, they become material instantiations in some form in the brain of that person. It is not because words inherently code for what they stand for—Ferdinand Saussure got rid of that idea long ago when he pronounced the arbitrariness of the signifier in relation to the signified (Saussure *et al.* 1931). Instead, a word through prior

use in context becomes material in linking up between the present and the past, as exemplified in what it previously has stood for. This is the famous Saussurean conventions, and it may activate the reverberations that surround the word to use a Bakhtinian/Voloshinovian term (Voloshinov 1986; Wallentin *et al.* 2007), the coordination of memory and attention, to use Clark's phrase, or perhaps resonance in a neuronal network.

7. SYMBOLS ALLOW FOR ANTICIPATION AND CONDENSATION

However, the sceptical reader may argue, this may work well for words but how does it translate into other forms of symbols? Very little is known about that, it has hardly been on the cognitive neuroscience agenda. However, a recent EEG experiment may be interpreted along those lines. Widmann and colleagues in Helsinki examined what would happen when the convention for a symbolic representation was broken. They exposed subjects to two different pitches, a high pitch and a low pitch. Immediately prior to each sound, a bar on a screen would indicate which sound to expect, a low bar suggested a low pitch while a high bar suggested a high pitch.

Every now and then, there would be a mismatch between the symbol and the subsequent sound. An analysis of these deviants, which broke with the anticipation established by the prior symbolic representation, demonstrated that 100 ms after the sound that had been misrepresented, a particular neuronal signature, arguably arising from the primary auditory cortex, had already been generated. To quote the authors: 'These results suggest that the auditory system can establish a representation of an expected stimulus on the basis of visual symbolic information' (Widmann *et al.* 2004). The experiment is a nice example of cross-modal interaction, of how a stimulus in one sensory domain may set up an expectation in another sensory domain. Increasingly, symbols have become useful structures in neuronal network models, also within modalities. A recent paper (Konig & Kruger 2006) argues that symbols, understood as 'condensed and discrete semantic representatives for certain pieces of knowledge...on which operations can be performed and which correspond to relevant functional relations in this framework', may emerge in neuronal networks. Konig & Kruger claim that these 'up-stream' entities represent condensed pieces of knowledge that are no longer analogue. Instead, they function as arguments in a framework of transformations that realize predictions (p. 325). Applied to Widmann *et al.*'s experiment, these symbols appear, then, to be able to resonate across specific sensory modalities.

This suggests that something which has the properties of symbols clearly exist as material entities in world space, e.g. in the form of words and images. According to Konig & Kruger, it may also emerge as material entities in brain space, defined as complexes of condensed knowledge and predictions that allow for anticipation across brain regions. But it does not tell us much about how the particular materiality of concrete things can come to do any kind of brain work.

8. PUZZLING OBJECTS

One of our postgraduates recently set out to examine how object configurations could be imbued with meaning (Tylén *et al.* 2007). With a background in cognitive semiotics, Kristian Tylén was very interested in how well-known objects in unusual configurations can almost call out for an interpretation. To investigate the brain activations associated with this, he constructed a set of test images of everyday objects, which he presented to volunteers in a passive viewing task in an fMRI scanner. In half of the images, the configurations of the objects were highly unusual, such as a hand axe inserted into a printer or a gold fish swimming in a blender. The other pictures showed similar objects in 'ordinary' situations. Subsequently, subjects' experiences were probed in a post-scan interview to rate whether they thought that a particular constellation had been set up with a communicative purpose. These subjective data were then used for a *post hoc* analysis of the imaging data (Jack & Roepstorff 2002).

Based on our hypothesis, apparently confirmed by the post-scan interviews, we had expected to find activation to the intentional configurations in the now semi-classical 'theory-of-mind' areas in the medial prefrontal cortex (Amodio & Frith 2006) when people read a communicative intent in the image. However, even when applying very liberal statistical thresholds, this particular region was completely empty. Instead, striking bilateral activities were found in the ventral stream of the visual system and in the pars triangularis of the inferior frontal gyrus, a part of Broca's area. The latter region is particularly interesting because it has been implicated in language production, comprehension and retrieval.

To our knowledge, this is the first study of how passive viewing of material objects, given a proper contrastive context, comes to tap into what has traditionally been considered classical language areas. What is at stake here is, perhaps, another instance of material symbolism. It can be phrased as puzzling superimpositions of well-known objects, but equally it is a production of new meanings, new coordinations in brains, new reverberations in networks, based on the very material symbolicity of the particular objects established by prior use, conventions and expectations. It offers a thinking through things, not because the objects have to be translated into a new mentalese language, but because the clash between the objects, which appear as material symbols both in world space and in brain space, calls out for new configurations. Whereas the previous studies showed how words, in brain space, can come to act as that which they represent, this study suggests that objects, given the right configurations, can come to look almost like words.

Thereby, to paraphrase Clark, the presence of material symbols (or images thereof) productively plays with the fulcrums of attention, perception and action through an interplay with more biologically basic models of internal representation. It is highly tempting to do the neurophenological trick, and place the productive play in the bilateral pars triangularis activation, and the internal representations somewhere along the ventral stream of object processing.

9. THINKING WITH WORDS AND OBJECTS

Based on an analysis of recent brain imaging experiments, framed within Clark's notion of material symbols, I have attempted to show how the material world, including words, objects and representations, may come to a productive interplay with previous experiences, as they are represented as particular configurations in brains: resonances; coordinations; or whatever else we should call them. It appears to allow for 'the world' to be a major driving force in providing objects that are at the same time material and symbolic, just as the representations in the brain are. I have elsewhere argued that it may be through such high-level resonances, tongue-in-cheek called top–top interactions (Roepstorff & Frith 2004), that human communication can occur (Roepstorff 2004). Translated into the framework developed here, this implies that words and other material symbols in the world may in the brain function as symbols in König & Krüger's sense, as condensations in frameworks of predictions and past experiences (see also Jordan 2008). This does not entail a translation into a generalized, abstract new mentalese, rather it may be the symbols themselves, which are material both 'on the outside' and 'on the inside', although not in the same material, that do the work, usually in a shared social world of experiential condensations already established around particular symbols. Such analysis has long been laid out for old-style symbols of classical anthropological analysis that were mainly characterized by their immaterial meaning (Turner 1967). However, what Clark's perspective seems to offer is, on the one hand, an anchoring in material, in world and in brains, and, on the other hand, a set of mechanisms that may apply both to objects and words, and to other forms of representations. It is still a somewhat open idea and to advance it further will require investigations and conceptual developments of material symbols, in the form they take both in brains and in the world.

Clark and other distributed cognition researchers seem to suggest that structures in the environment are crucial for allowing cognition, action and other processes that are traditionally conceived of as mental. They may be so by providing elements for scaffolding, both externally and internally. Renfrew (1996) has cogently coined *the sapient paradox* to describe the apparently puzzling finding that in the first 60 000 years from the putative emergence of anatomically modern humans, approximately 100 000 years ago, nothing much happened when seen through the archaeological record of material findings. However, if cognition and other mental processes do not occur in brains in isolation but are embedded in material and social relations and objects, it may take a lot of bootstrapping—at the same time mental and the material (Johannsen forthcoming; Read 2008)—to create the possibilities for that unprecedented process of innovation, which began approximately 10 000–15 000 years ago (op. cit.). If one accepts the idea of the 'anatomical modern human', Renfrew's sapient paradox can hence be translated into a statement that 'anatomy' does not do it alone. Instead, constructions and exchanges of both words and objects—material symbols in other words—may have been absolutely

crucial in setting up an environment within which innovation and development could take place. Understanding such interactions appears to require sensitivity to the materiality of objects and to the processes of symbolicity and exchange, and it may indicate a field where archaeology and anthropology can provide highly pertinent contributions to contemporary discussions in cognitive research and neuroscience.

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