

# Language Needs A 2<sup>nd</sup> Order Representations + A Rich Memetic Substrate

Joanna J. Bryson (jjb@cs.bath.ac.uk)

Artificial models of natural Intelligence (AmonI) Group, University of Bath England, UK

Recent research has shown that human semantics can be replicated by surprisingly simple statistical algorithms for memorizing the context in which words occur (McDonald and Lowe, 1998; Landauer and Dumais, 1997). Assuming one accepts the point that semantics *is* the way that the word is used (which cannot be argued in one page, but see Wittgenstein (1958) or Quine (1960), and which is the underlying assumption of memetics) then why wouldn't more species have supported the evolution of this useful system of rapidly evolving cultural intelligence?

Recent work in primatology tells us three relevant facts. First, we know that apes and even monkeys do have culture (de Waal and Johanowicz, 1993; Whiten et al., 1999). That is, behavior is reliably and consistently transmitted between individuals by non-genetic means. So we know that the question is not "why doesn't animal culture exist", but rather "why isn't it on the same scale as ours?"

Second, we know that primates have uniquely complicated social representations. For some time, this has been one of the basic hypotheses concerning why primates are so intelligent (Byrne and Whiten, 1988; Dunbar, 1995). But one particular aspect of social reasoning may be especially relevant to language – the ability to reason about agents relative to each other rather than simply maintaining a list of relationships between other and self. Harcourt (1992) presents evidence that all social species behave as if they keep record of relations between themselves and their group members (e.g. positive and negative interactions), but only primates behave as though they keep tabs on the relations between other agents. For example, apes will avoid fighting with close associates of dominant animals, and may try to befriend them (de Waal, 1996).

This sort of second-order representation and reasoning may be a necessary foundation for the compositional aspect of human languages. But if so, and we share it with other primates, why don't other primates display language and memetics? Perhaps there is another representation issue — this time the underlying representation which supports the disembodied communication of semantic content. If our memetic representation is a more fertile substrate for supporting unsupervised cultural evolution, then our culture would have a richer design space in which to evolve.

This leads to the third interesting discovery about primates: humans are the only species of primate capable of precise auditory replicative imitation (Fitch, 2000). My hypothesis is that the original basic unit of cultural transmission for humans was and is the auditory phrase. Auditory phrases are full of ordered information on a large number of axes: timing, duration, phonetics, and pitch.

There are a number of questions about this hypothesis, not least of which is whether other primates are capable of remembering precise timings for gestures: if not, they

	2 <sup>nd</sup> -ord. soc. rep.	no 2 <sup>nd</sup> -ord reps
vocal imit.	people	birds
no voc. imit.	other primates	most animals

Figure 1: Human-like cultural evolution might require both a rich memetic substrate as provided by vocal imitation, and the capacity for second order social representations.

might have evolved a sign language as rich as our vocal one. However, if I am correct, and the trick is that the richness of the substrate representing the strictly semantic, ungrounded cultural transmission is the key, then we now have an explanation for why other primates don't share our level of culture.

Birds do have this same substrate (in fact, perhaps a richer one) but do not share the cognitive capacities of primates, possibly including the critical 2<sup>nd</sup>-order representations. Thus the only other animals which might then hold a culture approximating our own are the cetaceans, the whales and dolphins. I will resist speculating about these.

## References

- Byrne, R. W. and Whiten, A., editors (1988). *Machiavellian Intelligence: Social Expertise and the Evolution of Intellect in Monkeys, Apes and Humans*. Oxford University Press.
- de Waal, F. B. M. (1996). *Good Natured: The origins of right and wrong in humans and other animals*. Harvard University Press, Cambridge, MA.
- de Waal, F. B. M. and Johanowicz, D. L. (1993). Modification of reconciliation behavior through social experience: An experiment with two macaque species. *Child Development*, 64:897–908.
- Dunbar, R. I. M. (1995). Neocortex size and group size in primates: A test of the hypothesis. *Journal of Human Evolution*, 28:287–296.
- Fitch, W. T. (2000). The evolution of speech: A comparative review. *Trends in Cognitive Sciences*, 4(7):258–267.
- Harcourt, A. H. (1992). Coalitions and alliances: Are primates more complex than non-primates? In Harcourt, A. H. and de Waal, F. B. M., editors, *Coalitions and Alliances in Humans and Other Animals*, chapter 16, pages 445–472. Oxford.
- Landauer, T. K. and Dumais, S. T. (1997). A solution to Plato's problem: the latent semantic analysis theory of induction and representation of knowledge. *Psychological Review*, 104:211–240.
- McDonald, S. and Lowe, W. (1998). Modelling functional priming and the associative boost. In Gernsbacher, M. A. and Derry, S. D., editors, *Proceedings of the 20th Annual Meeting of the Cognitive Science Society*, pages 675–680, New Jersey. Lawrence Erlbaum Associates.
- Quine, W. V. O. (1960). *Word and Object*. MIT Press.
- Whiten, A., Goodall, J., McGew, W. C., Nishida, T., Reynolds, V., Sugiyama, Y., Tutin, C. E. G., Wrangham, R. W., and Boesch, C. (1999). Cultures in chimpanzees. *Nature*, 399:682–685.
- Wittgenstein, L. (1958). *Philosophical Investigations*. Blackwell.