social learning must be matched to models of memory before we can determine whether units of cultural inheritance (cultural genotypes) exist.

A related argument often used to justify the assumption that there must be cultural transmission is the fact that human culture is cumulative: For each generation, there seems to be a larger store of knowledge which cannot have arisen through genetic causes; culture changes too fast to be genetic, in effect (Tomasello et al. 1993). However, it is possible that this accumulation is occurring not in people's brains but in the technological world we have created. Niche construction can result in the inheritance of information through the persistence of information-bearing artefacts from generation to generation (Odling-Smee et al. 2003). The interaction of social learning with artefacts makes humans such a powerful force for environmental change (Aunger 2002; Donald 1991). Again, the exact nature of the exchange of information between people and their technological products is not clear. It is possible that much of the "knowledge" associated with technological practices is embodied in "cognitive artefacts" themselves (Hutchins 1995), which "afford" humans the perception of increased intrinsic power (Norman 1988).

There are obvious examples of Darwinian processes involving information replication – and hence inheritance – through processes not involving genes. In one case, units of computer code – call them "instructions" – exist as states of computer memory (the instruction's genotype), but also have consequences that lead to the production of exact replicas in other machines through infection – epidemics of computer viruses, in effect. Similarly, prions are infectious proteins which can cause other proteins to acquire their information by reshaping them; the prion's genotype is an abnormal shape that can be duplicated through a process of refolding of another protein via contact with an existing prion molecule (Prusiner 1995). In both cases, non-genetic information is duplicated and spreads through a population of hosts (computer memory and protein molecules, respectively).

In some ways, it is thus clearer that evolutionary processes are occurring in the environment than in social groups of human beings. This is because it is still not known whether culture as normally considered – as a pool of information in people's heads modified via the inter-individual transmission of information – involves the transfer from person to person of a cultural genotype. As a result, it is still unclear whether culture evolves independently of DNA. We therefore need to identify a cultural inheritance process – and thereby exclude the possibilities of jukebox-like recall or niche construction as accounts of how individuals come to exhibit similar "cultural" behaviours – before the analogy the authors make between genetic and cultural evolution will be secure. How this project will be undertaken is not clear.

Vertical/compatible integration versus analogizing with biology

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Abstract: Vertical/compatible theoretical integration provides an alternative way of unifying sociocultural anthropology and related disciplines. It involves analyzing theoretical statements for their implicit and explicit assumptions at multiple levels of analysis and then determining whether these assumptions are compatible with consensus in the relevant disciplines (e.g., does the sociological theory include an assumption at odds with consensus psychology?). Incompatibilities indicate a need for further research. This approach is much more likely to salvage the bulk of humanities-oriented anthropology than is that of the authors.

Mesoudi et al. are to be congratulated for their survey of biology, and I agree with much of what they say. For example, sociocultural anthropology clearly has not progressed in the cumulative fashion of evolutionary biology. (Goody [1982, p. 8] is probably right in arguing that the former field tends to mistake mere changes in emphasis for progress.) I also agree with the authors' implicit position that training in biology (and psychology!) should be a prerequisite for training in anthropology. But here our reasons differ.

Biology may owe its integration to Darwin, but not necessarily its success. I have met biologists who know little of Darwin, whereas that branch of biology known as medicine achieved much even in its pre-Darwinian, pre-Ewald, and pre-Nesse and Williams days (Ewald 1994; Nesse & Williams 1994). No doubt the social sciences would benefit if more of its practitioners were trained in some area of biology. I suspect, however, that had the authors' expertise combined meteorology and anthropology, they would have made a similarly convincing case for the former field's probabilistic models promise of unity for the human sciences.

The authors' proposal neglects most of sociocultural anthropology and related fields. What they include is worthy, but they pay scant attention to the likelihood that very few of the field's practitioners are interested in modeling their endeavor on *any* science, whether biology or meteorology. Perhaps this is why we are reading this article where we are reading it, and not in *Current Anthropology*. Most of sociocultural anthropology has, in the past 25 to 30 years, joined the humanities. When social scientists speak of "theory" nowadays, they usually mean social philosophy and political commentary, and the research they conduct only occasionally involves hypothesis testing. This is not the place to discuss why this is true, but a glance at the table of contents of any issue of the *American Anthropologist* will confirm that it is indeed so. My point, however, is neither to condemn nor to lament this state of affairs but to recommend salvage.

Rather than seeking to rebuild the social sciences (largely) from those bits and pieces that have analogues in biology, an alternative both more modest and more feasible exists: the approach of vertical/compatible explanation (Barkow 1989a; 1989b; 2006; Cosmides et al. 1992; Walsh 1997). Not just biology but the sciences as a whole have been so successful in part because they take vertical integration for granted. This means, for example, that a chemist does not seek to reduce chemistry to physics but does assume that the principles of physics apply to every chemical process. Biologists do not reduce evolution to nothing but chemistry but do assume that biological processes are compatible with what we understand of chemistry. Scientific psychologists take care to ensure that their theories are compatible with biology (including evolutionary biology), as well as with chemistry and physics. And so forth. If we are to apply this idea to sociocultural anthropology and the rest of the human sciences, then their theories must be tested for compatibility with psychology (and biology, etc.). This is not a reductionistic argument, and "compatible" does not imply "nothing but" – each level has its own theories, and no one would think to reduce ecology to chemistry or the social sciences to psychology. The approach is not necessarily even entirely hierarchical – theories of consciousness need to be compatible with what we know of neurophysiology but they may or may not be at the same level of organization.

Vertical/compatible integration is usually ignored in the human sciences as a matter of ideology (confusingly labelled "theory"). Most of sociocultural anthropology and sociology interprets Emile Durkheim as having established the principle that one must ignore the psychological. In practice, a non-psychological (often anti-psychological) approach is a group-identity marker and hence never questioned (see Barkow 1989b for discussion and exceptions). But vertical/compatible integration can, unlike the admittedly useful analogize-with-biology approach argued by the authors, rescue (in the

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sense of "become part of mainstream science") much of sociocultural anthropology and related fields.

The "rescue" involves applying the compatibility test. This task is possible and worth doing but not necessarily easy, given the often vague vocabulary and ever-changing buzzwords of the disciplines involved. The goal is to salvage the bulk of existing sociocultural anthropology – all those studies of that change-in-scale phenomenon now labeled "globalization," all those multi-sited ethnographies, all those moral mission ethnographies seeking to expose social injustice – all of this simply wonderful, even if humanities-rather-than-science-oriented – anthropology. The material now becomes ore to mine and then to refine by passage through the compatibility sieve. Wherever a sociological assumption (e.g., the "glass ceiling" is socially constructed rather than a reflection of different male/female fitness interests) rings the incompatibility bell, there is a problem to be addressed. Perhaps one discipline is right and the other wrong, perhaps both are wrong – let us seek a grant to study the issue.

Academic disciplines are fairly autonomous, and it is very doubtful that most sociocultural anthropologists will pay attention either to the authors' call for biology or to my own for vertical/compatible integration. Instead, humanities-oriented anthropologists will probably simply lose the turf war as policy-makers and the educated public turn to the hypothesis testers, the data gatherers, the mathematical model builders for their understanding of human societies. But I think that vertical/compatible integration represents a way of salvaging much of the existing discipline. Both the efforts advocated by the authors and the approach for which I am here spreading propaganda, are entirely compatible, and I would like to see both proceed.

Why we need memetics

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Abstract: Memes are not best understood as semantic information stored in brains, but rather, as whatever is imitated or copied in culture. Whereas other theories treat culture as an adaptation, for memetics it is a parasite turned symbiont that evolves for its own sake. Memetics is essential for understanding today's information explosion and the future evolution of culture.

Mesoudi et al. have helpfully situated memetics within the framework of theories of cultural evolution. I disagree with parts of their formulation and suggest some further reasons why memetics is essential for understanding cultural evolution.

First, Mesoudi et al. claim that "A common assumption of memetics is that cultural knowledge is stored in brains as discrete packages of semantic information" (target article, sect. 3.5.2, para. 1). I disagree. This was not assumed by Dawkins (1976) when he invented the term "meme" thirty years ago this year, nor by Dennett (1991; 1995), nor by me (Blackmore 1999; 2001). Aunger (2002) does take this view, but otherwise it is mostly the critics of memetics who do so – aiding their attempts to demolish memetics.

There are at least three issues here: whether memes must be stored in brains, whether they are discrete, and whether they consist of semantic information. The discreteness issue is clearly dealt with by the authors, so I shall comment on the other two. Like others, I have argued that memes need not exist in brains, and this follows directly from Dawkins's original formulation. He derived the term "meme" from the Greek *mimeme*, meaning "that which is imitated," giving as examples "tunes, ideas, catch-phrases, clothes fashions, ways of making pots or of building arches." Ideas (if such a vague term can be pinned down) may arguably be thought of as semantic information in brains – depending on one's definition of "idea" – but what about skills and fashions? A new skill copied from someone else undoubtedly involves changes in the brain, but these changes are not "semantic information" and in any case they are not what is copied; somehow, through the complexities of the human capacity for imitation, a second person ends up acquiring a new skill from having observed the first. By definition, whatever is copied in that process is the meme. This may be a hard concept to pin down and to build theories upon, but we miss the point if we think of memes as little bullets of information inside heads.

Mesoudi et al. also claim that "cultural information is represented primarily in the brain" (sect. 3.5.3). Since it is hard to measure quantities of cultural information, I cannot dispute this, but I would like to point out that as every day passes, more and more cultural information is being stored in computers and digital media of various kinds. Just as we can reconstruct a little of ancient Greek philosophy from the memes left behind by its proponents, so a future civilisation might reconstruct a great deal of our culture from the far more extensive memetic debris left behind. Memetics can handle this far better than other theories of cultural evolution, including the possibility that memes might continue to thrive and evolve even if all humans died.

Mesoudi et al. comment that there is no clear equivalent of the genotype/phenotype distinction in culture, an issue bearing on the vexed question of whether cultural inheritance is "Darwinian" or "Lamarckian." I agree with them that without further advances the distinction is speculative, but I would like to go further.

Memes are relatively new on this planet, and their replication and storage has not yet settled down to anything like the efficient system adopted by genes. If evolutionary systems themselves evolve, then we should expect improvements in their copying and storage systems over time. The process of separating the genotype and phenotype protects against information loss and is an obvious improvement (more generally conceptualised as a shift from "copy-the-product" to "copy-the-instructions"; Blackmore 1999).

We can see that this shift has happened in memetic evolution in the past and it is still going on today. Unaided human imitation is crude and unreliable, entailing huge information loss, but human meme machines were only a first step in the coevolution between memes and their copying machinery. The evolution of language improved fidelity, and writing and printing presses improved fecundity and longevity, but more recently new processes have appeared that have a clear distinction analogous to Weismann's barrier. An example is the program with which this commentary is being written – Microsoft Word. All over the planet there are millions of copies of this program that are all identical, or very nearly so. Yet each copy of Word leads to completely different documents, and it is the success of these documents that prompts people to buy copies of Word and the factories to turn out more of them. Copying the instructions for making documents leads to much faster evolution than copying the documents themselves.

So do we need memetics? Yes, because of the fundamental difference between memetics and all other theories of cultural evolution. This is best illustrated by Dennett's (1995) powerful question "Who benefits?" According to other theories, culture is an adaptation, and (in spite of occasional maladaptive cultural traits) the genes will always, as Wilson puts it, "keep culture on a leash" (Lumsden & Wilson 1981). In this view humans or their genes are the ultimate beneficiaries. Until recently Boyd and Richerson's theorising appeared to be close to memetics, but they have now made it clear that they do not consider memes to be replicators that evolve for their own sake (Richerson & Boyd 2005). So for them, too, culture is an adaptation.

According to memetics, culture is not and never was an adaptation. It began as a by-product of the evolved capacity for imitation that then took off on its own evolutionary trajectory, using us

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