Cultural evolution is not equivalent to Darwinian evolution

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Abstract: Darwinian evolution, defined as evolution arising from selection based directly on the properties of individuals, does not account for cultural constructs providing the organizational basis of human societies. The difficulty with linking Darwinian evolution to structural properties of cultural constructs is exemplified with kinship terminologies, a cultural construct that structures and delineates the domain of kin in human societies.

Cultural anthropologists, according to Mesoudi et al., are concerned with the same kind of issues and questions as evolutionary biologists. Because variability, inheritance, and selection also apply to cultural phenomena, then cultural anthropology, they suggest, could benefit by taking advantage of the theoretical and methodological advances made by evolutionary biologists. The only barrier, they note, is the unwarranted refusal by cultural anthropologists to drop their assumption that evolution (read: Darwinian evolution) is not relevant to understanding culture change. Yet cultural evolution, though not in the form of Darwinian evolution, has long been a central concept in anthropology: "Cultural selection . . . operates not on individuals but *on cultural traits* and *on societies*" (Carneiro 1985, p. 77, emphasis in the original). However, despite championing Darwinian evolution for understanding cultural evolution, the authors admit in the end that the matter may be more complex: "'social constructions' . . . have no real equivalent in the biological domain . . . [and this] requires a different evolutionary treatment from the one developed within biology" (target article, sect. 4, para. 5). So can we account for change within "culture as a kind of mental phenomenon" (D'Andrade 2001, p. 243) by reference to Darwinian evolution, where selection is based on properties of individuals? The answer is no (Read 2003). To see why, consider a universal cultural construct fundamental to human social systems, namely kinship, as it is expressed through a kinship terminology.

By a kinship terminology, I mean the terms that identify one's (cultural) kin; for example, mother, aunt, cousin, and so on, for English speakers. The terms are culture-specific (e.g., unlike some kinship terminologies, English speakers do not have separate terms for mother's sister versus father's sister); hence, there is a problem translating the terms from one language/culture to the terms of another language/culture. Analytically the translation problem is circumvented by mapping kin terms to a common genealogical domain that makes possible genealogical definitions of kin terms regardless of language, such as aunt = {parent's sister, parent's brother's wife} for English speakers.

We can see the social importance of kinship terminologies by considering the role of kinship in small-scale societies. Typically, societal membership is determined through kinship. Hunter-gatherers in the Kalahari Desert of Botswana, for example, refer to themselves as the *ju/wasi*, which means, roughly, "we, the real people" (Marshall 1976, p. 17). Real persons are one's kin, and one's kin are those persons included in the scope of reference of kin terms. The distinction between kin and non-kin is nontrivial, and for some groups, such as the Waorani of Ecuador, it meant the difference between being able to engage in social interaction or being killed on sight (Wilson & Yost 2001).

Terminological knowledge is located in individuals and hence can be considered to be part of the phenotype of individuals. Yet individual benefit does not arise, unlike for many biological traits, simply from having terminological knowledge as a trait. Instead, individual benefit arises from the properties of the social group formed of persons sharing the same terminology and who thereby are mutually kin.

How do we account for the macro-level phenomena of social relations and individual benefit structured through a kinship terminology? Mesoudi et al. consider that evolution occurs at the trait level because they accept uncritically the idea that macro-evolution is Darwinian microevolution writ large (but see Erwin 2000; Carroll 2001; Simons 2002; among others, for some of the issues involved). However, their argument does not work for kinship terminologies.

A terminology is not just a collection of terms, as it has a structural form (in the algebraic sense) determined by the way we compute kin relations using kin terms (Read 1984; 2001; 2005). If John, Mary, and Jim are English speakers and John refers to Mary by the kin term *aunt* and Mary refers to Jim by the kin term *son*, then when John refers to Jim by the kin term *cousin*, *cousin* is the product of the kin terms *aunt* and *son*. More generally, if person A (properly) refers to person B using the kin term *K* and person B (properly) refers to person C using the kin term *L*, then the product of K and L is the kin term *M* (if any) that A properly uses for person C. Through ethnographic elicitation of this kind of kin term usage, we can make evident a conceptual structure that expresses the manner in which the kin terms forming a particular terminology constitute a structured set of symbols (=terms).

The form of the structure is highly constrained. It can be constructed algorithmically by expanding a core structure so as to structurally introduce two basic properties of kinship terminologies: (1) reciprocity of kin terms, and (2) sex marking of kin terms. The core structure is generated algebraically by applying repeatedly the kin term product to the generating term(s), such as the kin term *parent* for the American kinship terminology.

Terminologies differ from one another with respect to the set of generating kin terms and the algorithms for introducing the above two terminological properties but share commonality by having structures that can be generated in this manner. Even more, the generative logic leads to 100% correct predictions of the genealogical definitions of kin terms, even though seemingly simple changes to a terminology (such as introducing the terms *aunt-in-law* and *uncle-in-law* into the American kinship terminology) would negate the ability to correctly predict genealogical definitions of kin terms.

The generative logic of terminologies would not arise from historically contingent selection based on phenotypic properties of individuals acting at the level of individual kin terms. Further, though terminologies are mental constructs transmitted in a social context through a developing child's enculturation, knowing in more detail the mapping of individual kin terms – seemingly good candidates for memes – onto neurological location(s) will not tell us much either about the structural arrangement of kin terms or about the processes used by the brain to infer the implicit organizational structure of a kinship terminology. The structural logic of kinship terminologies appears to be inferred, much as the brain infers the implicit organizational structure of a language. The selection acting on kinship terminologies occurs at the level of structural properties and their consequences for the social organization of kin determined through the kinship terminology.

Evo-devo, modularity, and evolvability: Insights for cultural evolution

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Abstract: Evolutionary developmental biology ("evo-devo") may provide insights and new methods for studies of cognition and cultural evolution. For example, I propose using cultural selection and individual learning to examine constraints on cultural evolution. Modularity, the idea that traits

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vary independently, can facilitate evolution (increase "evolvability"), because evolution can act on one trait without disrupting another. I explore links between cognitive modularity, evolutionary modularity, and cultural evolvability.

Mesoudi et al. argue that the methods and tools used to study biological evolution can profitably be applied to the evolution of culture, particularly human culture. Evolutionary developmental biology ("evo-devo") is a major research axis of evolutionary biology, given little attention in the target article. Evo-devo studies the mechanisms that generate the phenotype, and whether these channel, bias, or limit evolution (Brakefield 2003). Issues studied include the evolutionary origins of phenotypic novelty, how fitness improvements are made without compromising past adaptation, influences and constraints on the rate and course of evolution, and whether evolvability, evolutionary adaptability, can itself evolve (Kirschner & Gerhart 1998; Wagner & Altenberg 1996; West-Eberhard 2003). Parallel issues are key to understanding cultural evolution, so there is potential for cross-fertilisation of ideas.

Of particular relevance is the notion that modularity can favour evolvability, the capacity to generate heritable, selectable phenotypic variation (Hansen 2003; Kirschner & Gerhart 1998; Wagner & Altenberg 1996; West-Eberhard 2003). In evo-devo, "modular" describes traits that have some degree of genetic and developmental independence: they are semiautonomous units. Such independence is argued to facilitate biological evolution, allowing traits to change without interfering with other traits' functions (Hansen 2003). For example, a common theme in biological evolution is differentiation of repeated modules, such as teeth along a jaw or segments of an insect body. Replication, and the resulting redundancy, facilitates evolutionary change without the disadvantage of loss of original function. Cultural evolution may provide similar examples. During language evolution, single words might be duplicated to form several words of similar meaning. This could facilitate subsequent cultural evolution, because some of these duplicated words can diverge in meaning without loss of the original word's meaning.

Cognition may also have a modular structure, although the extent and developmental causes of cognitive modularity are hotly debated (Fodor 1983; 2000; Panksepp & Panksepp 2000; Sperber 2002). This modular structure could influence the tempo and course of both cognitive evolution and cultural evolution. Critical defining characters of cognitive modules, such as computational distinctiveness and informational encapsulation, imply independence between modules (Fodor 1983; Shettleworth 2000). Independence could facilitate cognitive evolution, because selection can act on one cognitive module without affecting the function of others. Hence, although the Fodorian and evo-devo modularity literatures have generally developed separately (but see, e.g., Sperber 2002), Fodorian cognitive modules may be modular in the evo-devo sense. Cognitive structure and processes are essential in supporting and moulding culture (Mesoudi et al. 2006; Sperber & Hirschfeld 2004). Now, the question is: are the cognitive processes that support cultural evolution modular, do cultural traits themselves form modules, and does this influence cultural evolution?

Culturally transmitted traits often occur in clusters. For example, speaking French is associated with religious, dietary, technological, and societal preferences and norms. Causes of trait clustering and consequences for cultural evolution are important issues: How and why are these stable clusters maintained? Do they act as modules? And does clustering limit or facilitate cultural evolution? Traits may occur together because each trait is an independent adaptation to a shared physical or socio-cultural environment, and/or because of cognitive, historical, or phylogenetic constraints. In addition, trait acquisition may facilitate acquisition of other traits. Evo-devo can inspire empirical methods to address these issues. For example, across-species comparison of butterfly wing patterns revealed that posterior and anterior forewing spots varied in size, and that some size combinations were observed in nature (e.g., both eyespots large or both small), whereas others (e.g., posterior eyespots large, anterior small) were not (Brakefield 2003). This would be equivalent to finding only particular combinations of *cultural* traits in comparative studies of natural populations (e.g., reliance on tools A and B is observed, as is reliance on neither tool, but reliance on A without B is never observed). Such a pattern of inter-group differences could suggest an evolutionary constraint: particular trait combinations evolve readily, and others, rarely.

Evo-devo can go beyond comparative investigation of whether traits are separable and modular. One can artificially select one trait (e.g., posterior eyespot size) and observe effects on other traits (e.g., anterior eyespot size). Moreover, by selecting for combinations of traits, constraints on evolution can be examined (Brakefield 2003). Such studies may produce counterintuitive results. For example, the natural distribution of eyespot patterns suggested an evolutionary constraint. However, under artificial selection, pattern combinations not observed in natural species evolved as readily as combinations observed in the field (Brakefield 2003). This suggests that other reasons beyond developmental or genetic constraints, such as ecological demands, are responsible for the natural distribution of these trait combinations. Thus, artificial selection experiments can help address why particular traits co-occur.

Similarly, artificial *cultural* selection could be used to identify and pull apart clusters of cultural traits. For example, the coevolution of culturally transmitted traits could be studied using laboratory microsocieties and transmission chain approaches (e.g., Baum et al. 2004). Another possibility would be examination of learning within individuals to assess the stability and integrity of culturally acquired trait clusters. If reinforcement of one trait facilitates or impedes production of another, cultural coevolution of the two traits will be affected. For instance, learning one tool technique (e.g., termite fishing; Whiten et al. 1999) may facilitate acquisition of another technique (e.g., nut-cracking) if common skills are involved, but may hinder acquisition if training in one skill reduces competence in another.

Finally, can evolvability itself evolve? Within biology, it is controversial as to whether architectures that favour evolvability are themselves adaptations (Earl & Deem 2004; Kirschner & Gerhart 1998; Radman et al. 1999). There is evidence that, for example, mammalian immunological systems are designed to favour the production of variability, on which selection can act. Furthermore, these variation-generating mechanisms are not general but targeted to the immunoglobulin genes (Radman et al. 1999; Weill & Reynaud 1996). The evolvability question is relevant to cultural evolution: Are there cognitive structures, artefacts, or societal designs that favour or hinder cultural evolution, do they target particular domains of cultural evolution, and have these structures evolved *because* of their optimising effect on rates of cultural evolution? If the production of cultural variants is too fast, beneficial variants may be lost, and if too slow, adaptability may be compromised. In conclusion, the evo-devo viewpoint suggests important questions for cultural evolution, but also provides a body of theory and methods that could help provide answers.

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A unified science of cultural evolution should incorporate choice

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Abstract: Analogies between biological and cultural evolution may be illuminating and suggest methods to pursue in the quest for a unified

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