Title
An evolutionary developmental approach to cultural evolution.

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Table 1: Expansion and Extension of the Darwinian Model

Darwinian model (1)	Modern synthesis (2)	Expanded synthesis (3)	Social/cultural extended synthesis (4)
Variation	Gene mutation	Evo-devo theory	Cultural idea systems
Inheritance	Mendelian inheritance	Plasticity and accommodation	Language and other symbolic forms of communication
Natural selection	Population genetics	Niche construction	Generative grammars
	Contingency	Epigenetic inheritance	Enculturation
	Speciation and trends	Replicator theory	Cultural models
		Evolvability	Intentionality and purposeful behavior
		Multilevel selection	Recursive reasoning
		Genomic evolution	Theory of mind
		Imitation/phenotypic inheritance[a]	Technological systems
		Social cognition[a]	Role systems
		Social behavior[a]	Organization systems
			Symbolic inheritance
			Invention and innovation
			Social boundary

Note. Cols. 1-3: Derived from figure 1.1 in Pigliucci and Müler (2010a). Col. 4: Proposed extension addressing cultural and social evolution.
[a] Additions to Pigliucci and Müler's expanded synthesis.

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The authors credibly integrate some of the new ideas of the expanded synthetis of evolutionary theory (Pigliucci and Müler 2010b) -- ideas that have expanded the modern synthesis (Mayr and Provine 1980; table 1, cols. 1-3) -- into a developmental approach for explicating cultural evolution. Relevant to their argument, the expanded synthesis can be extended to encompass ideas relating to the evolution of social/cultural systems (table 1, col. 4).

Whereas the modern synthesis focused primarily on gene evolution through mutation, inheritance and natural selection, the Expanded Synthesis has focused on endogenous processes affecting the development and expression of traits, not just their selection as optimal solutions to externally imposed change. The authors suggest that accounts of cultural evolution should focus similarly on endogenous processes relating to the development and formation of cultural phenomena. The goal is laudable; the means proposed for so doing are incomplete.

The authors identify several processes central to the evolution story applied to culture: the internal innovation cycle, exaptive bootstrapping, the external innovation cycle, generative entrenchment, and a multi-level perspective. As the authors note, none is specific to cultural evolution. Though these provide a richer and more complete picture of the evolutionary process than is obtained through focusing on traits and trait selection alone, still unanswered is a fundamental question: Why did the trajectory leading to *Homo* diverge radically from the trajectory leading to *Pan*, despite both trajectories having the same beginning point? Some have argued incorrectly that cultural evolution defined as an extension of biological evolution by including non-genetic traits transmitted socially and having an impact on behavior makes the difference.

The cultural side of *Homo sapiens*, though, is not determined through social transmission. As the authors comment, in the neo-Darwinian framework there is "no room [for] explanations having to do with how culture is organized, how it develops and how it interacts with other processes" (see also Lane *et al*. 2009; Wimsatt and Griesemer 2007). Lacking is a critical innovation transformation introduced during hominin evolution that fundamentally redefined what constitutes the evolutionary process with regard to the cultural side of *Homo sapiens* (Read 2012; Read et al. 2009). The transformation changed innovation from an externally exogenous random mutation process to "innovation that allows for organizational change through endogenous processes acting on an assessment of current organizational functionalities [that] … did take place during hominin evolution" (Read et al. 2009:44). This "innovation innovation" (Read et al. 2009) reversed the previous pattern of functionality at the group level emerging from functionality at the individual level, to functionality at the individual level being derived from functionality introduced at the group level.

We can see the reversal in the development during the Upper Paleolithic of "an external cognitive architecture by which hominins achieved social extension within local groups and a wider community" (Gamble 2010:32), thereby transcending individually framed, cognitive abilities through group level organization of individual cognitive abilities. The "cognitive architecture" enabling this social extension derives from the "culturally constructed systems of kinship [that] provide the basis for all the other culturally based forms of social organization that arose with modern *Homo sapiens*" (Leaf and Read 2012:19). Culturally constructed kinship systems whose organization is ex-

pressed linguistically through a kinship terminology enabled social relations to be extended in time and space beyond the local group, and the boundary of a community was thereby no longer limited by the scope of face-to-face interaction, as is the case with the non-human primates (Read 2012). Instead, the social system was transformed into a relation-based form of social organization expressed linguistically through a kinship terminology system (Read 2012). The culturally defined kinship terminology system provides the foundation for the social organization of hunter-gatherer societies from which more extensive forms of social organization have evolved.

The kinship terminology system neither emerges from patterned behavior of individuals (Leaf and Read 2012:16), nor provides functionality except through the group level: individually knowing a kinship terminology provides no functionality to that individual. Instead, functionality for the individual arises from a group collectively having and sharing a kinship terminology system, thus reversing the sequence for the expression of functionality implied by neo-Darwinian evolution. As a consequence, the social boundary for small scale societies is determined by those who can mutually determine they are kin, using the kinship terminology as a symbolic computational system (Read 2001; 2007), hence the boundary became the consequence of an internal, rather than an external, process, in the manner discussed by the authors. The reversal in the expression of functionality implies that cultural evolution is not derived from evolution of individual traits, genetic or otherwise, but from evolutionary processes acting on the structure and organization of cultural idea systems (Leaf and Read 2012:14).

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