or similar social roles but different social structures (juries and managers may have different roles in different kinds of court proceedings or in different companies).

Some patterns of cultural transmission tend to reduce cultural diversity. These patterns include copying of random individuals (Alexander 2007; Abrams 2013), bias toward copying successful or high-status individuals, and bias toward copying high-frequency cultural variants (Boyd & Richerson 1985). Models in which individuals' beliefs are weighted averages of others' generally produce consensus, as long as no individuals are isolated from others and degrees of trust are stable (DeGroot 1974; Grim et al. 2011; Lehrer & Wagner 1981; Zollman, personal communication, cf. Zollman 2013). Some models can maintain diversity, however.

A coordination game models a situation in which it is better for each person to do the same as others, even if one coordinated action might be preferable to another. In one kind of model, each person makes a single choice in simultaneous games with each neighbor on a network with bidirectional, unweighted links. The best response to neighbors' choices depends on the percentage of them who play various options, and the payoffs for coordination with each. Iterating the process can spread a given choice: if enough of my neighbors adopt, say, option *A*, I will do the same, which may eventually cause a neighbor who has been playing *B* to switch to *A*, if her neighbors switch as well. This models cultural transmission in which individuals are influenced both by the number of neighbors adopting a variant and its perceived intrinsic attractiveness.

Morris (2000) showed that distinct cultural variants can be maintained in such a model if some groups have high enough *cohesion*, also known as *cohesiveness* (Vega-Redondo 2007; Young 1998). The cohesiveness of a group is the minimum of the ratio between the number of intra-group links and the number of all links, in each group member's links. A group with high cohesiveness is one with mainly within-group communication. Members' interactions reinforce their common cultural variants despite attractive alternatives presented by outsiders.

Alexander (2007) investigated agent-based simulations of various combinations of (a) games and payoffs, (b) network structures, and (c) rules for copying from neighbors. Some combinations of these factors make it difficult or impossible to maintain cultural diversity; others make it easy. Alexander's results appear to show that on the whole, more social interconnections tend to make cultural disagreement less likely, thus apparently broadening Morris's result to a variety of other cases.

Morris's sense of cohesion is related to others (Wasserman & Faust 1994) and to measures of community structure (Newman 2010). Using a cohesion measure called *close-knittedness*, Young (1998) proves results for stochastic coordination games that support the idea that cohesion allows local reinforcement and global disagreement (at least in the short run). My own experiments with a simple model of cultural transmission that does not use averaging for updating of beliefs (http://modelingcommons.org/browse/one_model/3829) suggest that cultural diversity can easily be maintained by cohesion on reasonable timescales.

Plausibly, the influence of collaborative interdependence on social network structure sometimes generates structures in which groups exhibit cohesion, communicating largely with members of the same group on certain topics of discussion. This is a second way that collaboration can help maintain cultural diversity within a population.

As suggested by some of Durham's (1991; 1992) proposed transmission isolating mechanisms mentioned by Smaldino (sect. 6, para. 1), individual resistance to alternative variants or certain kinds of interlocutors can maintain cultural diversity (Axelrod 1997; Hegselmann & Krause 2002; Mueller et al. 2010). Note though that cognitive processes such as inference and emotion can transfer influence from one mental state to another, and people seem to be quite capable of keeping large domains of thought isolated from others. This suggests that resistance to alternatives might be modeled in terms of cohesion-like properties of networks of influence between mental states (cf. Colombo 2013). Then different social roles may encourage "cohesive" cognitive subnetworks, reinforcing particular patterns of thought in individuals who fill similar social roles. Perhaps cohesion mediates both effects of collaborative interdependence on cultural diversity highlighted above.

The primacy of scaffolding within groups for the evolution of group-level traits

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Abstract: Although both a "simple dyad or a population of thousands" are groups, these are, respectively, face-to-face embodied groups and collective symbolic groups. We applaud Smaldino for recognizing and describing the concept of the group-level trait. As an expansion, we propose an evolutionary-developmental model of face-to-face groups that scaffolds theorizing the evolution of cultural group-level traits.

One look at the human body – bipedal, no claws, pitiful canines, and a long developmental period – and it is clear that humans could have only evolved from groups, not from a primal condition of solitary living. Members of other ancestral species, not even bipedal, faced the initial problems in the evolution of coordinated activity. Group-living evolved as an interface between individual and habitat (e.g., protection from predators; exploitation of large, patchy, distributed resources). Groups that formed more coordinated units to interact with the habitat (thereby benefiting component individuals) would have been relatively more persistent than less coordinated units. Both minimum and maximum constraints on group size would occur: eventually too small a group would have a higher risk of perishing; too large a group strains the carrying capacity of the environment. Because a group mediates individual contact with the environment, and the number of niches within groups is constrained by minimum group size and carrying capacity of the habitat, we expect the evolution of perceptual, affective, and cognitive processes that support the development and maintenance of group membership (Caporael et al. 1989). In short, we expect humans to have evolved to be *obligately interdependent*, unable to reproduce and survive to reproductive age outside a group. Few would disagree with this minimalist scenario. The point of traction is how we conceive of group structure, social motives, and cognition generally. We agree with Smaldino that more highly coordinated groups are likely to outcompete less coordinated ones, but we also emphasize that within-group pressures have the major role in evolved group-level traits, not between-group conflicts.

Anthropologists identify three categories of functional group organization among hunter-gatherer groups: hunting and gathering is typically done by workgroups, subdivisions of a band. A band undertakes domestic functions – butchering, preparing food for storage, child-rearing, and adjudicating conflict. A macroband is a seasonal gathering of bands, with a wide range of ritual, social, cognitive, and informational activities. The organizational structure is remarkably stable through time, across continents, and different habitat types. Independently, Hull (1988) observed similar configurations in his participant-observation research on the organization of scientific practice. He identified a "demic structure of science" consisting of small research groups, "conceptual demes," and seasonal society meetings. Group size at these three levels was comparable – about 3 to 5, 30 to 50, and 100 to 500 individuals (cf. Dunbar 1993), respectively. With the addition

Table 1 (Caporael & Garvey). *Repeatedly Assembled Core Configurations*

Core configuration	Group size	Modal tasks	Group-level traits
Dyad	2	"Up-close" interactions; sex, artifacts, infant–caregiver interaction	Microcoordination
Task group	5	Foraging, hunting, gathering, direct interface with habitat	Distributed cognition
Deme (Band)	30	Movement from place to place, general processing and maintenance, work group coordination	Shared construction of reality (includes indigenous psychologies), relational group identity
Macrodeme (Macroband)	300	Seasonal gathering, exchange of individuals, resources, and information	Stabilizing and standardizing language; ontologies, collective identities

The names of core configurations refer to distinctive kinds of situated activity. The term "bands" is used to refer to (idealized) hunter-gatherers; otherwise, "deme" refers to the model. Except for dyads, the group size numbers should be considered as basins of attraction. Reprinted and modified from Caporael (2014).

of the dyad, considerations of repeatedly assembled morphology, tasks, and group size motivate a model of core group configurations that form a sociocognitive selective environment. This selective environment scaffolds both MLS and cMLS approaches, providing far richer possibilities for theoretical development and elaboration consistent with Smaldino's concept of the group-level trait.

Table 1 summarizes the model of core configurations (Caporael 2014; see also Caporael 1997). Core configurations are associated with examples of modal tasks that scaffold the evolution and development of group-level traits (Caporael et al. 2014). The model generally posits that human mental systems should have evolved for core configurations; once evolved these can be combined, extended, and co-opted to novel tasks. Selective advantages for sociality include coordination of activity and the acquisition, transmission, and maintenance of information and knowledge.

Seasonal *macrodemes*, composed of related demes, should be particularly active sites in human biocultural evolutionary studies. First, macrodemes are not persistent; they are intermittent over time. Second, members of groups may come and go within demes without changing the group structure and dynamics at the deme and macrodeme levels (Brewer & Caporael 2006). The situated activity of hunting, foraging, playing, and other activities at deme and macrodemes differ little from each other. However, macrodemes generate a new set of dynamics, which are largely social and psychological with downward causal consequences. These emergent abilities include distributed cognition, reduced distinctions between self and non-self, and collective and categorical identities, rather than just interpersonal and relational identities. The interpersonal relational identity within bands is complemented by an emergent collective identity at the macroband level. Collective identity in a seasonal macrodeme scaffolds exchanges of crucial information about changing conditions in more distant parts of a local ecology. Language, and its stabilization and standardization, is highly significant for describing what lies beyond the next hill. Layton and O'Hara (2010) report that modern languages universally include the equivalent of terms such as "now," "before," "after," "here," and "far." A lack of such *not-present* ecological information can lead to the loss or even partial destruction of a foraging party, which in turn can lead to the end of a band. Although that end may be the literal deaths of its members, participation in a macroband with a shared collective group identity can scaffold the absorption of surviving group members by other demes. In other words, macrodemes serve as a safety net at the band and individual levels. Furthermore, the seasonal aspect of macrodemes, combined with shared symbolic communication among demes, scaffolds the transition from foraging lifeways to settlement living.

Although we do not disagree with Smaldino that intergroup competition and conflict occur, we are skeptical about using such traits as lynchpins for the evolution of a distinctive "human nature." It takes a great deal of *within*-group selection for the evolution of the kind of coordinating capacities demanded by engagement in inter-group conflict, even at the level of a minor mêlée. By the same token, intrademic, individual, and subgroup competition in various symbolic, ritual, and occasionally embodied ways, is a lively and refined sport.

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Tackling group-level traits by starting at the start

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Abstract: We agree that emergent group-level properties are important; however, we disagree that current approaches, especially culture-gene coevolutionary (CGC) approaches, have neglected them. We explain how CGC helps demystify the tumult of humans' group-level complexity by "starting at the start," and why (a) assuming undifferentiated individuals and (b) focusing on cooperation are actually powerful tools to this end.

The culture-gene coevolutionary (CGC) approach recognizes the importance of emergent, group-level properties. CGC focuses of the evolutionary causes and consequences of our species' capacity to transmit complex cultural information, including the emergence of complex, differentiated, interacting phenotypes that no single individual could have developed in isolation.

Once culture began evolving, fascinating new evolutionary dynamics emerged. These led our ancestors to conform (Boyd & Richerson 1985), imitate prestigious leaders (Henrich & Gil-White 2001), differentiate into symbolically marked ethnic