

of new conceptual developments that is expected to strongly influence the future of basic science and applied research in several different fields. As Ernest Hemingway said:

It is good to have an end to journey toward; but it is the journey that matters, in the end.

Collaboration in classical political economy and noncooperative game theory

doi:10.1017/S0140525X13002926

Roger A. McCain

Department of Economics and International Business, Lebow College of Business, Drexel University, Philadelphia, PA 19104.

mccainra@drexel.edu <http://www.drexel.edu>

Abstract: This commentary suggests (1) that there are precedents for Smaldino’s “collaboration” in the history of economic thought before 1900 and (2) that the distinction of collaboration from what is thought of as cooperation in game theory is less clear than Smaldino suggests.

Smaldino’s reconsideration of the importance of group traits that involve differentiation of roles is useful and important. However, it could be enriched by a more complete understanding of game theory and also by a revisit to some of the ideas of the classical political economists. This comment will take the two points in reverse order.

We find a parallel in Adam Smith’s *Wealth of Nations* (Smith 1994), in which he discusses the division of labor and illustrates it with the famous example of the pin factory, among others. According to Smith, in the first sentence of Chapter One, “The greatest improvement in the productive powers of labour, and the greater part of the skill, dexterity, and judgment with which it is any where directed, or applied, seem to have been the effects of the division of labour.”

In his *Principles of Political Economy*, John Stuart Mill (1987) returned to Smith’s discussion of the division of labor. Mill clearly thought of the division of labor as a (if not the) fundamental cause of improving standards of living. Mill used the term “complex co-operation” to designate what Smith had called “division of labor,” and he distinguished it from “simple cooperation,” which seems to correspond to what Smaldino (sect. 2.2, para. 2), following Wimsatt (1974), calls “aggregate” group properties (or group actions). Mill stresses that complex cooperation (“collaboration” for Smaldino) offers further increases in labor productivity beyond that available through simple cooperation.

In McCain (2014, Ch. 2) the theory of production shared by Smith and Mill is called a “complex combination of labor” theory, that is, one that holds that labor productivity is primarily determined by the complex combination of labor, rather than by the combination of simple labor with great quantities of other resources. Another example of a complex combination of labor theory of productivity is found in the writings of the Elder Austrian School, (esp. Menger 1871/1976), which stresses the complexity of production in terms of the tools used. These two strains of complex combination of labor theory were synthesized by Ely (1901) but largely lost sight of in the twentieth century.

Complex cooperation in the writings of Mill seems to correspond more closely to what Smaldino calls collaboration than to what he calls cooperation. No doubt this terminological novelty is worthwhile: the word “cooperation” has a great deal of baggage. It is not so much ambiguous as polygynous.

Nevertheless, Smaldino’s understanding of game theory and its relation to cooperation or collaboration seems incomplete. Smaldino stresses some rather simple game examples, but these by no means exhaust the resources of noncooperative game theory. Here is an example, only slightly more complex, that seems to capture both complex cooperation as understood by Mill and collaboration as understood by Smaldino (esp. sect. 2, para. 1; sect. 4.1, para. 1).

Table 1 (McCain). A Smith–Mill Game

First payoff to Worker 1; Second payoff to Worker 2.		Worker 2		
		Work alone	Task 1	Task 2
Worker 1	Work alone	1,1	1,0	1,0
	Task 1	0,1	0,0	4,4
	Task 2	0,1	3,3	0,0

The Smith–Mill game shown in Table 1 is adapted from McCain (2014), Chapter 3. Essentially the game in McCain’s Chapter 3 expands the “Stag Hunt” game to allow for division of labor. The game at Table 1 modifies it further to allow for different aptitudes along the lines of Mill’s discussion of complex division of labor and Smaldino’s kayak maker and seal hunter example (sect. 4.1, para. 3). The players are Worker 1 and Worker 2. The strategies are to work alone or work collaboratively taking Task 1 or Task 2. Assume Worker 1 has a “knack” for Task 1 and Worker 2 for Task 2. To realize the benefits of collaboration, it is necessary that each worker take one of the two tasks.

This game has three distinct Nash equilibria that are ranked in Pareian terms. As such, it mixes elements of a coordination game (e.g., the Stag Hunt) and an antcoordination game (Tardos & Vazirani 2007). One possible solution is a hierarchy, whereby one of the two is designated as “leader” and the other as “follower.” The “leader” directs the strategies of both. In this case, it does not matter which player is designated as “leader,” because it is in the interest of both to choose Task 1, Task 2. (This is further discussed in McCain 2014, Ch. 7, sect. c).

It seems that the Nash equilibrium in the rightmost column in the second row from the bottom is the collaborative outcome of this game as Smaldino understands it. It is also the unique cooperative solution. For noncooperative games in standard form (such as Table 1), there seems to be no very general way of identifying a cooperative solution. In this case, however, we can rely on Aumann’s (1959) criterion as the distinct cooperative solution to the game. The collaborative solution in the rightmost column is the only *strong* Nash equilibrium in the game. It will also correspond to each of the several criteria for solutions of cooperative games.

Responding to social-dilemma examples along the lines of public goods, Smaldino writes, “Yet, the group-level behavior is defined not simply in terms of individuals donating or withholding contributions, but in terms of each individual doing his own part in a coordinated and organized manner. These hunters are doing more than cooperating: they are collaborating” (sect. 4.1, para. 1). Nevertheless, they are enacting the cooperative solution, not to a simplified game, but to the game they are playing.

Individual-level psychology and group-level traits

doi:10.1017/S0140525X13002938

Michael Muthukrishna and Mark Schaller

Department of Psychology, University of British Columbia, Vancouver, BC V6T 1Z4, Canada.

michael@psych.ubc.ca schaller@psych.ubc.ca
<http://www2.psych.ubc.ca/~schaller/schaller.htm>

Abstract: Psychological research on social influence illuminates many mechanisms through which role differentiation and collaborative interdependence may affect cultural evolution. We focus here on psychological processes that produce specific patterns of asymmetric influence, which in turn can have predictable consequences for the emergence and transmission of group-level traits.

Smaldino makes a compelling case that role differentiation, collaborative interdependence, and emergent group-level traits play an important role in cultural evolution. Smaldino offers preliminary speculations about processes through which group-level traits might emerge, but a lot remains to be specified. What specific role differentiations have implications for the emergence of important group-level traits? What specific proximal mechanisms might account for the emergence of these group-level traits and for their change over time? How might these processes be affected by specific circumstances? Answers to these questions require input from the sciences that focus on proximal mechanisms.

It may be especially useful to draw upon insights from the psychological sciences—especially research that explores the many ways that individuals influence each other during interpersonal interactions. Particularly relevant are lines of research documenting specific ways that influence outcomes differ depending on the social context—including the roles occupied by the individuals involved (Cialdini & Goldstein 2004; Hogg 2010; Wood 2000).

It is easy to overlook this literature when addressing questions about long-term cultural outcomes, because psychological inquiry focuses on the immediate actions and outcomes of individuals and rarely considers their population-level consequences. But there are exceptions to this disciplinary restraint (Resnick et al. 1991; Schaller & Crandall 2003).

Consider, for example, research on dynamic social impact theory (DSIT; Harton & Bullock 2007). Drawing upon a few basic principles of social geography, social interaction, and social influence, DSIT shows how mutual influence that occurs during dyadic interactions has, over time, inevitable consequences for population-level outcomes. These emergent outcomes include changes in the popularity of beliefs and behaviors and changes in the extent to which these beliefs and behaviors correlate and cluster. Furthermore, DSIT shows how the psychology of social influence can create and sustain patterns of diversity within a cultural population. Diversity—of beliefs, behaviors, aptitudes, etc.—is an outcome of particular relevance here. As Smaldino observes, diversity sets the stage for collaboration, which can then give rise to new group-level traits. Second, because diversity is the fuel that fires the engine of evolution, it has implications for cultural evolution more generally.

One important reason why the psychology of social influence produces predictable population-level consequences is because, within any social interaction, influence is rarely symmetrical. Some individuals are more influential; some individuals are more influence-able. DSIT typically treats these influence asymmetries as random variation. But they are not just random. The psychological literature documents specific kinds of role differentiations that have specific implications for patterns of asymmetric influence; this, in turn, can have predictable long-term consequences for cultural diversity and other group-level traits.

Leadership roles are one obvious example. Smaldino speculates that leadership, and its consequences, is one likely means through which group-level traits emerge. There is an extensive empirical literature on the psychology of leadership and followership and implications for group outcomes (Van Vugt et al. 2008). By applying insights from this literature, it will be possible to predict group-level traits with greater precision.

Other forms of asymmetric influence arise from a variety of other social distinctions—some obvious and some not—that connote differences in power, dominance, expertise, or prestige. These differences have consequences for individual-level cognition and additional consequences for social influence (Cheng et al. 2013; Fiske 2010; Galinsky et al. 2008). Because of these asymmetrical influence implications, there will be further consequences for the emergence and transmission of group-level traits.

It may also be productive to explore the implications of sex differences. The male/female distinction is perhaps the most fundamental form of collaborative interdependence within the

human species (in the sense that men and women collaborate interdependently to produce offspring). The mating game is a dynamically unfolding process in which individuals' thoughts and actions are influenced by the presumed thoughts and actions of other men and women in the immediate vicinity. But men and women do not influence each other in exactly the same way; their influence is predictably asymmetrical. The implication, explored in research on “dynamical evolutionary psychology,” is that the specific distributions of men and women within a population, and the specific characteristics of those men and women (e.g., the extent to which they are available or unavailable as mates), can affect the emergent properties of the entire population (Kenrick et al. 2003). The implications of sex differences for group-level traits are not limited to the domain of mating behavior. The male/female distinction has profound implications for division of labor and distribution of knowledge across a wide range of behavioral domains (Fried 1967; Wood & Eagly 2010). Research that systematically integrates the psychological literatures on sex differences (Geary 2010) and social interaction with Smaldino's perspective on group-level traits is likely to reveal additional novel implications for cultural evolution.

The psychological processes that govern social interaction and social influence—and lead to emergent group-level traits—are themselves moderated by additional features of local ecologies. For example: the prevalence of infectious diseases in the local ecology appears to have many relevant implications. Among other outcomes, the sociological and psychological bases of asymmetric influence—rigid status hierarchies, authoritarian attitudes, etc.—are more evident under circumstances of higher disease prevalence (Murray et al. 2011; 2013). The implication is that when diseases pose less of a threat, a more diverse set of beliefs and behaviors are likely to be expressed and maintained within a population. So, by carefully considering the specific psychological processes that govern the emergence of group-level traits, we may also be able to more fully identify connections between ecological circumstances and cultural evolution.

The take-home message is this: to realize the vast potential of the perspective outlined by Smaldino, it will be helpful to draw more fully on the vast psychological literature on social influence. As a happy corollary, this kind of conceptual integration will benefit the psychological literature too.

Cultural evolution and emergent group-level traits through social heterosis

doi:10.1017/S0140525X1300294X

Peter Nonacs^a and Karen M. Kapheim^b

^aDepartment of Ecology and Evolutionary Biology, University of California, Los Angeles, CA 90095; ^bDepartment of Entomology, Institute for Genomic Biology, University of Illinois at Urbana-Champaign, Urbana, IL 61801.

pnonacs@biology.ucla.edu

<https://www.eeb.ucla.edu/index.php>

kapheimk@illinois.edu

<http://www.igb.illinois.edu/>

Abstract: Smaldino proposes emergent properties of human groups, arising when individuals display both differentiation and organization, constitute a novel unit of cultural selection not addressed by current evolutionary theory. We propose existing theoretical frameworks for maintenance of genetic diversity—social heterosis and social genomes—can similarly explain the appearance and maintenance of human cultural diversity (i.e., group-level traits) and collaborative interdependence.

Human groups are not aggregates of interchangeable parts. The “who” of groups matters. Diversity across individuals produces collective group phenotypes that are both variable across groups