BBS COMMENTARY (DRAFT)
on Paul E. Smaldino, The Cultural Evolution of Emergent Group-Level Traits

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TITLE
The collaborative emergence of group cognition

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Abstract

We extend Smaldino's approach to collaboration and social organization in cultural evolution to include cognition. By showing how recent work on emergent group-level cognition can be incorporated within Smaldino's framework, we extend that framework's scope to encompass collaborative memory, decision-making, and intelligent action. We argue that beneficial effects arise only in certain forms of cognitive interdependence, in surprisingly fragile conditions.

Main text

Smaldino rightly distinguishes genuinely emergent group organization from mere aggregation, pointing to the active collaboration of individuals with different capacities as the key form of cooperation. We offer two friendly but important extensions. We incorporate group cognition into Smaldino's framework; and we see the conditions under which structured differentiation is beneficial as more fragile than he acknowledges. These modifications encourage integration of work on the cultural evolution of group-level traits with substantial research traditions on distributed cognition, organizational psychology, and collaborative recall.

On standard views in cognitive science, cognition is strictly an individual-level achievement. 'Social' cognition is thought to occur when people think *about* social phenomena, or when social stimuli trigger cognitive processes. But cognitive processes are conceived in non-social terms. If *group cognition* is countenanced, it is understood atomistically, as the aggregate output of individual cognition plus social processes of combination. Little attention is paid to collaborative interdependence as the hallmark of emergent group-level cognition, as expressed in the Gestalt maxim that "the whole is greater than the sum of its parts".

This attractive but puzzling concept is clarified in a large body of rigorous experimental research on group problem-solving in social and organizational psychology (Laughlin 2011) that is surprisingly neglected both in Smaldino's presentation and in cognitive science at large. In one key work, Steiner (1966) distinguished five types of group tasks. In additive and compensatory tasks, group members do not interact in producing an outcome. In additive tasks, the group outcome is indeed the sum of the member contributions. In compensatory tasks, the group

outcome is a statistical average of individual solutions. The proper aggregation of estimates or predictions can yield greater information gains than the sum of individual contributions (Bettencourt, 2009), as in the 'wisdom of crowds' (Surowiecki, 2004). But such crowd intelligence is largely aggregative in the sense of Wimsatt (1986), as Smaldino argues.

Although conjunctive, disjunctive, and complementary tasks require interactions among group members, only the latter are collaborative in a richer sense. Conjunctive and disjunctive tasks are end points on a spectrum of how many group members must succeed individually for the group to succeed. A disjunctive task, for example, would be a group working on a sudoku, where the group succeeds if any of its members solves the puzzle. Here, the role of social interactions is a matter only of recognizing and adopting a solution found by any one member. In complementary group tasks, on the other hand, members coordinate and combine their diverse knowledge, abilities, and cognitive resources into a collective, organization-dependent outcome that no individual could have produced alone. Psychological processes studied from this group-level perspective include problem-solving (Larsen & Christensen, 1993), collective induction (Laughlin & Hollingshead, 1995), the development of transactive memory systems (Wegner, 1986), and creativity (Hargadon & Bechky, 2006).

Likewise, the "distributed cognition" framework studies collaborative, dynamically-evolving work practices mediated by the use of tools and representational instruments, and carried out in environments that provide a rich organizational structure (Hutchins, 1995; Perry, 2003; Sutton, 2010). It borrows from traditional cognitive science an emphasis on processes of creating, transforming, and propagating representational states, but views them as part of larger cognitive

ecologies that involve the coordination of resources across people, tools, and shared environments. Complex collaborative tasks that have been analyzed as distributed cognitive systems include maritime navigation crews (Hutchins, 1995), emergency/rescue management (Garbis & Waern, 1999), theatrical practices in Elizabethan drama (Tribble, 2005), bioengineering labs (Nersessian, 2006), and crime scene investigation (Baber et al., 2006). Expanding Smaldino's framework, we argue that these cases exemplify emergent group-level cognition (Theiner & O'Connor, 2010; Sutton et al., 2010; Theiner, 2013).

Our concept of emergent group cognition differs from the 'assembly bonus effect', when "the group is able to achieve something collectively which could not have been achieved by any member working alone or by a combination of individual efforts" (Collins & Guetzkow, 1964, p. 58; cf. Larson, 2010). Firstly, an assembly bonus effect can occur without emergent group cognition. The 'wisdom of crowds' critically depends on the *lack* of collaborative interdependence. It requires, ideally, that individual decision-makers are connected only through suitable information aggregators such as market pricing, but otherwise do not influence each other's judgments.

Secondly, emergent group cognition does not necessarily produce assembly bonus effects. This is why Smaldino's claim that 'structured differentiation is often beneficial to group success', while appropriately correcting standard views, needs some qualification. For example, though shared remembering in dyads or groups is a ubiquitous human activity, experimental studies of collaborative recall find that groups often remember *less* than the sum of their parts (Weldon & Bellinger, 1997; Harris et al., 2013). The most common explanation for such *collaborative*

inhibition is that hearing others recall disrupts individuals' idiosyncratic mnemonic strategies (Basden et al., 1997). The fact that collaborative facilitation is surprisingly hard to find experimentally (but see Meade et al., 2009; Harris et al., 2011) suggests not that emergent group cognition does not occur, but that the conditions under which it is beneficial are surprisingly fragile. As Smaldino notes, the history of group organization matters, as does the structure of differentiated expertise. A further key factor is the fine-grained nature of the communicative interactions in active collaboration among group members (Sterelny, 2012; Sutton, 2013). This point can be neglected in *social combination* approaches in small group research, which tend to be output- rather than process-oriented, and concerned mostly with intellective tasks where comparison with traditional baseline models (e.g., *truth-wins, better-than-best-member*) makes sense. Apart from lacking ecological validity, such narrow focus can lead us to misconstrue the functions of real-world group cognition. An important function of shared remembering, for example, is to reinforce social bonds, by merging disparate memories into a stable rendering of shared past experiences (Barnier et al., 2008; Hirst & Manier, 2008; Hirst & Echterhoff, 2012). Recognizing the beneficial effects of collaborative interdependence requires that we conceptualize 'group success' more broadly.

This concept of emergent group cognition can centrally inform ecologically realistic studies of the co-evolution of minds, groups, and cultures.

References

Baber, C., Smith, P. A., Cross, J., Hunter, J., & McMaster, R. (2006). Crime scene investigation as distributed cognition. *Pragmatics and Cognition, 14*(2), 357-385.

Barnier, A. J., Sutton, J., Harris, C. B., Wilson, R. A. (2008). A conceptual and empirical framework for the social distribution of cognition: the case of memory. *Cognitive Systems Research 9*(1), 33-51.

Basden, B. H., Basden, D. R., Bryner, S., & Thomas III, R. L. (1997). A comparison of group and individual remembering: Does collaboration disrupt retrieval strategies? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*(5), 1176-1189.

Bettencourt, L. M. A. (2009). The rules of information aggregation and emergence of collective intelligent behavior. *Topics in Cognitive Science, 1,* 598-620.

Collins, B. E., & Guetzkow, H. (1964). *A Social Psychology of Group Processes for Decision-Making*. New York: Wiley.

Garbis, C., & Waern, Y. (1999). Team co-ordination and communication in a rescue command staff: The role of public representations. *Le Travail Humain, 62*, 273-291.

Hargadon, A. B., & Bechky, B. A. (2006). When collections of creatives become creative collectives: A field study of problem solving at work. *Organization Science, 17*(4), 484-500.

Harris, C. B., Keil, P. G., Sutton, J., Barnier, A. J., & McIlwain, D. J. F. (2011). 'We remember, we forget': collaborative remembering in older couples. *Discourse Processes, 48*(4), 267-303.

Harris, C. B., Barnier, A. J., & Sutton, J. (2013). Shared encoding and the costs and benefits of collaborative recall. *Journal of Experimental Psychology: Learning, Memory and*

Cognition, 39(1), 183-195.

Hirst, W., & Echterhoff, G. (2012). Remembering in conversations: the social sharing and reshaping of memory. *Annual Review of Psychology, 63*, 55-79.

Hirst, W., & Manier, D. (2008). Towards a psychology of collective memory. *Memory, 16*(3), 183-200.

Hutchins, E. (1995). *Cognition in the Wild*. Cambridge, MA: MIT Press.

Larson, J. R. (2010). *In Search of Synergy in Small Group Performance*. New York: Psychology Press.

Larson, J. R., & Christensen, C. (1993). Groups as problem-solving units: Toward a new meaning of social cognition. *British Journal of Social Psychology, 32*(1), 5-30.

Laughlin, P. R. (2011). *Group problem solving*. Princeton: Princeton University Press.

Laughlin, P. R., & Hollingshead, A. B. (1995). A theory of collective induction. *Organizational Behavior and Human Decision Processes, 61*, 94-107.

Meade, M. L., Nokes, T. J., & Morrow, D. G. (2009). Expertise promotes facilitation on a collaborative memory task. *Memory, 17*, 38-48.

Nersessian, N. J. (2006). The cognitive-cultural systems of the research laboratory. *Organization Studies, 27*(1), 125-145.

Perry, M. (2003). Distributed cognition. In J. M. Carroll (Ed.), *HCI models, theories, and frameworks: Toward an interdisciplinary science* (pp. 193-223). San Francisco: Morgan Kaufmann.

Steiner, I. D. (1966). Models for inferring relationships between group size and potential group productivity. *Behavioral Science, 11*, 273-283.

Sterelny, K. (2012). *The Evolved Apprentice.* Cambridge, MA: MIT Press.

Surowiecki, J. (2004). *The Wisdom of Crowds*. New York: Doubleday.

Sutton, J. (2010). Exograms and interdisciplinarity: history, the extended mind, and the civilizing process. In R. Menary (Ed.), *The Extended Mind* (pp.189-225). Cambridge, MA: MIT Press.

Sutton, J. (2013). Collaboration and skill in the evolution of human cognition. *Biological Theory 7*.

Sutton, J., Harris, C. B., Keil, P. G., & Barnier, A. J. (2010). The psychology of memory, extended cognition, and socially distributed remembering. *Phenomenology and the Cognitive Sciences, 9*(4), 521-560.

Theiner, G. (2013). Transactive memory systems: A mechanistic analysis of emergent group memory. *Review of Philosophy and Psychology, 4*(1), 65-89.

Theiner, G., & O'Connor, T. (2010). The emergence of group cognition. In A. Corradini & T. O'Connor (Eds.), *Emergence in science and philosophy* (pp. 78-117). New York: Routledge.

Tribble, E. B. (2005). Distributing cognition in the globe. *Shakespeare Quarterly, 56*, 135-155.

Wegner, D. M. (1986). Transactive memory: A contemporary analysis of the group mind. In B. Mullen & G. R. Goethals (Eds.), *Theories of Group Behavior* (pp. 185-208). New York: Springer.

Weldon, M. S., & Bellinger, K. D. (1997). Collective memory: Collaborative and individual processes in remembering. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*, 1160-1175.

Wimsatt, W. C. (1986). Forms of aggregativity. In M. G. Grene, A. Donagan, A. N. Perovich & M. V. Wedin (Eds.), *Human nature and natural knowledge* (pp. 259-291). Dordrecht:

Reidel.