5 The Emergence of Group Cognition

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1. INTRODUCTION

The *Group Mind Thesis*—understood as the claim that groups as a whole can be the subjects of mental states—was a popular idea in the intellectual landscape of the late nineteenth and early twentieth centuries.[2] For many scientists and philosophers of that period, it provided a succinct expression of what they perceived to be two characteristic features of groups: on the one hand, their ability to function as collective agents who can have intentions, make decisions, and pursue their own goals; on the other hand, the idea that groups are emergent wholes which are more than the sum of its members. Combine the two features, and the functional analogies between individual and group behavior strongly suggest adopting an intentional stance towards both.

But the group mind thesis fell out of grace with the rise of behaviorism and operationalism—no doubt expedited by the fact that some of its traditional expressions trafficked freely in unexplained mentalistic and vitalistic idioms that were rightly considered to be at odds with a scientifically informed worldview. As Wegner et al. (1985: 254–256) point out in their brief history of the group mind concept, the main problem was that the group mind seemed to lack its own body. Hence it remained unclear where to look for its properties, and how to measure them. One way to summarize the precarious ontological status of group minds is in the form of a theoretical dilemma. If the group mind is nothing over and above the collection of individual minds and the group processes by which they interact, an appeal to group minds appears to be superfluous. However, if the group mind is something over and above all these things, it appears to imply a collective version of mind-body dualism. This raises the familiar question of how the group mind exercises its causal influence on individual group members. Suggested answers included the mediation of a genetic "ectoplasm" (Jung, 1922) or telepathic communication (McDougall, 1920). Neither horn of the dilemma makes the idea of group minds seem very attractive.

Despite its historical ballast, the idea that groups can have cognitive properties of their own has recently gained new ascendancy in a wide

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range of disciplines concerned with group behavior. Economists and political scientists continue to explore the relationships between individual and group rationality (List, 2008; Pettit, 2003; Satz & Ferejohn, 1994). Sociologists, anthropologists, and historians find it useful to express generalizations about social groups in terms of their collective memory (Burke, 1989; Le Goff, 1992). Social psychologists studying problem solving and decision making in small groups increasingly embrace the view of groups as information processors (Larson & Christensen, 1993; Hinsz, Tindale, & Vollrath, 1997). Organizational scientists study the memory and learning processes of firms and organizations (Argote, 1999; Sandelands & Stablein, 1987; Walsh & Ungson, 1991). Evolutionary biologists have revived the idea that groups can evolve into adaptive units of cognition as a result of group-selection (D. S. Wilson, 1997, 2002; D. S. Wilson, van Vugt, & O'Gorman, 2008). Recent studies of animal behavior have revealed a number of collective decision-making mechanisms that are shared across a wide range of group types such as swarming ants, schooling fish, flocking birds, and even humans (Bonabeau, Dorigo, & Theraulaz, 1999; Hölldobler & E. O. Wilson, 1990; Seeley, 1995). The framework of distributed cognition has been used to study the dynamics of collaborative work practices which are socially, technologically, and temporally distributed, and whose coordination is mediated by rich situational, material, and organizational constraints. (Hollan, Hutchins, & Kirsh, 2000; Hutchins, 1991, 1995a, 1995b). It has recently been embraced by some philosophers of science as a unifying framework to overcome the present hiatus between "rationalist" and "social-constructionist" approaches to scientific cognition (Giere, 2002; Giere & Moffat, 2003; Nersessian, 2006). Finally, philosophers seeking a conceptual analysis of collective intentionality have tied their accounts to the recognition of groups as intentional subjects in their own right (Gilbert, 1989; Schmitt, 2003a; Tollefsen, 2004).

If we take these proliferating appeals to group cognition at face value, do they run into the same embarrassments that plagued traditional versions of the group mind thesis? In a series of papers and monographs examining the social dimension of cognition, Rob Wilson (2001a, 2004, 2005) has argued the contemporary appeals to group cognition remain fraught with unnecessary ontological commitments that have no real explanatory value. First, it is not sufficient to show that groups can collectively perform *actions* which are explained by psychological processes if all these processes are reducible to forms of "socially manifested" individual cognition. Wilson's way of putting his point with respect to Hutchins's (1995a) analysis of ship navigation as a form of socially distributed cognition is that "[t]he statement 'the crew saw the oncoming ship and decided to change direction' might be made true simply by individual-level psychological facts, together with other, nonpsychological facts about social organization" (2004: 291). Considering David Sloan Wilson's (1997, 2002) analysis of groups as adaptive decision-making units in their own right, Rob Wilson goes on to argue that he "would

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seemingly need to show that this functions at the group-level by individuals relinquishing their own decision-making activities. For it is only by doing so that he could point to a group-level psychological characteristic that is, in the relevant sense, emergent from individual-level activity" (2004: 297). The point of Wilson's argument is to cast the contemporary proponent of group cognition in a similar mold as the older collective psychology tradition, in which the emergence of group-level activity was taken to degrade and corrupt individual cognitive abilities (e.g., Le Bon's 1895/1960 suspected transformation of autonomous individuals into "maddening crowds").

Clearly, what drives much of the current philosophical interest in the idea of group cognition is its appeal to the manifestation of psychological properties—understood broadly to include states, processes, and dispositions—that are in some important yet elusive sense *emergent* with respect to the minds of individual group members.

Like the group mind thesis, the term "emergence" had long fallen into disrepute, only to be rehabilitated for its seeming applicability to a wide variety of empirical phenomena as well as its usefulness in articulating certain claims in metaphysics, particularly claims concerning the ontology of the mind. However, care needs to be taken in understanding the usage of particular authors. It is apparent that there are at least three families of concepts that are at play in different contexts. (See O'Connor & Wong, 2000, for further discussion.) First, some intend a purely *epistemological* concept: emergence in this broad sense implies unpredictability (in some sense) from a certain vantage point. Second, there are *modest metaphysical* concepts: emergent properties of certain complex systems are taken to be real and non-identical to structures of underlying properties and to make a distinctive causal contribution to the world, yet this is explicated in such a way as to be consistent with a broadly (albeit non-reductive) physicalism. Finally, there are *strong metaphysical* concepts: emergent properties whose manifestation is explicitly avowed as being inconsistent with one or other defining feature of physicalism—either the causal completeness (or "closure") of physics (Gillett's 2006 "strong emergence") or both completeness and the realization of all macro-level features (O'Connor & Wong's 2005 notion of "ontological emergence"; see also O'Connor & Churchill, forthcoming).

As these last citations indicate, one of us is friendly to the possible application of a strong, physicalism-negating concept of emergence. But such a view is very much a minority view in contemporary philosophy of mind and metaphysics. (Some doubt its coherence, thinking it must collapse into an outright mind-body dualism.) For the present chapter, we ask the reader to assume that, when it comes to human cognition and consciousness, strong metaphysical varieties of emergence, on the one hand, and austerely reductive or eliminativist views, on the other, are all off the menu of serious options on present evidence. That is to say, we will suppose for the sake of argument the correctness of the majority view that human mentality is a wholly physical phenomenon yet emergent in some modest metaphysical sense.

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Our goal will then be to address a set of related, conditional questions: *If* human mentality is real yet emergent in a modest metaphysical sense only, *then*

- what would it mean for a group to have emergent cognitive states?
- is this even a metaphysically coherent view?
- relative to which notion of emergence do we have reason to believe that certain groups in fact have emergent cognitive states?

We will argue that, *given* our central assumption, evidence from a wide variety of social science domains makes it plausible that there are group cognitive states and processes no less metaphysically emergent than human cognitive (and other special science) states and processes. We leave it to the reader to draw your own conclusion: some will follow one of us in supposing that the consequent is to be embraced as a surprising and enlightening empirical discovery. Others may follow the second of us in taking the truth of the conditional to provide significant reason for doubting its antecedent.

2. TOWARD A CONCEPTUAL FRAMEWORK FOR ANALYZING GROUP COGNITION

The undeniable sex appeal of the idea that groups can have emergent psychological properties is frequently purchased at the expense of conceptual clarity and rigor. In this section, we propose a conceptual framework for analyzing group cognition. For philosophers of mind, there is an inherent danger to remain narrowly focused on the question, relative to which notion of the mental can groups be considered the subjects of mental states (e.g., can groups have consciousness?). Adopting a 'big tent' approach, we treat the notion of cognition as a theoretical term, and break it down into several distinct capacities that we take to be indicative of cognitive systems. But even if we confine ourselves to a predominantly functional understanding of *cognition*, it remains an open question whether groups can have emergent cognitive properties in their own right. To address that question, we flesh out three different features that *emergence* can plausibly be taken to signify in the context of group cognition: *dependence on the social organization* and interactions among individuals; the *manifestation of unintended cognitive effects* at a group level; and the *multiple realizability* of cognitive properties by different types of group structures.

2.1. A 'Big Tent' Approach to Cognition

A promising strategy for making sense of the idea of group cognition is one that has been quite successfully employed in cognitive science, where

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the concept of cognition is treated as a theoretical term that is largely defined by its role in our explanatory practices. In cognitive science and related fields, the relevant meaning of *cognition* is partly inspired by but nevertheless to be distinguished from what we would ordinarily consider as instances of mental states or activities.[3] In this section, we likewise propose to employ a flexible notion of cognition that we can plausibly consider as common ground in the present debate over group cognition. Bearing in mind the conditional nature of our enterprise that we have outlined earlier, there are several desiderata for a suitably ecumenical, 'big tent' approach to cognition.

First, we need a notion of cognition that is not bio-centric (i.e., a notion which is not essentially tied to the physical substrate of cognitive processes occurring inside the sheath of biological organisms). In philosophy, the putative substrate-neutrality of mental properties is commonly associated with functionalist theories of mind (Block 1980, 1996; Fodor, 1968; Lewis, 1972; Lycan, 1987). Broadly speaking, functionalist theories of mind claim that what makes something a mental state of a particular type does not depend on its intrinsic material constitution, but rather on the way it functions in the system to which it belongs.

A second desideratum is to analyze the notion of cognition as a cluster concept which subsumes a more or less loosely knit family of capacities that we can distinguish for taxonomic purposes (for similar approaches, see Chadderdon, 2008; Dennett, 1996; Poirier & Chicoisne, 2006). The possession of each capacity enables its bearer to engage in a distinctive range of behaviors that we associate with signs of intelligence. This divide-and-conquer strategy is necessary to keep all parties of the debate from drawing cheap but unreliable inferences about the occurrence of group cognition. For instance, when we consider the rationality of ant colonies as unitary decision makers in their own right (Edwards & Pratt, 2009), we do not wish to imply that they possess a collective form of consciousness. Consequently, the absence of consciousness from the catalogue of group-level cognitive properties does not by itself refute the broader idea of group cognition. In defense of this approach, we should emphasize that our goal here is not to provide a reductive analysis of cognition but to provide a set of diagnostic criteria that allow us to classify and compare various systems in terms of their cognitive prowess. The criteria that we shall propose are not meant to be mutually exclusive or jointly exhaustive. To exemplify the 'big tent' approach we have in mind, consider the following list of capacities that have all been discussed in the literature as characteristic features of cognition. We shall say that system S is *cognitive* to the extent that

1. **AD** (*adaptability*): S can adapt its behavior to changing environments.
2. **IP** (*information-processing*): S can process information from its environment.

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3. **H** (*heed*): S can selectively and purposefully attend to its environment.
4. **IT** (*intentionality*): S can create internal representations of its environment.
5. **E** (*extension*): S can modify its environment through the creation of artifacts.
6. **R** (*self-reflexivity*): S can become aware of itself as a cognitive agent.
7. **C** (*consciousness*): S can have conscious experiences of itself and the world.

Moving from the possession of one or more of these capacities to the subject of cognitive properties, the associated notion of a "group mind" should thus not be considered as an all-or-nothing phenomenon, but one that admits of degrees. Cognitive systems which exhibit more of the relevant cognitive capacities are ranked higher in terms of their "mindfulness". It is a desirable consequence of our list that individual human beings are very "mindful" creatures, although we do not assume that the cognitive profile of human beings always provides the gold standard of what it means to be *cognitive*. In this paper, we are only concerned with the first five conditions. But for the sake of completeness, let us say a few words about the remaining two conditions on our list.

Condition R is borrowed from recent philosophical discussions of epistemic agency (Burge, 2000). It refers to the essentially indexical capacity of deliberate epistemic agents to think of themselves in first-person terms. In his discussion of group minds, Pettit (2003) has argued that certain groups can not only be intentional systems in their own right, but would also qualify as institutional persons. As opposed to the former, Pettit takes it as a mark of persons that they can be held responsible for failures to unify their intentional states and actions in a way that complies with rational norms. For persons to assume this kind of responsibility, they must actively avow and acknowledge their intentional mental states and actions as their own. Burge (2000) has suggested that the characteristic immediacy by which one is moved to think and act in accordance with one's own reasons (but not anybody else's) is based on understanding the first-person concept. Against epistemic agent individualism, Tollefsen (2004) has argued quite convincingly that groups can be subject to the same rational assessment when they self-consciously act from a first-person plural point of view. If Pettit and Tollefsen are right, their examples show how certain collectivities can satisfy condition R.

Finally, let us explain how consciousness fits into this picture. Clearly, the pre-theoretical notion of consciousness is ambiguous and admits of different interpretations (Chalmers, 1996; Tye, 1995). For instance, it is sometimes used to denote phenomena which are already captured under conditions IT, H, or R. Condition C is meant instead to cover the phenomenal aspects of consciousness. Consider the distinction between what

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Block (1995) has called *A-consciousness* and *P-consciousness*. Phenomenal (P-) consciousness describes the character of experience; the phenomenally conscious aspect of a state is what it is like to be in that state. The mark of access (A-) consciousness, by contrast, is being directly available for global executive control, such as being poised for use in reasoning and rationally guiding speech and action. As we understand condition C, it truly applies only to cognitive systems which have the capacity to entertain P-conscious mental states. Our implicit assumption here is that A-consciousness can be reduced to a composite of other conditions—especially IP, IT, H, R, and perhaps E—in which case it would be redundant to assign it a level of its own. We currently see no compelling evidence that there are any groups which satisfy condition C. Views of human mentality that reject physicalism may suppose that this acknowledgment is no small concession, but one that gives the whole game away: it is open to the dualist to suppose that true mentality is constitutively tied to the capacity for conscious awareness. But this sort of view, it seems to us, would be very implausible for a physicalist, for whom conscious mental states are just one special variety of physically realized state playing certain causal roles in a person's mental economy. We will, in any case, return to the issue of consciousness and the status of group minds at the end of the chapter.

2.2. What's Emergent About Group Cognition?

2.2.1. Emergence$_1$ as organization-dependence

The intuition that a distinction must be made between genuine *systems* (e.g., a biological organism) and mere *aggregates* (e.g., a heap of stone) is epitomized in the popular slogan that systems are emergent wholes which are "more than the sum of their parts". Taking this slogan in a very uncompromising sense forces a choice between "holism" and "atomism", with the holist supposing unity-conferring emergent properties beyond the reach of mechanistic explanation. Thus explicated, holism is committed to emergent properties in the strong metaphysical sense that is abjured here. How instead should a physicalist who takes seriously the reality and importance of the system/aggregate distinction seek to elucidate it?

In a series of papers, Bill Wimsatt (1974, 1986, 1994, 1997; collected in Wimsatt, 2007) proposes that the emergence$_1$ of complex system properties is defined as a failure of "aggregativity", considered as a strong form of organization-dependence. (See especially Wimsatt, 1986.) Let s_1 to s_m stand for the m components of a system S (relative to some decomposition D); p_1 to p_n for the n properties of S's components; and F for the organization or mode of interaction between $p_i(s_j)$, such that a system property P(S) is determined by the composition function: P(S) = F[$p_i(s_j)$ for i = 1 to n, and j = 1 to m]. For P(S) to be purely aggregative, it must satisfy the following conditions 1–4 (for a given decomposition D of S); otherwise, it exhibits degrees of emergence$_1$.

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1. **IS**: P(S) is invariant under the inter-substitution of parts of S, or any other parts taken from a relevantly similar domain.
2. **QS**: P(S) remains qualitatively similar (differing only in value) under the addition or subtraction of parts.
3. **DR**: P(S) is invariant under the decomposition and re-aggregation of parts.
4. **CI**: There are no cooperative or inhibitory interactions among parts.

Consequently, we can say that a group S instantiates a cognitive property P(S) just in case P(S) is emergent$_1$ relative to a decomposition of S into its members, their behavioral and psychological properties, and their modes of social interaction.[4] Let us briefly elaborate on some features of this analysis.

First, since Wimsatt's definition of emergence$_1$ presupposes the existence of a composition function, emergent$_1$ properties of a system can in principle be mechanistically explained in terms of the system's components, their properties, and the totality of their interactions. We note that Wimsatt refers to the suggested type of componential analysis as a form of "reductive" (1997: S373) explanation, because he considers the composition function as an "equation" which yields "an inter-level synthetic identity, with the lower level specification a realization or instantiation of the system property" (1997: S376).[5] (Whether the term 'reductive' is an apt one in this context will be hotly disputed, but we need not consider it here.) Second, complex systems with emergent$_1$ properties fail to be "near-decomposable" in the sense of Simon (1969). Since the properties of such systems are largely dependent upon the interactions between parts that do not perform any tasks which can recognizably be associated with a functional decomposition of the whole, the classic twin strategies of decomposition and localization fall short (Bechtel & Richardson, 1993). This means that their behavior cannot be properly understood by first dividing up the entire system into a number of independently working component units, characterizing the contributions of these units as if they were isolated from each other, and then adding up their contributions by associating them with specific aspects of what the system does as a whole. Wimsatt has argued that expressions of *nothing-but-tery*, such as 'the mind is nothing but neural activity' or 'social behavior is nothing but the actions of individuals', are a result of such functional localization fallacies (1997: S382–S383). They reflect our disposition to use the assumption of near-decomposability as a powerful kind of meta-heuristic when we seek out mechanistic explanations, because aggregative decompositions afford regularities which are less context-dependent, and support simpler theories and models. However, this does not put emergent$_1$ properties beyond the wider scope of more sophisticated (and surely empirically more adequate) mechanistic models that are better equipped to deal with interactional complexity (Bechtel, 2006; Bechtel & Abrahamsen, 2002).

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2.2.2. Emergence$_2$ as the absence of intentional design

A recurring thread in the fabric of social life is that the behavior of individuals is often not a good predictor of its collective consequences. Public benefits can flow from selfish intentions. Adam Smith's (1776) conception of the "invisible hand" famously refers to the idea that a community of traders, acting purely from self-interest, is driven by the competitive forces of the marketplace to furnish goods for all, at an affordable price. Conversely, public vices can spring from private virtues. The "tragedy of the commons" (Hardin, 1968) illustrates a scenario in which a community of independently acting rational individuals suffers detrimental long-term consequences that are not in anybody's self-interest. Collective actions that generate effects other than what individuals intended or expected stir our natural curiosity, because they violate untutored intuitions about how local behavioral rules scale to the global properties of inter-connected wholes (Resnick, 1994). We shall say that emergent$_2$ cognitive properties arise from the local interactions between many individuals, but without being planned or purposefully designed by any of these individuals (or some central planning agency), and which those individuals may even fail to notice.[6] Let us briefly characterize a few of the roles which the notion of emergence$_2$ has played in the social sciences.

As our two examples indicate, some of the historically most influential statements of emergence$_2$ come from economics, where it has been used to advocate a reductionist doctrine known as *methodological individualism* (Popper, 1957; Watkins, 1957). This might come as a surprise at first, since methodological individualists contend that all social phenomena can and should be explained in terms of the actions of individuals and how they are interrelated. However, in order to carve out a niche for economics as an autonomous discipline vis-à-vis psychology, individualist economists pointed to the occurrence of undirected collective effects that can spring from the actions of the many. For instance, Hayek wrote that "the conscious action of many men produce undesigned results [. . .] regularities which are not the result of anybody's design. If social phenomena showed no order except in so far as they were consciously designed, there would indeed be no room for theoretical sciences of society and there would be, as is often argued, only problems of psychology" (1942: 288, cited after Sawyer 2005: 43). Far from showing an essential incompleteness of individual-level explanations, Hayek thus took the absence of intentional design as an impetus to discover the laws by which emergent$_2$ social phenomena arise (e.g., Hayek's (1944) "compositive method").

A different intellectual tradition pre-occupied with emergent$_2$ social phenomena is known as (the sociology of) *collective behavior* (Blumer, 1939; Lang & Lang, 1961; Park & Burgess, 1921). In this tradition, the term 'collective behavior' refers to a class of social phenomena that are not shaped by pre-established social structures (e.g., laws, institutions, conventions),

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but arise "spontaneously" from people behaving en masse, guided only by simple and purely local concerns. Paradigmatic examples of collective behavior (in this sense) are mob actions, riots, rumors, mass delusions, and fads, although Park also advanced the stronger claim that "institutions and social structures of every sort may be regarded as products of collective action" (1927: 733).

Third, the remarkable coherence and synchronization of collective animal behavior such as swarming ants, flocking birds, and schooling fish has long stirred the imaginations of scientists and philosophers. "They must think collectively, all at the same, or at least in streaks or patches—a square yard or so of an idea, a flash out of so many brains", wrote the field naturalist Edmund Selous (1931) upon observing the splendor of tens of thousands of starlings coming to roost (cited after Couzin, 2007: 715). In similar vein, the entomologist William Morton Wheeler (1920, reprinted in Wheeler 1939) coined the term 'super-organism' to denote the high degree of co-dependence and functional integration among eusocial insects (e.g., ants, bees). Arguably, what makes the attribution of $emergent_2$ psychological capacities—including perception, planning, and decision making—to "super-organismic" groups so intuitively compelling is the stark discontinuity between the complex collective behavior that we observe and the rudimentary cognitive resources of individual members.

Finally, the concept of $emergence_2$ has also fueled the new wave of "mechanists" in contemporary social science who reject the traditional deductive-nomological covering law model of explanation (e.g., Hempel, 1965) in favor of generative, process-oriented approaches (Alexander & Giesen, 1987; Macy & Willer, 2002; Sawyer, 2004). Unlike some traditional versions of individualism, the new mechanists do not deny the reality of higher-level social structures, but re-emphasize the need to provide "bottom-up" explanations of the link between micro-social interactions and macro-social patterns. Since the 1990s, a powerful computational methodology by which researchers have studied the mechanisms of social $emergence_2$ is known as *agent-based modeling* (Epstein & Axtell, 1996; Goldstone & Janssen, 2005; Miller & Page, 2007). The concepts and theoretical tools on which agent-based models are based stem largely from complexity theory (Bak, 1996; Ball, 1998; Holland, 1975, 1995; Kauffman, 1993). A fundamental insight of complexity theory has been that a set of relatively simple rules governing the behavior of decentralized components can give rise to qualitatively novel, global patterns of organization, without being regulated by an outside source or managed by a centralized controller. $Emergent_2$ ordering processes such as phase transitions, non-equilibrium bifurcations, and power-law distributions are generic phenomena that occur in the same way over a wide range of superficially diverse systems. Agent-based models demonstrate how the inexorable dynamics of collective phenomena such as traffic jams, crowd movements, market fluctuations, the growth of firms and cities, the formation of alliances, and the evolution

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of cooperation can emerge$_2$ from a few underlying regularities as long as they are followed by a great many people (Ball, 2004).

2.2.3. Emergence$_3$ as multiple realizability

In metaphysics and philosophy of science, there has been considerable debate over the question of whether physical realization is an ontological dependence relation which supports ontological reductions (Fodor, 1974, 1997; Horgan, 1993; Kim, 1989, 1992, 1998; Lewis, 1972; O'Connor & Churchill, forthcoming; Shoemaker, 2007; Van Gulick, 2001). A cluster of influential arguments against the reduction of higher-level properties to their lower-level realizers is based on the premise—commonly referred to as *multiple realizability*—that functional system properties can in principle be instantiated by indefinitely many distinct physical structures (Block, 1997; Fodor, 1974, 1997; Gillet, 2003; Shapiro, 2000; Sober, 1999).[7] Arguments for the multiply realizable nature of mental states are commonly associated with functionalist theories of mind (Block, 1996). Broadly speaking, functionalists claim that what makes something a mental state of a particular type does not essentially depend on its intrinsic material constitution, but rather on the way it functions in the system to which it belongs. Functionalism is thus consistent with the idea that individuals and groups can be sufficiently alike in their functional organization that they share the same mental states, even though the mechanisms by which these mental states are realized are obviously quite different in each case.

The implication that groups could think if they are properly organized has often been used by critics to chastise functionalism for its unabashed "liberalism" (Block, 1978; Searle, 1980, 1992). However, what some see as a fundamental "bug" of functionalism that needs to be fixed, others embrace as a theoretical virtue that we ought to preserve. Our ecumenical 'big tent' approach to cognition departs from traditional versions of functionalism in at least two crucial respects. First, since we do not claim that phenomenally conscious mental states fall within the purview of functionalism, the most pressing philosophical objections against functionalism do not carry much weight against the understanding of group cognition that is presented here. Second, functional characterizations of group cognition that derive from a conceptual analysis of folk-psychological concepts often remain on a very coarse-grained level, and thus appear to be explanatorily "shallow". However, this deficit simply reflects the fact that they are conceived out of the armchair, without paying any attention to empirical facts about the abilities of groups to solve cognitive tasks. Let us briefly revisit three fields of group research in which the functional equivalence between individual and group cognition has served as an organizing framework.

First, in the social psychology of small group performance, there has been a growing trend to consider groups as the seats of cognition (e.g., problem solving, judgment, inference, and decision making) and knowledge in their

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own right.[8] Their functional approach to understanding group problem-solving is predicated on a view of groups as information processors. For instance, Larson and Christensen (1993: 6) emphasize that they use the term "social cognition" "at the group level of analysis to refer to the social processes (e.g. introducing information into a group discussion) that relate to the acquisition, storage, transmission, manipulation and use of information for the purpose of creating a group-level intellective product. [. . .] At the group level of analysis, cognition *is* a social phenomenon". In their focused review of research on small-group performance, Hinsz et al. (1997) employ a generic information-processing model as an organizing framework that is directly borrowed from cognitive psychology. In this model, a group obtains *information* through interaction with its environment. The context in which certain information is acquired, during the *attention* phase, influences the choice of *processing objectives*. The *encoding* process involves the selective transformation of information into representations, which can be *stored* in and *retrieved* from memory components. In the *processing work space*, information integration and schematic processing occur on the basis of a variety of rules, strategies, heuristics, and procedures. After enough information has been processed to meet the relevant objective, the cognitive agent makes a *response* which changes the situation and may lead to *feedback* that informs the agent about these changes. All of these processes are potentially subject to modification through *learning* (Hinsz et al., 1997: 43).[9]

Second, another research framework in which the realm of cognition is extended from an individual to a collective unit of analysis is the theory of *distributed cognition* (Hollan et al., 2000; Hutchins, 1995a, 1995b; Norman, 1991). It can be characterized by two main theoretical commitments (Hollan et al., 2000: 3). First, the boundaries of cognitive systems are delimited by the functional relationships among its constitutive elements, rather than the intuitive biological boundaries of the individual. Second, there are no intrinsic constraints on the range of mechanisms that may be assumed to participate in cognitive processes. For instance, Hutchins (1995a) provided a detailed study of ship navigation crews as socially and technologically distributed cognitive systems. By extending David Marr's (1982) tripartite computational analysis of cognition from the individual to the collective unit of analysis, Hutchins was able to gain novel insights into the ways in which individuals, artifacts, representational media, and the environment are coordinated in the context of navigation tasks.[10] An important function of social organization—together with the structure added by the concrete context of activity—is to determine the flow of information within the crew. Summarizing his analysis, Hutchins concludes that "organized groups may have cognitive properties that differ from those of the individuals who constitute the group. These differences arise from both the effects of interactions with technology and the effects of a social distribution of cognitive labor. The system formed by the navigation team

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can be thought of as a computational machine in which social organization is computational architecture" (1995a: 228).

Third, in the field of animal cognition, it has been shown that collective decision making of grouping animals has some important features in common with neural mechanisms of decision making in the brain (Couzin, 2009). This is particularly striking in the case of ant colonies, which function as unitary decision makers in the context of foraging for resources, choosing a place to live, or constructing a nest. Passino, Seeley, and Visscher (2008) highlight a number of interesting functional parallels between the synchronized patterns of rhythmic activity displayed by ant swarms and neural networks. Ants exhibit a "neuron-like" behavior insofar as inactive ants have a low propensity to become spontaneously active, but can become excited by other ants with whom they come into contact. Similar to the beyond-threshold depolarization of a neuron, ants seem to temporally integrate the inputs they receive, and start moving if their activation exceeds a certain level. Conversely, ants are prone to lapse back into inactivity if their activation is not sufficiently reinforced, and even exhibit a short refractory period (similar to neurons) before they can be reactivated—a mechanism which keeps the swarm from getting permanently "locked" into an excitatory state. Another functional parallel concerns the role of rhythmic oscillation for input selection. It has been shown that rhythmic neuronal network activity is an energy-efficient way to elevate the brain into discrete windows of high responsiveness to external stimuli. Similarly, the periodical synchronization of ant activity might provide privileged windows of opportunity for the swarm to respond to external foraging opportunities, or efficiently allocate workers for maintenance tasks within the nest.

3. RATING GROUP COGNITION

By now, it should be clear that the multi-faceted notion of *emergent group cognition* that we propose is neither trivial nor shrouded in metaphysical mystery. To sharpen the focus of our analysis, we now look at three well-documented cases of group-level activity through the lens of our theoretical framework, and rate each of them in terms of their respective degrees of cognition and emergence$_{1-3}$. We have chosen these toy examples not because we believe that they are equally spectacular instances of its kind, but because they enable us to test the discriminatory capacity of our diagnostic tools—especially where the suggested criteria pull us in different directions.

3.1. Distributed Problem Solving in Groups

In order to investigate the impact of social network structure on the distributed problem-solving abilities of groups, Kearns, Suri, and Montfort (2006) studied groups who were attempting to solve the graph-coloring

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problem. A familiar instance of this problem arises if one has to find a way to color a map of the United States with the smallest possible number of colors such that no two adjacent states may share the same color. They chose the problem as an abstract model of social settings in which it is desirable to distinguish one's behavior from that of one's neighbors. Examples of these settings include the scheduling of events in a limited number of rooms, selecting a ringtone that differs from one's friends, or the differentiation of expertise within a social organization. In the experiment, subjects had to collectively solve a number of coloring problems as part of a network that had one of six possible topologies. Each of the chosen network topologies, which corresponded to recently proposed models of network formation, belonged to one of two families. Members of the cycle-based family, all of which required a minimum of two colors, included a simple cycle, two "small-world" networks (Watts & Strogatz, 1998), and a more centralized leader cycle containing two privileged nodes. The other two topologies were generated according to the "preferential attachment" model (Barabási & Albert, 1999), with two (minimum of three colors) or three (minimum of four colors) links initially added to each node. The subjects were connected through a computer platform which provided them with either local or global information about the structure and current coloring state of their network, but without receiving any strategic hints of how to play.

The ability of groups to solve the coloring problem was strongly affected by the topology of their network. Within the cycle-based family, for which coloring was generally easier, a smaller average shortest-path length led to reduced solution times. This means that while the addition of links complicates the coordination problem faced by individuals (because they must take into account a larger number of neighbors), it evidently has the opposite effect for the group as a whole by reducing the number of links coloring conflicts must travel through the network in order to be resolved. Similarly, the effects of varying the locality of information provided to the subjects again depended on network structure. Whenever individuals seem to have a strong intuitive grasp of the collective effort that is required to converge on one of the optimal solutions, a high-information view was beneficial. However, in more complex situations where this is not the case (e.g., for preferential attachment networks), giving individuals more information about the collective state of their network significantly hampered their performance as a group. As a possible explanation, Kearns et al. (2006: 826–827) point out that the time and effort subjects spend on attending to, and perhaps even trying to influence (e.g., by signaling behavior) more distant network activity may effectively distract them from doing their own local subtask.

Let us briefly evaluate the example as a putative instance of emergent group cognition. To begin with, we take it as uncontroversial that graph coloring (and all formally equivalent instances of the same problem) is a computationally hard task that requires a substantial amount of intelligence if it is performed by a human being or a machine (Jensen & Toft,

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1995). Based on parity considerations, we further claim that one ought to ascribe the corresponding level of intelligence to a group if its members are collectively responsible for solving the same optimization problem. At the cognitive minimum, our diagnostic criteria suggest that groups which can solve the coloring problem are *adaptive information-processing* units in their own right (see also Gureckis & Goldstone, 2006). This achievement ranks relatively high in terms of $emergence_1$. The coloring pattern means that condition IS is restricted to subsets of individuals with the same color. Furthermore, the selective influence of different network topologies implies a violation of condition DR, and condition CI fails because every individual's choices are constrained by the choices of her neighbors. The resulting pattern of differentiation is an $emergent_2$ effect of repeated cycles of social interactions. In particular, we have seen two unexpected ways in which the regularities governing individual- and group-level behaviors pull into opposite directions. Finally, in virtue of the formal equivalence between social coordination tasks that conform to the coloring problem, any generalizations about the problem-solving abilities of groups that are couched purely in relational terms of their network structure are multiply realizable and thus count as $emergent_3$.

3.2. Transactive Memory Systems in Groups

When people regularly have to remember things together as a group—as intimate couples, families, or work teams do—they tend to develop a division of cognitive labor, assuming that each member can reliably access the desired information from others on a need-to-know basis. To study the functional organization of memory as a group-level phenomenon, Daniel Wegner (Wegner, 1986, 1995; Wegner et al., 1985) introduced the notion of a *transactive memory system* (TMS). A TMS generally consists of two components: a *representational* component which is the sum total of individual memories, including transactive meta-memories about who knows what, and a *procedural* component which includes all direct and indirect communication processes ("transactions") by which members cooperatively allocate, encode, retrieve, elaborate, and share information. For instance, allocating memory items and encoding responsibilities, the semantic elaboration of memories in group discussion, and interactive cueing are physically constitutive vehicles of transactive memory procedures which partly occur outside people's heads. Wegner claimed that a TMS is "a knowledge-acquiring, knowledge-holding, and knowledge-using system that is greater than the sum of its individual member systems" (1986: 256).

If Wegner is right, how can we track a group-level cognitive construct such as TMS, other than measuring group performance (e.g., collective recall)? To answer this question, consider a study by Liang, Moreland, and Argote (1995), conducted within the assembly-task paradigm.[11] The goal of their study was to show how the experience of working together as a

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group can induce a TMS that improves group performance. As predicted, they found that groups whose members were trained together to assemble radios recalled more steps of the procedure and produced radios with fewer errors than when trained alone. But to infer that TMS acted as a mediator of group behavior, they had to open the "black box" of group cognition (Figure 5.1).

In their analysis, TMS is treated as a (second-order) latent variable hypothesized to underlie three (first-order) cognitive manifestations that were found to be positively correlated with each other and group performance: *memory differentiation* (M1), the tendency of group members to specialize in recalling distinct aspects of the assembly process; *task credibility* (M2), how much members trusted one another's expertise (associated with behavioral measures such as less need to claim expertise, better acceptance of procedural suggestions, less criticism); and *task coordination* (M3), the ability of group members to work together more smoothly (measured, e.g., by less need for explicit planning, fewer misunderstandings, greater cooperation). The combined scores on each first-order factor were used to create a TMS-index. For three other social, but non-cognitive variables (*task motivation*, *group cohesion*, and *social identity*), no correlation with group performance was found except for social identity. Finally, a multiple regression analysis confirmed that TMS, but not social identity, mediated the influence of group training on work performance.

So far, we have looked at TMS as collective repositories of task-specific knowledge that make groups better at doing the kinds of things which they were initially trained to do. What evidence do we have that TMS are not just collective memory systems, but also collective *learning* systems? Lewis, Lange, and Gillis (2005) studied the effect of TMS on group learning, learning transfer, and adaptation to changing task demands. Underlying their "learning-by-doing" framework is the assumption that every task performance that is mediated by a group's previously induced TMS at the same time provides a learning environment which changes formerly established TMS structures and processes, and thereby enables the group to acquire new problem-solving skills.

Whenever a group utilizes its existing TMS to carry out the task for which it was originally trained (e.g., assembling a radio), it undergoes a re-organization as a result of practice which prepares the group to transfer its knowledge to similar tasks in the same domain. First, group members get a chance to revise and recalibrate their beliefs about who knows what, based on immediate feedback for their performance as individuals and as a group. Second, group members have an opportunity to elaborate and contextualize their transactive memories, based on how their own task-related knowledge relates to other members' jobs, roles, and expertise. Shared conceptualizations of *interrole knowledge* have been shown to enhance group coordination and performance (Marks et al., 2002). Third, greater

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experience also creates more specific expectations about how transactive memory procedures are likely to unfold, which leads to a regularization of habitual practices.

Moreover, groups with a history of applying their TMS to a variety of related tasks should also be primed to develop a deeper understanding of the task domain. First, the interactive cueing processes which are characteristic of efficient TMSs prompt group members to draw explicit comparisons across tasks, which heightens their ability to recognize structural commonalities. The *analogical encoding* of two different but structurally similar problems promotes the occurrence of knowledge transfer and abstract understanding (Gentner, Loewenstein, & Thompson, 2003). Second, the growing refinement of shared higher-order knowledge supports a process of *collective induction* (Laughlin, 1999) by which groups can collectively infer general principles underlying the task domain.

In sum, the "learning-by-doing" framework implies that groups with active TMS should outperform those with no prior TMS on similar follow-up tasks, and are more likely to demonstrate abstract knowledge about the task domain. Consistent with earlier research on TMS in intimate couples (Hollingshead, 1998; Wegner, Erber, & Raymond, 1991), it also entails that groups which experience a disruption of a prior TMS (e.g., as a result of membership change) perform *worse* on subsequent learning tasks than those which have never developed a TMS. Even though Lewis et al. (2005) did not find in their experiment a significant effect of TMS on learning transfer when it was previously utilized in a single task only, their findings generally confirmed the suggested predictions.[12]

A group whose members collectively enact a TMS manifests several of the cognitive capacities we have mentioned. First, the ability of groups with a TMS to learn new tasks provides strong evidence that TMS can adapt to changing environments. Second, it is easy to see how we can apply a generic information-processing model as the one discussed earlier (Section 2.2.3) to describe the functional organization of memory as a group-level

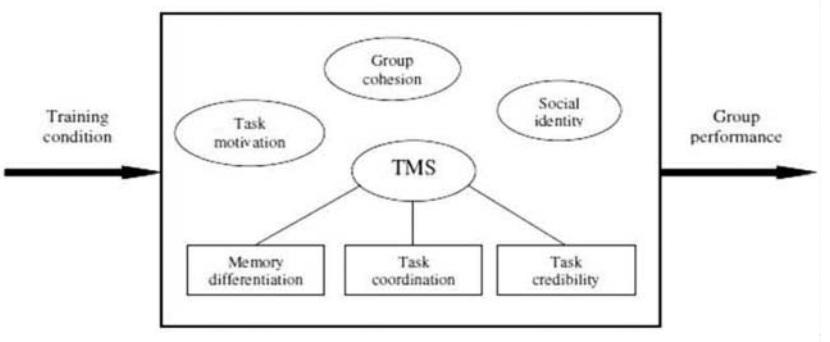

Figure 5.1 Opening the "black box" of Group Cognition.

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phenomenon. The task-specific TMS that we have described is most plausibly construed as an instance of procedural memory, because it concerns an implicit knowledge of how to assemble a radio as a group. However, after the occurrence of TMS learning, it also encompasses a body of declarative knowledge about principles of the underlying domain. Third, the allocation of members' time and effort to acquire and retain specific knowledge about the assembly process reveals how much attention the group is paying to different categories of information.

Do TMS exhibit a collective form of intentionality? Understanding attributions of collective intentionality in the context of explaining collective actions has been a topic of considerable controversy in analytic philosophy of action.[13] Individualists hold that collective intentionality can be analyzed in terms of an interlocking complex of appropriately shared individual intentions together with a mutual awareness of each other's intentions (e.g., Bratman, 1993, 1997); anti-individualists deny this claim. There are two main camps among anti-individualists who differ in what they take to be the subject of collective intentionality. According to the "singularist" option, collective intentional states form a special class of intentional states that are directed toward the performance of a group action, but possessed by the individuals who intend to act their part in the pursuit of this goal (e.g., Searle 1990, 1995). The other, "pluralist" option is to hold that collective intentional states are literally properties of collective agents (e.g., Gilbert, 1989; Schmitt, 2003a; Tollefsen, 2004).

While we agree with the pluralist claim that groups can be genuine subjects of collective intentionality (if our guiding assumption is correct), our reasoning is importantly different from standard accounts of anti-individualism. Standard arguments for anti-individualism essentially hinge on the propositional *content* of mental states that are directed toward doing something together as a group. In contrast, our claim is concerned not with the intentional content, but the physically constitutive *vehicles* of intentional mental states (Hurley, 1998). What underpins the collective intentionality of TMS-states is not (just) that they are directed toward group actions, but that the memory resources which are jointly sufficient to realize any of these states are distributed across the members of the group. The relevant sense of *distribution* here, we shall now argue, is that of emergence$_1$, or organization-dependence.

As a group-level psychological property, consider a three-man team with an established TMS for assembling a radio, a mixed body of partly declarative, partly procedural memory about a complex task that no team member knows how to perform individually. For instance, imagine that member A knows how to insert all the mechanical components into the circuit board, B knows how to handle the electronic components, and C knows how to connect each component to all the others in the proper manner. Because of their differentiated expertise, condition IS fails. It might be argued that each expert could in principle be replaced by hiring and training an individual

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taken from "a domain of relevantly similar parts". However, as Wimsatt (1986: 262) has pointed out in a related context, the relevant equivalence class of parts must be characterized in terms of the intrinsic properties which the substituted parts have regardless of their organizational arrangement. By definition, this excludes the differentiation of expertise which is imposed socially by a division of labor. Condition QS fails, because taking out enough members who possess critical but unshared knowledge would effectively lesion the TMS and drastically reduce group performance. Since the TMS of groups which have been trained together markedly differs from the TMS of groups whose members are trained individually (and then put together), condition DR is violated. Finally, conditions CI fails, since members' awareness of how expertise is distributed affects their individual likelihood of acquiring, recalling, and communicating memory items pertaining to specific categories of information.

The collective cognitive activities of teams with a TMS are not emergent$_2$ to the same degree as emergent$_1$. To see that, let us recall that the collections of simple agents in physics-based models of collective behavior merely perform pre-specified jobs from their limited local perspective, but without being aware of any collective goals and purposes. Our team members, on the other hand, actively collaborate in the sense that their behavior is actively structured by their awareness that there is a collective task to be accomplished. This awareness introduces an extra layer of higher-order cognitive requirements on the part of individuals which is not directly related to the instrumental knowledge about their subtask, but concerns the need to coordinate their individual contributions with each other. For instance, individual team members must remember each other's expertise and trustworthiness to offer suggestions and criticisms of each others' work, and represent complex hierarchical plans so they can communicate about how to integrate their individual contributions into the collective work flow. In short, agents must be capable of observing and representing complex global aspects of social structure—a cognitive process which Castelfranchi (1998) has aptly termed *immergence*. Relative to the rich immergent knowledge held by individual members, the properties of a TMS are not very emergent$_2$.

What now remains to be shown is that this realization relation satisfies the criteria for emergence$_3$. Fodor (1974, 1989, 1997) has argued that functional higher-level properties cannot be reduced to the disjunction of their actual and possible lower-level realizers, because the two are not nomologically coextensive. The gist of his argument is that a metaphysically "gerrymandered" disjunction of natural kinds is not itself a natural kind, and thus cannot equally figure in the expression of genuine causal laws.[14] Fodor's argument, if sound, generalizes to the expression of lawful regularities about groups that are couched in terms of their development of a TMS. First, there do not seem to be any constraints specifiable within individual psychology that would make any particular memory states nomologically

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necessary for the realization of a TMS at a group level. What makes a person's transactive memories constitutive for the operation of a TMS is determined relationally by the social role she has been assigned to play in the group context of a memory task. But for any given task, a group can always in principle adopt one of indefinitely many divisions of cognitive labor that are sufficient to get the job done (even though not all of them will be equally effective in practice). Transactive memories are thus good candidates for *socially manifested* cognitive processes (i.e., cognitive processes of individuals that can be realized only insofar as those individuals participate in groups of a certain kind) (Barnier et al., 2008; R. Wilson, 2004: ch. 8, 2005).[15] Second, there are also no intrinsic constraints on the kinds of social interactions which can serve as the realization of transactive memory procedures. For instance, groups are known to employ to a number of different strategies to accomplish the essential tasks of transactive memory updating, information allocation, and retrieval coordination (Wegner, 1995).[16]

3.3. Collaborative Creativity in Groups

Our third and final example concerns the collaborative group processes that go into the choreography of a contemporary dance performance. By its very nature, the art of contemporary dance poses unique difficulties but also opportunities for insight into the dynamics of creativity (K. Stevens et al., 2000). First, the medium of contemporary dance is the collective movement of bodies through time and space while they continuously interact with one another. As an essentially multi-modal form of artistic behavior, dance contains visual, motor, tactile, aural, kinaesthetic, cognitive, sensual, evocative, affective, spatial, temporal, dynamic, and rhythmic elements that must all be coordinated in real time. Second, because of the ephemeral nature of movement material (compared, e.g., to visual or plastic arts), there are usually few preserved records of the processes which lead to the development of the final work. Third, an increasingly typical feature is the interactive nature of "dance making" in which choreographers and dancers collaborate, often in a highly improvisational manner, in the course of creating a dance.

Based on a careful analysis of annotated video recordings and journal entries recorded over a period of roughly six months, C. Stevens et al. (2003) have offered us a fascinating window into the complex psychological processes that underlie the inception, development, and refinement of dance material—processes to which they collectively refer to as *choreographic cognition*.[17] A significant part of their analysis is framed in terms of the *Geneplore* model of creative cognition (Finke, Ward, & Smith, 1996), which assumes that creative cognition involves two distinct phases: *generation* and *exploration*. During an initial phase, generative processes such as memory retrieval, association, synthesis, analogical transfer, and categorical reduction yield "pre-inventive"

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structures. In the second phase, the properties of these structures are then explored, combined, discarded, modified, and re-interpreted in novel ways. The resulting structures of these exploratory activities continue to be focused or expanded, depending on the desired degree of refinement, and edited until they reach their final form. A creative process typically involves multiple iterations of generation/exploration.

The most salient feature of their analysis is that the choreographic processes described by the Geneplore model of creative cognition do not exclusively reside inside the head of the individual choreographer. Instead, they are co-constituted by the interactions between the choreographer and the dance ensemble, the dancers and their bodies, and the artistic props and recording devices on which they rely (Figure 5.2). The creative dynamics of choreographic cognition reflects the transformations of these interactions over time—a process that Sawyer (2003b, 2003c) has dubbed "collaborative emergence". Manifestations of collaborative emergence receive a high score on all three dimensions of emergence that we have distinguished.

First, the classification of the mental representations and operations outlined in the Geneplore model are essentially substrate-neutral (emergent$_3$). Hence it is consistent with their functional specification that they are realized by a socially and technologically extended activity system that stretches beyond the boundaries of the individual (Barnier et al., 2008; Clark, 2003, 2008; Hutchins, 1995a; Sawyer & Greeno, 2009; Theiner, 2008; R. Wilson & Clark, 2009). For instance, the composition of new movement patterns by combining, intersecting, and merging individually developed phrases can be seen as a manifestation of *attribute finding*. The speculative experimentation of dancers with the book/spine paper sculpture—considered as a pre-inventive structure—corresponds to an instance of *functional inference*. Choreographing a dynamic DNA-like helix pattern made up of five dancers in constant motion proved to be a particularly complex task that required a great amount of *hypothesis testing* which consumed many hours of joint experimentation. A preliminary analysis of the task was carried out on paper, with the help of a color braid and its visual representation on paper. Later, a trial-and-error process was executed on the dance floor, using colored tape to mark out the different strands of movement (Stevens et al., 2003: 316–318).

Second, moving the relevant unit of choreographic analysis from the individual to the group reveals the intricate ways in which the creation of a dance performance is distributed (i.e., emergent$_1$) along three principal dimensions, each of which provides its own forms of "scaffolding" (Hollan et al., 2000; Sutton, 2006).[18] Choreographic cognition is distributed in *space*, insofar as bodily and environmental resources transform the nature of the cognitive load hoisted upon biological brains; over *time*, insofar as the outcomes of earlier stages of cognitive processing transform the task demands during the later stages; and *socially*, insofar as membership in the ensemble (as well as more temporary interactions between dyads and triads)

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transforms the cognitive tasks faced by each individual. Consider how misguided it would be to analyze the creative dynamics of the choreographic process by first trying to understand the properties of people and artifacts in isolation, and then stitching them together in a purely aggregative fashion. In the creation of *Red Rain*, the generation, exploration, selection, and refinement of dance material was achieved through all sorts of collaborative "entanglements", including the discussion of texts, images, and cues provided by the choreographer that are mapped into exploratory movement patterns and subsequently adopted, modified, verbally paraphrased and critiqued by others; the interpersonal synchronization of bodily movements; the perceptual spread of "contagious" movement patterns across dancers; the development of shared kinesthetic memories; the playful appropriation and integration of artistic props (e.g., beans, wax, a paper sculpture); or the public viewing of video recordings made of improvised dance phrases displayed at an earlier stage.

Third, since novelty is an essential mark of creativity, the inherent creativity of choreographic cognition implies a higher degree of emergence$_2$ which appeared to be lacking in our previous two examples.[19] At the beginning of the choreographic process, there is often little more than a few vague images which a choreographer might bring to the table, but no representation of a fixed plot, no sense of how these images can be combined to construct a narrative which can be transformed into bodily movement, no pre-formatted sequence of moves, and so on. Improvisation is a crucial aspect of creative processes—one that is frequently sparked by collaborative

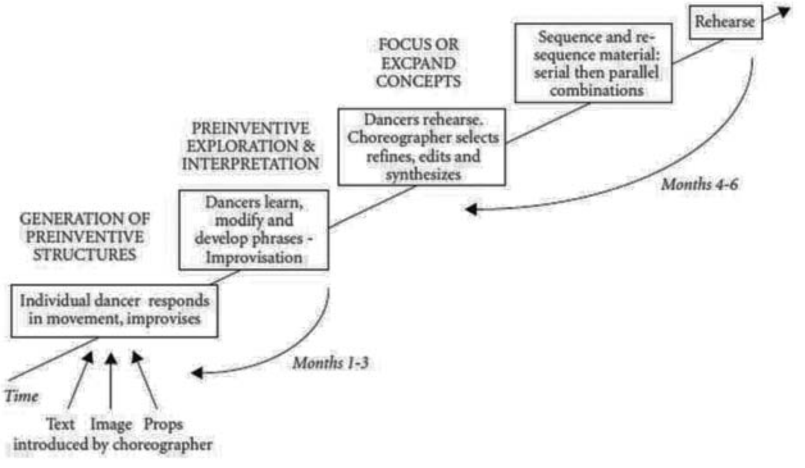

Figure 5.1 Phases of the choreographic development of dance material for *Red Rain*, classified in terms of the Geneplore model of creative cognition (shown in uppercase). A number of different phrases of movement were in development at any given time. From C. Stevens et al., (2003: 312).

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interactions. For instance, during week 5, the choreographer introduced an improvisation task to "perturb" habitual movement patterns that were embodied in the dancers' kinesthetic and muscular memories. This was achieved by *externalizing* cognitive and motor control processes that would usually run smoothly inside the sheath of the biological body into the social environment—by letting other dancers dictate which and how the parts of one's body ought to be moved. Each dancer was forced to respond to impromptu verbal cues issued by other dancers (e.g., "right elbow behind back, shoulders tilting, left hand reaching"). The elicited movement patterns were recorded on video, reviewed by the choreographer, discussed with the dancers, and later re-enacted by the dancers from video observations before some of them would eventually be incorporated into the dance (C. Stevens et al., 2003: 304–305).

A final point about the diachronic dimension of "collaborative emergence" is worth emphasizing.[20] Although we can retrospectively (at least in principle) identify each participant's contributions to the incremental process of creating a new dance, many of its effects on the emerging_2 organization are not explicitly intended or planned as such by the time these contributions are made. This is because the full cognitive significance of "dance-making" actions and intentions frequently depends on the subsequent flow of activities, and may thus not be revealed until a much later phase of choreographic cognition. For instance, some of the improvised movement patterns produced in the first couple of weeks (e.g., in response to dripping blood or the pulsing in-and-out motif) acted as recurrent "seeds" that inspired and framed choreographic processes at much later stages before they assumed their final shape (C. Stevens et al., 2003: 306–308).

4. OBJECTIONS AND REPLIES

Let us restate the ontological commitments of our analysis of group cognition. As we have emphasized from the outset, our account is contingent on the plausibility of non-reductive physicalism, in particular as it has been applied to the realm of the mental (Block, 1997; Davidson, 1970; Fodor, 1974, 1989; Horgan, 1993) and the social (Kincaid, 1997; Pettit, 1993; Sawyer, 2002, 2003a). We claim that, on that assumption, it is likewise plausible that groups can be the bearers of psychological properties which are distinct from the psychological properties had by its members. Second, we grant that group-level psychological facts are metaphysically determined ("realized") by the totality of individual-level psychological facts, together with other, non-psychological facts about their social and material organization. At a minimum, this implies that any two groups which are composed of the exact same members participating in all the same social interactions cannot differ in their psychological properties—a relatively weak variety of ontological dependence commonly known as

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global supervenience. Third, the supervenience of group cognition on its lower-level realization is consistent with its emergence in each of the senses we have outlined—its organization-dependence, its unpredictability from the standpoint of individual cognition, and its multiple realizability. In virtue of the latter, the relation between group-cognitive properties and their lower-level realization must be one of token-identity (or perhaps token-realization)[21], but not type-identity in the stronger sense that is required for inter-theoretic reduction.

With these assumptions in place, we now consider two basic metaphysical objections to the very idea of group cognition.

4.1. Is Group Cognition Epiphenomenal?

The first objection concerns the causal efficacy of emergent psychological properties that are instantiated by groups as a whole. The supervenience of group cognition on its lower-level realization arguably implies what we may call the causal completeness of the individual level.[22] By this, we mean the claim that for every aspect of an individual's behavior, there is a sufficient cause which refers only to properties of that individual and her social interactions, but does not take into account any psychological or non-psychological (e.g., behavioral) properties of the entire group to which that individual belongs. Suppose further that we rule out an individual's behavior being systematically overdetermined by both individual- and group-level causes. Then it appears that there is no real causal work for the psychological properties of groups to do, because any influence it could exercise on individuals is effectively "screened off" by its lower-level realizers. Does this show that the phenomenon of group cognition—even if it is real—is epiphenomenal?

In response, let us observe that this objection is very similar to the so-called "causal exclusion" problem in the philosophy of mind, where it has been invoked to demonstrate the causal irrelevance of mental properties vis-à-vis their physical realizers (Kim, 1989, 1992, 1998; Malcolm, 1968). An important similarity is the portrayal of the relationship between higher-level properties and their lower-level realizers as causal competitors in the production of behavior. This assumption requires that both properties figure in causal explanations of one and the same tokens of behavior. However, this is not always the case. For instance, we attribute a TMS to a group in order to explain how the group performs as a *whole* (e.g., how accurately it assembles a radio), whereas we refer to properties of individuals (including their opportunities for social interaction) to explain how they perform as *parts* of the group. If we can conceive of individual- and group-level psychological properties as links of two separate causal chains influencing the behavior of entities at different levels of composition, and if, further, these chains do not stand in a zero-sum competition, the present form of the objection does not get off the ground.

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However, we can further press the objection by reflecting on the fact that group behavior itself is a social (albeit non-psychological) property which is realized by the psychological and behavioral properties of individuals, together with their modes of social interaction. What the causal completeness of the individual level implies, then, is that there is in principle a complete causal account of this *collective* state of affairs which does not refer to the cognitive properties M_g of groups, but is couched entirely in terms of the lower-level realization of M_g. This follows from the (here presumed) fact that the causal powers associated with M_g are fully determined by the causal powers of its lower-level realization. Therefore, one might still conclude that M_g cannot make a non-redundant causal impact on group behavior (Kim, 1998, 2005; O'Connor & Churchill, Forthcoming).

A familiar theme in response to this objection has been to argue that the inter-level relationship between mental properties and their physical realization is not one of rivalry, but of compatibility (see, e.g., Block, 2003; Horgan, 1993; Jackson & Pettit, 1990; Kim, 1984; Shoemaker, 2001, 2007). There are several ways one might seek to cash out this idea.

One way is to stress that the metaphysical connection between mental properties and their physical realizers is sufficiently intimate so that the former "inherit" the causal powers of the latter, rather than being excluded by them. Insofar as mental properties exercise their causal influence *through* their physical realizers, it is claimed, the charge of overdetermination is thereby avoided. Taking this line further, one can distinguish the causal *relevance* of higher-level properties from the causal *productivity* of the physical mechanisms by means of which the former are realized.[23] Such a strategy can be extended to accommodate the causal relevance of group-cognitive properties. For instance, consider the causal impact of a TMS on group performance in terms of Jackson and Pettit's (1990) *program model* of causal relevance. According to this model, the occurrence of a higher-level property "programs for" a certain same-level effect by ensuring the presence of suitable lower-level realizers which bring about the specified outcome.[24] In the case of TMS, we can grant that the mechanism in virtue of which a TMS is causally relevant for explaining the performance of a group involves the appropriate cognitive abilities, motivations, and opportunities for social interaction at the level of individuals.

A second, related response to the exclusion worry appeals to counterfactual dependence patterns in order to ground the causal relevance of higher-level event-types (Horgan, 1993; LePore & Loewer, 1989; Loewer, 2002; McLaughlin, 1989). For instance, Horgan (1993) argues that a single event-token can be causally relevant on more than one level, in virtue of falling under multiple event-types which are not nomologically coextensive. Assuming that something like counterfactual dependency suffices for causation or causal relevance, properties at multiple levels could thus each be causal because they all support different counterfactual dependence patterns among events. Now consider the claim that if a group were to develop

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a TMS, it would be able to assemble a radio accurately. Is this true, or is the causal relevance of TMS preempted by the occurrence of its lower-level realizer? Let us apply the criteria for preemption suggested by Loewer (2002). From the causal completeness of the individual level, it follows that the radio assembly would have been equally accurate if it were somehow performed by a member-by-member duplicate of the group with the same social organization S, but without a TMS.[25] But now consider a situation in which a TMS develops, but without its actual lower-level realization. Assuming that the properties of a TMS are multiply realizable, the closest possible world in which this can happen is one in which the functions of the TMS are performed by a group with a slightly different social (and corresponding individual-psychological) configuration S*. Since it remains true that a group whose TMS is realized by S* can assemble the radio accurately, it follows that S does not preempt the causal relevance of TMS. (See Loewer, 2002, for further discussion.)

Now, it may well be the case that neither of these proposed strategies for harmonizing the causal completeness of physics with mental-physical realization is entirely neutral with respect to theories of the nature of causation. O'Connor and Churchill (forthcoming) argue that harmonization fails on a non-reductive production account of particular. If that is correct, then our guiding assumption carries with it an implicit rejection of this metaphysical theory. (Again, one who is attracted to the non-reductive physicalist account of human mentality has a choice here between modus ponens or modus tollens, a question on which we are neutral here.)

4.2. How Robust are Group Cognizers?

The second objection to the thesis of emergent group cognitive states and processes that we consider here concerns the metaphysical unity of groups. Individual biological subjects possess a robust systemic unity defined in terms of the biological persistence of the body and/or its most vital component, the brain. This unity has spatial, temporal, and functional aspects. Owing to these features, its persistence through time (on the relevant time scale) is reasonably well defined in biological terms. The objection's premise is that nothing like this is feasible for an attempted account of the persistence of groups having allegedly emergent cognitive states, and it concludes that there simply *are not* any persisting groups of the sort that could serve as the subjects of those states.

This objection raises a large issue that we cannot fully explore here. However, we can briefly make some points that go a substantial ways, we think, toward challenging the suggested starkness of the contrast between individual and group cognizers. To begin with, we want to draw attention to a similar debate that is currently raging over the "extended mind" thesis (Clark, 2003, 2008; Clark & Chalmers, 1998; R. Wilson, 2004).[26] In their original statement of this thesis, Clark and Chalmers (1998) suggested

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a number of 'coupling conditions' which the causal intercourse between a biological organism and capacity-enhancing bio-external artifacts (e.g., notebook, iPhone, or neural implants) ought to satisfy in order to constitute a unified agent's extended cognitive apparatus. Their conditions require that the external resource should be reliably available and typically deployed when confronted with the task at hand, that any relevant information contained in the resource should be easily accessible, and that any information retrieved from the external device should be more or less automatically endorsed, and treated as a trustworthy source. In response to the presently explored objection, we maintain that similar principles of system-individuation are at least equally convincing if they apply to the cognitively significant interactions among people (see also Tollefsen, 2006).

We consider two sorts of cases in which groups can be collectively coupled, to be understood as two poles in a continuum from the fleeting to the more permanent. In the first sort, 'disbanding' happens regularly, insofar as cognitive activity does not more or less continuously persist, but is instead sharply episodic. Examples would be work assembly lines, dance troupes, and philosophy departments. Individuals assembled in one of these groups function at particular times as a collective cognitive system and then go their separate ways, no longer causally coupled with one another toward a common task. Even so, this regular disbanding and re-forming does not ruin the integrity of the system over time as long as the functional organization remains invariant across such episodes, such that the collective plausibly may continue to persist even though individual members don't persist. There will of course be borderline cases of more radical change where it is quite unclear whether we are dealing with the very same group, but analogous problems beset accounts of the persistence of thinking organisms. (The strong, physicalism-denying emergentist may well claim an advantage here, since the emergence of ontologically basic properties seems to be an all or nothing affair. But we are proceeding on the premise that this view is off the table.) Granted, the existence of certain kinds of intermittent group cognizers, unlike individual cognizers, is tied down to time-on-(cognitive-) task. But it is not obvious that this difference has the metaphysical import that the objection assumes.

On the other side of the spectrum, there is a second sort of group cognizers whose persistence is continuous, because disbanding would seriously limit, if not relinquish, the ability of its parts to function in isolation. Examples of this sort are tightly integrated, long-standing social groups whose individual members (and their sub-assemblies) have come to behave as a kind of collective "super-organism" (D. S. Wilson, 2002; D. S. Wilson, van Vugt, & O'Gorman, 2008; D. S. Wilson & E. O. Wilson, 2007). In biology, the existence of such "major evolutionary transitions" (Maynard Smith & Szathmary, 1995) was originally posited to explain the formation of eukaryotic cells as highly interdependent symbiotic associations of prokaryotic (bacterial) cells. But the idea was later generalized to encompass

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to the formation of chromosomes, multi-cellular organisms, social insect colonies, and the evolution of human sociality in our ancestral environments. In each of these rare but momentous transitions, the cooperation of entities at a lower level has strongly beneficial effects for their arrangement as a whole, due in large part to the differentiation of functions. Hence a major evolutionary transition can occur if between-group selection outweighs within-group selection. This requires the existence of lower-level mechanisms that continually suppress competition among selfish individual units, and thus enable the collective to overcome the problem of "free riders" (Sober & D. S. Wilson, 1998). For human groups, especially small-scale human societies that have historically dominated the evolution of sociality in our species, this job is performed by fairly strong mechanisms of social control. These are believed to include a variety of biological and cultural co-adaptations such as religion (D. S. Wilson, 2002), social emotions like anger and guilt (Haidt, 2007), practices of shaming and gossip (Richerson & Boyd, 2005), but also the joy of synchronized movement in song and dance (Haidt, Seder, & Kesebir, 2008). In sum, $emergent_1$ social systems whose members are deeply interdependent for their physical, cognitive, as well as emotional functioning *as individuals* are also the most likely candidates to act as maximally robust *group* cognizers.

5. CONCLUSION

Can groups think? In this paper, we have probed into a wide range of contemporary frameworks that seem to be committed to giving an affirmative answer to this question. A common methodological thrust of these research programs is to overcome the strong individualist bias in psychology and cognitive science, and to give a wider berth to environmental (social, material, and cultural) factors in shaping and participating in cognitive processes (see, e.g., the papers in Robbins & Aydede, 2009). As philosophers, our primary goal has been to offer an ontological reconstruction of what it would mean for a group of people interacting with one another to have emergent cognitive properties. Based on the predominantly functional understanding of *cognition* that is proffered in the theoretical frameworks we examined, we have outlined three different features that *emergence* can plausibly be taken to signify in the context of group cognition: its dependence on the social organization and interactions among individuals; the manifestation of unintended cognitive effects at a group level; and the multiple realizability of cognitive properties by different types of group structures. From a metaphysician's bird's-eye view, all of these features are compatible with various brands of non-reductive physicalism. Hence our advocacy of the idea that groups can think is conditional twice over: first, on the explanatory scope of the research frameworks we have discussed; second, on the ontological coherence of non-reductive physicalism as a general view of the

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mental. Accordingly, our updated portrayal of emergent group cognition departs from metaphysically stronger versions of the *Group Mind Thesis* in several crucial respects.

First, during the heydays of the *Group Mind Thesis*, the idea of a "collective psychology" was often used to emphasize the essential like-mindedness of people in groups—"the mass movements of a crowd, the majority decisions of the electorate, or the sweetly homogeneous mindlessness of people in love" (Wegner, 1986: 206). While we certainly agree that the social alignment of shared concepts, attitudes, and values can be important prerequisites of group cognition, it is rather the integration of diverse but complementary contributions that directly underpins the emergent cognitive properties of groups.

Second, the dilemma that group minds are either "nothing but" collections of individual minds or doomed to inhabit preternatural realms ("telepathy") rests on an inadequate understanding of interactional complexity. Based on the suggested reading of emergence_1 as organization-dependence, there is no reason to think that *group*-level properties must always have a purely aggregative decomposition relative to which we can neglect the social interactions and communication processes by which individuals coordinate their behavior. Moreover, if group-level *cognitive* properties are multiply realizable, the non-reductive physicalist can grant that all cognitive facts about a group supervene globally on the totality of individual-level psychological facts about its members, plus other, non-psychological facts about their social organization (R. Wilson, 2004; cf. Section 1 in this chapter). This is because the global supervenience of group cognition on its total physical realization (Shoemaker, 2007) is consistent with its emergence in all of the three senses we have sketched.

Third, group cognition is here taken to occur without any dubious sort of collective consciousness. Group cognitive states and processes of the sort suggested by contemporary empirical theories do not entail that there is a conscious, self-aware subject of them. As we emphasized in the beginning, we favor the 'big tent' approach to cognition that is reflected in much of recent cognitive science. How we should think about phenomenal consciousness in particular is quite unsettled. But it seems clear that none of the group cognition–friendly theories give reason to posit collective consciousness on any of the most promising philosophical accounts of the nature and function of consciousness (whether physicalist or dualist).

Keeping this point in mind, it is worth mentioning a possible asymmetry between the "extended mind" thesis (Clark & Chalmers, 1998) and the kind of "group mind" thesis considered here. One might argue that a move to the group mind thesis involves a riskier generalization of the strategy underlying the case for extended individual cognition, precisely because the former (but not the latter) invokes the existence of a subject who is not capable of having phenomenal consciousness. This suggestion, which is due to David Chalmers (personal communication), is most convincing if

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one accepts the following two claims: first, that the presence of or potential for conscious awareness is the single most uncontroversial—if not indubitable—criterion for the existence of a mind; and second, that the conscious mental states of such a subject, contrary to its non-conscious cognitive states and processes, are not likewise extended. For instance, it may turn out that the physical basis of consciousness requires certain forms of high-bandwidth signal processing and fine temporal coordination that are (at least currently) not supported by organism/environment-interactions, nor by interactions between people (for such hybrid views, see Chalmers, 2008; Clark, Submitted).

If both these claims were accepted, the "group mind" thesis, at least where it does not involve implausible posits of group consciousness, would be a nonstarter. It is thus not surprising that Chalmers, a dualist about phenomenal consciousness, should be attracted to the consciousness criterion for genuine mentality. But it is not an equally plausible position for a physicalist to take. From a physicalist perspective, conscious states are not intrinsically distinctive (as on dualism), but are merely a particular variety of complex, physically realized mental states. On many physicalist views, consciousness is ultimately understood as some sort of representational capacity restricted to sophisticated, highly complex cognitive systems—something characteristic of particularly advanced cognitive systems, rather than a necessary condition for *any* cognition to take place. In our reconstruction, we have already granted that the repertoire of cognitive capacities displayed by groups need not—and typically does not—live up to the full-fledged mentality of individual human beings. Consistent with an incrementalist, 'big tent' approach to cognitive complexity, the physicalist should thus be quite comfortable with admitting the existence of collective cognitive systems, while remaining agnostic about group minds as indicated by the consciousness criterion.

NOTES

1. The research of the first author has been supported by an Izaak Walton Killam Post-doctoral Fellowship.
2. For historical overviews, see Wegner (1986), Wegner, Giuliano, and Hertel (1985), R. Wilson (2004: ch. 11).
3. See, e.g., Chomsky (1980) and Thagard (1996) for discussion.
4. An application of Wimsatt's conception of emergence$_1$ to the idea of group cognition (understood as socially distributed cognition) is also offered by Poirier and Chicoisne (2006).
5. As Wimsatt (1994: 8n.) points out, the relevant notion of *identity* that his conception of ontological reduction implies falls somewhere between token-identity (which he considers as too weak a requirement for reduction) and general type-identity (which he considers as too strong a requirement for reduction) between higher-level properties and their lower-level realizers. We shall get to the putative multiple realizability of higher-level types (kinds,

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properties) as a potential obstacle for ontological type-reduction in Section 2.2.3.

6. Our notion of *emergence*$_2$ is related to several other conceptions of emergence that have been discussed in the literature, in particular Chalmers's (2006) notion of "weak emergence", Clark's (2001: 114) notion of emergence as "unprogrammed functionality", as well as the spectrum of weaker vs. stronger versions of "diachronic emergence" discussed in Rueger (2000) and Stephan (2006).
7. Wimsatt (1981, 1986, 1994) has drawn attention to the fact that the multiple realizability of macro-properties is a rather natural consequence of functional redundancy in the compositional organization of complex systems, and not incompatible with mechanistic explanations of their behavior in terms of its parts and their interactions. As Wimsatt (1981) points out, redundancy is an important design feature of many complex systems, such as built-in hardware redundancy in computers, excess capacities of cells in organisms, and bilaterally symmetric redundant organs in animals. Redundancy ensures a limited form of "sub-aggregativity" between subsets of actual parts (1986). If we further consider that Wimsatt's condition IS also involves the counterfactual replacement with possible parts taken "from a relevantly similar domain", the modal implications of multiple realizability become apparent.
8. See, e.g., Cicourel (1990), Hinsz et al. (1997), Larsen and Christensen (1993), Mohammed and Dumville (2001), Propp (1999), Stasser (1999), Wegner et al. (1985).
9. As Hinsz et al. (1997: 44n.) point out, their model does not necessarily depict a blueprint of the cognitive architecture by which information is actually processed (in individuals or in groups), which is likely to be less sequential and more highly interrelated than the model suggests. But this does not diminish its analytic value for identifying various factors and mechanisms which underlie the collective performance of cognitive tasks.
10. Working on human vision, Marr proposed to split the task of explaining how a system (e.g., a cash register or a brain) processes information into three levels. On Marr's level-1, the goal is to give a functional analysis of the behavior to be performed. This requires that we pin down the precise input-output function of the task at hand and provide a procedural characterization of the subtasks which the system has to carry out. Marr's level-2 is concerned with describing how the relevant inputs and outputs are represented, and which algorithms are used to compute the required mappings. Finally, level-3 concerns the implementation of these computational processes in a physical substrate.
11. See Moreland (1999) for an overview.
12. These findings are consistent with research on learning at the individual level, which suggests that experience with only one task may not be sufficient for a subject to detect the underlying analogies between superficially dissimilar problems (Gentner et al., 2003). Further analysis by Lewis et al. revealed a significant interactive effect between group type and expertise stability. An intact prior TMS was most beneficial for learning transfer in groups whose members had been reassigned but kept their expertise specialization. On the other hand, an intact prior TMS was detrimental for groups when expertise stability across tasks was low—either because members had been reassigned or the groups abandoned their initial distribution of expertise (see also Lewis et al., 2007).
13. See Schmitt (2003b) for an overview of this debate.
14. Fodor's argument against reduction has been heavily scrutinized (Kim, 1989, 1992; Polger, 2004). We do not wish to adjudicate the current state of this

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debate here, since our reasoning is conditional upon the viability of the non-reductive physicalist's gambit. That perspective's chief motivation is precisely the one given by Fodor. As applied to the domain of the social, Ruben (1985: ch. 3) has argued that the argument from multiple realizability is ultimately more compelling for what he calls "variable" social properties (e.g., *being a mayor*) than it is for mental properties. Since the manifestation of these social properties is partly determined by social conventions, there are even fewer lawful constraints on the class of mental and/or physical properties which are sufficient for their realization. Sawyer (2002, 2003a) has leaned heavily on Fodor's argument in his defense of the causal-explanatory autonomy of social properties vis-à-vis individuals and their interactions, proposing a theory of social emergence$_3$ that he calls *non-reductive individualism*.

15. An implication of this "active" kind of externalism is that the individual-bound portions of these interactions are not metaphysically sufficient for socially manifested cognitive processes of the requisite sort to occur (R. Wilson, 2001b, 2004).
16. Wegner (1986: 190–191) gives a particularly nice example of transactive retrieval coordination that involves both intrapersonal and interpersonal components and is distributed over internal and external storage spaces: "A client asks the boss for information, for instance, that the boss has no idea about—but thinks the secretary may know. [. . .] it may be that the secretary fails to find the item internally, perhaps finding instead some other information related to the label. As it turns out, perhaps the secretary recalls that the boss asked for this information at another time and reports to her boss: 'I gave that to you last Tuesday'. The boss may now be able to use the new lead to retrieve some item internally or externally. He might now recall that the information he asked for Tuesday was in the top desk drawer in a file labeled 'THIS IS IT'." Surely there is nothing nomologically necessary about transactive retrieval coordination happening in this idiosyncratic way.
17. The study describes the choreographic realization of dance work carried out during 1999–2000 that involved choreographer Anna Smith and eight professional dancers. It led to the production of *Red Rain*.
18. While the focus of our paper has been the social dimension of cognitive extension, we believe that the gist of our analysis of distribution as a form of emergence$_1$ carries over to all three dimensions of distributed cognitive systems.
19. For present purposes, we rely on a fairly broad conception of creativity defined as "a socially recognized achievement in which there are novel products" (Barron & Harrington, 1981: 442).
20. This point is forcefully raised by Sawyer (2003b: 18) as an argument for the irreducibility of "collaborative emergence" to the actions and intentions of individual actors. For further discussion, see Sawyer (2003c).
21. For discussion of the merits of token-realization, see Shoemaker (2007) and Pereboom (2002).
22. For a discussion of closure principles with respect to the physical properties and their relationship to mental properties, see, e.g., Kim (1998, 2005), Lowe (1993), Melnyk (2003), and O'Connor and Churchill (forthcoming). For a discussion of the causal completeness of the individual level with respect to the social, see particularly Kincaid (1997), Pettit (1993), and Sawyer (2003a).
23. This requires that we depart from the "homogeneity assumption" (Crane, 1995) that mental and physical causation are theoretically on a par. Notice that what counts as "higher" and "lower" levels of realization in a given context is itself dependent on the phenomenon that we seek to explain.

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24. Jackson and Pettit's program model is very similar in spirit to Kim's (1984) notion of *supervenient causation*. See Menzies (2007) for a recent discussion.
25. Whether this situation is even metaphysically possible at all depends on the exact sense in which we take the psychological states of groups to supervene on their lower-level realizers.
26. For a critical evaluation of this thesis, see Adams and Aizawa (2008) and Rupert (2009), as well as the responses offered on behalf of the "extended mind" by Clark (2008, in press), R. Wilson (in press), and R. Wilson and Clark (2009).

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