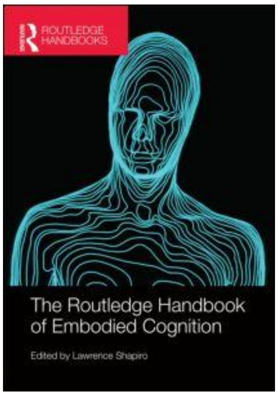

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Varieties of Group Cognition

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VARIETIES OF GROUP COGNITION

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Introduction

Benjamin Franklin famously wrote that "the good [that] men do separately is small compared with what they may do collectively" (Isaacson, 2004). The ability to join with others in groups to accomplish goals collectively that would hopelessly overwhelm the time, energy, and resources of individuals is indeed one of the greatest assets of our species. In the history of humankind, groups have been among the greatest workers, builders, producers, protectors, entertainers, explorers, discoverers, planners, problem solvers, and decision makers. During the late nineteenth and early twentieth century, many social scientists employed the notorious "group mind" idiom to express the sensible idea that groups can function as the seats of cognition, intelligence, and agency in their own right (Allport, 1968; Wilson, 2004). In their quest to stress (rightly) that group phenomena are something "over and above" the sum of individual contributions, a fondness for vitalist metaphors led them to believe (wrongly) that genuine group cognition must be the result of tapping into individualistically inaccessible, "holistic" forces. Today, inspired in part by historically unparalleled forms of mass collaboration enabled by the Internet, it has once again become popular to speak of collective intelligence, group agency, or even the emergence of a "global brain" (cf. the wiki-edited *MIT Handbook of Collective Intelligence* [MIT Center for Collective Intelligence, n.d.]).

In this chapter, I review some contemporary developments of the idea of group cognition, defined broadly as the collaborative performance of cognitive tasks such as remembering, problem solving, decision making, or verbal creativity for the purpose of producing a group-level outcome. My discussion serves a twofold purpose. First, by discussing how the idea of group cognition can be operationalized, I seek to show that we can retain some central theoretical insights of the "group mind" thesis without succumbing to its eccentric metaphysical overtones. Second, by providing a useful array of generalizable taxonomic resources, I hope to foster greater degrees of mutual awareness among insufficiently integrated areas of research on group performance.

From individual to group cognition

When people join together to solve a problem in groups, their performance depends on the knowledge, abilities, and resources of individual members, plus the interpersonal processes that determine how those are combined into a collective group activity or output. In his seminal work on group productivity, Steiner (1966, 1972) distinguished various types of combination processes in terms of the demands that are dictated by the task a group is trying to solve. He suggested that task demands vary depending on three main dimensions: the divisibility of a task, the desired type of output, and the combination scheme that is used to complete the task. Building on Steiner's taxonomy will help us to tighten our grip on the notoriously slippery notion of group cognition.

Steiner's first dimension concerns the question of whether a task can be broken down into different components. *Divisible* tasks have subcomponents that can be readily identified and assigned to different group members (e.g. running a football play), whereas *unitary* tasks cannot be performed in such piecemeal fashion (e.g. catching a football). The second dimension concerns a distinction between *maximization* tasks that call for a high rate of production, as opposed to *optimization* tasks in which the quality of a performance is measured by comparing it to some predetermined criterion. Running a 400-meter relay is an example of the former, whereas estimating the number of beans in a jar is an example of the latter. Laughlin (1980) similarly proposed a group task continuum that is flanked by *intellective* and *judgmental* tasks. Intellective tasks such as logic or math problems have demonstrably correct solutions within some agreed upon conceptual framework, hence the proposed solutions can be objectively appraised as right or wrong. In contrast, judgmental tasks such as a jury deciding on a verdict, or a hiring committee deciding on a job candidate, involve evaluative judgments for which no single correct answer can be authoritatively determined.

Finally, group tasks can be distinguished in terms of how individual inputs are combined to yield a collective outcome. *Additive* tasks can be solved by summing up the contributions of co-acting individuals. An example would be a university admissions committee whose members independently process student applications without interacting with one another. In *compensatory* tasks, the group outcome is obtained by averaging the independently obtained judgments, estimates, or recommendations of its members. The surprising accuracy of compensatory decision making, which can be explained in terms of general information-theoretic properties of statistical sampling (Bettencourt, 2009), has been popularized lately as the "wisdom of crowds" (Surowiecki, 2004). Surowiecki's opening anecdote tells the story of legendary nineteenth-century polymath Francis Galton, well-known for his elitist obsession with individual genius, who was flabbergasted when he discovered that the crowd at an English country fair had produced a more accurate estimate of an oxen's weight, when their guesses were averaged, than any of the recognized cattle experts. According to Surowiecki, the key to extracting wisdom from crowds is to foster a diversity of opinions, by allowing mutually independent individuals to draw on local, specialized sources of information, and to install a suitable mechanism for aggregating individual judgments (e.g. market pricing, as used in prediction markets). Importantly, the wisdom of crowds is not due to increased levels of collaboration, but results from a relative immunity to performance losses due to imitation, conformism, loafing, and other social phenomena that commonly occur in interacting, especially face-to-face groups.

In contrast, *conjunctive*, *disjunctive*, *discretionary*, and *complementary* tasks all depend more or less directly on interactions among group members. In *cooperative* interactions, all group members share the same goal or objective, and are equally affected by the consequences of a given outcome. This contrasts with *mixed-motive* interactions, such as social dilemmas, where different group members, or groups as opposed to individual members, have different preferences. Steiner's examples of interactive group tasks are of the cooperative variety, but differ in their respective degrees of cognitive interdependence they impose on its members. Conjunctive and disjunctive tasks are end points on a spectrum of how many members must succeed for the group to succeed. A disjunctive task, for example, would be a group of software engineers trying to identify a bug in a computer program. Here, the role of social interactions is mostly a matter of convincing the group to adopt the correct solution once it has been found by any one of its members. A conjunctive task would be a group of software engineers frantically typing up source code to meet an impending deadline, which requires that everybody works as fast and error-free as possible. In other words, a disjunctive task is one in which the quality of group performance depends on that of its most capable member, whereas a conjunctive task is one in which it is constrained by that of its least capable member. In addition, Steiner also identified a class of relatively unstructured tasks that can be completed by a variety of combination schemes, to be chosen at the discretion of the group. An example of a *discretionary* task would be the improvised performance of a jazz trio, or the corporate design of a new advertisement campaign.

The disjunctive-conjunctive continuum also corresponds to the spectrum of social combination models or decision schemes, which are formalized models of group processes that assign probabilities to each group response given all possible distributions of member preferences (Stasser, 1999). For example, a *minimal quorum* ("truth wins") assumes that a group response is correct if at least one member's response is correct (disjunctive), a *quorum of two* ("truth-supported wins") requires at least two correct responses, and *unanimity* requires that all members are correct (conjunctive). Other commonly used social decision schemes include *majority*, *proportionality*, or *delegation*. They provide an important class of baseline models which can be tested against actual group performance.

Based on his taxonomy, Steiner conceptualized the potential productivity of a group in terms of individual member resources and the demands of the group task. He recognized that groups often fail to achieve their full potential due to faulty group processes, and distinguished two main types of *process losses*. Motivation losses generally occur if members make a less than optimal contribution, either due to social loafing, free riding, or perhaps for selfish, competitive reasons. Coordination losses occur because of a less than optimal integration of individual members' contributions, such as when a group fails to acknowledge a correct solution proposed by one of its members. Even though process losses are very common, it is also possible for groups to exceed their potential, contrary to Steiner's pessimistic assessment. For example, since success in a conjunctive task is contingent on the performance of its weakest link, the proficiency of a group can often be improved by assigning different members to particular subtasks that fit best with their expertise, provided that the original task is divisible. This effectively turns a conjunctive task into what Steiner (1966) called a *complementary* task, in which group members collaboratively pool their diverse pieces of knowledge, skills, and resources into a single, collective outcome. Examples of complementary group performances with high levels of collaboration and cognitive interdependence include an orchestra performing a symphony, a football team running a play, or the police investigation of a crime scene.

The power of complementary problem solving is captured by the Gestalt maxim that "the whole is greater than the sum of its parts." It implies that a group may collectively achieve something that could not have been done by any single member – even the most capable – working alone, nor by the sum of members working individually towards the same outcome. Such an outcome is also known as an *assembly bonus effect* (Collins and Guetzkow, 1964; Larson, 2010). It exemplifies the broader concept of *synergy*, which occurs whenever the joint outcome of two or more interacting parts of a system differs from the aggregated outcome of the parts operating independently (Corning, 2003).

Based on these considerations, *group cognition* can be defined as the collaborative performance of cognitive tasks such as remembering, problem solving, decision making, or verbal creativity for the purpose of producing a group-level outcome. Importantly, our use of the term does not directly refer to any particular quality of the group-level outcome, such as the collective verdict of a jury, the co-authored publication of a scientific discovery, or the joint performance of an improvised dialogue. Those outcomes may be the result of group cognition, but they are not intrinsically "group-cognitive." Instead, the defining feature of group cognition is the *collaborative interdependence* among cognizing group members – that is, it concerns emergent modes of organization by which the actions, ideas, and resources of individuals are coordinated, combined, and integrated into a group-level outcome (Theiner and O'Connor, 2010). The *emergent* character of group cognition can be understood as a failure of *aggregativity* in the sense of Wimsatt (1986). Wimsatt argued that properties of systems that are *aggregative* satisfy the following conditions: they (1) are invariant relative to the rearrangement of parts, (2) remain qualitatively similar under the addition or subtraction of parts, (3) are invariant relative to rearranging the parts into different subgroups, and (4) are not affected by any cooperative or inhibitory interactions among the parts. Many interesting phenomena that we would intuitively classify as instances of group cognition violate three or even all four of Wimsatt's diagnostic criteria (Theiner, Allen, and Goldstone, 2010; Theiner, 2013). In what follows, I discuss several research paradigms which have contributed to our understanding of group cognition in this sense.

Groups as decision-making units

There has been a growing trend in small-group research to consider collaborative groups as cognitive units in their own right (Wittenbaum *et al.*, 2004). This conception is based on a functional analysis of the steps or processes that groups generally follow in the course of producing a specified group-level cognitive outcome. For example, a standard functional model of group decision making involves a sequence of four main steps (Forsyth, 2006): (i) an *orientation* phase, during which a group has to define the problem, set its goals, and plan out its procedures, (ii) a *discussion* phase, during which a group needs to gather, exchange, analyze, and weigh information, (iii) a *decision* phase, during which a group has to map members' inputs into a collective solution based on one or more social decision schemes, and (iv) an *implementation* phase, in which the decision is put into action, and its impacts are being assessed. Based on this analysis, the main goal is then to describe in detail the cognitive, social, and communicative mechanisms by which these decision functions are carried out, and to identify the conditions under which groups tend to perform better than individuals. Taking a *collective information-processing* approach to group decision making implies that during the discussion stage, which is arguably the most critical part of the process, groups can benefit from improving their memory, by increasing their information exchange, and by processing information more thoroughly (Larson and Christensen, 1993; Hinsz, Tindale, and Vollrath, 1997; Propp, 1999). Each of these implications has been the subject of experimental research in social and organizational psychology.

Transactive memory

The ability of dyads and small groups to expand their collective memory capabilities through a division of mnemonic labor has been studied in the literature on *transactive memory* (Wegner, 1986; Ren and Argote, 2011). For example, one partner of a long-standing couple may remember how to procure their favorite food and pay their bills, while the other knows how to maintain their home security system and prepare their joint tax return. By cooperatively allocating the tasks of encoding, storing, modifying, and recalling task-relevant information among members with specialized abilities or knowledge, groups can build transactive memory systems (TMSs) that are greater than the sum of individual memory systems. The integrated functioning of a differentiated TMS requires that group members develop a shared set of higher-order ("transactive") memories for keeping track of who knows what, and for trusting each other's expertise. For example, transactive memories are used for determining how, and in what format incoming information ought to be stored in a group, and for cueing the recognized experts whenever an interactive information search is executed.

Research has shown that collaborating groups remember more than their average or even their best single member, but often remember less than same-sized collections of non-interacting individuals (Weldon and Bellinger, 1997; Harris, Barnier, and Sutton, 2013). The most common explanation for the occurrence of such *collaborative inhibition* is that hearing others recall disrupts individuals' idiosyncratic mnemonic strategies (Basden, Basden, Bryner, and Thomas, 1997). The detrimental effects of group recall can be reduced, or even reversed, by the choice of decision schemes such as consensus which invite more collaborative forms of error checking, the skilful deployment of collaborative practices as found in teams of expert pilots remembering aviation-related scenarios, or when group members are actively encouraged to develop joint retrieval strategies during a period of shared encoding, especially when the material to be remembered is emotionally meaningful to the group (Harris *et al.*, 2013).

The search for assembly bonus effects is sometimes hampered by a one-sided understanding of the purposes which the activity of shared remembering fulfills for real-world groups. What is tested in many studies of transactive memory is the ability of groups to optimize the amount or accuracy of recall. This creates an incentive for members to remember different items, which rewards the development of differentiated transactive memory structures. However, an equally important function of collaborative remembering is to reinforce the social bonds among its members, by merging disparate memories into a stable rendering of shared past experiences (Hirst and Manier, 2008). This creates an incentive for members to remember the same information, which rewards the development of assimilated transactive memory structures. Viewed from this perspective, the relevant assembly bonus of group memory consists in the joint construction of collectively shared memories that more effectively support the enduring social identity of a group. Consistent with this more flexible interpretation of group memory is Hollingshead's (2001) proposal that the formation of a TMS is driven by the two fundamental processes of *cognitive interdependence*, which is a function of the extent to which each individual's contribution depends on those of others, and *convergent expectations*, which is a shared conception of what each member ought to do to achieve a positive group outcome (Harris, Keil, Sutton, Barnier, and McIlwain, 2011; Theiner, 2013).

Collective information sampling

The superiority of groups as decision makers is often justified with the idea that by pooling the resources of its members, groups can take into account far more information than any one of its members. However, research shows that groups are strongly biased towards discussing information that is already shared, and consistently underutilize information that is known only to a few (Wittenbaum *et al.*, 2004). Because of this bias, groups frequently fail to recognize superior decision alternatives that would require the integration of critical yet unshared information. This so-called *hidden profile* effect has been replicated under many experimental conditions, and is surprisingly robust (Stasser and Titus, 2003). It is stronger in groups that are working on judgmental rather than intellective tasks, and more pronounced when their members are under the impression that they lack sufficient information to make a fully informed decision.

The bias towards shared information reflects the double purposes of group discussions, which serves both informational and normative purposes. From a purely informational standpoint, one would expect that groups who are striving to make the best possible decision would primarily sample information that is unevenly distributed among its members. But concomitant desire for reaching a consensus, getting closure, or convincing others to adopt their own views counteracts that tendency. In addition, individual members may selectively withhold information to gain a competitive advantage over others, or to impress others by feigning agreement. The latter influence can be particularly hard to overcome, because people tend to rely on the exchange of shared information as a reliable social indicator of members' competence and task credibility. Consequently, since information that is unshared cannot be used to validate one another's expertise, group discussants will tend to rehash points that are already common knowledge, thus further diminishing the group's chance of discovering a hidden profile.

A variety of interventions have been shown to improve a group's attention to unshared information. For example, being designated an "expert" on some topic made it more likely for that person to contribute unique information in her designated area of expertise, and for her contribution to be acknowledged by the group. It is also known that senior group members, who usually enjoy a higher social status, are more likely to bring up, as well as repeat information that is unshared. Other methods of avoiding the bias include increasing the diversity of opinions, emphasizing the importance of dissent, priming members with counterfactual thinking, introducing group discussion as a new order of business rather than a return to previously discussed material, and the use of computer-mediated decision support systems to display, access, and collaboratively modify the total stock of knowledge that is available to the group as a whole (Forsyth, 2006).

Collective induction

Groups not only have the potential to recall and exchange information more effectively than individuals, but to process information more deeply by evaluating the strengths and weaknesses of different options, correcting each other's errors, and integrating diverse viewpoints. *Collective induction* is the cooperative search for generalizations or rules which require groups such as scientific research teams, auditing teams, or air crash investigators to undergo a cycle of hypothesis generation and testing (Laughlin, 1999). Collective induction is a divisible and complementary task in which groups have the potential to collectively perceive patterns, propose and reject hypotheses, and arrive at interpretations that none of their members would have achieved individually.

Laughlin (1999) outlines a theory of collective induction which synthesizes a series of experiments in which groups had to induce a rule that partitions ordinary playing cards into examples and non-examples of the rule (e.g. "two diamonds alternate with two clubs") in as few trials as possible. Laughlin's rule-induction task has both intellective and judgmental components: non-plausible hypotheses may be demonstrated to be incorrect, but plausible hypotheses may not be demonstrated to be uniquely correct vis-à-vis other competitors. Given enough information and time, groups performed at the level of the best of an equivalent number of individuals. The best fit of social combination models with actual group performance indicates that: (1) if at least two members propose demonstrably correct and/or plausible hypotheses, the group selects among those only; otherwise, it selects among all; (2) if a majority of members proposes the same hypothesis, the group applies majority voting; otherwise, it takes turns among the proposed alternatives, and formulates an emergent hypothesis that was not proposed by any member with probability $1/(H + 1)$, where H is the number of group members. The experiments also revealed that collective induction improved more by increasing evidence than by increasing the number of hypotheses, and positive tests (examples) provide better evidence than negative tests (non-examples).

Subsequent work showed that groups of size three working on complex letter-to-numbers decoding problems were able to outperform even the *best* of a same-sized equivalent of independent individuals (Laughlin, Bonner, and Miner, 2002; Laughlin, Zander, Knievel, and Tan, 2003). Correct answers to these problems could be demonstrated by experimenter feedback, arithmetic, algebra, logical reasoning, or knowledge of certain number-theoretic properties. Because of the highly intellective nature of the task, there was a clear-cut way for members to recognize answers that were correct, and to reject erroneous responses. By combining different types of reasoning strategies to solve letter-to-numbers problems, groups were better at solving the task according to a complementary model, rather than by selecting the single best-member solution according to a disjunctive model (Laughlin, 2011).

Groups as distributed cognitive systems

The "distributed cognition" framework was pioneered in the mid-to-late 1980s by Edwin Hutchins as a new way of studying cognition (Perry, 2003). Contrary to traditional cognitive science, where cognition is equated with information processing at the level of the individual mind/brain, it analyzes collaborative work practices which are often heavily mediated by the use of technology and the physical layout of the workspace as distributed cognitive systems in their own right. The key to this outward extension is a functional conceptualization of cognitive processes in terms of the *propagation of representational states across different media* (Hutchins, 1995). The term *media* is understood broadly to encompass both covert representations formed inside a person's head, but also overt representations which are physically embodied in verbal exchanges, bodily gestures or movements, or artifacts such as maps, charts, tools, instruments, or computer displays. By focusing on the coordination mechanisms supporting the collaborative creation and transformation of representational states in the performance of various cognitive functions – rather than on any intrinsic substrate of cognition – the distributed cognition approach does not posit a deep gulf between mental/physical, individual/social, and cognitive/cultural resources. Instead, cognitive processes can be viewed as extending seamlessly across the traditional metaphysical boundaries between subjects and objects.

More specifically, cognitive processes can be distributed in at least three dimensions (Hollan, Hutchins, and Kirsh, 2000). First, cognitive processes may be distributed across the members of a social group. This means that the social organization of a group – together with the material structure of the environment in which it operates – can itself be seen as a form of cognitive architecture determining the patterns of information propagation. Conversely, it also means that the concepts and models used to describe socially distributed systems may also be fitting to describe the distributed organization of individual minds (Minsky, 1986). Second, cognitive processes can be distributed across neural, bodily, and environmental resources. In particular, work materials such as a blind man's cane, a cell biologist's microscope, or a mathematician's calculator can become so deeply integrated into one's cognitive processing, by scaffolding the structure of a task and even providing active sources of information processing, that they are more properly viewed as parts of an extended cognitive system, rather than as mere stimuli or passive external memory resources for a disembodied mind (Clark, 2008). Finally, cognitive processes may be distributed through time, such that the products of earlier events can greatly transform the task demands at subsequent stages of processing. From this perspective, culture can be seen as a potent, cumulative reservoir of resources for learning, problem solving, and reasoning, "ratcheting" up the collective insights of previous generations so individuals do not have to start from scratch. Taken together, the mediating effects of the social, technological, and cultural distribution of labor imply that the cognitive properties of groups may differ significantly from those of individuals.

The proper investigation of distributed cognitive systems requires an interdisciplinary kind of "cognitive ethnography" based heavily on participant observation, which brings together and refines many different techniques for capturing the richly embodied, socially embedded, and often surprisingly opportunistic nature of meaningful human activity in real-world settings. These observations provide naturalistic data that can be further tested by conducting more constrained experiments and developing formal models, but they also lead to concrete proposals for improving the design of cognitive artifacts and workplaces, which ultimately feed back into the process of theory construction. Detailed studies of distributed cognition "in the wild" include diverse collaborative activities performed by maritime navigation crews (Hutchins, 1995), emergency/rescue management operations (Garbis and Waern, 1999), theatrical practices in Elizabethan drama (Tribble, 2005), bioengineering labs (Nersessian, 2006), and crime scene investigation (Baber, Smith, Cross, Hunter, and McMaster, 2006).

Groups as complex adaptive systems

Many group-living species such as ants, fish, and humans display adaptive, remarkably robust forms of coordinated collective behavior that seem to arise spontaneously, in non-supervised fashion, in response to environmental changes. For example, to avoid a predator attack, a school of fish flees almost simultaneously, in near perfect synchrony, as if it was collectively sensing the imminent danger, even though there is no external blueprint or centralized controller who broadcasts instructions of how to respond. Instead, the adaptive group response results from the dynamic self-organization of large collections of partially connected agents, following relatively simple behavioral rules. Those agents interact either directly, through various sensory channels, or indirectly, by leaving stigmergic traces in the environment that can be sensed by others (Moussaid, Garnier, Theraulaz, and Helbing, 2009; Goldstone and Gureckis, 2009; Miller and Page, 2007).

A frequently cited example of self-organized collective information processing through indirect communication is the formation of foraging trails in ant colonies (Moussaid *et al.*, 2009). When a single ant randomly stumbles across a new food source, it drops pheromones on its way back to the nest. The attractive influence of pheromones will cause nearby ants to modulate their random exploratory behavior towards the trail, which increases their chances of locating the same food source. This creates a positive feedback loop: as more ants are recruited to a given source, the concentration of pheromones increases, which in turn further increases the attractiveness of the trail. The resulting non-linear amplification of the incipient trail is held in check by negative feedback processes such as the evaporation of the pheromones, the depletion of the food source, but also the availability of nearby foragers, all of which help to stabilize the flow of ants. In addition, ants also modulate their trail-laying intensity in proportion to the quality of the food. Faced with a choice between two unequal food sites, what may initially be only a slightly higher pheromone concentration left on the trail towards the richer source will quickly become magnified, directing the colony to focus almost exclusively on the more profitable option. The same reinforcement mechanism also allows colonies to discover the shortest path to an existing food source.

The interplay between amplification and dampening of information underlies the synchronized responses of flocking birds or schooling fish (Couzin, 2009). The social interactions among the members of a flock, for example, are governed by a few rules such as near-range repulsion to maintain personal space, long-term attraction to ensure group cohesion, and a preference to align the direction of travel towards one's nearest neighbors. An external perturbation, such as the presence of a resource or a predator, may initially only be discovered by a small proportion of flockmates due to their limited sensory capabilities and crowded vision. However, the close behavioral coupling between nearest neighbors allows localized changes in movement to be amplified, and swiftly propagated through the flock. Hence, the flock as a whole forms a mobile, distributed perceptual system whose effective range exceeds that of any single member. Depending on the task demands, flocks can modify their interactions in context-sensitive ways. Under a threat of attack, individuals tend to align more strongly with one another, thus increasing the collective vigilance of the flock, though at the expense of causing false alarms. Conversely, since long-term migration requires that flocks are not too sensitive to local fluctuations in noisy, long-range resource gradients and to individual errors, birds adopt rules that favor social cohesion in order to facilitate a collective dampening of information.

Even though the self-organized dynamics of many forms of collective human behavior can often be modeled with surprisingly simple behavioral rules (Ball, 2004), the greater cognitive sophistication of humans introduces additional complexity that can interfere with collective dynamics. In particular, because people can quickly adopt new behavioral strategies in response to past experiences, novel behavioral conventions can emerge on much shorter timescales, for a larger variety of different settings, and in ways that are sensitive to cultural variations.

Group agency

In ordinary parlance, we often say that a government pursues ways to increase tax revenues, that a firm intends to release a new smartphone, or that a church opposes gay marriage. A literal attribution of agency to groups seems to imply that we consider groups as capable of having collective beliefs and desires, forming joint intentions, making evaluative judgments, managing their epistemic coherence through forms of collective reasoning that are robustly rational, and self-ascribing intentional attitudes from a first-person plural perspective (List and Pettit, 2011; Gilbert, 1989; Ludwig, 2007; Huebner, 2013). Drawing on a wide range of work on joint intentionality, social ontology, social choice theory, the sociology of collectives, and studies of collective responsibility and legal personhood, List and Pettit (2011) have forcefully argued that our concept of group agency cannot be reduced to that of individual agency, and indeed plays an indispensable causal-explanatory role in our ordinary as well as social-scientific discourse.

Their main argument against reduction is based on a logical paradox that arises when multi-member groups have to aggregate the distinct and possibly conflicting sets of intentional attitudes of its members into a single system of collective attitudes that is endorsed by the groups as a whole. In analogy to Arrow's (1951/1963) more widely known impossibility theorem about preference aggregation, List and Pettit (2002) have shown that there can be no judgment aggregation function that (i) accepts as input any possible profile of member attitudes (*universality*), (ii) produces a consistent and complete group output (*rationality*), (iii) gives all members equal weight in determining the outcome (*anonymity*), and (iv) is *systematic*, that is, the group attitude on each judgment depends only on members' attitudes towards that very judgment (*independence*), and that the same pattern of dependence between individual and collective attitudes is accepted for all judgments (*neutrality*). More constructively, this means that groups which seek to form collective attitudes must relax at least one of these four conditions.

List and Pettit suggest that the most promising organizational design in response to this dilemma is to lift systematicity, in particular independence, by prioritizing some judgments over others, and letting the group attitudes on the first set determine those of the second (without giving individuals any further say). This way of "collectivizing" reason most clearly reflects the purposes of a reason-driven collective agent, because it implies that coherent group outcomes can only be purchased at the expense of individual rationality. In addition, by further lifting anonymity, groups can implement distributed decision-making procedures in which different subgroups are assigned to "fix" the group's attitudes on specific judgments. Adopting the former procedure shows that a group's attitude cannot be derived in a strict, proposition-wise fashion from members' attitudes, and adopting the latter procedure also introduces heterogeneity because different members play different roles in determining the group outcome. Taken together, the fact that individual and group attitudes can come apart in surprising ways further underscores the theoretical autonomy of group agency.

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