Chapter 9

Transactive Memory: A Contemporary Analysis of the Group Mind

Daniel M. Wegner

The most influential theory of group behavior that has ever been developed is currently in disfavor. This is the theory of the *group mind*. Social commentators once found it very useful to analyze the behavior of groups by the same expedient used in analyzing the behavior of individuals. The group, like the person, was assumed to be sentient, to have a form of mental activity that guides action. Rousseau (1767) and Hegel (1807) were the early architects of this form of analysis, and it became so widely used in the 19th and early 20th centuries that almost every early social theorist we now recognize as a contributor to modern social psychology held a similar view. McDougall, Ross, Durkheim, Wundt, and LeBon, to name just a few, were willing to assume that the group has a mental life that plays a part in the patterning of group behavior.

Theories of the group mind fell victim to the behavioral revolution in psychology and have not yet returned. Even as research in cognition, memory, artificial intelligence, and information processing reaches feverish intensity in the field, group mind ideas seem generally ignored, perhaps because the group mind concept still reminds many of the worst excesses of mentalistic theorizing—from genetic theories of thought content (e.g., Pareto, 1935) to explanations based on telepathy and the supernatural (e.g., Jung, 1922). Obviously, these ideas do not represent the only direction in which group mind theories may develop (cf. Bartlett, 1932), and this chapter presents a fresh start toward a more useful formulation. The study of transactive memory is concerned with the prediction of group (and individual) behavior through an understanding of the manner in which groups process and structure information. Like early theories of the group mind, transactive memory draws deeply on the analogy between the mental operations of the individual and the processes of the group. Unlike early theories of group mind, the new notion of transactive memory benefits from recent advances in the study of the thinking processes of the individual.

General Principles

A transactive memory system is a set of individual memory systems in combination with the communication that takes place between individuals (Wegner, Giuliano, & Hertel, 1985). To understand how such a system operates, it is useful to consider its components. We begin, then, by looking at the individual's memory system and turn subsequently to see how this system becomes connected with those of other individuals.

Individual Memory

The processes of a person's memory are commonly understood to occur at three different stages. Information is entered into memory at the *encoding* stage, it resides in memory during a *storage* stage, and it is brought back during the *retrieval* stage. This breakdown of stages is useful for analysis because the successful operation of memory at one stage may have little consequence for the operation of memory at another. We have all had the experience of feeling we had encoded something, for instance, but found it impossible to retrieve. When this happens, it is not obvious where the memory failure has occurred. Did the item get into memory but somehow fall out? Did it get in and stay in, but we could not find it? Or did it really never get in at all? These questions highlight the possibility that separate processes may operate on information at each of these junctures. We may witness a robbery and, in the excitement, fail to encode the robber's face or clothing; we may fail in storing this information because someone asks us confusing questions about the robbery and suggests things to us we did not even see; we may fail to retrieve the information because later the prosecutor does not jog our memory by asking us the proper questions.

A further set of issues in individual memory centers on how the stored information is organized. Obviously, it takes a marvelous filing system to retrieve the color of a tomato in under a second—when one considers the millions of other questions that can be answered successfully by most people in the same short interval. Memory theorists have proposed a variety of organizational processes whereby items of information are not merely stored one by one but are stored as connected sets. This means that whole sentences may be stored as connected sets of items or, in the case at hand, that *tomatoes* may be stored with the color *red*. Processes that make or break such connections can occur during encoding to create organization, and complementary processes that operate at retrieval can locate the item by taking advantage of the organized storage that has been produced. By this logic, at some point early in one's experience with vegetables, the words *tomato* and *red* were encoded and the connection between them was encoded as well. Subsequent retrieval of either one then is often accompanied by retrieval of the other. At the same time, retrieval of one of these items very seldom yields the memory of a *waterfowl*, allowing us to recognize that disconnections can also be stored (perhaps as absent connections) for later retrieval.

The description of individual memory entertained to this point is not very far from what one might find in an introductory psychology text. To advance a bit more, we can incorporate the idea of *metamemory* in our discussion. In the last few years, memory theorists have noted that people have beliefs about their own memory facilities (Flavell & Wellman, 1977). One person who reads a book chapter may say she "knows" it, for instance, whereas another person who reads it may say he does not "know" it. The two may have precisely the same pattern of retrieval when they are tested, however, and so it becomes clear that they have differed primarily in what they meant by saying they "knew" it. This is thus a matter of memory about memory, or metamemory. As it turns out, metamemory is important in determining how well we use our memory skills. If we know how much we have to study before something is fully encoded, for example, we are in a better position for retrieval than someone who has little inkling of how much or what kind of studying to do. In essence, a person with a strong metamemory is able to take full advantage of whatever memory capacities he or she has. Someone with a weak metamemory, on the other hand, is like a person who has lost the instructions for operating a computer. No matter how much memory capacity is available in the computer, without good instructions the capacity may never be used. Metamemory can include knowledge about encoding, storage, and retrieval processes, and so may be useful at each of these stages.

External Memory

Now, introductory text views of memory begin receding into the distance at a faster rate—as we discuss an aspect of individual memory that has seldom received formal recognition in the scientific literature. It is surprising, actually, that the psychological study of memory has dwelt so little upon the extraordinary human tendency to record items in external storage media. Our walls are filled with books, our file cabinets with papers, our notebooks with jottings, our homes with artifacts and souvenirs, our floppy disks with data records, and at times, our palms with the scribbled answers to a test. Quite simply, we seem to record as much outside our minds as within them.

People use external storage for many everyday memory tasks (Harris, 1978). Remembering an upcoming engagement, for example, is not something people have to do forever, so they commonly rely on placing reminders in conspicuous places or on following their calendars (Meacham & Leiman, 1982). External storage is not only used as an "aid" in this way, however; often it is the central storage area for large bodies of information that cannot be retrieved elsewhere. The scrawlings one may make in a diary or daily log, for example, typically become the only record of many of the day's mundane activities. Internal storage of many details is rather sketchy, and although we may be able to reconstruct our day in general without recourse to a diary (e.g., "I went to work"), the external source provides some startling reminders. In a larger sense, realms of information we have never even encoded may become available for our retrieval because we are able to access external storage in the form of books, files, microfilm, and other media.

Externally stored items of information are retrievable, however, only when we know something about what they are and where they are. Although external memory aids such as notes may stare at us from the desktop and so present no identity or location mystery, the more frequent case is that we need some item of information and only know generally what and where it is. In search of a phone number, for instance, we may know we're looking for "Rudy's number" but not know the number itself. To retrieve the number we may need to look it up in the telephone directory, check the notepad by the phone, or call Rudy's ex-girlfriend to find out. The successful retrieval of a memory item (such as this number) thus requires the prior encoding of at least two additional pieces of information—a retrieval cue or *label* for the item (e.g., "Rudy's number"), and a notion of the *location* of the item (e.g., in the book). This seems to be a general requirement for the use of external storage.

The notions of a memory item, its label, and its location have their parallels in internal storage. As a rule, we can retrieve items from internal storage merely by knowing their labels, but these labels often can be broadly defined. If we are searching for "Rudy's number" internally, of course, it usually just pops to mind when we think of that label. We may sit down by the phone and be reminded of the number, however, without having a very clear prior thought of that particular label for it. We may be thinking instead of some other idea that happens to be organized with the number in memory (e.g., Rudy's toothless grin), and so have the number come to mind. The memory item is thus reached through any of a number of cues that perform the function of a label only implicitly (Graf & Schacter, 1985).

Location information, on the other hand, is something we never have to specify to ourselves in searching for internally stored items. Rather than wondering "Where did I put that?" we simply retrieve the item or not. We do, however, hold a certain kind of location information about our own memory items—in the form of our metamemories. We have opinions about what we know and do not know, and these allow us to judge whether an item or set of them is to be found in our own memories. Using this facility we can report, for instance, that we know Rudy's number without even reviewing it; or, without trying to reproduce the number, we can assert that we do not have it. Such judgments of location allow us to make both general and specific assessments of our internal information stores.

The processes of encoding, storage, and retrieval can now be understood to have both internal and external manifestations. When an item of information is encountered, it may be encoded internally or externally.

location information held internally by the other, information that the other uses to keep track of what the individual knows. The transactive memory system, in short, is more than its individual component systems.

If we ask a question of a person who is a well-integrated part of a transactive memory network, this person often is able to answer (after consultation with other network members, of course) with information well beyond his or her own internal storage. Asking any member of a family a question about the family's summer vacation, for example, can prompt the retrieval of several members' accounts of the experience. The success we have in retrieving certain items depends on the degree to which the person we begin with has location information about the items we label. Even if we ask the person to retrieve an item with an obscure label, however, the person may be able to help us enter the storage system. Asking Bud how much the family paid for gasoline in Orlando, for instance, may lead him to quiz Dad—who generally knows about car-related items. Or perhaps Bud suspects that Father knows nothing and so instead asks Mom about the gas prices. There are a variety of potential paths to the information, and it may even be the case that no one knows, or everyone knows. Gaining entry to the group's stored knowledge is likely to be an efficient enterprise, however, even when we begin with a fairly inexpert member. This person may not have internal access to many items but is likely to have stored the main locations of information in the group.

The transactive quality of memory in a group is evident also in the transactions that take place during encoding and retrieval. In transactive encoding, people discuss incoming information, determining where and in what form it is to be stored in the group. Transactive encoding sometimes takes the simple form of direct instruction for one group member to encode information internally (e.g., "Lulu, remember this phone number"), but more often involves complex negotiations regarding the common labels that should be assigned to items (e.g., "What *was* that?"), the matter of responsibilities for internal storage (e.g., "Isn't this your bailiwick?"), the preferred locations of items (e.g., "I'll take care of that"), and the like. In this process, the very nature of incoming information can be changed, translated into a form that the group can store.

Transactive retrieval, in turn, requires determining the location of information and sometimes entails the combination or interplay of items coming from multiple locations. Transactive retrieval begins when the person who holds an item internally is not the one who is asked to retrieve it. A client asks the boss for information, for instance, that the boss has no idea about—but thinks the secretary may know. If the secretary can produce the item and pass it along, transactive retrieval comes to a successful conclusion. However, 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 this to the boss: "I gave that to you

Successful encoding of either type requires that a label of some kind be attached to the information, that the label be encoded internally, and that at least one other piece of information be encoded internally as well. What we normally think of as internal encoding requires that the *item* be encoded internally along with the label. External encoding, however, requires that that *location* be encoded internally with the label—and for this reason, the item itself need not even be known. As an example of this, suppose that one encodes this book in memory. To encode it internally requires learning some sort of label (e.g., the book's title), and then memorizing the rest of it from cover to cover. To encode it externally also requires learning the label, but then only calls for learning where the book can be found. In either encoding process, the minimum requirement is that two categories of information are placed in internal storage.

In the course of a day, much of what we encounter is encoded internally, but probably much more is encoded externally. This is because the labels we encode for externally stored information can be very general, referring to hundreds or even millions of items. We surely cannot encode this much information internally in a short time, and it is for this reason that a large part of our internal storage capacity is devoted to location information that allows us to retrieve external items. For example, the average college professor may have an impressive internal store even when caught off guard in the classroom by an inquisitive student. However, this professor will have access to more information, enough to stupefy even the most challenging questioner, as the result of a brief sortee to the office, the microcomputer, or the library. Knowing where things are to be found can be a more important consequence of education than merely knowing things.

Transactive Memory

Other people can be locations of external storage for the individual. The professor may be the prime location for certain arcane bits of knowledge occasionally desired by the student, for example. For that matter, the student may also be an external storage facility for the professor; the professor may fail to learn the student's name, for instance, knowing that this is retrievable because the student is available in the classroom on a regular basis for consultation. In either case, one person has access to information in another's memory by virtue of knowing that the other person is a location for an item with a certain label. This allows both people to depend on communication with each other for the enhancement of their personal memory stores. At the same time, however, this interdependence produces a knowledge-holding system that is larger and more complex than either of the individuals' own memory systems. Each individual may know the system from one perspective—having in internal storage many items, labels, and locations, and knowing that the locations are in the other's memory. However, this individual usually will not be aware of the complementary 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." The item is found, then, thanks to neither the boss nor the secretary—but to the combined transaction of the boss and the secretary. The transactive process may thus operate at retrieval to search for a label that can prompt access to the desired item in the internal or external storage of at least one group member.

The Transactive Memory System

The transactive memory system in a group involves the operation of the memory systems of the individuals and the processes of communication that occur within the group. Transactive memory is therefore not traceable to any of the individuals alone, nor can it be found somewhere "between" individuals. Rather, it is a property of a group. This unique quality of transactive memory brings with it the realization that we are speaking of a constructed system, a mode of group operation that is built up over time by its individual constituents. Once in place, then, the transactive memory system can have an impact on what the group as a whole can remember, and as a result, on what individuals in the group remember and regard as correct even outside the group. In short, transactive memory derives from individuals to form a group information-processing system that eventually may return to have a profound influence upon its individual participants. In what follows our discussion centers on these developments in sequence.

Constructing the Transactive System

A transactive system begins when individuals learn something about each others' domains of expertise. Usually, such information is not at all difficult to obtain. When we walk along a crowded sidewalk, we can make inferences on the basis of dress, race, sex, possessions, and the like about the domains of expertise that may be afforded us by every person we see. In impromptu groups, these superficial bases of inference may be all we have and lead us, therefore, to make only some fairly broad distinctions. The other members of a jury decide that the retired Air Force General is likely to be smart, for instance, and so elect him foreman. Expertise judgments based on stereotypes are prone to exaggeration and error, however, and it is thus not surprising that impromptu groups may be poor memory systems. In longer standing groups, however, the history of conversation about who has done what and heard what and been where and studied what and with whom and under what circumstance could be exceedingly rich, and so allows members to discern with much greater precision just who is expert in each of a variety of information domains.

Known experts in a domain are usually held responsible for the encoding, storage, and retrieval of any new information encountered in that domain. The family member who is the known expert on the fleet of rusting cars and machinery out behind the barn, for example, is likely to be faulted if any harm comes to the fleet without his or her knowledge. The expert is responsible for continuing to encode incoming information. Questions about the domain (e.g., "How long has that hornets' nest been in the Chevy?") are typically directed to this person by default, and it is sometimes difficult for the person to escape continuing responsibility for storage in the domain once expertise is generally acknowledged. Other group members usually contribute to this centralization of information by delivering new information to the appropriate expert. The phone call from the Sheriff regarding the fleet will soon be conveyed to the family rusting machinery expert, allowing other family members to relax knowing that the information is properly stored in the group.

It is when a clear candidate of this kind is not available that difficulties arise in the allocation of information within the group. Very commonly, formal groups will make the assignment of responsibility for information domains to individuals on other bases. The classroom teacher will ask Ricky to become an expert on teeth by the weekend, the restaurant owner will ask a waiter to begin looking into wine, or the church choir will vote to appoint someone to keep track of the robes. In the absence of such explicit assignments, more subtle rules are used to direct continuing responsibility. For example, the person who initially reports a domain to the group may be held responsible; when the wife learns first of an upcoming party she and her husband may attend, for instance, she is subsequently held responsible for finding out additional information about the party. The person who most recently encounters a domain of information may also incur responsibility for it; when the husband intercepts a telephone update on the party plans, he may become accountable for the successful conduct of the whole enterprise. Overall, then, there are two sources of information people use to decide who is to be the acknowledged location of a set of labeled knowledge in the group. Individuals are seen as linked to knowledge on the basis of their *personal expertise*, or through the *circumstantial knowledge responsibility* that accrues as a result of how the knowledge has been encountered by the group.

An effective transactive memory in a group should not leave the responsibility for information to chance. If a clear expert does not exist in a domain, a channel for the processing of that information should nevertheless be established, either explicitly or implicitly. A study by Giuliano and Wegner (1985) supports this general hypothesis by showing that in intimate couples, transactive memory operates to keep one or the other partner responsible for information at all times. Couples selected for the study had been seeing each other exclusively for at least 3 months and were given the

Table 9.1. Percentage Recall as a Function of Perceived Expertise and Circumstantial Responsibility for Knowledge[a]

Partner expertise	Self-expertise: Self not expert	Self-expertise: Self expert
Self is circumstantially responsible for knowledge		
Partner not expert	29.8	34.3
Partner expert	24.2	27.3
Partner is circumstantially responsible for knowledge		
Partner not expert	17.3	24.9
Partner expert	19.8	23.6

[a]Cell means are based on a within-subjects analysis for 20 dating couples (40 subjects). When the self is circumstantially responsible, there is a reliable main effect for partner expertise, $F(1,39) = 5.85$, $p < .01$. When the partner is circumstantially responsible, there is a reliable main effect for self expertise, $F(1,39) = 5.79$, $p < .03$. Data from Giuliano and Wegner (1985).

laboratory task of *together* remembering 64 items of information. Each of these items was drawn from an area of expertise; the item "Kaypro II," for example, was drawn from the area of computer expertise. The items were embedded in context sentences (e.g., "The Kaypro II is a personal computer") that made it clear even to the nonexpert what area of expertise they represented. Each partner was asked (either before the memory experiment or afterwards) to review the 64 domains of expertise and to indicate in each case whether a particular area was one in which the male was more expert, the female was more expert, both were expert, or neither was expert. For the memory portion of the study, eight trials were conducted in which each subject was given a set of four items to study for 1 minute, and then was instructed to pass these to the partner, who was asked to review them for 30 seconds. In this way, both partners became aware of their relative advantage (or disadvantage) in encoding time for each item.

These manipulations placed couples in the position of trying to remember information that varied in both personal expertise and circumstantial responsibility. Items had been sorted by each participant into four categories of personal expertise (self, partner, both, or neither), and then were encountered under circumstances that led either self or partner to be more responsible for them—in that either self viewed the items longer than partner or vice versa. The results, presented in Table 9.1, show the proportion of items recalled by each partner in these conditions. The most general effect was for the personal expertise of self. Across the board, subjects remembered items from categories they had judged to be their own areas of expertise. This is not particularly surprising and can be expected solely on the basis of a theory of individual metamemory; people know which areas of their own experience are most richly elaborated and well developed and simply predict their own memory performance on this basis.

The other effect of interest here reveals a clearly transactive phenomenon. Subjects who were circumstantially responsible for a topic more often recalled items from that topic when they believed their partner was not personally expert in that topic. In other words, members of these couples accepted the responsibility for information placed upon them by their circumstance, even when they were not expert, but did so only when they knew their partner had no history of personal expertise in the area. This, then, is a case in which an individual's internal memory retrieval is affected by transactive constraints—knowledge of what someone else's memory can or cannot do.

These transactive memory strategies combine to ensure that information the couple needs will always be captured by at least one of the partners. When either partner encounters a piece of information useful to the pair, that partner is placed in the position of having circumstantial responsibility for the knowledge. Normally the person lets the item "pass by"—to be remembered by the partner—only when the partner is known to be expert in the domain of that item. Because individuals regularly remember items in their own domains of expertise, moreover, the partner comes forward to "catch" the item before it escapes the group. It should be noted, however, that this efficient group encoding and storage system is critically dependent on each partner's knowledge of the other's domains of expertise. Faulty location knowledge on either member's part dooms the system, allowing items to pass through the group without being stored. Early in the development of the relationship, this is to be expected; later on, it signals the improper construction of the transactive system and can result in chronic memory failure for the dyad. Such a couple can lose the laundry, forget to pick up the children, and arrive at the theater just in time to watch the carpenters renovate the mezzanine.

The construction of a working transactive memory in a group is a fairly automatic consequence of social perception. We each attend to what others are like and in this enterprise learn as well what we can expect them to know. Then, when the group is called upon to remember something, information is channeled to the known experts. When no expert is known to exist, the individual who is entrusted with the information by circumstance holds on to it, allowing the group subsequent access. In sum, transactive memory can be built because individuals in a group accept responsibility for knowledge.

Transactive Processes in the Group

There is no guarantee that an item of information presented to an individual can subsequently be retrieved in the same form. Likewise, the group has an effect on the information it encounters, sometimes retrieving it unscathed, but sometimes losing it and sometimes changing it. These changes can take place because of individual memory effects but are perhaps just as likely to accrue as a result of transactive phenomena. When people talk about items of information, the information can change dramatically.

Individuals may talk about some items of information as they are encoding them. When such transactive encoding occurs, labels are linked to the item by the conversants as a group. Although this has the benefit of allowing each group member subsequent access to details of this item unknown to self but known to others, it also tends to color what is perceived by the group. Whatever label is applied first, perhaps arbitrarily, becomes the catchword for the item. This label may even be incorrect, but it serves as the common denominator for discussion and so becomes part of the item for everyone. This is particularly likely because individuals tend to encode items well when there is elaborative rehearsal—reviewing of the item's organization ties to other items (Anderson & Reder, 1979). Group commentary on incoming memory items provides just such rehearsal, and for this reason, individuals are more inclined to remember items as discussed than items as perceived. The group-acknowledged label thus can become more than a tag, growing to provide the major portion of what is remembered of the item by all group members. The term "UFO," for instance, might serve as a rallying point for a wide array of specific memories held by individuals who witnessed an event one evening. The label suggests a common experience and provides a common foundation for explanation and elaboration. Without this label, individuals might variously speak of seeing, say, "funny lights" or a "bright object," but with the label, a core memory is formed that provides an interpretive scheme for many different items of information—and so provides the group a night to remember.

Discussion that occurs well after the intake of information can have similar consequences. Modification of information may take place during storage, as has been shown to occur in individuals (Loftus, Miller, & Burns, 1978). This modification can occur much more quickly and with greater impact than in the case of individual memory, however, because the storage of information in the group may be more scattered and, hence, easily replaced by misinformation. In the UFO case, for instance, one family member may come home to tell the story of the unusual experience; other family members hear the story and get it wrong in places; members who have not even seen the event talk about it and resolve inconsistencies in their stories; finally, the group as a whole may end up with a majority opinion of the event that differs in many details from what the original witness saw. When they are asked what this person experienced, they will introduce their version as fact, and eventually may even convince the witness that certain things were encoded that truly were not present at all.

When the group attempts to retrieve information, transactive effects could occur that render individual memories more or less available for retrieval. The label that is used at the beginning of the transactive retrieval attempt can be translated into another label, as noted earlier, because one person finds internally stored information related to the initial label that serves as a useful cue for the internal search being conducted by another person. It is quite possible for groups to forget what they were looking for in this process, however, or to find useful items that they did not actually set out to find. The interesting aspect of transactive retrieval, then, is its "traveling" character, its tendency to wander.

Consider, by way of illustration, your visit to the computer store to ask why your new machine keeps saying "Invalid command." In short order, you find yourself in a conversation among all the salespeople. Each one seems to mention something different. Cryptic references to the software arise in certain quarters, are replaced by "loose chip" talk at one point, and amidst further murmurs, the person you first asked nods knowingly. An anticipatory shiver runs through you, and then you are apprised of several factors about your computer that you already knew. You eventually leave, perhaps with the solution, maybe suspecting only vaguely what must be done, but certainly with some new facts about the machine that you did not intend to find. In most cases, the person who you ask for group-stored information acts as your guide, checking to ascertain that your question has been answered. In the process, however, much other information is retrieved as well.

The transactive processes that occur at each stage of memory processing do not only produce errors. Although the examples we have entertained to this point suggest that transactive memory is often the source of departures from reality, it must be emphasized that useful creative products are just as likely to be produced by transaction. This occurs when different items of information that are held separately by individuals or subgroups are brought together. In essence, a group is capable of achieving integrative processes in memory that parallel the integration that can occur at the individual level. Hayes-Roth & Thorndyke (1979) describe integrative memory in the individual, noting that when memory items can be integrated or combined, the individual is more likely to remember those items. In transactive memory, this can occur when individuals respond to a particular information label, and one group member retrieves one item whereas a second member retrieves something quite different. In their subsequent discussion, it is determined that the two items add up to yet a third idea, one that is a qualitative departure from either of its constituents. Aircraft mechanics who are asked about a plane's safety, for example, might each volunteer different facts; Betty might note an unexplained bit of oil on the runway, while Veronica remembers that a hydraulic indicator light was not functioning. Taken one at a time, these observations may not be noteworthy. Taken together, however, they point to an oil leak, and this integration could turn out to be significant indeed. Both mechanics thus are likely to remember both facts, as well as their integrated meaning.

Integrative processes are among the most important transactive events in groups because they manufacture new knowledge for the group—and so for all the group members. Information coming from different locations in the transactive system is tied together by a common label, and during this juxtaposition is discovered to mean something new. And in well-developed transactive systems, there seems to be a strong press for just such integration. Intimate couples, for instance, strive for integrative agreement in their group solutions to problems, often abandoning solutions suggested by each partner alone in favor of a solution that emerges at the group level (Wegner *et al.*, 1985). The group exerts a strong directive pressure on what is to be encoded, stored, and retrieved and places a special premium on integrative transactions. Integration affirms the need to have a group in the first place, showing all members the utility of coming together to remember.

Impact on Individuals

The usefulness of a transactive memory for the individual is beyond question. The individual's expertise is expanded dramatically on the construction of a transactive system with others, and the specialization of knowledge that individuals can develop within such a system becomes beneficial to all. The individual gains others' domains of expertise, of course, but also gains access to the knowledge that is created through integrations occurring within the transactive memory. There is another benefit of company in that information relevant to the individual often is encoded and stored when the individual alone would miss it. Others can process knowledge and make decisions even as the individual sleeps. Moreover, a group with a smoothly functioning transactive memory is likely to be effective in reaching its goals and will thereby satisfy its members. Individuals thus benefit both directly and indirectly from transactive systems. These various advantages of transactive memory systems no doubt promote the formation of transactive memories within groups and, to be sure, provide the impetus for the formation of many groups that would not even be formed otherwise.

Transactive memory is not without its drawbacks, however. The complexity that is added to an individual's memory system by the existence of connections to other memory systems creates the potential for new sources of confusion and error. The most obvious source of difficulty is the incomplete specification of paths of knowledge responsibility within the group. As mentioned earlier, a partially constructed transactive system may leave certain individuals not knowing who is expert in important domains of knowledge or may leave everyone wondering how to decide when circumstance confers responsibility for knowledge. When an organizational system is built that channels information away from experts, for instance, things may be forgotten. When expertise is in dispute, information may fall in the cracks as well. Likewise, when clear group expectations regarding circumstantial knowledge responsibility are not developed, trouble may arise. These problems can exact a serious toll on the individual's information-processing capacities.

Typically, for instance, the person one reaches by phone in a household is responsible for bringing the desired family member to the phone. If the desired member is not home, a message is taken. This "first contact" person is crucial for connecting the family to outside information sources, and this person's job is typically to maintain contact with the outside source until some connection with the proper location of information in the family has been made. In many businesses, however, the first contact person knows little if anything of the expertise structure in the organization; the person is an "operator" who is hired to "work the phone equipment," and this person is never heard from after setting up the initial connection. The caller is sent to some contact and, if that does not work out, may have to start all over with redialing the phone. Such faulty connections in business mean that members of the company lose contact with each other and with outside information. What is really needed in the first contact position is a transactive memory expert, a person with quite extensive knowledge of who knows what in the company. This person must understand the requirement to maintain the responsibility for incoming information and continue to do so until a clear connection with someone who is the proper expert is established.

Individuals can suffer from transactive memory, though, even when it is well established and running smoothly. This happens when they overestimate its capabilities. Just as a person's metamemory offers information about what the person knows, a transactive memory system provides individuals information about what knowledge they may access in the group. This may result in a brand of the "feeling of knowing" (Hart, 1967) that yields an overconfidence in one's own ability to access knowledge. In the presence of one's Scout troop, for instance, one might fairly bristle with the lore of the woods and so set forth to conquer nature without doing much information seeking for oneself. If there are any shortcomings in the information provided by the troop, they are not likely to be met by one's own keen analysis. Thus, if the camporee factsheet has no mention of insect repellent, one may fail to think this a worthwhile accessory and so spend an uncomfortable weekend courtesy of one's confidence in the troop's preparedness. Such trust in the group for information makes one's own contribution less useful, of course, and also paves the way for the group to make poor decisions (cf. Janis, 1983).

The impact of transactive memory on the individual may be most clearly seen in its absence. When a group dissolves, formerly interdependent individuals are left with the individual remnants of what was once a transactive system. These remnants can be not only useless but troublesome in themselves. Much location information held by the individual is now unimportant; indeed, the knowledge that a departed spouse knew all about, say, balancing the checkbook, serves only as a bitter reminder that one does not now know these things for oneself. Labels for information that the individual shared with fellow group members may be unintelligible to others; the terms for bodily sensations or symptoms used in one's family may be confusing or just plain silly to one's physician. Items of information themselves, if the individual has been holding them for the group, become quite valueless; one may have been the only manager who could name every company employee—as the company drifted into bankruptcy proceedings. Major elements of the information that is shared in transactive memory thus become, at best, irrelevant and, at worst, misleading in the person's quest to form an independent individual memory.

Applications

Despite its roots in a tradition of group mind theorizing that stretches back many years, transactive memory is relatively new and unexamined. For this reason, it is important to chart the domains in which the idea may find useful application and empirical investigation. Transactive memory was first introduced to account for certain phenomena of intimate relationships, and that topic begins the discussion. Then the utility of transactive memory analysis is examined in the study of health behavior, instructional psychology, and organization management.

Intimate Relations

The most intricate and accurate transactive memories can be formed by people when they spend their whole lives together. The bonds of intimacy bring with them a large degree of cognitive interdependence, a tendency for individuals' thought processes and structures to be mutually determined (Wegner *et al.*, 1985). This means that the labels intimates use for knowledge domains are often idiosyncratic to the pair (Hopper, Knapp, & Scott, 1981), that there exists a mutually understood organization of expertise and responsibility for information (Atkinson & Huston, 1984), and that information is processed by the pair in certain typical ways that are partly negotiated and partly implicit (Reiss, 1981). Transactive memory in intimates, then, represents much more than the observation that intimates can fill in stories for one another, alternating in their retrieval of shared information. Although this is part of the idea, the transactive memory developed in close relationships is yet more central, both a sign and a foundation of the successful relationship itself.

Relationship development is often understood as a process of mutual self-disclosure (e.g., Archer, 1980). Although it is probably more romantic to cast this process as one of interpersonal revelation and acceptance, it can also be appreciated as a necessary precursor to transactive memory. After all, partners must learn about each other's areas of expertise, and one function of early self-disclosure is the development of such location information in each partner. It is interesting that couples who come to agree on who knows what in the relationship are generally more satisfied with their pairing than couples who disagree. This is particularly true when the couples are asked to indicate whether one partner knows more than the other on each topic. In responses of 60 heterosexual couples who completed a questionnaire (also used by Giuliano & Wegner, 1985) that called for each partner to judge whether self, other, both, or neither were expert in each of 64 knowledge domains, a couple's agreement on self versus other expertise judgments was significantly correlated with each member's assessment of satisfaction with the relationship. This was not the case for agreement on "both" or "neither" judgments, indicating that the differentiation of knowledge domains in the heterosexual dyad may be an important key to success.

Perhaps some proportion of the sex role differentiation that occurs in couples may be traced to the utility of differential expertise in transactive memory. Although the development of "experts" in families has been acknowledged before (Davis, 1976), it has not been emphasized that this development may produce more efficient functioning in the group. When each person has group-acknowledged responsibility for particular tasks and facts, though, greater efficiency is inevitable. Each domain is handled by the fewest people capable of doing so, and responsibility for the domains is continuous over time rather than intermittently assigned by circumstance. The allocation of tasks may be determined initially by minor variations in circumstantial responsibility; the female, for instance, may more often be present when memory items relevant to the baby become known to the group. This gathering of knowledge serves as a kernel of expertise that draws additional items from other group members. The female quickly becomes the "baby expert," and even in the pressure toward egalitarian relationships that comes in a dual-career family, the female's informational duties in mothering may progress more rapidly than the male's duties in fathering.

Ideally, the differentiation of transactive memory is not one sided. The most efficient couple would likely develop equally large and equally taxing domains of individual expertise. This means that breaking up is likely to reduce the memory capabilities of both dyad members. Indeed, much of the grief and disorientation that accompanies the dissolution of a close relationship can be traced to the loss of transactive memory capacities

Divorced people who suffer depression and complain of cognitive dysfunctions may be expressing the loss of their external memory systems. They once were able to discuss their experiences to reach a shared understanding, but such transactive encoding is gone. They once could count on access to a wide range of storage in their partner, and this, too, is gone. Their former capacity to retrieve information in their own memories by bantering with their partner until a helpful label can be found, also, is gone. In short, much of the joy and much of the utility of close relationships can be found in their transactive memory systems. The loss of transactive memory feels like losing a part of one's own mind.

Health Behavior

Transactive memory phenomena are relevant to health behavior at several levels. The success of self-diagnosis, the success of physician diagnosis, and the success of medical compliance, at minimum, are all affected by transactive memory processes. This is because some form of group decision making is often involved at each stage—when the patient decides to seek medical care, when the patient and physician discuss the nature of the problem, and when the patient is sent away with a prescribed medical regimen.

People seldom reach self-diagnoses alone. They commonly contact family or friends to make initial expressions of their symptoms (Pennebaker, 1982), and the process of deciding that the symptoms need treatment is thus a social one. It has been argued that individuals judge symptoms and decide whether to seek treatment on the basis of their cognitive prototypes of illnesses (Bishop, Sikes, Schroeder, McGregor, & Holub, 1985). Having a stuffy nose and sore throat, for example, is usually sufficient to convince people only that their symptoms match the prototypic "head cold," and this self-diagnosis then leads them to whatever action they associate with that prototype. Illness prototypes can be supplied by friends and relatives, however, and so can multiply the complexity of the decision to seek treatment. A circle of friends who have relatively impoverished cognitive prototypes of illness may lead the individual to make infrequent or mistaken illness self-diagnoses, whereas friends who are all in medical school may lead the individual to make relatively more frequent (but perhaps equally mistaken) self-diagnoses. The illnesses that friends and acquaintances have had themselves, of course, provide a point of comparison for the individual's symptom constellation, and this suggests that people in groups will often all appear to come down with the same thing. They may in fact have a common illness, or they may have a transactive memory that has encoded each person's idiosyncratic symptoms in terms of the group-provided illness label (cf. Colligan, Pennebaker, & Murphy, 1982).

The physician-patient dialog can also be understood as a transactive memory process, one of a slightly different kind. Here, the physician is an expert on illness generally, while the patient is an expert on the symptoms and manifestations of his or her particular malady. Both interactants usually know this, and the effect they seek by coming together is the completion of a successful transactive retrieval procedure—a meeting of the minds. The process can be led by either physician or patient, but it is clearly a sequential search in which early interaction phases determine the path of later phases. The patient's illness prototype will probably constrain the patient's symptom reports at first to those most relevant to the suspected illness. The physician may learn this illness label from the patient at the outset and may subsequently be influenced by it. This can be problematic because the early, albeit tentative acceptance of the label can constrain the physician's line of inquiry, ultimately moving the investigation along a narrow path determined in large part by the patient, the lesser expert in the pair. At the same time, it is possible for the physician to give the patient's hypotheses too little credence, and in this way to fail in fulfilling the patient's desires to be reoriented and reassured.

The transactive memory system developed between the patient and physician may eventually be expanded to include the patient's relatives and friends. This is necessary when the patient is given a prescribed regime by the physician—medication, perhaps, or a special diet, exercise, or activity plan. The patient may fail to adhere to this prescription, as is often the case (Sackett & Snow, 1979), and such failure can undermine the entire health care delivery process that has occurred to this point. Noncompliance can happen because the transactive memory system surrounding the patient is not sufficiently developed to support the patient's compliance. The patient forgets to take a pill, for example, and because the patient is usually considered the expert on his or her own self-medication this is ignored by family. The patient forgets again and again, and the prescription is finally abandoned. The physician finds out several weeks later when the patient is back with further problems, or the physician may not find out at all. Perhaps physicians or health-care professionals in this position should convey information about the patient's prescription to the entire family. Emphasizing such knowledge to them may increase their acceptance of circumstantial responsibility for the patient's remembering, and so provide a "safety net" should the patient fail to self-medicate. This advice seems simple enough but it is often forgotten when the patient's memory is understood only as an individual system and not as part of a transactive system.

Instructional Psychology

A teacher and student form a transactive memory system that has some special properties. Their roles are defined, of course, in terms of a lopsided distribution of knowledge in the system, and the transmission of internal memory storage from the teacher to the student is typically the overarching goal of the group. The usual instructional setting, however, is only a temporary transactive memory system, the purpose of which is the formation of a permanent individual memory system on the part of the student. This means that instructional success occurs if the transactive memory system can replace itself. This would occur if the teacher could be replaced with some more portable or generally available external memory source (e.g., a library), or if the student could encompass in internal memory all that once was part of the transactive system.

This movement of memory from one location to another occurs most efficiently when frequent transaction is possible. Wood (1980) summarizes studies indicating that instruction through dialog is more effective than a number of seemingly comparable instruction techniques—including didactic communication and encouraged exploration. Mothers instructing their children, for instance, engage them in a conversation that creates a "scaffolding" of control around the child's activity, one which provides just that level of intervention necessary to get the child over his or her current difficulties. The mother steps in to offer control, suggestion, and information when the child fails at some attempted action, and steps back, in turn, offering progressive relaxation of such direction when the planning and execution of the action are going well. Wood finds that this technique is particularly likely to impart task mastery to children and that parents who use it are the best teachers.

This technique tends to insure optimal transmission of information from one locale in transactive memory (the teacher) to another (the student). Independent, internally guided action is allowed and encouraged in the student at every step, but the watchful instructor intervenes with externally stored information when this is necessary to keep the student progressing. The activities elicited in the student are likely to be remembered well because this ongoing transaction takes full advantage of the "generation effect" in memory—the tendency to remember better the information one has generated than the information one has merely encountered (Johnson & Raye, 1981; Slamecka & Graf, 1978). A limited context is imposed by the instructor, and in it the student generates new language and action. Because these self-generated responses have been guided and arranged through the "scaffolding" procedure, very few lengthy but wholly inappropriate lines of action are produced. Checks and interventions occur throughout the information transmission period, for transactions retrieve information from the teacher just to match points at which the student requires the encoding of the particular item. In the end, the new structures of expertise are transferred to the student with minimal amounts of communication and maximal resultant internal memory.

As an example, we might consider the interaction of a chemistry teacher and student when the student asks how to operate a balance. One teacher might take this as the opportunity for a lecture and launch into 20 minutes of balance theory, whereas another might encourage the student to experiment with the balance on his own. The first technique might be effective in the long run, but it would be inefficient indeed; the second might be easy for the teacher but has the potential of being completely fruitless. In contrast, a teacher using a transactive approach would encourage the experimentation but then would watch to find the student's first error, correct this, and then encourage more experimentation. Each subsequent mistake, as it is corrected, provides the opportunity for transmission of precisely the information the student needs to complete the operation. The instruction passes information easily and certainly, and the reorganization of the group's memory that results takes place with the minimum of confusion. It is interesting that people drift naturally toward such transactive instruction, and that it works so very well.

Organization Management

The managers of organizations are sometimes put in the unusual position of having to design a transactive memory from scratch. Although they may not know they are doing this, they go ahead and assemble a group of people, give them positions in the organization, tell them who to report to, write their job descriptions, and so on. More often, of course, managers do not have the luxury of starting fresh in this way and must manage instead by making revisions in the organizational structure when these become possible. In either case, however, the structuring of an organization is clearly an exercise in structuring transactive memory as well. Classic studies of organizational communication patterns (e.g., Leavitt, 1951; see Mullen, Chapter 1, this volume), have alerted many managers to the "connections" that are being made when an organization is put together.

The task of structuring organizations for the most effective transactive memory systems is a formidable one. It is helpful, however, to consider the dimensions along which such structures could vary. This at least allows the manager some sense of the appropriateness of the organization's memory to the organization's purpose. Wegner *et al.* (1985) have suggested that transactive memories can vary in the same structural dimensions often used to analyze individual memories—differentiation and integration. A differentiated transactive memory occurs when *different* items of information are stored in different individual memory stores, but the individuals know the general labels and locations of items they do not hold personally. An integrated transactive memory occurs when the *same* items of information are held in different individual memory stores, and the individuals are aware of the overlap because they share label and location information as well. Integrated transactive memory in an organization represents, then, an extreme of one kind; all organization members have duplicate knowledge. Differentiated transactive memory in an organization represents the opposing extreme; organization members share a limited core of labels and locations but otherwise diverge dramatically in their domains of storage.

These structural extremes vary in their effectiveness depending on the organization's task.

An organization with an integrated transactive memory is desirable when every member of the organization must personally carry out every function of the organization. A sales organization in which all employees are selling the same product, for instance, will give customers the most immediate information if every salesperson knows all about the product. The individual doing the selling should not have to call for technical help or ask someone about a price detail. This plan for organization design is useful, then, whenever the individual organization member must represent the organization without contact with other organization members. This plan for organization design does not give the individual member access to much information in transactive memory outside that available already in personal memory. For this reason, the individual member is not particularly dependent on the organization for informational support. The person could easily slip off and perform the appropriate functions alone or with another organization. In this structure, moreover, individual members who are already installed in the organization seldom benefit by getting together to compare notes. Because their knowledge bases are already duplicated, their conversations seldom bring together different items of information under the same label and so only infrequently will produce new and creative integrations of disparate items of information.

The operation of a differentiated transactive memory in an organization is useful in producing new integrations. When many people in the organization perform different functions, each has access to knowledge that others may label and locate, but do not know. Discussions among people in this sort of organization can be confusing, for they bring together items from different locations that may be only vaguely related to the label that is currently being considered. However, these discussions produce creative group products. (Eventually, it might be noted, such integrative discussions can transform the differentiated organization into an integrated one.) The potential for knowledge storage and production in a differentiated organization is naturally much greater than that in an integrated organization. Because individual minds are not duplicating their efforts, there is a much more efficient use of storage. Each individual brings to the organization a wide array of new knowledge, and contact with the appropriate knowledge location experts in such an organization can yield much more information than any individual could produce. Unless all the members of the organization are connected with high-speed computer communications devices, however, the organization's encoding and retrieval processes will be sluggish indeed, resembling those of a brilliant slow person.

Many difficulties in organization management can be traced to the improper matching of transactive memory structures to organizational tasks. The wise manager would consider the properties of each of these structures in planning the layout of an organization. In putting together a retail store, for instance, one might assume that salesclerks are interchangeable; certain benefits in the uniformity of training, the replaceability of workers, and the like would result from the strategy of organizing these people into an integrated memory structure. A customer asking a question about a product in the stereo department might be met with a blank stare by every employee in the store, however, and so leave one wondering whether an assembly of experts in the various retail areas would not be better. A more differentiated transactive memory would allow the organization to provide the information services that people often want to accompany their products. Depending on the kind of retail outlet one wanted to develop, then, very different transactive memory strategies would be appropriate. Of course, the integrated and differentiated structures need not characterize the entire organization uniformly. These could be mixed and matched in different departments of the organization, with the appropriateness of each to the task of each organizational unit taken into account.

Conclusions

The idea of transactive memory provides a useful way of understanding how people think together. The traditional theories of the group mind, aside from their aforementioned problems, have always suffered from an overly simplistic view of group mental operations. The notion of the group mind has always served as a shorthand for the uniformity of individuals' mental processes and behaviors. In the mass movements of a crowd, the majority decisions of an electorate, or the sweetly homogeneous mindlessness of people in love, theorists have only seen the *similarity* of individual minds as a hallmark of the group mind. Transactive memory describes a social network of individual minds that transcends such uniform agreement.

A transactive memory system is interesting precisely because it connects disparate minds. The fully integrated transactive structure is, in a sense, a deterioration of the richness and complex connectedness of individual minds that can be found in a group. When everyone thinks the same thing at the same time, there really is no reason to speak of a group mental entity—for there is nothing new added by the social context of the individual's thought processes. This, then, is the real departure that transactive memory theorizing makes from the tradition of group mind theory that characterized early social psychology. Transactive memory incorporates the system of interconnections that exists in individuals' communications of information and, hence, places direct emphasis on the social organization of diversity rather than on the social destruction of diversity.

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research reported here. Address correspondence to the Department of Psychology, Trinity University, San Antonio, TX 78284.

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