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Collaborative Remembering and Collective Memory

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Abstract

A trip down the memory lane is often a social experience. To understand how recalling the past with others shapes our memory, it is important to appreciate the reciprocal influences between the collective and the individual. In this chapter, I focus on cognitive research that examines individual and collective memories that develop in a social context. The studies reviewed here are typically experimental in nature although some studies involved other research techniques such as surveys. The theoretical explanations reviewed here, including a framework we have previously proposed, identify cognitive mechanisms that operate when people engage in collaborative remembering. A confluence of these cognitive mechanisms not only influences the group memory product, it also produces post-collaborative changes in what people remember and how they organize these memories. I also discuss research on collaborative remembering across the lifespan, collaborative memory for emotional information, and the social transmission of false memories. While collaborative memory studies have used mainly small groups, I also include recent research that uses larger groups and social networks to understand social transmission of memory. Finally, I focus on the nature of collective memory. While collective memory has been a topic of long-held interest in sociology, anthropology, and history, recent research has brought to light psychological perspectives. In the context of studying the cognitive bases of social remembering, I discuss experimental studies that are particularly relevant for understanding the relationship between collaborative remembering and collective memory.

Collaborative Remembering and Collective Memory

Humans are social creatures. Whether we are entering kindergarten, studying for a major exam, catching up on the news, reminiscing about a vacation, regaling a new family member with family lore, or remembering to take medicine, we learn and remember with others throughout our lives. To understand how social context shapes our memories, it is critical to appreciate that there exists a reciprocal relationship between the collective and the individual. The collective shapes what information individuals receive from others. In turn, individuals process this incoming information within their unique, pre-existing cognitive architecture, thus filtering it before they propagate it further and reshape the collective.

What can cognitive research tell us about how mechanisms of learning and memory operate in these socially constrained situations? How does information transmit and transmute among social connections? What unique theoretical and experimental insights can we uncover about how cognition underpins this reciprocal relationship between the nature of individual memory and the emergence of collective memory?

Interestingly, over a century of traditional experimental research on human memory has focused mainly on the individual. I will call this *the individual memory approach.* In this tradition, memory researchers have assiduously treated social influences as extraneous factors that need to be controlled in experiments rather than testing them as variables of interest. To be clear, there was no lack of recognition that social context influences memory. In fact, Bartlett's (1932) classic book on this subject and his influential ideas therein have remained current to date. Ebbinghaus (1885) too acknowledged that social influence permeates memory and for that reason recommended controlling for it so that we could arrive at core memory

principles. As students of memory research know, this pristine approach paid big dividends in the decades to come (Crowder, 1976). We now have a rigorous body of research yielding principles that explain numerous memory functions in the individual.

The individual memory approach also created a foundation upon which we can now situate interdisciplinary questions about the nature of social memory. We can leverage existing cognitive principles and design novel experiments to test how social interactions change memory. I will call this *the social memory approach*.

The historic context, of a turn from a focus on individual memory to asking questions about socially situated memory, makes this review of recent cognitive research on social memory particularly useful. I have organized this chapter into two sections. In the first section, I provide a selective review of the cognitive research on the nature of collaborative remembering. In the second section, I focus on the study of collective memory in psychological research and I connect processes of collaborative remembering that give rise to collective memory. I conclude with some closing remarks.

Collaborative Remembering

Just over two decades ago, Weldon and Bellinger (1997) published an article titled "Collective memory: Collaborative and individual processes in remembering". This article appeared in the same issue of a journal alongside another article on a comparison of group and individual remembering by B.H. Basden and colleagues (B.H. Basden, Basden, Bryner, & Thomas, 1997). Together, these seminal papers offered great examples of leveraging individual memory principles to study social memory and helped usher in a new area of study in cognitive psychological research to understand "memory as a social process" (Weldon, 2001).

The experiments on collaborative memory research in the 1990s (e.g., B.H. Basden et al., 1997; Meudell, Hitch, & Boyle, 1992; Weldon & Bellinger, 1997) offered a method that can be distilled into a prototypical paradigm shown in Figure 1. In a typical collaborative recall study, all participants study the to-be-remembered information alone. This information may consist of words, pictures, narratives, film, emotional information, and so on. The memory test of interest involves collaboration between two or more of these participants. The study-test interval typical of memory experiments usually consists of a few minutes but can be longer depending on the researchers' interests in the effects of delay. This interval can be also filled in meaningful ways where the individual participants continue to perform tasks to shape their content and organization of memory before they engage in collaborative recall (Congleton & Rajaram, 2011).

The collaborative recall paradigm. A test of collaboration occurs during recall in this paradigm. Half of the participants recall the studied information in small groups, usually consisting of three members though in occasional studies consisting of dyads or four members (B.H. Basden, Basden, & Henry, 2000; Thorley & Dewhurst, 2007) and the other half of the participants recall the studied information alone. As intuition suggests, collaborative recall is typically higher than individual recall, as illustrated in Figure 1. The key comparison is between the recall of collaborative groups compared to nominal groups or groups in name only. A nominal group is constructed by pooling the recall of three randomly selected participants who recalled individually and counting the redundant items in their recall only once. This comparison provides a measure of changes in memory performance as a function of collaboration during recall.

Figure 1 shows the prototypical collaborative recall paradigm, as earlier noted. Variations of this paradigm have been used to test a number of hypotheses. Figure 2 shows *an integrative cognitive framework* we have developed to capture the pre-existing cognitive structures that individuals bring to the collaborative recall situations, the different mechanisms that come into play during collaborative recall, and the consequences these mechanisms produce on memory during and after collaboration (Rajaram, 2011; Rajaram, 2017; Rajaram & Maswood, 2018; Rajaram & Pereira-Pasarin, 2010). Throughout this chapter, I will refer to the details of this framework to organize and describe the processes and consequences of collaborative remembering.

Collaborative recall produces memory deficits: Retrieval disruption and retrieval inhibition. The outcome of a comparison between the recall of collaborative groups and nominal groups is counterintuitive. Collaborative groups recall reliably less than nominal of equal size. Weldon and Bellinger (1997) tested this comparison using well known memory principles in the individual memory literature and examined group recall for studied words as well as studied pictures, for information studied for meaning as well as at a shallow level, and for a discursive narrative (the *War of the Ghost* story, previously used by Bartlett). Collaborating groups consistently exhibited a memory deficit while exhibiting the well-replicated picture superiority effect (better recall for pictures than words; Paivio, 1971), and the levels of processing effect (better recall for meaningful processing than shallow processing; Craik & Lockhart, 1972). Weldon and Bellinger (1997) called this group deficit phenomenon a *collaborative inhibition in recall*.

The collaborative inhibition effect has been replicated many times (see Marion & Thorley, 2016, for a meta-analytic review) and for a variety of study information (see Rajaram & Pereira-Pasarin, 2010; Rajaram & Maswood, 2018). This memory deficit reliably occurs for groups consisting of three or more members. For dyads, the collaborative inhibition effect is usually smaller and less reliable (B.H. Basden et al., 2000; Thorley & Dewhurst, 2007). In much of the research, the group members consist of strangers in order to control for unsystematic influences of different degrees and nature of familiarity across groups. Empirical work has clarified that the collaborative inhibition effect does not occur due to social loafing that leads to diffusion of responsibility (Latane, Williams, & Harkins, 1979; Weldon, Blair, & Huebsch, 2000).

It is also important to note that the collaborative inhibition effect is specific to the free recall task, as this effect is reduced in cued recall (Finlay, Hitch, & Meudell, 2000) and absent in a recognition task (Clark, Hori, Putnam, & Martin, 2000). Furthermore, the collaborative inhibition effect usually occurs for episodic memory, as it has not been observed in the recall of pre-existing (or semantic) information such as historical events (Andersson & Rönnberg, 1996) or general knowledge (Weldon, 2001).

The retrieval disruption hypothesis of collaborative inhibition. Why do people recall less than their potential when working in groups? To answer this question, B.H. Basden et al. (1997) drew upon the retrieval strategy disruption hypothesis that was previously proposed to explain the well-known part-set cuing deficit (Slamecka, 1968, 1969) in individual memory performance. In the part-set cuing procedure, participants are presented with a subset of the studied words to use as retrieval cues to recall the remaining studied words. Participants work on this individually. Interestingly, these studied word cues lower recall for the remaining

studied words compared to a free recall condition where participants receive no cue to aid recall. According to the retrieval strategy explanation for this individual memory deficit, the part-set cues interfere with the idiosyncratic organization people develop for recalling studied information and this disruption lowers recall. In the collaborative recall situation, study items recalled by other group members create a similar *retrieval disruption* to the listening members' idiosyncratic organization of information, which serves to lower each group member's recall and consequently the recall of the collaborating group. This explanation receives support from the evidence noted above that collaborative inhibition reduces in the cued recall task and disappears in the recognition memory task. In these tasks, partial or full study information is fixed by the experimenter and, as a result, the participant's own idiosyncratic retrieval strategies are not likely to play a role in performance as is the case in free recall

The loss of information during collaborative recall can be temporary such that on a later recall task, where each member performs the task alone (and thus experiences no disruption), some of the previously unrecalled items *rebound* (Congleton & Rajaram 2011). But other items are not recovered even on a recognition task (Barber, Harris, & Rajaram, 2015). Since recognition memory task makes the items available, these findings indicated that these items are not just blocked from access but are suppressed or inhibited in memory. Such information loss due to collaborative recall has been also reported in another paradigm derived from the individual memory literature. In the retrieval-induced forgetting procedure (Anderson, Bjork, & Bjork, 1994; see also Chapter 6.3) utilized to examine the nature of forgetting in individual performance, practicing the recall of some exemplars from a given category lowers recall of the unpracticed exemplars from that same category compared to recall of unpracticed exemplars

that belonged to a completely different, entirely unpracticed category. Studies have shown that when participants listen to a conversational partner recall some exemplars (i.e., practiced exemplars), the listening participants exhibit socially induced forgetting of the unrecalled exemplars from that same category (Cuc, Koppel, & Hirst, 2007). .

When does the collaborative inhibition effect diminish, and can collaborative facilitation occur? There are conditions where the collaborative inhibition effect is reduced or even reversed. Research shows that if group members are friends or spouses, the collaborative inhibition effect reduces but it does not usually disappear (Andersson, 2001; Andersson and Ronnberg, 1995; Johansson, Andersson & Ronnberg, 2000, 2005). This reduction is said to occur because long-term practice with collaboration allows transactive memory arrangements where partners divide the work of remembering (Wegner, Guiliano, & Hertal, 1985). As noted above, collaborative inhibition is also temporary such that collaborative inhibition is absent when a 2-h (Congleton & Rajaram, 2011) or 1-week (Takahashi & Saito, 2004) is inserted between study and recall.

Another factor that reduces or eliminates collaborative inhibition is the strengthening of each group member's retrieval organization before they perform the collaborative recall task. We know that individuals organize their recall and one principle they use to do so is semantic clustering, that is, recalling together items that are related in meaning (e.g., see Manning & Kahana, 2012; Polyn, Norman, & Kahana, 2009). Further, repeated study (e.g., Rundus, 1971) as well as repeated retrieval (Roediger and Karpicke, 2006a, b; see also, Chapter 11.1) improve later recall and memory organization (Congleton & Rajaram, 2012; Roenker, Thompson, & Brown, 1971; Zaromb & Roediger, 2010). Drawing upon these findings,

researchers implemented repeated study (Congleton & Rajaram, 2011; Pereira-Pasarin & Rajaram, 2011) and repeated retrieval conditions (Congleton & Rajaram, 2011) in individual recall prior to asking participants to carry out collaborative recall. Repeated study reduced collaborative inhibition and repeated retrieval eliminated the effect. This outcome is consistent with the idea that strengthened retrieval organization is less susceptible to disruption from collaboration and therefore protects memory performance in collaborative situations. Consistent with this rationale, Meade, Nokes, and Morrow (2009) reported that when expert pilots collaborated to recall recently reviewed aviation-related scenarios, they exhibited a collaborative facilitation effect. Experts by definition can develop well-organized representations of related study information that facilitate acquisition of new, related information (Brod, Lindenberger, Wagner, & Shing, 2016). Expert pilots also exhibited better communication style, reminiscent of cross-cueing benefits described later, where they could trigger rather than disrupt each other's memories.

Collaborative recall produces memory gains: Re-exposure, cross-cueing, error pruning, and relearning via retrieval. Surveys show that older and young adults believe collaboration improves memory (Dixon and de Frias, 2007; Dixon, Gagnon, & Crow, 1998; Henkel and Rajaram, 2011). Why do people believe collaboration helps memory when experimental findings show that collaboration not only lowers group recall but also leads to transient post-collaborative memory deficits?

Several consequences of collaboration improve memory and as such support people's beliefs. One is the process of *re-exposure* (Blumen & Rajaram, 2008). When participants engage in collaborative recall, they are often exposed to study information that they had forgotten but

other group members recalled. This re-exposure is essentially another opportunity to study the information such that it can improve later memory performance. We know from a long tradition of research on individual memory that repeated study improves recall and recognition (e.g., Rundus, 1971). The memory benefits of re-exposure that occur during collaboration are then measured on a follow-up individual memory test by comparing performance of those who collaborated versus those who recalled alone earlier, as shown in Figure 3. These gains in individual memory following collaboration are more than the gains observed through the process of hypermnesia where people show gains from one recall to the next across repeated recalls even when recall alone (B.H. Basden et al., 2000; B.H. Basden, Basden, & Reysen, 2002; Finlay et al., 2000; Rajaram and Pereira-Pasarin, 2010; Weldon and Bellinger, 1997). Several studies show that prior collaborative recall improves later individual memory performance (Blumen & Rajaram, 2008; Blumen & Rajaram, 2009; Blumen & Stern, 2011; Congleton & Rajaram, 2011; Henkel & Rajaram, 2011; Weldon & Bellinger, 1997) and this effect is particularly evident following repeated collaborative recall sessions compared to repeated individual recall sessions (Blumen & Rajaram, 2008; Blumen & Stern, 2011).

In order to determine whether collaborative remembering leads to downstream memory decrements (e.g., as with retrieval inhibition) or memory improvements (e.g., as with re-exposure), or both, several experimental procedures and scoring methods may be implemented. A calculation of which group member recalled what items during collaborative recall and in post-collaborative recall, the re-exposure gains as well as retrieval inhibition effects can be separately calculated (see Congleton & Rajaram 2011, for an analysis of such gains and losses). Returning to the phenomenology of collaboration benefits, being able to later

recall items that one had heard from a group member before gives rise to the belief that collaboration helps memory.

Cross-cueing during collaboration is another process that supports the beliefs that collaboration improves memory. When one group member recalls an item, it can trigger for another group member the memory for a studied item that they had not remembered until then and thus give rise to the experience of benefitting from collaborative recall. Benefits of cross-cueing have been more difficult to measure although some lines of indirect evidence support the operation of this process during collaboration and its memory benefits (Blumen & Rajaram, 2008; Blumen & Stern, 2011; Congleton & Rajaram, 2011; Meudell, 1996; Meudell, et al., 1995; Meudell, Hitch, & Kirby, 1992).

Collaborative remembering improves memory by also enabling group members to *prune errors in* others' recall (Weigold, Russell, & Natera, 2014). When one member incorrectly reports an item as studied but another member corrects that error, this process not only increases the accuracy of group recall and of post-collaborative individual recall, it also provides the experience of benefiting from working with others. The extent to which collaboration enables error pruning can depend on the particular method of collaboration. For example, compared to nominal group recall, when people engage in free-flowing collaboration (Figure 4, Column titled "Collaborative: Free-flowing"), such that they can jump in with their contributions whenever they want, correct others' recall, and develop their own approach to settling on the final recall product, or when the group members are required to reach consensus, the group product shows lower recall intrusions (Harris, Barnier, & Sutton, 2012; Meudell et al., 1995;

Ross, Spencer, Linardatos, Lam, & Perunovic, 2004; Thorley and Dewhurst, 2007; Weldon & Bellinger, 1997).

By contrast, when group members take turns to report the studied items and speak only on their turn (Figure 4, Column titled "Collaborative: Turn-taking; Social Contagion"), little error correction or consensus building can take place and the group product shows more intrusions than the nominal group (B.H. Basden et al., 1997; Thorley & Dewhurst, 2007). Why might experimenters use the turn-taking procedure when it can lead to more intrusions? A clear benefit of the turn-taking procedure lies in being able to prevent social loafing where group members might leave the responsibility of recall to others instead of making full contributions (B.H. Basden, et al., 1997). Increases in memory errors can also occur in a typical social contagion paradigm where the target participants take turns when working with a confederate to produce the studied items (e.g., Roediger, Meade, & Bergman, 2001). In this procedure, once again there is usually little opportunity to challenge or correct the confederate's responses or to benefit from the confederate's corrections, and thus there can be an additional increase in memory errors both during and after the collaboration session.

Collaborative recall also involves *relearning via retrieval* when people recall in group settings. This process is like the benefits of repeated retrieval on memory that have been widely reported in individual memory performance (e.g., Roediger & Karpicke, 2006b). In the context of collaborative recall, repeated retrieval is instantiated in the speaker rather than the listener and therefore ought to improve retention more for the speaker than the listener. Evidence for the benefits of this relearning process comes from an experiment where participants studied Swahili-English vocabulary word pairs (Abel & Roediger, 2018). During

recall, when participants listened and monitored the speaker's recall of word pairs, their long-term retention measured after two days was no better than having simply restudied the word pairs. In contrast, overt recall of vocabulary word pairs by the speakers led to their showing better retention two days later. Only when the listeners paid attention to their own covert recall rather than paying attention to the speaker's output did the listeners exhibit better long-term retention of the study information. In other words, in situations of collaborative remembering, it is the speaker or the group member who does the recalling that exhibits long-term gains of collaboration.

Collaborative recall influences memory organization. The description so far has focused on the consequences of collaborative recall on the content of later individual memory, that is, what people remember afterwards. Collaborative recall also produces a deeper change in memory beyond the changes in memory content; during collaboration, not only do group members experience disruption to the way they prefer to organize information, but people also reorganize information in their memory as a function of collaboration (Congleton & Rajaram, 2014). The structure of memory is typically calculated by examining the organization of retrieval using the pair-frequency (PF) measure (Sternberg and Tulving, 1977) and the adjusted ratio of clustering (ARC) measure (Roenker et al., 1971). The PF measure requires comparing the outputs from two consecutive recall efforts and it has the advantage of calculating memory organization even for unrelated information based on how often people recall the information in the same sequence across the two tests (Gates, 1917; Sternberg and Tulving, 1977; Tulving, 1962). The ARC measure is used for recall of information and is calculated by quantifying in recall the degree to which items are clustered together in recall from the same taxonomic

category (e.g., fruits, furniture, etc.; Bousfield, 1953). ARC's advantage is that it can be used to assess organization within a single recall output.

As we know from the literature on individual memory, recall influences retrieval organization. A growing number of experiments now show that collaborative recall also influences retrieval organization. When people collaboratively recall information, their recall is organized differently than when they recall alone. For unrelated words, the PF measure across two recall attempts has shown that collaborative groups show marginally more consistency across two recalls (collaborative, collaborative) than do individuals who recall alone (individual, individual) (Blumen & Rajaram, 2008; Choi, Blumen, Congleton, & Rajaram, 2014; Weldon & Bellinger, 1997). Another set of findings show two interesting patterns in an experiment where participants studied words from various taxonomic categories and the ARC measure was used to compute retrieval organization (Congleton & Rajaram, 2014). First, when people recall multiple times (individual first, collaborative second, or vice versa; see Figure 4), their most recent prior recall has a stronger impact on their final individual recall. Second, relative to prior collaborative recall, a prior individual recall sequence has a stronger impact on final individual recall. This finding makes sense because individual recall organization is more strongly matched to the pre-existing cognitive structures people bring to the recall situation (see Figure 2); the collaborative recall organization is newer and more labile, by comparison. These findings also suggest that as people continue to collaborate especially with the same partners, they are likely to develop a new, group-driven organization of information in memory (see Choi et al., 2014).

Collaborative remembering across the lifespan. A major motivation in the study of collaborative remembering has been to understand this process not only in young adults but

also across the lifespan. First, looking at the counterintuitive and disruptive consequences of collaborative recall, studies show that collaborative inhibition in recall is not limited to young adults. Children aged 7 to 14 years (Andersson, 2001) or 7 to 9 years (Leman and Oldham, 2005) exhibit collaborative inhibition in recall. Furthermore, healthy older adults also show collaborative inhibition in recall. This recall deficit in older adults is reliable (Blumen & Stern, 2011; Henkel & Rajaram, 2011; Johansson, et al., 2000, 2005; Meade & Roediger, 2009; Ross, Spencer, Blatz, & Restorick, 2008; Ross et al., 2004), and has been observed for a variety of memorized information such as unrelated words (Blumen & Stern, 2011), categorized words (Henkel & Rajaram, 2011; Meade & Roediger, 2009), emotionally valenced, picture stimuli (Barber, Castrellon, Opitz, & Mather, 2017), and household scenes (Ross et al., 2008). The collaborative inhibition effect in older adults is typically equivalent to that exhibited in young adults despite concurrent evidence for age-related, memory decline in older adults (Henkel & Rajaram, 2011).

The disruptive effects of collaboration on memory notwithstanding, there has been considerable interest in asking whether socially supported reminiscence can also improve memory functions in normal and pathological aging. This interest is particularly supported by the evidence noted earlier that many cognitive mechanisms that operate during collaborative recall contribute to memory improvement in young adults (re-exposure, cross-cueing, and error pruning) and the disruptive effects of collaborative inhibition in recall are often temporary (Blumen, Rajaram, & Henkel, 2013a, 2013b). In this context, some researchers have been particularly interested in examining the possible benefits of collaboration using more ecologically valid memory content (relative to lab-based words lists), such as recalling shopping

lists, landmarks, recalling names of persons in participants' Rotary club or recalling shared events such as a couple's first date (Harris, Keil, Sutton, Barnier, & McIlwain, 2011; Johansson, et al., 2000; Ross et al., 2004). One study reported that when 12 married couples recalled personally relevant information, some couples exhibited collaborative inhibition in recall whereas others exhibited collaborative facilitation, with the latter outcome being attributed to group-level strategy use (Harris et al., 2011). In another study, older couples once again exhibited collaborative inhibition for recalling shopping lists and landmarks (Ross et al., 2004) but made fewer false recalls when working together (Ross et al., 2004). In yet another study, older couples exhibited collaborative inhibition in recall for the details of a campus visit although once again those who used the group strategy of transactive arrangements for recall did not exhibit this inhibition (Johansson et al.2000).

Returning to the traditional word list paradigms studied in laboratory settings, emerging evidence shows that like young adults, older adults also show downstream memory improvement in individual recall following collaboration (Blumen & Stern, 2011; Henkel & Rajaram, 2011; but see Meade & Roediger, 2009). Continued discoveries in this area of research are particularly important for addressing the urgent and widespread need for economical and effective strategies to support memory function in aging.

Collaborative remembering of emotional information. The majority of laboratory studies on collaborative remembering provided neutral information to participants for memorization and recall. This body of work helps establish the basic principles of social influences on memory and enables researchers to address next the range of situations that make life richer, deeper, and complex, such as where we reminisce about emotionally salient

experiences with others. Indeed, psychological research suggests that people are more likely to share emotionally salient than neutral information with others and forward emotional news (Berger, 2011; Berger & Milkman, 2012; Heath 1996; Luminet, Bouts, Delie, Manstead & Rimé, 2000). A key reason for sharing emotional information is hypothesized to be to regulate negative affect tied to that information, to boost positive affect, or to enhance social bonds (Rimé, 2009). Developmental research also shows that mother–child conversations of emotionally salient events help children build affiliation with their caregivers and develop emotion-coping strategies (Wang & Fivush, 2005; Fivush & Wang, 2005). Such evidence suggests that people are particularly likely to engage in social sharing of emotional information, prompting the question how sharing emotional information shapes individual and collective memories and how such memories transmit in social networks.

First turning to the collaborative inhibition effect in recall, as noted earlier, participants show the standard memory deficit in recall for emotional salient information when they collaborate versus when they recall alone. The collaborative inhibition effect has been reported for the recall of emotional picture-word stimuli (Barber et al., 2017; Choi, Kensinger, & Rajaram, 2017) and negatively valenced emotional information, such as an emotional film (Wessel, Zandstra, Hengeveld, & Moulds, 2015) and the recall of the assassination of Israel's Prime Minister Itzak Rabin (Yaron-Antar & Nachson, 2006). Not only does the collaborative inhibition effect occur for emotional information, it is often of a comparable magnitude to that observed for neutral information.

Studies of individual memory for emotional information show that people not only remember emotional information better than neutral information (Buchanan, 2007; Hamann,

2001), they also often remember negative information better than positive information (Kensinger, 2007). This negativity effect is further enhanced in post-collaborative recall, where a memory advantage for negative information persists if collaboration took place earlier (Choi et al., 2017). As Choi et al. (2017) suggested, this negativity effect as a consequence of collaborative recall may reflect people's motivation to discuss negative events more in order to regulate the associated negative emotion (Rimé, 2007). Consistent with this possibility, when participants recalled an autobiographical event (e.g., an exam that all three members took), collaborative recall down regulated the valence ratings for the event and increased the positive tone in their later individual account of it (Maswood, Rasmussen, & Rajaram, 2019).

Collaborative remembering confers another protective benefit on memory for emotional information and this occurs in the form of reducing the social contagion errors people make in memory performance. Two different paradigms, a version of the collaborative memory paradigm as well as of the social contagion paradigm where a target participant works with a confederate to take turns to recall information, have yielded converging patterns of results. People make fewer memory errors for valenced information than neutral information following collaboration than when working alone to perform the memory tasks (Kensinger, Choi, Murray, Rajaram, 2016).

In contrast to the collaborative remembering of past emotional information and events discussed so far, a recent study examined the effects of valence for prospective rather than retrospective events (Shrikanth, Szpunar, and Szpunar, 2018). These researchers asked participants to list things that they were excited about or worried about in the next week, next year, or in five years. In addition, to provide this assessment for the collective future,

participants answered the same questions with regard to the future of their country. A consistent pattern of responses emerged across several experiments, spanning participants tested from the U.S. or from Canada, and tested in the lab or on the crowd-sourcing Mechanical Turk platform. Participants provided their individual views about the future. While they were positive about their personal future, they showed negativity about the collective future. Although outside the realm of retrospective memory investigations on which this research has largely focused, this dissociation suggests a new perspective on understanding how sociality and valence intersect in prospective memory.

Social transmission of memory: Propagation of true and false memories. A major goal behind the experimental research on collaborative remembering is to understand how memories transmit across social connections (for related findings, see Chapter 12.9). As with a long-standing interest in collective memory, social scientists have been interested in the spread of social influence in communities and societies (e.g., Cialdini, 2001; Christakis & Fowler, 2009; Schelling, 2006). In this research area, sociological and epidemiological work has produced striking patterns of findings to show that behaviors such as smoking can be influenced by our social networks, and even psychological characteristics such as loneliness are associated with the networks we inhabit (Christakis & Fowler, 2007, 2008). Recent computational modeling research based on the cognitive principles of collaborative recall have tested mechanisms of retrieval disruption and re-exposure gleaned from experimental research using small groups (described earlier in this chapter) to examine how information propagates in large social networks (Luhmann & Rajaram, 2015). By including both direct connections of neighbors in these social networks as well as indirect connections that are separated by intervening

neighbors, this agent-based model revealed that our memories are influenced by those with whom we interact directly as well as those who are indirectly connected to us, that is, our neighbor's neighbors and so on.

In this vein, experimental work using small groups has examined social transmission of memory via collaborative recall of a list of words in identical groups versus reconfigured groups. This work focuses on transmission of accurate information although some experimental designs additionally allow a test of the transmission of false information (e.g., Choi et al., 2017). In the identical groups, people recall the studied words with the same two partners and in the reconfigured (or diverse) groups partners change from one collaboration session to the next while holding the total number of collaborative sessions constant (see Figure 5; Choi et al., 2014; also see Choi et al., 2017). The reconfigured groups provide many interesting characteristics to ask questions about the social transmission of memory. Because partners change from one collaborative session to the next, this procedure creates both direct and indirect partners whose influences can be tracked across collaboration sessions. In a design where three members collaborate at a time, the reconfigured groups also enable the experimenter to measure the influences of as many as eight partners (four direct and four indirect) on any given individual's memory. Finally, a comparison of identical versus reconfigured groups enables a test of how collective memories (overlaps in the post-collaborative memories of individuals who previously collaborated together) emerge in groups where the recall process, and presumably as a result also the content, remain insular (identical groups) or become diversified (reconfigured groups).

This laboratory work, conducted with participants in face-to-face, collaborative recall situations, shows that our memories are influenced by both direct and indirect partners (Choi, et al., 2014). Furthermore, participants exhibit shared (collective) memories with both directly and indirectly connected group members, such that the similarity in memory content is greater for those who are closely connected and declines as the separation between partners increases (Choi et al., 2014; Coman, Momennejad, Drach, & Geana, 2016; Luhmann & Rajaram, 2015). Furthermore, our research has shown that when participants are presented with emotionally valenced versus nonemotional information to study and recall, identical groups amplify memories for negative information compared to reconfigured groups (Choi, et al., 2017). Identical groups also promote confidence in false memories compared to diverse groups (Choi et al., 2017). These laboratory paradigms illustrate the opportunity to precisely track people's memories as they transmit information in different group structures and the memory distortions that might occur in that process. Analysis of how group structures influence memory transmission and the emergence of collective memory also offers direct insight into real-world phenomena such as echo chambers on social media, biased news reporting, sharp contrasts in socio-political identities, and sectarian views often seen in public discourse. I now turn to some examples of studies that specifically focus on the social transmission of false information.

Social transmission of false or distorted memories. Frederic Bartlett's (1932) ideas and research reported in his seminal book *Remembering: A Study in Experimental and Social Psychology* continue to be highly influential in our understanding of how social transmission can distort memories. Bartlett noted in the preface of his book that he aimed to combine the controlled method espoused by Ebbinghaus for investigating memory functions with as much

realism as possible. Bartlett's major thesis was that memory is a reconstructive process and that people use their pre-existing schemas to make sense of incoming information. In this process, they distort and align new information and its recollection to fit it into their existing cognitive framework. To examine this thesis, Bartlett reported two primacy techniques. The first is known as the repeated reproduction method where the same participant repeatedly recalls studied information such as a narrative. The second technique is known as serial reproduction or a chain method where the recall by one participant is handed as study material to the next participant, and so on. Bartlett reasoned that the serial reproduction method entails social influences on remembering and, though he did not directly compare the two reproduction conditions, his findings suggest that the socially influenced method of serial reproduction leads to more memory distortions than the repeated reproduction method that does not involve social transmission of information.

Several studies have examined each reproduction method since Bartlett (1932) introduced them. But a direct, formal comparison of these two methods became available only recently, and findings from this study concur with Bartlett's observations (Roediger, Meade, Gallo, & Olson, 2014). Participants studied Deese-Roediger-McDermott (DRM) lists (Deese, 1959; Roediger & McDermott, 1995) of associatively related words (e.g., *bed, rest, awake, tired, snooze, and blanket*), which lead to subsequent false recall and false recognition of a critical related lure that was never presented (e.g., *sleep*) (see Chapter 6.5). Repeated reproduction, where participants worked alone to recall the studied DRM lists, led to a constant level of accurate recall of studied words across repeated recall attempts. By contrast, relative to all the words studied by the first participant in the Serial Production Chain, accurate recall declined

across the social chain where recalled information was passed from one participant to another. But when the analysis took into account the words that the second, third, and fourth participants in the social chain could have studied, i.e., the number of studied words accurately recalled by participants one, two, and three, respectively, the accurate recall actually increased. This pattern is consistent with the findings that recall improves as the study list becomes shorter (Crowder, 1976). Finally, the recall of critical lures (i.e., false memory) remained stable across repeated attempts in both conditions, which proportionately means that there was greater memory distortion, i.e., an increase in the recall of the critical lures related to recall of all items (accurate items plus critical lures), and therefore lower accuracy in recall in the socially influenced condition of serial reproduction compared to the repeated reproduction condition.

Since Bartlett's (1932) early work, memory researchers have had a long and ongoing interest in the social contagion of memory errors (see Maswood & Rajaram, 2018). Social contagion errors refer to a process where people incorporate into their own memory performance the erroneous or false recall of information made by others, and this phenomenon has been studied using different memory paradigms (e.g., Loftus, 2005). For example, the research on eyewitness memory and witness identification procedures that often employ individual responses nonetheless evaluate memory errors that arise from exposure to misinformation from social sources. Here, a few studies have tested this effect with dyads as well (e.g., Gabbert, Memon, & Allan, 2003; Gabbert, Memon, Allan, & Wright, 2004).

These approaches also involve the use of a confederate to systematically introduce memory errors and examine its influence on the memory errors that the target participant makes in their memory performance (e.g., Roediger et al., 2001). Contagion of memory occurs

for information such as everyday scenes (Davis & Meade, 2013; Huff, Davis, & Meade, 2013; McNabb & Meade, 2014; Meade & Roediger, 2002; Roediger, et al., 2001), pictures of crime scenes (Wright, Self, & Justice, 2000), and the associatively related DRM words (B.H. Basden et al., 2002). Social contagion errors are resistant to correction, such that participants incorporate incorrect suggestions made by their partners even when they are told that their partner has poor memory abilities (Numbers, Meade, & Perga, 2014).

In collaborative memory experiments, researchers have examined how group remembering among strangers gives rise to false recollections and the transmission of false memory (Figure 2, the social contagion mechanism). As noted earlier, in this paradigm the turn-taking procedure (where no back and forth discussion occurs) propagates memory errors because one member's erroneous recall goes uncorrected and gets incorporated into others' memory compared to the free-flowing procedure where error corrections are possible. These errors can increase under social pressure that promotes conformity (Reysen, 2007). Another factor that influences the propagation of memory errors concerns the size of the collaborating group. Thorley and Dewhurst (2007) reported that in the recall of DRM lists, the turn-taking method of collaboration produced more memory errors than did the free-flowing method of collaboration, and the memory errors increased as the group size increased, with the most errors being produced by those in the largest, turn-taking quartets. In contrast to the DRM stimuli that foster memory errors, research shows that emotional information reduces social contagion errors compared to non-emotional information, and this pattern occurs even when the experimental procedure uses a confederate to systematically introduce memory errors during the collaboration procedure (Kensinger, et al., 2016).

The examples of studies described in this section show the varied approaches that have emerged to examine how memories transmit in groups and can sometimes become distorted in the process. These experimental tests of the distribution of memories as a result of the transmission process allow us to also examine how memories become homogenized within a group, that is, how collective memories emerge. In the next section, I review a sample of studies that address this question.

Collective Memory

The concept of collective memory in the social sciences. The concept of collective memory has had a long history in social sciences, specifically in anthropology, history, political science, and sociology, where scholars have engaged in qualitative analyses of collective memory. Despite this widespread appeal, or perhaps because of it, there is not a single clear definition of collective memory (Wertsch, 2008). Dating back to Halbwachs' (1980, 1992/1925) groundbreaking work, collective memory has been defined in various ways. These definitions make a distinction between distributed memories that are contextualized out in the physical world and consist of artifacts such as texts, monuments, and museums versus memories that reside within individuals who comprise the collective (Hirst & Manier, 2008; Olick, 1999). These characterizations of collective memories can be also seen in the distinction between cultural memories that last for centuries and are embodied in artifacts of various sorts versus communicative memories that denote information shared across individuals or across generations and that can extend up to about a century (J. Assmann, 1995). In these definitions put forth by social scientists, a central feature of collective memory includes the function it serves to define the social identity of a group (A. Assmann, 1999). For example, memories of

the September 11 attacks are not only collectively held by Americans, these memories also relate to their identity as Americans. In contrast, the tsunami destruction in the Indonesian region is known to many Americans but does not pertain to their own group identity.

Collective memory in psychological science. The study of collective memory has been a more recent exercise in psychology. Here, the definitions psychologists have adopted to study the social transmission of memory generally align with the social scientists' ideas of memories residing within the individual or communicative memories. In psychology, too, different approaches have emerged for defining and measuring collective memory. Roediger and Abel (2015) identify three such definitions where collective memories can represent a body of knowledge, a narrative structure or an image of themselves that a group of people use to describe their collective past, or as a process by which people debate, challenge, and re-structure the details of the past to develop a specific representation of past events (Roediger & Abel, 2015). With respect to collective memory as knowledge, data from four different time points show that people exhibit a typical serial position curve (Deese & Kaufman, 1957; Murdock, 1962) in the recall of the U.S. Presidents' names, much as they do for recalling a list of words, where recall of the first few and the most recent Presidents' names is much higher than for the names of the Presidents who took office in the years in between (Roediger & DeSoto, 2014). The idea of collective memory as a narrative or an image of a people refers to the ways in which people identify the salient events in their collective history and the versions of this history they narrate. For example, the Japanese bombing of Pearl Harbor, the D-Day invasion of France, and the U.S. bombing of Hiroshima and Nagasaki are remembered as the beginning, middle, and end of World War II by Americans (Zaromb, Butler, Agarwal, & Roediger, 2014).

The idea of collective memory as a process refers to the negotiation or fight over what details to include in the collective narrative.

In other albeit related approaches, scholars have also drawn a distinction between collective memory and collective remembering and between collective memory and history (Wertsch & Roediger, 2008). Here, collective memory represents a static collection of events people remember whereas collective remembering refers to the process of negotiating what details to remember and reflects the active process of meaning construction Bartlett (1932) implied in the subtitle "Remembering" for his defining psychological book on social memory. In comparison to history, collective memory represents a biased perspective whereas history is intended to be an objective account of the past albeit this account can also be biased. For example, in collective memory how people remember historic events such as wars can differ depending on the side from which their country fought (Abel, Umanath, Fairfield, Takahashi, Roediger, & Wertsch, 2019). This meaning of collective memory embodies the component of social identity central to views about collective memory in the social sciences.

As with different definitions, the methodologies to study the nature of collective memory have also varied in psychological research. These methodologies include the use of surveys as well as laboratory- based experimental approaches, and for the latter, studies can vary in the extent to which stringent procedures versus ecologically valid elements are incorporated into the experimental designs. Occasionally, content analysis has also been employed. Some examples of these different methodological approaches appear in the following section, with a focus on cognitive psychological studies. The variety in methodologies notwithstanding, the definitions and methodologies in psychological research serve an

overarching goal that all these approaches share which is to ask the following questions from a psychological perspective - how are collective memories formed, altered, or forgotten (Hirst & Manier, 2008)?

As we consider some examples of collective memory research in this section, it is worth emphasizing that much as the relationship I outlined in the previous section between principles of individual memory and their operations in the process of collaborative remembering, several notable examples illustrate the connections between individual memory phenomena and collective memory phenomena.

Collective memory for historical events. Here, studies can be considered from a perspective of how collective memories reported by respondents reflect group identity. Recent studies using surveys show that people exhibit narcissism at a collective level just as they show egocentrism in individual memory. Drawing upon the well documented findings of egocentrism (e.g., Gilovich, Medvec, & Savitsky, 2000; Kelley & Jacoby, 1996; L. Ross, Greene, & House, 1977) which is "failing to see the world from someone else's perspective" (Putnam, Ross, Soter, & Roediger, 2018, Page 2), Putnam et al. asked 2898 U.S. participants questions about their state's contributions to national history ("In terms of percentage, what do you think was your home state's contribution to the history of the United States?"; also see, Churchill, Yamashiro, & Roediger, 2019). The aggregate estimate for contributions made by one's own state exceeded 900%, suggesting a narcissistic bias, where greater availability of information about one's own state compared to other states likely drove up the estimates. Overestimation about contributions to world events can be also seen in considering the contributions of one's country. From 35 countries, 6185 students answered questions about their country's

contributions to world events in general ("What contribution do you think the country you are living in has made to world history?"; Zaromb, Liu, Paez, Hanke, Putnam, & Roediger, 2018). Participants reported estimates about their country's contributions to world events that together exceeded a thousand percent (1156%). Such ethnocentricity was also evident when 1338 respondents from 11 different countries answered a specific question, regarding their country's contributions to World War II, with the estimates of contributions reported by participants from Allied countries totaling 309% and from Axis countries 140% (Roediger, Abel, Umanath, Shaffer, Fairfield, Takahashi, & Wertsch, 2019). Differences in how nations perceive their own roles and the outcomes of world events seem to drive the percentages that participants report as their country's contributions. In other words, ethnocentric biases can drive the differences in the national narratives about a nation's identity, losses, and victories. These narratives are important for shaping the collective memories people report and for the differences in these reports across countries for the same world events.

Collective memory across generations. Another approach where memory psychologists have used survey and interview methods to probe collective memory has focused on asking people from different generations about their memories for details about wars. Here, participants were asked to report details that they personally experienced or learned from older generations, textbooks, or general sources. These studies show that collective memories can differ for personally experienced versus historically learned memories. When older and young adults in the U.S. recalled details about the Civil War, World War II, and the Iraq war (Zaromb, et al., 2014), their memories for the details differed. For example, young adults in general showed more consensus in their recall of details than older adults, whereas older adults

recalled more extended events of longer durations than young adults. In another study, three generations from five French-speaking Belgian families were interviewed for their memories of World War II and their responses were coded (Stone, van der Haegen, Luminet, & Hirst, 2014). The oldest generation who lived through the war told more personally relevant memories than national memories, but the transmission of such memories was limited across generations and middle and younger generations primarily recalled nationally relevant memories. Together, these studies suggest that collective memories retain personal details for those who experienced events but are semantic in nature for those who learn about these events through secondary sources. In broad strokes, these patterns correspond to considerations in individual memory research about how specific episodic memories change to semantic memories or knowledge with the passage of time.

Collective memories that exhibit principles of individual memory. As briefly noted earlier, people collectively exhibit a serial position curve in their recall of the names of U.S. Presidents in much the same way they recall a list of words presented to them in laboratory experiments. In this study, across the waves of data collected in 1974, 1991, 2009, and 2014 participants exhibited a serial positive curve in the recall of the Presidents' names such that they recalled the first few Presidents and the most recent Presidents better than those who held office in between (Roediger & DeSoto, 2014). The exception to this pattern was Abraham Lincoln's name, which was frequently recalled despite the fact that he took office somewhere in the middle of this time period stretching from the first President George Washington to Barack Obama. As the authors noted, the high level of recall for Lincoln's name also exhibits a well-known individual memory phenomenon, namely the von Restoff effect, where a distinctive

item produces an isolation effect in recall and increases its recall (von Restorff, 1933). Furthermore, recall of the Presidents' names in these data also showed the same power function of forgetting as that observed for word recall in laboratory experiments (Wixted & Ebbesen, 1991).

Emergence of collective memory: A cognitive experimental perspective. As noted earlier, in the social sciences the concept of collective memory has strong roots in its service to group identity. Cognitive experimental research has instead focused largely on uncovering the processes that give rise to shared memory representations. Here, the concept of collective memory does not make a reference to identity. In these studies, the groups are typically constructed in the context of the experiment and are usually composed of strangers working together to remember information they studied in the experimental setting. The concept of collective memory is tested in terms of shared, overlapping memories among the members of a group, where it is computed with items that all group members recalled in their post-collaborative individual reports and sometimes also includes items that all group members failed to report afterwards (e.g., Barber, Rajaram, & Fox, 2012; Choi, et al., 2014; Congleton and Rajaram, 2014; Luhmann and Rajaram, 2015; Stone, Coman, Brown, Koppel, & Hirst, 2014; Yamashiro and Hirst, 2014).

Laboratory experiments to study the mechanisms of collective memory. The artificial setting of the laboratory and the use of word or picture stimuli in many of these experiments seem far removed from the live notions of collective memory for real-life and large-scale events. But the former approach also has major advantages. It allows us to identify the mechanisms by which collective memories emerge and the process by which collaboration

reshapes the content and structure of memory (Congleton & Rajaram, 2014; Weldon & Bellinger, 1997). Also, as Tulving (1983) noted: ‘‘words to the memory researcher are what fruit flies are to the geneticist: a convenient medium through which the phenomena and processes of interest can be explored and elucidated. . . words are of no more intrinsic interest to the student of memory than *Drosophila* are to a scientist probing the mechanisms of heredity’’ (Tulving, 1983, p. 146). As one example, categorized word lists, that is, word lists consisting of multiple exemplars (apple, grape, kiwi, banana, car, bicycle, scooter, truck, etc.) from a few categories allow us to examine how the recall of these words is organized, and how collaboration may change this organization through the process of re-exposure, error pruning, cross-cueing and so on. Such experiments provide insights into the ways in which more naturalistic information comes to be shared and organized similarly in memory.

The *integrative cognitive framework* displayed in Figure 2 offers a systematic approach to identify and organize multiple cognitive processes that operate during collaborative remembering and shape and reshape collective memory. We have elaborated on this approach in other writings to pinpoint how targeted empirical tests can map the contributions of various collaboration conditions (e.g., see Figures 4 and 5) to the activation of these cognitive processes and explain the emergence of collective memory (Rajaram, 2011; Rajaram & Maswood, 2018; Rajaram & Pereira-Pasarin, 2010). For example, when participants collaborate to recall information, re-exposure facilitates members to acquire others’ memories that they had themselves forgotten, thus increasing the similarities in the items that are collectively remembered. Social contagion of errors can transmit erroneous details across all group members and increase collective false memory. Retrieval disruption and retrieval inhibition can

diminish later recall of details that were not produced during collaboration by any group member, thus increasing the similarities in the items that are collectively forgotten. Error pruning can similarly eliminate information from later recall to homogenize the memory content across group members. In this context, experimental evidence shows that when people repeatedly collaborate with the same group members, their collective memories become increasingly similar compared to collaborating with different group members across the same number of collaboration opportunities (Choi et al., 2014), thereby demonstrating how basic cognitive processes can shed light on the emergence of echo chambers in conversations (see Marsh & Rajaram, 2019).

The structure of collective memory. The question here is whether collaborative recall leads to overlap only in the content of the group members' memories as shown in studies described thus far, or does collaborative recall also begin to create overlap in the way group members organize their memories? In an earlier section on collaborative remembering, I summarized evidence showing that participants exhibited a different retrieval organization in individual recall following their participation in collaborative recall. This outcome shows that collaborative recall engenders deeper changes in one's memory by changing the structure of memory, rather than changing only the contents of memory.

I also described earlier how the basic cognitive processes outlined in the integrative cognitive framework (Figure 2) provide a roadmap for understanding how each group member begins to develop a new version of the recall content after participating in collaborative recall. This set of cognitive processes, including in particular the process of retrieval disruption and inhibition, also contribute to how there can develop greater alignment across group members

for the way in which they organize this memory content. If this reasoning is correct, later recall would be guided less by one's own organization of study material and more by the group-level organization following collaborative recall. Across a series of studies, we have found support for this idea. For example, a single collaborative recall opportunity increases the overlap in retrieval organization compared to no collaboration, and repeated collaborative recall opportunities with same group partners increases the shared retrieval organization even more (see Figure 4, Column, Multiple Collaborations; Blumen & Rajaram, 2008; Choi et al., 2014; Congleton & Rajaram, 2014.) Furthermore, we observed that as the size of the collaborative inhibition effect increased, indicating greater disruption of the individual-level retrieval organization, the shared retrieval organization also increased in the later individual recall outputs of those who previously collaborated (Congleton & Rajaram, 2014). In other words, collaborative recall has far-reaching downstream effects on the memory of the individuals who engage in it, providing insights into how collective memories develop.

Concluding Remarks

Ebbinghaus (1885) and Bartlett (1932) provided two distinct approaches to study the nature of human memory. Ebbinghaus focused on pristine laboratory techniques that controlled for social influences and Bartlett emphasized a study of the social influences. At the same time, each acknowledged the importance of the other's focus. The confluence of these historical approaches has been particularly beneficial for the study of social memory from a cognitive perspective. As the examples of research reviewed in this chapter illustrate, a study of collaborative remembering and collective memory has important implications for understanding how memories transmit and coalesce among social connections. A study of

cognitive processes shows how memory disruption in social settings can lower group recall, but also have cascading influences for promoting collective memories. Collaboration can increase or decrease memory errors and a systematic experimental analysis allows students of memory to predict when these influences may occur. These findings about memory accuracy and errors have important implications for educational settings where group study practices are prevalent and in legal settings where eyewitness testimony can be pivotal. Researchers have also used survey tools to probe the recall of historical events by large numbers of participants and the role of collective narcissism in shaping this recall. With respect to clinical implications, early evidence suggests that collaborative remembering can confer benefits of emotion regulation and can serve to provide scaffolding in aging, where memory decline is common. Finally, in an era of rapidly expanding platforms of electronic social media a study of how false and true memories spread across social connections has important implications for understanding how users learn and transmit information.

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FIGURES for the Rajaram Chapter

Figure 1. A schematic illustration of a prototypical collaborative memory procedure and collaborative inhibition in recall (Adapted and revised from Blumen, Rajaram, & Henkel, 2013a and Rajaram & Maswood, 2018).

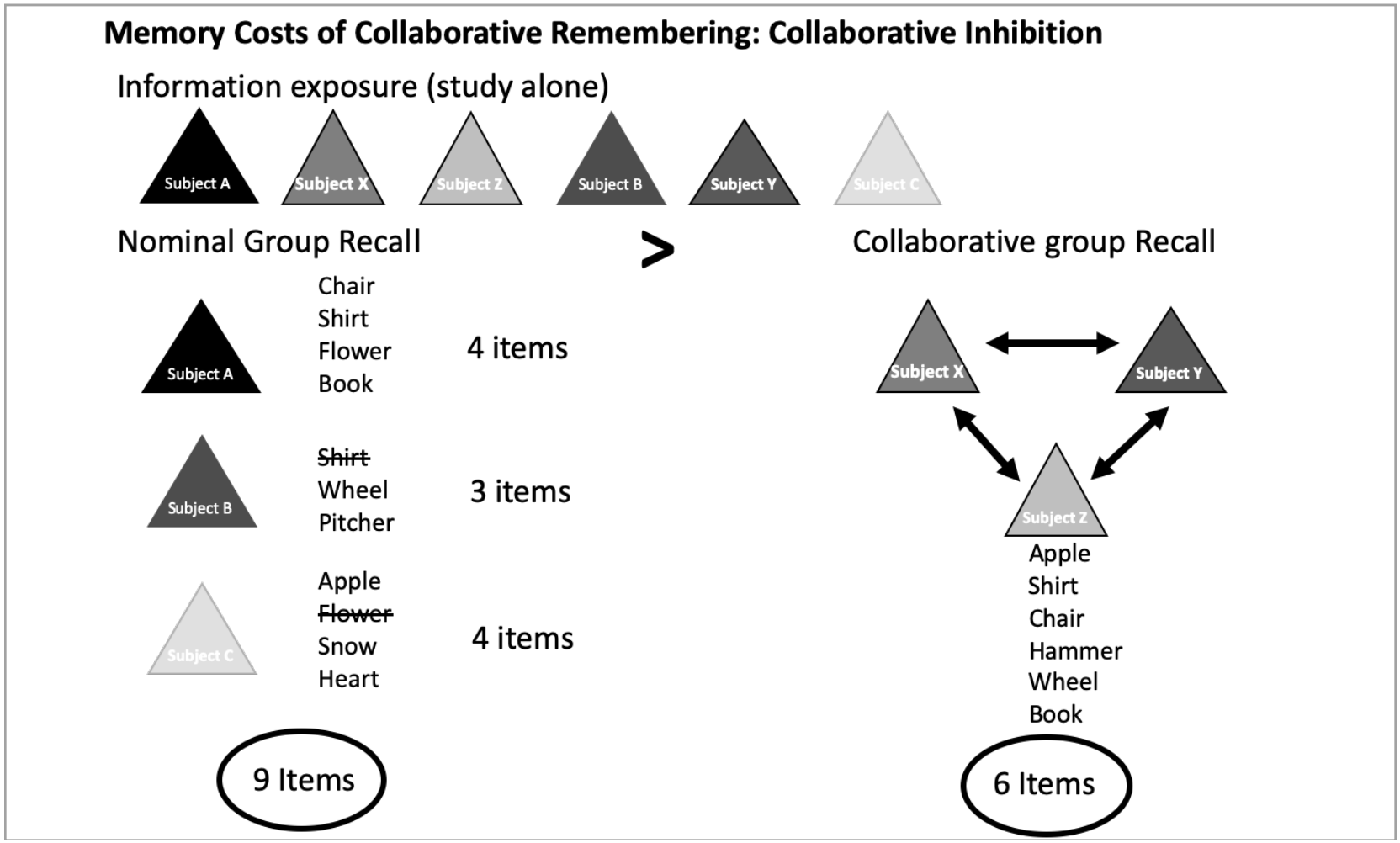

Figure 2. A framework to study collaborative memory (revised from Rajaram & Pereira-Pasarin, 2010 and Rajaram & Maswood, 2018). Positive and negative notations in the figure represent improvement or impairment in recall, respectively. S1, S2, and S3 denote participants in experiments.

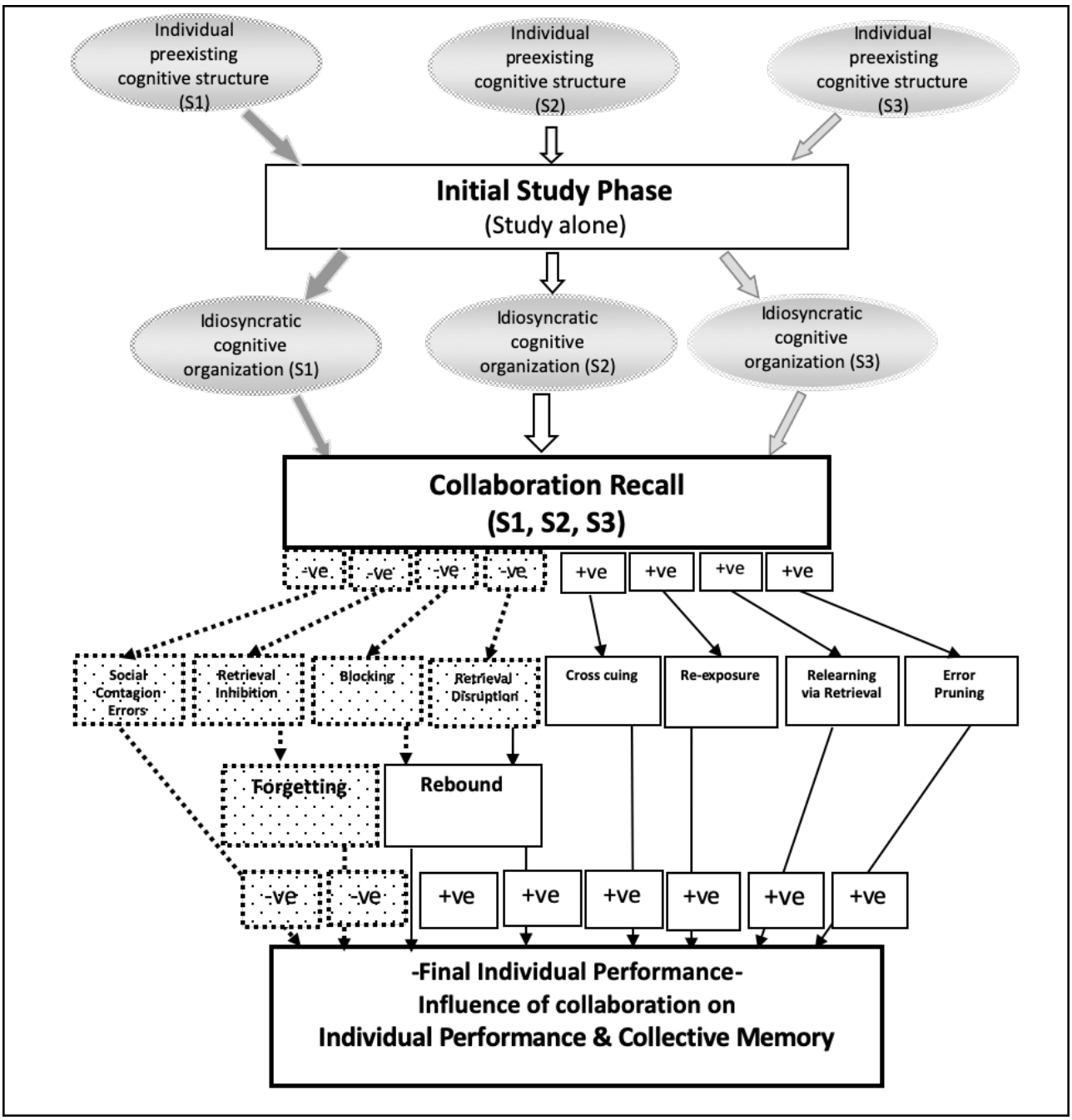

Figure 3. Individual memory performance is usually higher following collaborative remembering than individual remembering. Such social contagion of memory can also increase memory intrusions and false alarms if the conditions promote false remembering during collaboration (Adapted from Blumen, Rajaram, & Henkel, 2013a).

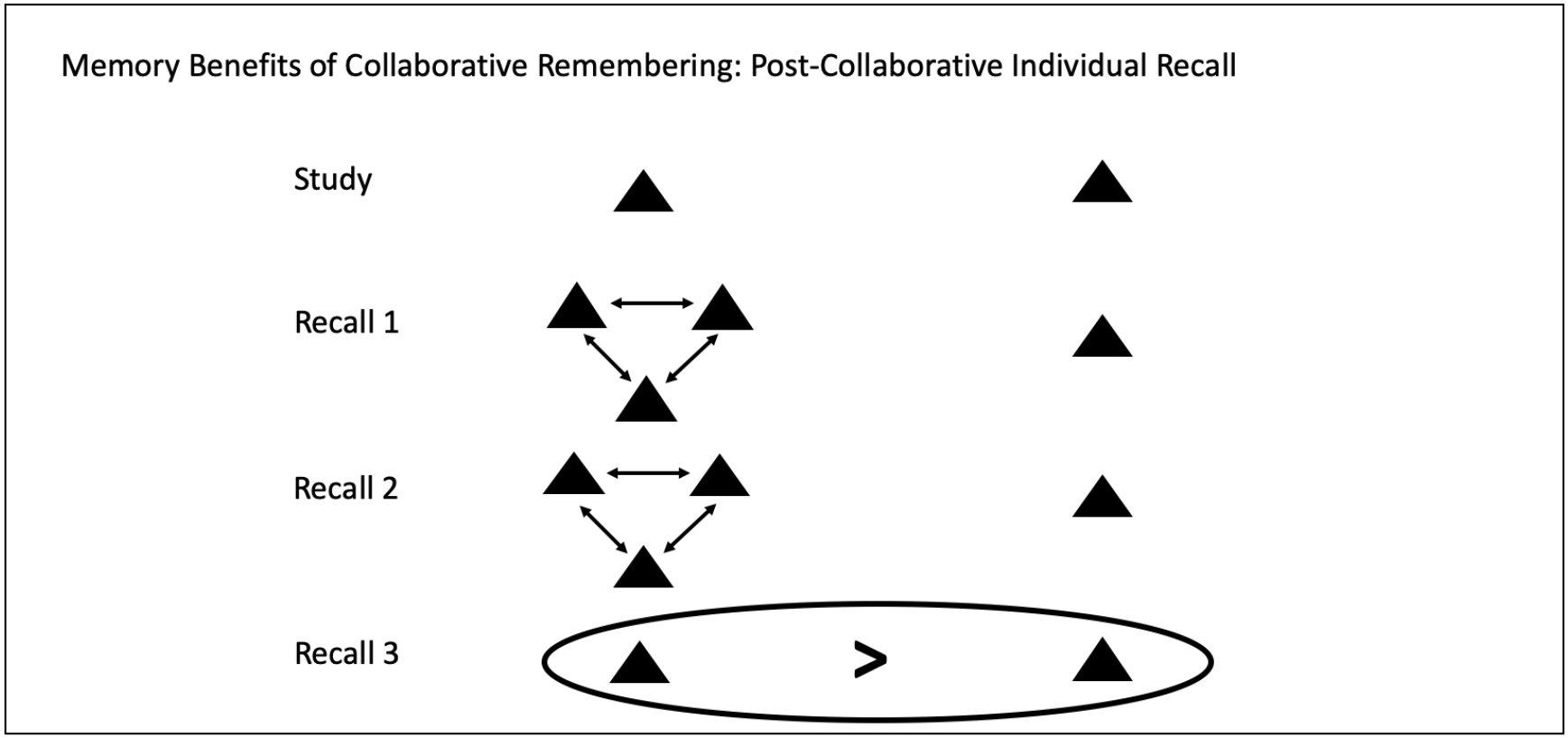

Figure 4. Representative examples of study and test procedures to examine the influences of collaborative remembering.

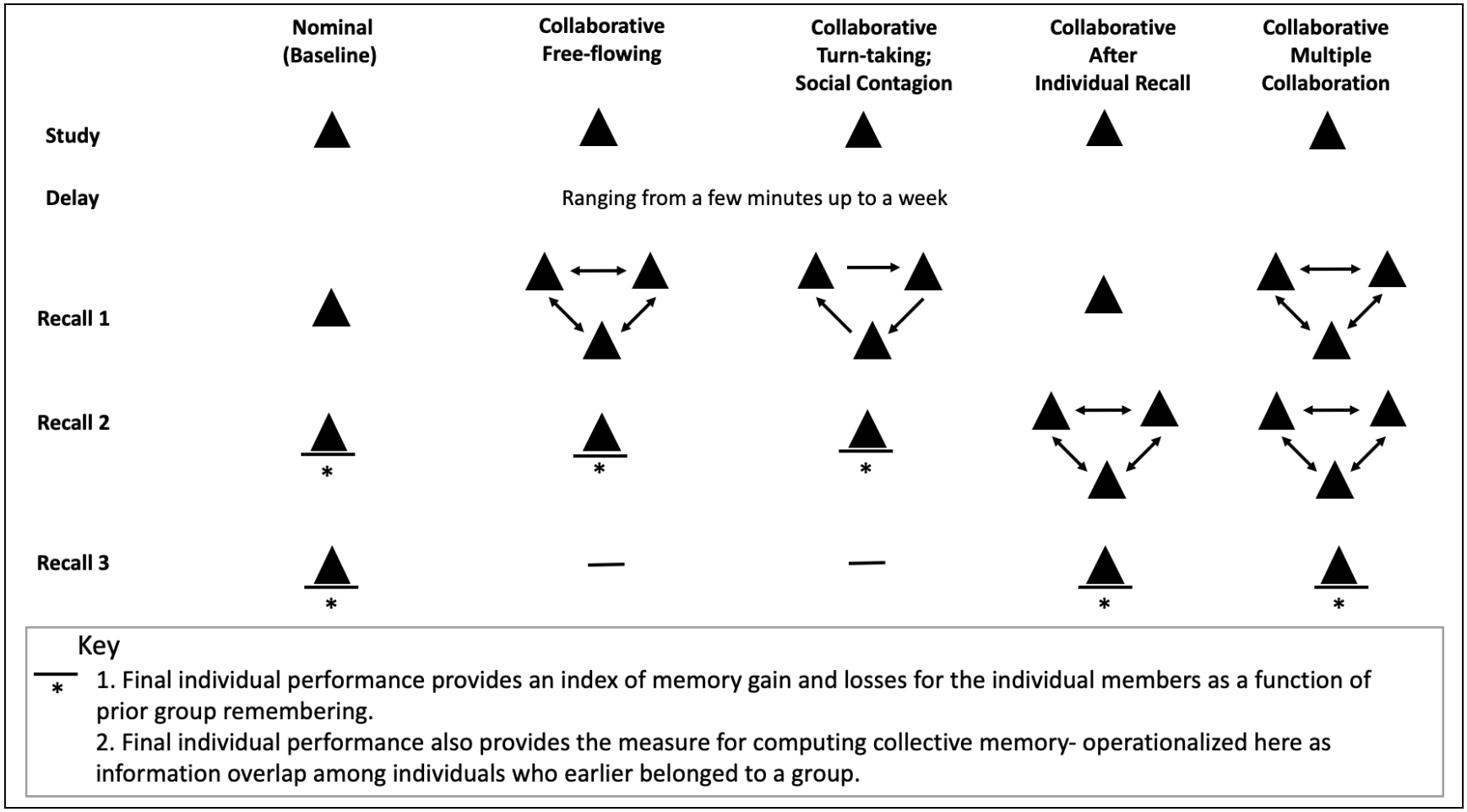

Figure 5. An illustration of the group structure for identical and reconfigured groups. Each shape and filled color tone represent a different participant within a group. (Adapted from Choi, Blumen, Congleton, & Rajaram, 2014).