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2.04 Collaborative Memory: A Selective Review of Data and Theory

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2.04.1 The Tug of Shared Reminiscing

The appeal of shared or collaborative remembering is captured in the popular notion that two heads are better than one. This appeal seems to reflect a sense that shared remembering has both social value and mnemonic value. With respect to its social value, as social beings people like to reminisce past events together (Berger and Milkman, 2012; Luminet et al., 2000), and psychological research posits that people engage in shared reminiscing to regulate emotion and to enhance social bonds (Rimé, 2009). It is everyday experience for people to recall autobiographical events together; discuss unfolding stories that engage public opinion; and debate historic and current events that have social, national, and cultural significance, and that presumably also underlie group identities.

People also intuitively value shared remembering because of the belief that it improves memory. Beliefs about the social as well as the mnemonic values of shared remembering also account for the popularity of study groups in schools and colleges. In fact, extensive research in educational and social psychology has been directed toward understanding the impact of collaborative learning techniques on social interactions, personality, and student engagement (e.g., Garfield, 1993; Johnson and Johnson, 2009; Keeler and Steinhorst, 1995; Slavin, 1991). Beliefs about the value of shared remembering are also important to consider in the face of memory decline in normal aging as well as in pathological aging, where social support for memory retrieval could confer significant benefits (for recent reviews, see Blumen et al., 2013a,b). Several surveys, conducted with both young and older adults, have captured these beliefs and show that people view collaboration as more beneficial for remembering than working alone, especially when the collaborator is someone they know well (Dixon and de Frias, 2007; Dixon et al., 1998; Henkel and Rajaram, 2011). Despite such intrinsic beliefs about shared remembering and its widespread practice, memory research in cognitive psychology until recently had been slow to move toward a systematic study of the nature of collaborative memory. A recent shift in this state of affairs has motivated the present chapter.

2.04.2 A Bit of History

Experimental study of collaborative memory represents an important new era for cognitive research in the 21st century. For about 100 years before, the dominant approach that cognitive psychological scientists employed to study the nature of human memory was what we will call "the individual memory paradigm." In this approach, individual subjects work in isolation to learn and
remember carefully constructed study materials. This widespread practice of isolating subjects to pinpoint memory function and its underlying mechanisms may be traced back to the recommendations made by Hermann Ebbinghaus (1885). This was a deeply considered recommendation, not because Ebbinghaus considered the social context (where much learning and remembering occurs) to be irrelevant, but precisely because he saw the ebb and flow of social influences in an experimental situation to complicate the precise interpretations and conclusions the experimenter could draw from the findings.

Ebbinghaus seemed so concerned about the extraneous influences in memory experiments that he even promoted the use of nonsense syllables as study materials since words, events, and narratives can be imbued with idiosyncratic variations in meaning, depending upon the personal and social history of the individual subject. Such has been the emphasis on precision in the Ebbinghausian tradition to eliminate confounds and work toward specifying the underlying memory principles.

As far removed as Ebbinghaus might have considered the collaborative memory movement from the pristine experimental study of individual memory he championed, in our work on collaborative memory we have deliberately and systematically leveraged the theories and findings that emerged from this long tradition. In fact, the Ebbinghausian tradition has been a precursor to the study of collaborative remembering in our laboratory as well as in the approach many other scientists have taken, and it has enabled scientists to investigate social memory with the necessary controls Ebbinghaus would have espoused.

Interestingly, this inspiration to systematically investigate the social side of memory with experimental control is not recent. It goes back to none other than Frederic Bartlett who explicitly promoted a study of social influences in understanding the nature of human memory (Bartlett, 1932). In the Preface of his book titled, Remembering: A Study in Experimental and Social Psychology, Bartlett (1932) noted that he took inspiration from Ebbinghaus’s approach of using strict experimental methods, initially even using nonsense syllables as his material to be recalled later. As Bartlett continued with his quest, he deliberately moved away from nonsense syllables but as he noted, “...I determined to try to retain the advantages of an experimental method of approach, with its relatively controlled situations, and also to keep my study as realistic as possible” (Bartlett, 1932, p. v).

The confluence of these sensibilities—implementing the rigors of experimental methods to study memory while expanding the range from investigating memory in a single individual to memory as an emergent social phenomenon that arises from the collaboration among several—began to gather momentum in the mid-1990s, and has since shaped cognitive psychological research on collaborative memory.

It is useful to keep in mind that the main idea that social context influences memory has had a considerable past in academic investigations outside cognitive psychology. A study of socially situated memory has thrived across disciplines such as anthropology, history, philosophy, and sociology (Bodnar, 1992; Cole, 2001; Durkheim, 1915; Halbwachs, 1950; Vygotsky, 1962, 1978). In these disciplines, the emphasis is on examining these memory phenomena at large scales and concepts such as the group mind, the extended mind, joint remembering, groupthink, cultural memory, and collective memory are expounded upon in depth (Janis, 1972; McDougall, 1920; Wegner, 1987). Some of these concepts, particularly collective memory, continue to influence memory research today. Social influences on memory have been topics of investigation within other areas of psychology as well. For instance, in developmental psychology and social psychology concepts of memory scaffolding and transactive memory, respectively, have been developed (Fivush and Graci, 2017; Reese and Fivush, 2008; Wang, 2008; Wegner, 1987). Even within cognitive research on memory, several important areas of study, such as eyewitness memory, memory shaped through oral traditions, memory developed for narratives through telling and retelling, and autobiographical memory all inherently incorporate the notion that social interactions influence memory (Alea and Bluck, 2003; Assmann and Czeplicka, 1995; Berntsen and Rubin, 2012; Halbwachs and Coser, 1992; Olick and Robbins, 1998; Marsh and Tversky, 2004; Rubin, 1997).

Against this backdrop, research on collaborative memory makes an important departure. To understand the social side of memory, the collaborative memory approach directly focuses on creating dyadic, triadic, or larger group interactions in the laboratory as group members learn or remember. It seeks to systematically map the consequences of collaborative remembering on the memory of the group and each member, the consequences on individual memory of those who previously interacted in groups, and the collective memories that emerge across group members as a consequence of collaboration. In other words, collaborative memory research takes the most direct approach to date to study group influences on memory within an experimental setting.

This chapter provides a selective review of this research to highlight major findings on the nature of collaborative memory. We note at the outset that all memory measures in this chapter will refer to accurate or true memory, that is, memory for information to which subjects were exposed earlier in the course of the experiment. Where we discuss memory errors or false memories, we will specifically note that change in the memory phenomenon of interest. We also note that, unless noted otherwise, studies described in this chapter tested groups (pairs, triads, or larger) composed of strangers.

2.04.3 A Paradigm to Study Collaborative Memory

In Fig. 1, we have presented a schematic representation that captures the widely used paradigm to study collaborative memory. Introduced in the 1990s (Basden et al., 1997a,b, 2000; Finlay et al., 2000; Weldon and Bellinger, 1997; Weldon et al., 2000), this paradigm has galvanized experimental research on this topic since.

At its core, this paradigm typically involves three phases common to most memory experiments – an initial study (or encoding) session, a distractor period (retention interval), and a memory (retrieval) test. In the initial study session, participants typically study the materials individually; that is, no collaboration takes place (except in studies that have specifically tested the
impact of collaboration at study; for example, Andersson and Rönnberg, 1995, 1997; Barber et al., 2010, 2012a,b; Finlay et al., 2000; Garcia-Marques et al., 2012; Harris et al., 2013). The study materials typically consist of word lists, but a variety of stimuli have been used across studies such as pictures, narratives, movies, and emotionally laden materials. The distractor period can last from 5 min to a week, depending on questions about the time course of memory (for example, Andersson et al., 2007; Andersson and Ronnberg, 1996; Barber et al., 2010; Congleton and Rajaram, 2011; Takahashi and Saito, 2004; Rajaram and Pereira-Pasarin, 2007). The retrieval tasks commonly consist of free recall, but other memory tasks such as recognition memory and cued recall have been also used (for example, Finlay et al., 2000; experiment 2; Clark et al., 2000). All in all, this is a typical procedure for a collaborative memory experiment.

In this paradigm, the key manipulation consists of comparing a condition where two or more participants collaborate to recall the studied materials with another condition where such collaboration does not take place and participants perform the task alone. In a majority of studies, the collaboration condition has consisted of triads (groups consisting of three members), although dyads and tetrads have been used occasionally. In terms of performance, it is no surprise that a group remembers more than an individual. To understand the role of collaborative processes, a better comparison is one where performance of the collaborative group is compared with the performance of an equal number of individuals who performed the task alone. This is precisely the comparison B.H. Basden et al. (1997a) and Weldon and Bellinger (1997) employed in their respective studies and called this baseline a nominal group or a group in name only. To assess the performance of this same-sized nominal group, all items recalled by the nominal group members are combined in a nonredundant fashion (such that items produced by more than one participant are included only once). Collaborative group performance is compared to this nominal group performance to assess the impact of collaboration on memory performance.

We focus on the case of free recall, a memory task that has been used widely in collaborative memory studies. In this task, participants recall all the items from the study phase that they can remember, in any order. Contrary to intuition, collaborative group recall produces significantly fewer items than does nominal group recall, a phenomenon Weldon and Bellinger (1997) called collaborative inhibition in recall. Since this surprising outcome was initially reported (Basden et al., 1997a; Weldon and Bellinger, 1997), it has been replicated across several laboratories and was recently summarized in a metaanalytic study (Marion and Thorley, 2016). Collaborative inhibition is not limited to word lists; it occurs for a wide variety of materials, such as stories, categorized lists, word pairs, associated word lists such as the DRM lists (Roediger and McDermott, 1995), pictures, emotional stimuli, and film clips (Andersson et al., 2006; Basden et al., 2002; Finlay et al., 2000; Takahashi and Saito, 2004; Weldon and Bellinger, 1997; Yaron-Antar and Nachson, 2006). Collaborative inhibition is also not limited to young adults; older adults show collaborative inhibition in
recall that is often comparable to that observed in young adults (e.g., Henkel and Rajaram, 2009; Johansson et al., 2000; Meade and Roediger, 2009; Ross et al., 2008), as do children (Andersson, 2001; Leman and Oldham, 2005). Even friends and couples—who presumably have experience collaborating together to recall past events—exhibit collaborative inhibition, albeit the magnitude of the effect can be reduced (Andersson, 2001; Andersson and Ronnberg, 1995; Johansson et al., 2000, 2005). In brief, collaborative inhibition in recall is a robust phenomenon.

Despite the robustness of this deficit in group recall, both scientists and the general public remain surprised by this result. As Weldon noted in 2001, “In presenting findings on collaborative inhibition, I am often met with extreme resistance by the audience. The result seems to fly in the face of most peoples’ intuitions or assumptions about what should happen, which is that collaboration should be beneficial. As evidence, people often mention the experience of sitting around with friends reminiscing about a shared experience, and how when someone cannot remember a particular detail, everyone joins in the effort to reconstruct the event, offering hints and tip-of-the-tongue information until the desired fact is remembered. This kind of experience certainly gives the impression that collaboration helps retrieval, although in reality it is only demonstrating that a group can remember more than an individual, which many data already show (Weldon, 2001, p. 99).” We get this same reaction more than 15 years later. We also agree with Weldon’s reflection further on where she notes, “nevertheless, it does raise questions about how generalizable the phenomenon is for different kinds of retrieval tasks.” Later in this chapter, we consider some experiments where, under certain conditions, collaborative inhibition in memory disappears or even reverses. Furthermore, it is also a matter of perspective whether lowered recall through collaboration necessarily implies negative consequences because shared forgetting can also have functional importance in helping people build an agreed upon account of their memories. We will briefly touch upon the implications of such a reduction in group recall for emergence of collective memory in a later section. For now, we simply conclude that collaborative inhibition in recall constitutes a well-replicated phenomenon.

2.04.4 A Framework to Study Collaborative Memory

We now know that collaboration affects memory. It is intuitive to assume that this relationship is influenced by social, cultural, and historic conditions within which collaboration takes place. These are the contexts that have preoccupied sociologists, anthropologists, and historians in their efforts to understand the nature of social memory. Our interest centers on the cognitive underpinning of this relationship. What does collaboration change in the operation of one or more cognitive processes that we know to influence individual memory? This is the place of inquiry where Weldon and Bellinger (1997) began their experiments. What processes are activated uniquely during collaborative remembering that do not come into play during individual remembering? Do the antecedent conditions in the rememberer’s cognitive architecture influence collaborative remembering? How does collaborative recall in turn influence the postcollaborative state of each group member’s memory? To understand these facets that influence, and are influenced by, collaborative remembering, we developed a framework to organize the cognitive flow of the antecedent conditions, the processes that may be activated during collaborative recall, and the postcollaborative consequences of these preceding stages on memory (Rajaram and Pereira-Pasarin, 2010). In Fig. 2, we present a slightly updated version of this framework. As with the previous version, this framework is meant to be descriptive and it is not exhaustive. It is work in progress, and it provides a working model for mapping out the concrete steps we can take to incorporate the “social” component in the transmission and reshaping of memory.

We first describe research on the processes that are activated during collaborative recall rather than starting with the antecedent conditions. This approach has a twofold advantage—it places the focus on the collaboration process itself first, and it provides a better context for understanding the role of the antecedent conditions that we describe next. Finally, we turn to the postcollaborative consequences on memory.

2.04.5 Cognitive Processes Activated During Collaborative Recall

When two or more individuals recall past information together, they are likely to influence one another’s memories (Fig. 2, Collaborative recall stage). In the case of collaborative inhibition, this influence lowers memory performance. Collaboration can also reduce the accuracy or the magnitude of memory through social contagion of false information, or when people pass along inaccurate or false memories during collaboration. But the news is not all bad. Collaborative recall can also improve the quantity and accuracy of recall through at least four processes that empirical studies have considered. One such process is error pruning (Rajaram and Pereira-Pasarin, 2010), where collaborating partners correct one another’s memory errors during recall. Another way collaboration improves recall is by reexposure (Blumen and Rajaram, 2008). Listening to a collaborating partner recall an item, particularly one that might have otherwise not been recalled, provides a second exposure to a studied item much like a second study opportunity. Although the reexposure is experienced during collaboration, its benefit on memory becomes evident during postcollaborative recall where an increase in the recipient’s memory product can be observed. A third process is something we have called relearning via retrieval, where the act of recalling an item serves as a second learning opportunity. The reader will correctly surmise that collaboration, that is, the presence of another person during recall is not necessary for this process to play out and that recalling individually also amounts to the same benefit where recalled items would be strengthened in memory. We include this process here because it nevertheless occurs when one group member recalls a memory to contribute to the group product.
Readers who are familiar with the landmark findings in a related area of memory research—effects of repeated study versus repeated testing on learning (e.g., Roediger and Karpicke, 2006a,b; Zaromb and Roediger, 2010)—will notice that the processes of reexposure and relearning via retrieval are similar in effect to repeated study versus repeated testing, respectively, and are likely to produce similar beneficial consequences on later memory. A fourth process in our framework, with the potential to increase recall, is cross-cueing during collaborative recall (see, Andersson et al., 2006; Congleton and Rajaram, 2011; Meudall et al., 1995, 1992; Takahashi and Saito, 2004). Cross-cueing refers to the idea that a memory recalled by one group member serves as a retrieval cue to trigger another memory for a different group member who might not have otherwise recalled that memory. Cross-cueing is particularly relevant in a collaborative, as opposed to an individual, recall situation. It is also a process that is intuitive and appealing, and tied to the idea that collaborative recall ought to increase recall productivity. As we will later review, the evidence for cross-cueing has been elusive and a test of cross-cueing has been rather difficult. Even so, some evidence of this process during collaboration is emerging.

This collection of processes shows how a single change during retrieval—adding one or two recalling partners—can trigger a cascade of impairments or enhancements in memory. In this context, we note two points here. (1) Not all of these processes need to be activated simultaneously every time collaborative recall takes place. The conditions of learning and remembering can determine the particular processes that become activated, and the consequences on memory would depend on the combination of processes that become activated during a given session of collaboration. (2) The notion of memory impairment or enhancement refers to the prevalent interpretation in the individual memory research, that is, a decrease or increase in accurate recall. But as we
briefly noted in the introduction, when it comes to collaborative recall an often desired goal for the collaborating partners is to come to an agreed upon account of the past. This goal can make accuracy secondary to quantity and consensus in recall. As such, “improvement” in collaborative recall can serve as an ambiguous measure of what improved – accuracy or consensus among those who recalled the information. Consistent with the prevalent practice in individual memory research, we will use the term increase or decrease in memory to refer to accuracy of recall in this chapter. However, we recognize the importance of shared agreement about the past, where applicable. Here, we turn to elaborating on the specific cognitive processes we have outlined earlier.

2.04.5.1 Collaborative Inhibition in Recall: The Mechanism of Retrieval Disruption

When people working together produce less, it is reasonable to explain this outcome as social loafing (Latane et al., 1979), defined as a diffusion of responsibility among group members, where each member ends up giving less of their effort in comparison to a situation where they are fully accountable for their individual output. Weldon et al. (2000) tested this possibility by manipulating several factors that were social in nature. Weldon et al. provided group members with monetary incentives to increase their recall performance. In other experiments, they used test instructions to reduce apprehensions about being evaluated on a task in a social setting, to increase personal accountability, or to increase group cohesion, and assessed whether group members would show increased recall as a function of these manipulations. Collaborative inhibition nonetheless persisted in group recall, making social loafing an unlikely explanation of collaborative inhibition.

Why, then, does collaborative inhibition occur? B.H. Basden et al. (1997a) proposed a retrieval disruption account where recall deficit is presumed to occur because listening to others’ output during recall disrupts the ability to recall one’s own remembered items. It has been known since Tulving (1962; also Sternberg and Tulving, 1977) that when individuals recall studied information, they organize their recall output in a subjectively preferred sequence. Past work has shown that when participants are given some items from the study list as retrieval cues, called part-list cues, their individual recall of the remaining set of studied items is worse than their recall of the same item set if they were not given any retrieval cues (i.e., in a free recall task). This is because the presence of the part-list cues disrupts the preferred way in which the participant would sequence their recall output and thereby lowers recall (Bäuml, 2008; Rundus, 1973; Basden and Basden, 1995; Basden et al., 1977). The retrieval disruption account in collaborative recall parallels part-list cueing deficits observed in individual recall. We describe this parallel later.

During collaborative recall, each group member brings their own preferred retrieval organization as they approach the task. Whereas certain elements of this organization overlap across individuals (for example, taxonomic categories such as fruits, vehicles, etc., cluster together), other elements differ because each individual brings a unique cognitive history to the learning situation and thus organizes the study information, and consequently the retrieval output, in an idiosyncratic sequence. According to the retrieval disruption account, when group members listen to one another recall the studied information in a group setting their own recall organization is disrupted by the idiosyncratic sequence of others’ recall output that differs from their own. This mutual disruption during collaboration lowers the amount each member recalls during collaboration compared to their potential, or the amount that they would produce in individual recall. As a result of this process, collaborative group recall is lower than the nominal pooling of individual recall. Two decades after the retrieval disruption account was proposed (Basden et al., 1997a), the accumulating evidence continues to support it as a key explanation of collaborative inhibition in group recall (see Marion and Thorley, 2016; Rajaram and Pereira-Pasarín, 2010; for reviews of several such studies).

2.04.5.2 Forgetting due to Collaborative Recall: The Mechanism of Retrieval Inhibition

The role of retrieval disruption brings to light an important point about the use of the term inhibition in describing the recall deficit of collaborating groups. When retrieval disruption occurs during collaboration, the process of disruption implies that items not recalled will rebound in memory when the disruptive forces of collaboration are removed. As a result, if group members later recall the study information, but do so individually by themselves, items not recalled during collaboration ought to bounce back in postcollaborative individual recall. Studies have frequently reported this outcome (e.g., Basden et al., 2000; Congleton and Rajaram, 2011; Henkel and Rajaram, 2011; Meudell et al., 1992; Reysen, 2005). The question then is whether the deficit in group recall is limited to the collaboration session or whether some information not recalled during collaboration is indeed functionally lost even afterward. Some evidence suggests that such forgetting occurs, and that retrieval inhibition observed in individual memory performance (Aslan and Bäuml, 2009; Bäuml, 2008; Bäuml and Aslan, 2006) is also associated with collaborative recall settings.

To elaborate, retrieval disruption and retrieval inhibition differ in the following way. When a participant’s recall is disrupted due to part-list cues or listening to other’s output, it is assumed that items this participant failed to recall during collaboration will bounce back, and appear, if this participant gets another opportunity to recall the study information alone. In other words, retrieval disruption implies that unrecalled items are not forgotten, and once the disrupting conditions are removed these items will be recalled. Interestingly, as just noted, several items not reported during collaboration appear in postcollaborative recall where former group members work alone. But other items are forgotten. This outcome suggests that collaboration can also result in inhibition in memory for at least some studied items.

Initial evidence for such extended forgetting came from a study where the collaborative inhibition effect was found to be larger in groups consisting of four members compared to dyads (Basden et al., 2000). This outcome is completely consistent with the retrieval disruption account due to the expectation that larger groups would create greater disruption during collaboration than smaller groups. At the same time, members from larger groups also showed less reminiscence on a later individual recall than did
members from dyads. Reminiscence refers to an outcome where items not recalled previously are recalled later and is a component of hypermnesia (the net gain in memory that is summed across what is additionally remembered vs. what is forgotten across repeated recalls, despite only one study exposure; Payne, 1987). Reduced reminiscence in larger groups implies that collaborative recall in larger groups not only caused more disruption but also more inhibition in memory than smaller groups (also see Meudell et al., 1992).

Subsequently, Reysen (2005) reported that when groups performed collaborative recall under pressure to recall more versus in the absence of such pressure, the latter group showed lowered recall during collaboration. Relevant to the present issue, members from groups who recalled less during collaboration continued to recall less on a later individual recall task when compared to members from groups who had recalled more. In other words, the expected rebound did not occur in later individual recall for the low output group, again implying forgetting. In another study, participants first completed a questionnaire about their memory for the 9/11 tragedy, then got together as dyads to recall this information, and finally performed a recognition task alone where the probes were based on their responses to the original questionnaires (Coman et al., 2009). On this last task, participants were significantly slower to respond to related memories that were not recalled during conversation than unrelated memories, once again suggestive of forgetting that resulted from collaborative remembering. In a recent study, we observed some evidence of forgetting in both young and older adults (Henkel and Rajaram, 2011). In a sequential procedure of three recalls, the initial and final recalls consisted of individual recall and the middle recall consisted of collaborative recall by triads. Although both young and older adults showed some item gains from recall 1 to recall 3, indicating the effects of reexposure benefits, we also observed that in recall 3 both young and older adults forgot some items they had recalled in recall 1. These studies together suggest that some forgetting occurs as a result of collaborative recall. But these studies were not designed to directly test a role of retrieval inhibition associated with such forgetting, leaving open the question whether, in addition to retrieval disruption, retrieval inhibition also operates in collaborative recall.

In a recent study, we directly tested the possibility that retrieval inhibition can result from collaborative recall (Barber et al., 2015). We presented three different study lists to three subjects who were to later become a triad and engage in collaborative recall. After collaborative recall, subjects either performed a free recall test alone (experiment 1) or a recognition test alone (experiment 2). In the control condition, subjects performed both recall attempts alone. Because subjects in this control (nominal group) condition together recalled nonoverlapping memories, the possibility of reexposure to studied information was eliminated and could not account for postcollaborative rebound of studied information that subjects did not recall during collaboration. In the collaborative recall condition, any rebound, on a later individual test, of studied information that was not recalled during collaboration would provide evidence for retrieval disruption whereas forgetting of these items on a later individual test would provide evidence of forgetting. This test would be most appropriate if the second test were a recognition task where all the studied items were presented to the subjects for recognition, and thus failure to correctly recognize studied information, compared to the control condition, would indicate retrieval inhibition. The negative effects of collaboration persisted on second individual recognition test, showing that, in addition to retrieval disruption, retrieval inhibition also contributes to collaborative inhibition in memory.

While a role of retrieval inhibition in collaborative memory is emerging, much work is needed to understand a fuller scope of its influence, and two additional points are worth bearing in mind. (1) Just as retrieval disruption has been mapped to influence both individual and group recall, the operation of the retrieval inhibition mechanism also has parallels in theories of individual recall (Anderson and Bjork, 1994; Bäuml and Aslan, 2004; Nickerson, 1984; Tulving and Psotka, 1971), and as just described, in collaborative recall. (2) In theories of individual recall, retrieval disruption and retrieval inhibition are proposed as two of three mechanisms in a cluster that lead to forgetting, with the third mechanism being retrieval blocking. We briefly consider this process next.

### 2.04.5.3 Retrieval Blocking and Collaborative Recall: An Untested Relationship

A third mechanism of forgetting proposed in individual recall concerns blocking (see Bäuml, 2008). In this process, when an item is blocked in memory, it is not produced on a later recall task. However, memory for that item can be detected on a recognition task where the item is presented for accepting or rejecting it as previously seen. In collaborative recall studies, the postcollaborative memory is often measured using a recall task, as can be seen in the studies we summarized earlier, and therefore an absence of rebound for studied items can result from either inhibition or blocking. In the Barber et al. (2015) study where participants were impaired at recognition in the postcollaborative phase, we saw evidence for inhibition. However, this evidence does not preclude the possibility that in other situations, items that were not recalled would be nonetheless recognized in a postcollaborative test. Such a role of blocking in collaborative recall remains an open question.

### 2.04.5.4 Is Collaborative Inhibition Inevitable?

While the evidence for collaborative inhibition in recall is widespread, and the mechanisms that produce this effect have come into considerable scrutiny, collaborative inhibition can also reduce, disappear, and on rare occasions even reverse in recall. Much of this evidence shows a consistent pattern about the role of retrieval disruption in producing these changes. As discussed in more detail later, when retrieval disruption is reduced through encoding (e.g., Congleton and Rajaram, 2011; Pereira-Pasarin and Rajaram, 2011), delay (e.g., Congleton and Rajaram, 2011; Takahashi and Saito, 2004), or retrieval (e.g., Basden et al., 1997a; experiment 4) manipulations, collaborative inhibition reduces or disappears. Relatedly, when conceptual organization of study information
is aligned among group members (Basden et al., 1997a; experiment 4), or equivalently disrupted using a recognition task that presents all the studied (and intermixed nonstudied) items, thereby disrupting the idiosyncratic organization of subjects in both collaborative and nominal group conditions (Clark et al., 2000), collaborative inhibition reduces or disappears. When conceptual organization is particularly strong (thus protecting against disruption) and aligned, and furthermore, when group members use certain collaboration skills, collaborative inhibition can even reverse (Meade et al., 2009; a study we describe at some length in a later section titled Stages Preceding Collaborative Recall: Antecedent Conditions, Preexisting Cognitive Structures, and Collaborative Encoding). Here, collaboration skills referred to interaction methods where members acknowledge, elaborate upon, and are receptive to each other’s ideas. The use of enhanced collaboration skills, two of which can be thought of as error pruning and cross-cueing and which will be discussed further, is particularly relevant when we consider collaborative remembering among those who develop longer-term associations, for example, students in a classroom, coworkers, friends, and life partners, to name a few relationships where the purpose of collaboration is typically assumed to benefit memory.

2.04.5.5 Social Contagion Errors Versus Error Pruning During Collaborative Recall

Nearly seven decades ago, social psychologist Solomon Asch (1951) reported the power of social pressure on performance inaccuracies in individuals. Under social pressure from a confederate, subjects made flagrant errors in reporting the length of a line even though they could clearly see and compare it to a target. The potential of social forces to influence performance has been a topic of great interest to memory scientists as well. Specifically, scientists interested in the nature of false memory have sought to investigate social influences on memory to understand the social genesis of false memories. For example, the research on eyewitness memory and witness identification procedures (though frequently employing individual responses) considers memory errors in the context of exposure to misinformation from social sources. A few studies have even examined this question with dyads (e.g., Gabbert et al., 2003, 2004). Other lines of false memory research have investigated social contagion of memory and reported transmission of memory distortion in procedures where a confederate systematically introduces memory errors (e.g., Roediger et al., 2001). Even the goals of memory narration can change memories where retelling a story to entertain others can lead to exaggerations compared retelling for accuracy (Marsh and Tversky, 2004).

Despite the long and ongoing history of interest in social influences on memory errors, experimental work on errors has not consistently, or even frequently, employed procedures that involve the actual social presence of others. In contrast, inclusion of others during encoding or retrieval has been prevalent in collaborative memory designs, except in a few experiments where techniques of perceived social presence or confederates have been used to create social presence where information presented via computers is attributed to other members who are connected via the computers (Basden et al., 2002). Collaborative memory experiments have largely examined how group remembering among strangers gives rise to false recollections. In keeping with the focus of the present chapter, this section provides an overview of findings from studies using the collaborative memory paradigm (Fig. 1) to investigate the transmission of false memory in groups.

Much of collaborative memory research explores two different possibilities – how group members can potentially contribute false information and promote false memory, and alternatively, how group members may be particularly advantaged to evaluate and exclude errors, as well as protect against false information. Over the last decade, findings indicate that the generation or pruning of false memory in groups largely depends on factors such as what study material is used, how the group collaborates, and how many members collaborate.

The early study of false memory using the collaborative memory paradigm was motivated by the finding that collaboration inhibited recall of studied information, yet it increased false recall (where subjects produced more intrusions) compared to the nominal recall condition (Basden et al., 1997b). These ensuing studies over the years converge to show that the susceptibility of groups to falsely recall critically depends on the material a group studies for later recall, the method of group collaborative remembering, and the associated group pressure.

The Deese–Roediger–McDermott (DRM) paradigm (Deese, 1959; Roediger and McDermott, 1995), which has generated a wealth of data in individual memory research, has also been frequently employed to investigate false memory in groups. In this paradigm, individuals study DRM lists that consist of words that are semantically associated with one another, e.g., bed, rest, awake, tired, snooze, and blanket. Later, participants typically produce a critical "lure," a word highly associated with the presented words, but one that was not included in the original list, e.g., sleep. In an early study, B.H. Basden et al. (1997b) used the DRM lists that contain associatively related words (experiment 1) and categorized lists (e.g., desk, ottoman, bed, chair – all exemplars of the category furniture) that contain superordinate-to-item associations (experiment 2) and found that collaborative groups were more likely to falsely recall critical lures from categorized lists than from associatively related DRM lists. This finding seems surprising given the robustness of false recall reported for the DRM lists in individual memory experiments. B.H Basden et al. (1997b) proposed that intrusions are greater for collaborative groups when study lists provide strong retrieval cues, as they argued was the case with categorized lists. A possible alternate explanation might come from a different aspect of their findings where collaborative inhibition in recall was observed in the experiment using the DRM lists (experiment 1) but not in the experiment using the categorized words (experiment 2). This pattern raises the possibility that the adjustments needed in the procedure where the categorized lists were used might have generally increased collaborative recall, both for true and false items, although this possibility is admittedly speculative. Moreover, in later studies, increased false recall by collaborating groups was observed for the DRM lists, where collaborating groups falsely recalled or recognized the critical lures more than the nominal groups (Thorley and Dewhurst, 2007, 2009).
In addition to the type of study material, group pressure can also be a source for false recall in collaborating groups. The collaborative recall procedure most commonly involves two methods of group recall—turn-taking and free-for-all. In the turn-taking method, as the name implies, group members take turns, one after another in a sequence, to recall units of information. This procedure reliably produces collaborative inhibition in recall (Basden et al., 1997a; Meade and Roediger, 2009; Wright and Klumpp, 2004) and also guards against social loafing, because each group member gets their turn and is expected to contribute during their turn (e.g., Basden et al., 1997a). But because of the sequential nature of this procedure where group members do not typically go back and forth in their discussion, they fail to eliminate information that others recall erroneously. Once a memory error is introduced in this way, it essentially gets "exposure" just like studied information that is recalled would get, and this error can subsequently get incorporated into the memory of the listener. As a result, such an error can propagate and appear in subsequent recalls of both the member who first introduced the error and the listener who did not make or hear a correction. In B.H. Basden et al. (1997a) where higher false recall was reported in collaborative group recall than in nominal group recall, participants were required to take turns during collaborative recall thereby creating greater social pressure than would be the case in the free-for-all procedure.

In contrast, in the free-for-all method, participants freely interact, discuss, and recall with each other with minimal instructions to coordinate recall. In this procedure, there is less pressure among group members to produce something, and there are also more opportunities for catching errors and making corrections that can prevent false recall. In the free-for-all procedure, members may be also more conservative so as to avoid making errors and being corrected by others.

The observation about the impact of social pressure accounts well for findings about the presence or absence of intrusions due to collaborative recall. Across studies, whether groups falsely remember has been found to be associated with which of the methods were used for collaborative recall, turn-taking or free-for-all. Studies that have implemented a turn-taking strategy have found increased false recall in collaborative groups relative to individuals and nominal groups (Basden et al., 1997a, 2002), whereas studies where group members freely discussed recall with one another have not observed increased false recall for collaborative groups (Blumen and Rajaram, 2008, 2009; Finlay et al., 2000; Maki et al., 2008; Pereira-Pasarin and Rajaram, 2011; Takahashi and Saito, 2004; Weldon and Bellinger, 1997; Yaron-Antar and Nachson, 2006). Thorley and Dewhurst (2007) demonstrated these patterns of differences in a direct comparison between the two types of collaboration procedures.

Why does the free-for-all interaction protect against false remembering in groups? There has been much interest in how group conversations impact group memory (Pritchard and Keenan, 2002; Harris et al., 2011; Ross et al., 2008; Meade and Gigone, 2011; Hirst and Echterhoff, 2012), and there have been suggestions that group discussion allows the rejection of errors in the studies on false remembering using free recall. A recent study using the collaborative memory paradigm specifically examined how groups filter out false information (Weigold et al., 2014). Similar to other studies (e.g., Basden et al., 1997b; Thorley and Dewhurst, 2007), Weigold et al. (2014) used the DRM lists and groups engaged in free-for-all recall. Group discussions were coded and analyzed, and the evidence suggested that group filtering curtails false recall in the free-for-all recall procedure. Group discussions were examined for evaluation, acceptance/rejection, and level of confidence. Weigold et al. (2014) found that when nonstudied words were brought up in the discussion, groups filtered out more than half of these errors. Errors were also typically brought up with low confidence. Ultimately, these words were rejected, and this contributed to the low recall of false memory in the groups.

Does false memory produced by collaborating groups impact later individual memory? For example, Thorley and Dewhurst (2007) asked whether falsely recalled items are retained by group members postcollaboration and reported by them on a later memory test they take individually. The authors argued that because the level of pressure during turn-taking collaboration is similar to that of social contagion studies where studies have reported retention of misinformation, turn-taking group members would similarly demonstrate false memory retention after collaborative recall. Accordingly, they found that the false recall of critical lures was retained and individually recalled for those previously in turn-taking groups. Such retention of falsely recalled items has also been found in later individual recognition in individual recognition tasks after collaborative group recall and perceived group recall (Thorley and Dewhurst, 2009; Basden et al., 2002 respectively).

By far then, the main predictor of false remembering in groups appears to be the method by which group members work together to collaboratively recall. However, additional factors have been also implicated. For example, group size appears to be an important variable for influencing false memory in collaborating groups. Thorley and Dewhurst (2007) systematically examined false remembering and levels of group pressure for free-for-all and turn-taking dyads, triads, and quartets. They reported that turn-taking groups recalled more nonstudied words than the free-for-all and nominal control groups. Further, false remembering increased with group size, with the most errors being from the largest turn-taking quartets.

Turning now to the process of error pruning, this process is the opposite of the social contagion process where group members transmit memory errors from one to another. As noted earlier, in error pruning, collaborating members can, and often do, correct erroneous recall by other group members as the group discusses the items, which each member produces during collaboration.

In a free-for-all method of collaborative recall, the evidence is consistent across studies for error pruning effects (Blumen and Rajaram, 2008, 2009; Finlay et al., 2000; experiments 2 and 3; Harris et al., 2012; Hyman et al., 2013; Johansson et al., 2000, 2005; Pereira-Pasarin and Rajaram, 2011; Takahashi and Saito, 2004; Weldon and Bellinger, 1997; Yaron-Antar and Nachson, 2006; Vessel et al., 2015). The case of collaboration procedure where group members are instructed to reach consensus on each item to be included in recall (Meudell et al., 1995; Ross et al., 2004) similarly reduces errors (Harris et al., 2012; Thorley and Dewhurst, 2007). In as much as improving memory accuracy can be an important goal in certain contexts, the error pruning function of collaboration—and the particular procedures that enable error pruning such as free-for-all or consensus collaboration—is a useful function to investigate further. Here one might ask whether changes in the intrusion rates in collaborative
recall can change the collaborative inhibition effect. Past work has not consistently reported the effects of intrusion correction on collaborative inhibition but it is usually the case that collaborative inhibition is larger than the differences observed for intrusions across collaborative and nominal group recalls. Consistent with this observation, when we corrected nominal and collaborative recall for intrusions, we found that collaborative inhibition persisted (Congleton and Rajaram, 2011). It is worth bearing in mind that the benefits of error pruning on memory are relevant, not only specifically for the impact on collaborative inhibition but also on postcollaborative processes. That is, correction during collaboration has the potential to improve the accuracy of members’ later individual memory.

2.04.5.6 Cross-Cueing During Collaborative Recall

Retrieval cues have a powerful effect on recall. A straightforward example is a comparison between a free recall task and a cued recall task, where retrieval cues greatly improve recall of studied information. For instance, if subjects in a memory experiment study paired associates such as “tiger-stripes” and are later asked to recall the second item of each pair (stripes), receiving no cues (i.e., a free recall task) leads to far fewer items recalled than receiving the first word (tiger) as a retrieval cue (i.e., a cued recall task) (e.g., Thomson and Tulving, 1970). Similarly, if subjects study a list of exemplars (strawberry, sweater, desk), they are likely to recall more of these items if provided with category names as cues (fruit, article of clothing, furniture) than if they tried to recall the studied items without any cues (e.g., Hamilton and Rajaram, 2003). In other words, both intralist cues (as in the first example) and extra-list cues (as in the second example) can be effective for increasing recall. It is therefore reasonable to expect that when people work together to recall past information, an item recalled by one member of the group can serve as an effective retrieval cue for another member to recall a related item that the latter member might have otherwise not remembered. Such a process is what people likely have in mind when they say that two heads are better than one, and that joint remembering helps jog memory.

Despite such strong intuitive appeal, and strong evidence for the power of retrieval cues, benefits of cross-cueing in collaborative recall have been slow to detect (Andersson et al., 2006; Congleton and Rajaram, 2011; Meudell et al., 1992, 1995; Takahashi and Saito, 2004). A practical problem for detecting cross-cueing (that would be over and above what self-generated cueing can yield in individual recall) is that when member A does remember an item in response to member B’s recalled item, it is difficult to ascertain whether member A would have recalled the item regardless and down the road within that recall session. In other words, the net advantage of cross-cueing is not straightforward to measure in a standard collaborative recall situation.

Retrieval cues can also complicate matters in another way in the collaborative recall procedure, and the part-set cueing deficit in individual recall captures this problem. As noted earlier, if subjects are presented with a subset of studied items to serve as cues for recalling the remaining ones, subjects recall fewer of the remaining subset than if they had not been presented with any cues (i.e., in a free recall task). This part-set cueing deficit is attributed to retrieval disruption, and this empirical finding and its theoretical explanation have served our understanding of one important basis for the collaborative inhibition effect in recall. How do these findings then square off with cross-cueing benefits?

On the one hand, an item recalled by member A can potentially serve to disrupt member B’s (and member C’s, etc.) preferred retrieval organization and thereby reduce recall of some items. On the other hand, this item can also potentially serve as a cue to recall other items that member B might not have otherwise recalled. Given this offsetting possibility, whether retrieval disruption produces more costs (lower recall) or cross-cueing produces more gains (increased recall) would likely be a function of many factors. What is clear here is that it is not entirely straightforward to predict net benefits from cross-cueing even though this process can in fact aid recall of some items and can also give rise to the subjective experience that others’ recall helped with one’s own recall. Furthermore, the commonly observed deficit of collaborative inhibition indicates that retrieval disruption is more powerful than cross-cueing, at least under the default conditions tested in experiments so far.

Considering that both retrieval disruption (and additionally, retrieval inhibition, as we described earlier) and cross-cueing operate during collaborative recall, and that it can be difficult to isolate the contributions of cross-cueing during collaboration, could the consequences of cross-cueing be detected when the influence of retrieval disruption lessens? Starting with the individual recall findings for the part-set cueing deficit, there is evidence that when the delay between study and memory test increases, individual recall under part-set cueing conditions improves (Raaijmakers and Phaf, 1999). In collaborative recall, Takahashi and Saito (2004) reported a standard collaborative inhibition effect for collaborating dyads compared to nominal dyads when the study–test delay was short (experiment 1). But at a study–test delay of 1 week (experiment 2), collaborative inhibition in group recall disappeared. In this second experiment, as in experiment 1, all participants first recalled the study information individually and then half of them recalled it collaboratively and the other half again individually, thereby providing data to compute nominal dyadic recall. From recall 1 to recall 2, participants in the collaborative dyads showed only about 5-item loss, whereas participants in the nominal condition lost about 14 items. This finding was interpreted to suggest that with passage of time, idiosyncratic retrieval organization declines, and there is less output to disrupt. This reasoning is consistent with the findings of a study where we investigated the relationship between retrieval organization computed with the adjusted ratio of clustering (ARC; Roenker et al., 1971) and collaborative recall of categorized study lists (Pereira-Pasarin and Rajaram, 2011). In that study, we found that when idiosyncratic retrieval organization weakened measurably, collaborative inhibition declined. So, it seems reasonable to suppose that collaborating conditions where there is less to disrupt presumably create better opportunity for group members to take advantage of cross-cueing benefits during collaboration, an opportunity that does not exist in the nominal recall condition. Consistent with this pattern, we have also found that collaborative recall remains stable after a 2-h delay between study and test, whereas nominal recall diminishes (Congleton and Rajaram, 2011; repeated study conditions).
In brief, although still slender, there is some experimental evidence for cross-cueing benefits and it supports the subjective experience of memory benefits from collaboration people report on surveys (Dixon and de Frias, 2007; Dixon et al., 1998; Henkel and Rajaram, 2011). Future work with richer stimuli (stories, films, narratives) could be one way to probe stronger tests of cross-cueing benefits during collaborative recall (see also Weldon, 2001).

### 2.04.5.7 Reexposure During Collaborative Recall

During collaborative recall, the act of listening to another group member’s recalled information serves as a second study opportunity. The benefits of repeated study on recall and recognition memory are well known (e.g., Cepeda et al., 2008; Crowder, 1976; Glenberg, 1979; Greene, 1989). But unlike cross-cueing or error pruning, the memory benefits of reexposure cannot emerge during collaboration. Instead, these benefits may be detected on a subsequent memory task where items that a particular group member failed to recall, either prior to, or during, collaboration are recalled on a postcollaborative task. In other words, successive recall opportunities consisting of individual versus collaborative attempts provide a means to isolate whether reexposure occurred during collaboration. Further, such a successive recall arrangement can help determine whether postcollaborative improvements come from reexposure during collaborative recall or from simple reminiscence (Payne, 1987) by tracking who-recalled-what across successive recall attempts. In a later section on Postcollaborative Consequences of Collaborative Recall, we summarize relevant findings from studies where such mapping across recalls has been reported to capture the reexposure process during collaborative recall and its cascading effects on memory.

As a related point, the reader will notice that exposure to another group member’s recall can take place for both studied information as well as nonstudied information, the information that a group member erroneously produced as it was not presented during the study episode. This “false memory” also provides exposure to the listening member and can lead to social contagion errors, as we described earlier. In other words, social contagion can consist of both propagation of false memory and true memory. In the case of true memory, the contagion occurs not from exposure but from reexposure, information that was first presented during study and then produced by a collaborating partner. This distinction between true and false memory is important to keep in mind. It is equally important to recognize that, regardless of veracity, a key product of collaborative recall consists of the contagion process—for true or false information, a theme we have been pursuing in our work on social transmission of memory (Choi et al., 2014; Luhmann and Rajaram, 2013).

### 2.04.5.8 Relearning Via Retrieval During Collaborative Recall

The act of recalling information provides an opportunity to rehearse information and make it more memorable in the long run than additional opportunities to simply study it again, a now-famed phenomenon known as the testing effect (Karpicke and Roediger, 2007, 2008; Roediger and Karpicke, 2006a,b). In a collaboration setting, when group members recall information during collaboration, not only do they provide reexposure to others but they also strengthen their own memory for that information. Relearning via retrieval then is not so much a collaborative process but an individual retrieval process that operates during collaborative recall, as we noted earlier in this chapter. At the same time, if an item is retrieved in response to cross-cueing through another item provided by a group member, then such relearning is activated through collaboration. Furthermore, if items are strengthened in memory because they were recalled and the likelihood of recalling them again consequently increases, it also implies that items not recalled become weaker in memory and are less likely to be recalled later. That is, just as in individual recall, where study items with strong representations are assumed to be recalled first (Rundus, 1973; Raaijmakers and Shiffrin, 1981; Wiitx et al., 1997), stronger items are likely to be recalled first during collaborative recall as well, and here, too, the stronger items can block and damage memory for the weaker to-be-recalled items. These mechanisms could not only induce disruption but also forgetting, a process similar to retrieval induced forgetting in individual recall (Anderson and Bjork, 1994; Bäuml and Aslan, 2004; Bäuml and Kliegl, 2017; Nickerson, 1984). The process of relearning via retrieval in collaborative recall situations—through one’s self-initiated recall or through cross-cueing during collaboration—can ironically also be a source of forgetting for items that were not recalled.

As we turn to a discussion of the other stages shown in the framework in Fig. 2, we note that the utility of the collaborative memory paradigm lies not only in the direct and controlled ways in which it enables a comparison of collaborative memory with noncollaborative memory performance but also in the ways it enables systematic expansions to examine memory processes both before and after the collaborative retrieval phase. With such expansions, researchers can measure as well as manipulate the antecedent conditions that shape collaborative memory. Similarly, they can map the downstream effects in the postcollaborative stages that are shaped by collaborative memory. In this way, it becomes possible to examine the sequential as well as iterative interactions between individual and group memory processes and their mutual influences. With such flexibility to expand the paradigm, we can begin to delve into the complex naturalistic conditions of social memory systematically. We turn to a selection of these findings next.

### 2.04.6 Stages Preceding Collaborative Recall: Antecedent Conditions, Preexisting Cognitive Structures, and Collaborative Encoding

In the preceding sections, we have discussed a collection of processes that can become active during group collaboration and shape memory. It is also essential to recognize that the collaborative process itself is affected by the unique perspectives people bring to
group conversations, perspectives that arise from the preexisting cognitive histories that participants have developed through life. Preexisting, idiosyncratic cognitive frameworks (see the topmost part of Fig. 2) develop from people’s exposure to diverse life and educational experiences. To take a simple example, people in Western cultures share the category structures that different types of fruits belong together, different pieces of furniture belong together, but the two categories are different from each other. Within the category fruit however, one individual might have stronger associations between mango and pineapple because of their frequent vacations in the Caribbean whereas another individual might have stronger associations between mangoes and peaches because they like the color butterscotch that these fruits share. Extrapolating from this small example, one can imagine the great spans of overlap in our cognitive structures as well as the variations for all sorts of information. This consideration of preexisting cognitive structures relates back to the role of retrieval organization in collaborative recall that B.H. Basden et al. (1997a) proposed originally. Retrieval organization refers to how an individual has organized the to-be remembered information presented during the study phase such that this structure is later used for remembering the information. In as much as preexisting cognitive histories overlap, or differ, the retrieval organization developed for the studied material may be aligned or nonaligned across the group members. In this way, preexisting cognitive history becomes integral to the retrieval strategy disruption hypothesis, which postulates that nonaligned idiosyncratic retrieval organization of studied information across group members results in lowered recall by each member and consequently, in lowered group recall, i.e., collaborative inhibition. Several studies have evaluated some aspect of the role of idiosyncratic retrieval organization by manipulating variables prior to collaborative recall and during the study phase.

2.04.6.1 Antecedent Conditions

In their seminal study, B.H. Basden et al. (1997a) reported that when participants recalled studied word list by category, collaborative inhibition disappeared (experiment 4). During recall, participants were instructed to retrieve all items from one specified category before continuing to the next category to recall. This procedure required all group members to adapt the same retrieval organization to recall words under that category. Under these conditions, collaborating groups recalled an equivalent number of items as did the nominal groups, presumably because the categories guided subjects to form similar retrieval organizations and this process deterred disruptive effects. In another study (Pinlay et al., 2000), subjects who later were to become group members were presented with study items in the same order with the expectation that aligned order of study presentation would reduce later disruptions in recall. The findings supported this argument as collaborative inhibition was reduced in comparison to the condition where subjects studied the words in different orders. We designed two experiments to manipulate the strength of retrieval organization developed during study to test the consequences on later collaborative recall (Pereira-Pasarin and Rajaram, 2011). In one experiment, we manipulated the number of study opportunities at encoding to strengthen each individual’s retrieval organization (see Rundus, 1971). It was expected that group members’ strengthened idiosyncratic organization would protect against retrieval disruption at recall and thereby reduce collaborative inhibition. In another experiment, we manipulated attention at study such that half of the information was encoded under conditions of divided attention and the other half under full attention. Encoding under conditions of divided attention was expected to reduce retrieval organization. We proposed that when there is not sufficient organization to disrupt, recall is also not likely to diminish considerably due to disruption. As a result, like strengthened retrieval organization (in experiment 1), weakened retrieval organization was also expected to reduce collaborative inhibition. The findings supported both these predictions. Overall, these findings suggest that collaborative inhibition and outcomes from group recall depend on the strength and similarity of the cognitive history and organization individuals bring to group remembering.

We now turn to a different way to manipulate retrieval organization prior to collaborative recall. This approach involves not the initial experience or the encoding per se, but instead the construction and reconstruction of organization through retrieval that occurs prior to collaboration. In one study, we investigated how learning methods—repeated study versus repeated testing—can impact retrieval organization and consequentially impact collaborative and individual recall (Congleton and Rajaram, 2011). We drew this comparison from the literature on the robust testing effect phenomenon where repeated testing has been found to be a more effective learning method for long-term benefits, whereas repeated study shows more immediate benefits (Roediger and Karpicke, 2006a,b). As both learning methods are aimed at consolidating new information, we were interested in how these learning methods may differ in the respective effects on retrieval organization, collaborative inhibition, and later individual memory. Repeated individual recall prior to collaboration was more effective for creating a strong retrieval organization such that collaborative inhibition was abolished following repeated retrieval while it was only reduced following repeated study. The development and strengthening of participants’ retrieval structures with repeated retrieval compared to repeated study also allowed them to benefit more from reexposure effects during collaboration, which then transferred to greater memory in postcollaborative individual recall (Congleton and Rajaram, 2011). Together, these findings show that antecedent conditions to collaboration can affect group collaborative recall as well as postcollaborative individual recall.

2.04.6.2 The Influence of Preexisting Cognitive Structures

There is an important and striking report of a reversal of the collaborative inhibition effect, that is, a presence of collaborative facilitation that is particularly intriguing for understanding the role of preexisting cognitive structures. Collaborative facilitation in group recall occurred in a study for expert pilots who studied aviation-related scenarios during study (Meade et al., 2009).
Because expertise in a domain of knowledge, such as aviation scenarios for experienced pilots, reflects shared, preexisting cognitive histories for the information that the subjects are to study in the experimental setting, such preexisting cognitive structures are likely to lead to strong and similar retrieval organization for that information. Thus, these subjects presumably organized the to-be remembered information similarly, and were less likely to disrupt others and be disrupted, thereby leading to enhanced group recall. The expert pilots also showed better communication style that aided recall of related information, a collaboration process that is reminiscent of the cross-cueing mechanism during collaboration that holds much intuitive value (see Fig. 2, for the collection of mechanisms.)

Some studies have reported reduced collaborative inhibition in recall among friend dyads and couples (Andersson, 2001; Andersson and Ronnberg, 1995; Johansson et al., 2000, 2005). As friends and couples have shared pasts, it is reasonable to assume that they also develop some shared ways of organizing that information, and therefore, they encode incoming information more similarly than do strangers. Systematic tests of this possibility are needed for stronger conclusions. The role of collaborative encoding can be tested experimentally as well, but as discussed in the next section on collaborative encoding, the findings here are as yet mixed.

2.04.6.3 Collaboration at Encoding

The experimental work we have summarized so far focuses on the relationship between collaboration and memory when collaboration occurs at the time of retrieval. What are the consequences of collaboration if interactive processing occurs during the initial experiencing of episodes, that is, during the encoding of information? In life, we experience countless events together. We go to the movies, celebrate birthdays and weddings, come together during losses and tragedies, take vacations as families and friends, or attend classes together where we might engage in discussions while learning new materials.

The published literature is strikingly limited on this question, and in our experience, this is not an oversight. It can be difficult to create encoding conditions that lend themselves to systematic collaboration. Nonetheless, since the mid-1990s, memory scientists have pursued tests of collaborative encoding. The comparatively small number of studies that have resulted from these efforts has yielded mixed patterns of results, with some studies showing that collaborative encoding impairs later memory while others show an improvement, and yet others show no particular effect at all (e.g., Andersson and Rönnberg, 1995, 1997; Barber et al., 2010, 2012a,b; Finlay et al., 2000; Garcia-Marques et al., 2012; Harris et al., 2013). It is not yet clear why these differences have emerged, and the variations in procedures, materials, or type of subjects complicate a ready understanding of these patterns.

In our lab, we have explored the nature of collaborative encoding using the following procedure. At study, we presented subjects with unrelated word pairs such as citizen–trail (see Graf and Schacter, 1985) and asked them to create a single sentence that connected the two words, e.g., The citizen walked the winding trail (Barber et al., 2010). Subjects either performed this task alone or in pairs (taking turns to start the collaborative coconstruction). We developed this procedure to ensure both members in a dyad engaged, and did so equally, to create a joint and novel encoding experience from the information presented to them. At retrieval, we used a cued recall task where subjects saw the first word (citizen) and retrieved the second (trail) either working alone or in pairs, and if working in pairs then with either the same partner with whom they had encoded the word pair or with a different partner. We observed a collaborative encoding deficit at recall. Subjects recalled less if they had studied word pairs in dyads than if they had studied alone. This outcome occurred when the partner changed from encoding to retrieval (but who had encoded the word with someone else) and held even when the partner was the same (Experiment 1). This pattern replicated when group was composed of triads instead of dyads, and the retrieval task consisted of the most typical free recall task used in collaborative memory experiments instead of cued recall (Barber et al., 2012a), or when free-for-all encoding was used (although the deficit attenuated following these instructions) instead of turn-taking at study (Barber et al., 2010; Experiment 2).

Collaborative encoding deficit in our experiments seems, in part, related to the quality of the joint memories partners construct, where better quality sentences created at study were associated with reduced magnitude of the collaborative encoding deficit (Barber et al., 2010; Experiment 2), and specific warnings during encoding about this deficit and specific task instructions for encoding eliminated this deficit (Barber et al., 2012b). However, it is not entirely clear why specific warnings work, because these warnings were not necessarily associated with better quality sentences but may have led to deeper encoding. Together, the extant studies in the literature do not yet show a clear picture for the role of collaboration on encoding for future memory, but findings provide directions for future work. A final interesting point we note here is that when we compared collaboration at encoding with collaboration at retrieval within the same paradigm in the same experiment (Barber et al., 2012a), the recall deficit from collaboration at encoding was smaller than the memory deficit arising from collaboration at retrieval, i.e., the collaborative inhibition effect. This outcome is consistent with a greater focus of the field so far on the collaborative inhibition effect arising at retrieval.

2.04.7 Postcollaborative Consequences of Collaborative Retrieval

2.04.7.1 Consequences on Postcollaborative Individual Memory

We now turn to the stage after collaboration to consider the cascading effects of collaboration. There is now an impressive body of findings to show that information mentioned during collaboration is remembered afterward even when collaborating members are no longer present. As shown in the framework presented in Fig. 2, we have called this process reexposure...
(see Blumen and Rajaram, 2008), and we described this process at some length in a previous section. To reiterate, reexposure during collaboration refers to an experience where participants are exposed to group members’ output of items that they did not recall, and also might not have recalled, themselves. This reexposure to items then serves as an extra study opportunity from which participants benefit when they later recall the study items alone. Unlike the benefits of cross-cueing and error pruning that typically improve memory during collaboration, the benefits of reexposure on memory are realized on a subsequent memory task. This mechanism has been implicated for improving postcollaborative individual remembering across a number of studies (e.g., see Basden et al., 2000; Blumen and Rajaram, 2008, 2009; Thorley and Dewhurst, 2007; Weldon and Bellinger, 1997). These postcollaborative benefits in individual memory are greater than the effects of hypermnesia from individuals recalling repeatedly alone and has been found for both recognition and recall (Basden et al., 2000, 2002; Finlay et al., 2000; Rajaram and Pereira-Pasarin, 2007; Rajaram and Pereira-Pasarin, 2010; Weldon and Bellinger, 1997). Furthermore, these benefits have been observed in young as well as older adults (Gagnon and Dixon, 2008; Henkel and Rajaram, 2009). The benefits of reexposure are presumably among the several motivating outcomes behind the pedagogical practices of student interaction during learning, in formats such as study groups and group projects (Garfield, 1993; Johnson and Johnson, 2009; Keeler and Steinhorst, 1995; Slavin, 1991). In this context, in a laboratory study, we observed benefits of reexposure among female participants for educationally relevant materials about statistical problem solving that required a conceptual understanding of the central tendency measures (Pociask and Rajaram, 2014).

Reexposure benefits can increase because of many reasons. For example, conditions that reduced retrieval disruption during collaboration can increase the opportunity for each group member to contribute more during collaboration, and this increased contribution can offer reexposure to the group members. This process can then increase the overall reexposure benefits. Different lines of evidence support this reasoning. In one study, we (Blumen and Rajaram, 2009) observed that participants maximally benefited from collaboration when they performed a collaborative recognition task that is known to reduce or eliminate disruption (Clark et al., 2000), and when the collaboration task was repeated and matched to the format of the final individual test.

In fact, when group members collaborate twice, even if they recall both times, the final individual recall of each member increases due to repeated reexposure to the items produced by their group members (collaborative, collaborative, individual recall sequence) when compared to the conditions where only a single collaboration precedes the final recall, even when controlling for the total number of recalls (collaborative, individual, individual recall sequence; Blumen and Rajaram, 2008). But what happens if the collaborating partners change across two group recall attempts? In another study, we manipulated group configuration across repeated collaborative recall sessions where in one condition identical triads collaborated twice to recall a list of studied words (the identical group condition), whereas in another condition the second collaborative recall session took place with triads who had previously collaborated as triads but with different group members (the reconfigured group condition) (Choi et al., 2014). With exposure to the recall content of a wider variety of partners in the reconfigured group condition, the predicted reexposure effect increased and led to increased postcollaborative individual recall compared to the identical group condition. The increased variety in recall was also computed by calculating the nominal group performance in the final individual recall, where those subjects in the reconfigured groups exhibited a greater variety of items in their final individual recall than those in identical groups. Reexposure benefits can also arise when retrieval organization is strengthened prior to collaborative recall. For example, in a study we discussed earlier (Congleton and Rajaram, 2011), repeated individual recall compared to repeated individual study, both carried out prior to collaborative recall, not only improved retrieval organization and eliminated collaborative inhibition in recall it also increased postcollaborative recall.

In sum, conditions that maximize the opportunities for reexposure during collaboration improve postcollaborative individual memory. We have not discussed memory errors that can similarly creep in from exposure during collaboration into postcollaborative individual memory, but a similar argument applies. In the case of these errors, the effects however would not arise from reexposure but rather from exposure since the former term is coined for items that subjects had originally studied.

2.04.7.2 Consequences of Collaboration on Memory Structure

We have reviewed how collaboration can shape what we remember, but does collaboration have the potential to influence how we organize these memories? In the preceding sections, we discussed the critical role that the retrieval organization of individual group members plays in shaping the collaborative process during recall. Here, we ask whether the collaboration process in turn changes the retrieval organization of group members. The empirical literature on this question is small but it is both interesting and consistent. In collaborative memory experiments, retrieval organization has been measured using adapted versions of two well-known measures in the individual memory literature, naming the paired-frequency (PF) measure (Stenberg and Tulving, 1977) and the ARC measure (Roenker et al., 1971) discussed earlier. The PF measure has been particularly useful for computing the nature of internal organization where studied stimuli may lack an obvious external structure, but subjects nonetheless impose a subjective organization in retrieval by chunking items into units (Gates, 1917; Sternberg and Tulving, 1977; Tulving, 1962). The PF measure relies on two consecutive recalls to assess such chunking. The ARC measure is prevalent in computing organization when retrieval is clustered into taxonomic categories (e.g., fruits, furniture, etc.; Bousfield, 1953) and can be assessed for a single recall output.

Every recall attempt presents an opportunity to reconstruct and reorganize recall. This newly reconstructed organization can potentially be used the next time one recalls the same information. Some of the questions, then, are whether the retrieval
organization that groups used to recall information would be used again by the group at the second group recall opportunity and by the individual group members later when recalling alone. Weldon and Bellinger (1997), using unrelated words as study materials, reported initial glimpses into such a process for collaborative recall; groups maintained marginally greater consistency in retrieval organization across two recalls (collaborative, collaborative) than did individuals across two recalls (individual, individual), suggesting that repeated collaborative recalls can begin to strengthen the group-level retrieval organization (also see Blumen and Rajaram, 2008; Choi et al., 2014; for similar patterns in later studies).

In a recent study, using categorized word lists as study materials, we examined the retrieval organization in final individual recall and found that it is influenced by the retrieval organization from prior recalls, where prior recalls consisted of individual or collaborative recall across conditions (Congleton and Rajaram, 2014). But there was also an interesting difference in these patterns; when prior recalls consisted of a combination of collaborative recall and individual recall, the final individual recall displayed retrieval organization that was similar to the retrieval organization evident in the most recent collaborative recall attempt, rather than the organization evident in an earlier collaborative recall attempt. We observed a converging pattern for the late collaboration effect when we examined the influence of repeated collaborative recall in reconfigured groups (where each group member collaborated twice, but each time with two different partners) where the retrieval organization of the second group configuration influenced final individual recall more than that of the first group configuration (Choi et al., 2014). In contrast to these patterns, if prior recalls consisted of repeated individual recall attempts, the retrieval organization in the final individual recall was influenced by the retrieval organizations from both early and late prior recalls (Congleton and Rajaram, 2014). These findings suggest that retrieval organization in individual recall has more enduring effects than the retrieval organization that develops during collaborative recall. This seems logical because collaborative recall brings together a new level of organization of information that subsumes idiosyncratic preferences of group members. Nonetheless, such influence of collaboration on later individual memory organization has potential implications for consequences of collaboration on future learning, an issue we have discussed at greater length in another publication (Congleton and Rajaram, 2014).

2.04.8 Collaborative Recall and Collective Memory

In this chapter, we have focused on the nature of collaborative memory. We briefly touch upon the concept of collective memory here because the process of collaborative remembering plays an important role in the formation of collective memory. However, a fuller treatment of this topic is beyond the intended scope of this chapter. A study of collective memory is relatively new in experimental memory research. This concept spans well beyond psychology, and it has had a long history of scholarly consideration in disciplines such as anthropology, history, and sociology (Bodnar, 1992; Cole, 2001; Halbwachs, 1950/1980). Within psychological research, collective memory has come to represent shared memories for a past that relates to the cultural, social, or political identity of the rememberers (Hirst and Manier, 2008; Wertsch and Roediger, 2008). In the experimental work on memory, the aspect about identity in this definition is not explicitly, or sometimes even implicitly, explored. The concept of collective memory is currently being investigated in terms of shared, overlapping memories among the members of a group, where these are experimentally constructed, culturally defined, or geographically represented (e.g., Abel et al., 2017; Barber et al., 2012a; Choi et al., 2014; Congleton and Rajaram, 2014; Luhmann and Rajaram, 2013, 2015; Muller et al., 2016; Roediger and Abel, 2015; Roediger and DeSoto, 2016; Stone et al., 2014; Yamashiro and Hirst, 2014; Zaromb et al., 2014).

The concepts of collaborative memory and collective memory are related, but these concepts also differ. In the current experimental framework, collaborative memory refers to the total number of memories that members produce together during group remembering, whereas collective memory refers to the total number of overlapping memories among the group members. Collaborative memory is typically measured during the collaborative recall phase, whereas collective memory is computed from the postcollaborative individual recall of the subjects who were previously group members. Because of this operationalization, we have sometimes referred to collective memory as shared memory (Congleton and Rajaram, 2014).

What processes during collaborative recall shape collective memory? As we have discussed in greater detail previously (Rajaram and Pereira-Pasarin, 2010), the collection of processes that come into play during collaboration can, in some combination or another, bring disparate contents of recall together. For example, reexposure to others’ recall during collaboration can make group members remember details they had themselves forgotten. Retrieval disruption and retrieval inhibition can diminish later recall of details that were not produced during collaboration by any group member, error pruning (either correctly or through simple rejection of correctly recalled details) can eliminate details from later recall, and social contagion of errors can transmit erroneous details across all group members. Such processes can together homogenize the contents of recall for group members and give rise to collective memory. In this vein, repeatedly collaborating with the same partners leads to greater collective remembering than collaborating with different partners across the same number of opportunities (Choi et al., 2014).

Beyond collective memory for what people remember, collaborative recall can also shape the structure of this memory. As we note in the section on consequences of collaborative recall on memory structure, repeated collaborative recall stabilizes the structure of collaborative recall (Weldon and Bellinger, 1997). In our work, we have also observed when identical groups engaged in repeated collaborative recall the retrieval organization of their recall output is more consistent than if they collaborated only once (Blumen and Rajaram, 2008), or if the group members collaborated the second time with different partners (reconfigured groups; Choi et al., 2014). Thus, collaborative recall changes the structure of memory not only for each group member as we noted in this chapter but also for the group’s collective memory. In a direct and quantitative test of this deep-structure consequence of collaborative recall, we
observed that collaborative recall processes have a powerful effect on the shared retrieval organization group members develop in their collective memory (Congleton and Rajaram, 2014).

2.04.9 Concluding Remarks

The arena of collaborative memory research in the cognitive experimental tradition lies in the middle of the Ebbinghausian tradition of individual memory experiments and the vast topic of social memory. Collaborative memory research leverages the former tradition and enables systematic steps toward incorporating the social influences. In this sense, the collaborative memory movement embodies the spirit of the approach Frederic Bartlett espoused. This chapter provides a selective overview of the progress made in collaborative memory research in the last couple of decades. This body of research provides a methodological platform to both press on the theoretical questions that arise from these early, exciting explorations, and explore questions of wide-ranging societal interest and significance such as how small groups and large communities transmit memories, influence one another’s cognitive structures, and develop collective memories.

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References


