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ADVANCED REVIEW

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Collective memory: Collaborative recall synchronizes what and how people remember

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Abstract

Memory researchers and theorists have long advanced the idea that the manner in which information is retrieved is critical. The way retrieval unfolds provides critical insights into how memories are organized and accessed—an important aspect of memory missed by focusing only on quantity. Cognitive studies of memory in social contexts, deploying the collaborative memory paradigm, have also noted the importance of such retrieval organization. Such memory studies often focus on how relative to "groups" that never collaborated, former members of collaborating groups recall more of the same material (*collective memory*) and they do so in a more synchronized fashion (*collective retrieval organization*). In this review, we leverage the diverse methodological and quantitative toolkits that have traditionally targeted individual retrieval to highlight the ways in which this social memory research has examined collective memory and collective retrieval organization. To that end, we consider how the collaborative memory paradigm has integrated *methods*, such as free recall, that afford rich assessments of retrieval organization. Likewise, we consider the application of *metrics* that characterize organization patterns in different contexts. With this background in mind, we discuss the important theoretical and broader implications of research on collective memory and collective retrieval organization.

This article is categorized under:
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KEYWORDS
collective, collaborative recall, collective memory, measurement, retrieval organization

1 | INTRODUCTION

Recalling material or events with others is an altogether common experience; students work in study groups recalling course content, colleagues recap a recent meeting, families reflect on a recent vacation, social media users recount and debate a notable event. In each of these cases, and in countless other situations, people reconstruct the past with others. Remembering, then, is often a profoundly *social experience*. Beyond remembering within social contexts, memories are often shared across individuals; a couple has similar memories of their wedding night, members of a sports team have similar memories of a big game, college students leaving a lecture all remember a fun anecdote, and a tragic headline is

remembered by the masses. Across these examples, and undoubtably many others, the same material is remembered by all or most members of a group. Thus, memories are often *collectively held*.

While some early empirical work advanced the observation that memory is molded by social contexts (Bartlett, 1977/1932), the majority of human memory research over the past 125 years has prioritized the study of individuals remembering alone (Crowder, 1976/2014; Surprenant & Neath, 2009). During this time, memory researchers working in the cognitive-experimental domain have developed and refined myriad experimental paradigms and theoretical frameworks to explain the complexities of human episodic memory, that is, how people remember specific events from the past, often invoking the importance of *how material is retrieved* (Rajaram & Barber, 2008; Roediger III, 2000). This emphasis goes beyond how much one remembers, factoring in the ways in which material is produced (Bousfield et al., 1954; Tulving, 1962), including how one initiates retrieval, transitions from response to response, and terminates retrieval (Kahana, 2012). Indexing recall in this way, where not just the content but the manner of retrieval is quantified, constitutes the assessment of *retrieval organization*,[1] and is essential for understanding memory and memory processes at a deeper level (Kahana et al., 2022; Wixted & Rohrer, 1994).

In the current review, we highlight the important connection between research on individual retrieval processes and research on collective memory, with a focus on retrieval organization. On the one hand, even though the studies on this topic are sparse, research on collaborative memory has been concerned with retrieval organization from the beginning, drawing inspiration from related paradigms and effects (e.g., Basden et al., 1997). Likewise, a handful of collective memory studies have examined how individuals come to recall the same material and in a similar fashion (Congleton & Rajaram, 2014; Greeley et al., 2022). On the other hand, considering retrieval organization in social contexts is not without challenges, considering the narrative nature that often characterizes collective remembering and the need for experimental paradigms that can identify the mechanisms that can explain such phenomena. The current review offers a novel perspective on the relationships between retrieval organization and collective memory; we not only highlight empirical evidence to date, but we also identify key points of integration, note critical gaps, and specify the hurdles to cross as research at this intersection advances.

1.1 | Key terms and definitions

Before considering how two typically disparate research traditions have and can continue to inform each other, we define the key concepts—especially for *collective memory* and *retrieval organization*—to make the task of sketching out a roadmap for integrating these concepts a more feasible one. These terms are also described in Table 1.

1.1.1 | Collective memory

Collective memory in the social sciences literature has at least two general definitions. While these definitions share some key common features, they also vary in scope and application. One definition is more closely associated with sociological, anthropological, and historical analysis (Beim, 2007; Halbwachs, 1992; Olick, 1999; Wertsch &

TABLE 1 Individual and collective organization: Key terms

Term	General definition	Highlighted organizational outcome	Feature definition
Retrieval Organization	The manner in which people retrieve material throughout the process of free recall	Semantic contiguity	Contiguous recall of semantically related targets
		Subjective organization	Recalling targets in similar sequences across repeated retrieval attempts
Collective Retrieval Organization	The extent to which group members converge on recalling the same material in a similar manner	Shared organization	Separate people (e.g., former collaborators) recalling the same targets in similar sequences

Note: Glossary of key terms relating to retrieval organization and collective retrieval organization. The current review briefly highlights individual semantic contiguity and subjective organization and focuses on collective retrieval organization. Specific metrics are included in Table 2.

Roediger, 2008). This view, which in its basic form can be traced back to Halbwachs (1992), asserts that collective memories are often present in the use of traditions, physical commemorations, and archives. Collective memory in this sense is central to group identity and may be considered at various levels, from small family units to entire nations (Assmann & Czaplicka, 1995). Across levels, collective memories of this sort survive and persist in large part because of reinforcement from the group (Halbwachs, 1992).

The cognitive-psychological conception of collective memory is quite different and far more constrained. Within cognitive psychology, collective memory is typically defined as *the amount of material recalled by all, or most, members of a group* (Barnier & Sutton, 2008; Choi et al., 2014; Congleton & Rajaram, 2014; Cuc et al., 2006; Stone et al., 2010; Wertsch & Roediger, 2008). This is the definition used here. For the purposes of empirical study and experimentation, this reduction is useful for several reasons. First, defining collective memory in this way provides clear boundaries; there is a floor (nothing recalled by all members of a group) and a ceiling (everything recalled by all members of a group). Likewise, the *memory* aspect of the definition is aligned with how memory is typically defined in cognitive psychology, it is objectively traceable to an earlier experience within a research study, and permits quantitative assessment of true versus false as well as distorted memories. This cognitive grounding is more focused than mapping "memory" onto an array of phenomena (e.g., traditions) that undoubtably require memory, but are more multifaceted. Finally, because of the clear boundaries and cognitive grounding, this account of collective memory affords experimentation (Choi et al., 2014; Congleton & Rajaram, 2014; Cuc et al., 2006). While research interest in collective memory from this cognitive angle has emerged only recently (within the past 20 years or so), significant insights have been gleaned. This research is reviewed later.

1.1.2 | Retrieval organization

Retrieval organization, despite being a general term, is more straightforward to define. In the context of a free recall experiment—during which participants produce to-be-remembered items (often words) in any order that they prefer—retrieval organization refers to the *manner in which participants recall material* (Bousfield & Sedgewick, 1944; Tulving, 1962). Note that this goes above and beyond how much a participant recalls, a more commonly targeted outcome, to assess how responses are produced. This can include how participants initiate retrieval, transition from response to response, and how people stop retrieval (Kahana, 2012). The current review is focused on the transition element, though the importance of retrieval initiation and stopping should not be understated.

Unlike the cognitive-psychological consideration of collective memory, which is relatively recent, the assessment of retrieval organization has been a central part of human memory research for well over a century (Ebbinghaus, 1913; Murdock, 1985; Slamecka, 1985). These investigations initially focused primarily on *semantic clustering*—the robust finding that participants group responses by semantic category or similarity (Bousfield et al., 1954; Gutchess et al., 2006; Mandler, 1967; Puff, 1974). Clustering is not limited to categories, however; responses may be grouped by modality experienced at study (Murdock & Walker, 1969), the perceived gender of the speaker at study (Nilsson, 1974), and the spatial context encountered at study (Miller et al., 2013). Another trademark finding is that, across repeated retrieval attempts for the same to-be-recalled material, recall outputs become increasingly stable—referred to as *subjective organization* (Sternberg & Tulving, 1977; Tulving, 1962). This occurs even when stimuli consist of unrelated words (Tulving, 1962). Temporal contiguity is another noteworthy organizational effect (Healey et al., 2019; Kahana, 1996), but it has not been explored in collaborative or collective memory contexts so is not discussed further.

1.1.3 | Collective retrieval organization

Collective retrieval organization is found at the crossroads of collective memory and retrieval organization. Specifically, collective retrieval organization refers to the *extent to which members of a group have synchronized retrieval strategies*. This merger of collective memory and retrieval organization is rather new, and to the best of our knowledge, only a handful of studies have assessed this explicitly (Congleton & Rajaram, 2014; Greeley et al., 2022). At the same time, the general concept is a familiar one. Bartlett (1977/1932) conception of a schema—at a high level—implies similarly structured, shared representations; schemas are shifting templates, molded by culture, context, and past experience, that guide learning and reconstruction at retrieval (Wagoner, 2013). Collective retrieval organization, as described here, has a narrower focus in as much as it is operationalized to provide quantifiable measures of how the recall process becomes synchronized for those who engaged in collaboratively recall.

To solidify the concept of collective retrieval organization, consider the following example. Three participants, strangers to each other, arrive at the lab and study a list of 90 to-be-recalled words. The participants then form a group, gather around a single computer, and work together to recall as many words as they can. After their allotted time is up, they return to their own computers and are told to recall the same words again, this time on their own. When the procedure is complete, the experimenter has several recall protocols with which to work; the group recall and—critically—the three, postcollaborative individual recalls. Focusing on the individual recall protocols for now, collective memory would be assessed by determining the number of words recalled by all or some members of the group. Likewise, depending on stimulus attributes, individual retrieval organization could be assessed in a number of ways (e.g., with respect to semantic clustering). Finally, assessing collective retrieval organization involves asking a different question; do former group members *recall the same material in a similar fashion*?

2 | METHODOLOGICAL AND CONCEPTUAL DIVERSITY: DEFINING THE SCOPE OF STUDY

Before considering how best to integrate the study of collective memory and retrieval organization—broad topics in their own right—we must first define the scope of interest. As mentioned previously, the vast majority of memory research conducted over the past century has centered on how individuals remember when working alone and in the absence of social influences. While the experimental tradition of studying collaborative remembering and collective memory is relatively new, adjacent lines of memory research also take this perspective to focus on group memory and cognition more broadly. For example, studies on memory conformity, transactive memory, and the social contagion of memory all adopt a group or social perspective (Roediger et al., 2001; Wegner, 1987; Wright et al., 2000). A full review of these literatures is beyond the scope of the current article, but it is worth noting where the study of collective memory and collective retrieval organization fit into this broader social memory perspective.

A large literature on *memory conformity* generally finds that individuals tend to update their memories after exposure to some socially provided, postevent information, that is, when an initial study phase (the event) is followed by a social source (another participant, a confederate) provides related information that was not presented in the initial study event (Wright et al., 2000). This phenomenon of memory updating holds when postevent discussion takes place among real-life "co-witnesses" that saw a different version of an event (Gabbert et al., 2003) and also when participants are simply shown response options selected by other participants (when they were in fact controlled by the experimenter, e.g., Betz et al., 1996). It follows, then, that participants exposed to the same postevent information may update their memories in similar ways, giving rise to a more homogenized representation. However, postdiscussion group-level memory similarity (which we would label collective memory) is not typically assessed in memory conformity studies, and postdiscussion memory tests are often recognition instead of recall based (though see Gabbert et al., 2003). These procedures preclude the opportunity to study collective memory and collective retrieval organization as we have described them here. Finally, determining the extent to which memory per se is updated is challenging; an updated report may not reflect what the participant (or witness) actually remembers. Instead, different forms of social influence or source confusion may be driving conformity (Walther et al., 2002).

Another adjacent line of research focuses on *transactive memory* (Wegner, 1987). Broadly, research on transactive memory considers the distribution of memories and memorial resources across a network of individuals, that is, a transactive memory system (Ren & Argote, 2011; Wegner, 1987; Zhou & Pazos, 2020). A given group—such as team in a workplace—may need to encode, represent, and retrieve more than any individual, even an expert, could manage. Research on transactive memory is concerned with how such networks coordinate these activities in the service of particular goals. Expectedly, this level of breadth has sparked decades of valuable research on both theoretical and applied questions (Austin, 2003; Peltokorpi & Hood, 2019). While the study of transactive memory is multifaceted, collective memory and collective retrieval organization have not been of particular concern. Instead, research has focused on variables such as individual expertise, total group knowledge, and how individuals appraise what others know (Austin, 2003; Ren & Argote, 2011; Wegner, 1987). In spite of the potential importance of collective memory and collective retrieval organization, *memory performance* in general is not a common outcome; behavioral and performance-based outcomes are more often encapsulated in measures of communication quality, innovation, creativity, and performance as rated by the team itself, clients, or a manager (see Zhou & Pazos, 2020 for a recent meta-analysis).

Finally, research on the *social contagion* of memory also takes a decidedly social point-of-view to consider how memories (often false memories) spread from person to person (Hirst & Echterhoff, 2011; Roediger et al., 2001).

Perhaps most relevant are studies that use a collaborative recall or discussion phase—with or without confederates—during which erroneous information is introduced to participants (Choi et al., 2017; Kensinger et al., 2016; Meade & Roediger, 2002). To gauge the extent to which participants integrate this information into their own memories, they are typically given a subsequent free recall or recognition test. Note here the significant overlap with the procedures associated with the memory conformity literature (e.g., Gabbert et al., 2003). In fact, the difference is largely semantic and if there is a distinction it boils down to the nature of the stimuli, such that memory conformity is often used in more applied contexts (e.g., eyewitness memory research). Likewise, a number of moderators of interest overlap with key moderators in the transactive memory literature (e.g., expertise and trust; Koppel et al., 2014). Critically, like these other frameworks, studies of social contagion are not usually concerned with if a collaborative group converges on recalling the same material or if retrieval organization becomes synchronized. Instead, focus is on how socially provided information reshapes *individual* memory.

In the current review, we focus on the application of the collaborative memory paradigm, which we describe in detail in a later section. For the current purposes, one key asset of the collaborative memory paradigm is that much of the methodological infrastructure is already in place; the paradigm includes the key procedural components necessary for assessing collective memory and collective retrieval organization in a variety of contexts (Congleton & Rajaram, 2014; Greeley et al., 2022, in Press). However, this is not to say that other empirical frameworks are unable or cannot be adapted to address questions relating to collective memory and collective retrieval organization. On the contrary, we see the paradigms associated other social memory literatures—particularly work on memory conformity, transactive memory, and social contagion—as having enormous potential for extending extant research. This will be especially true if we are to consider broader implications, whether in the courtroom, office, or on a social media timeline. In any case, with this more targeted scope, outlining specific integrative goals and challenges is a more feasible task to which we now turn.

3 | INTEGRATIVE GOALS AND CHALLENGES

If the examination of collective retrieval organization is to fulfill its potential, it is critical to lay out specific goals. Likewise, it is important to acknowledge and make plans for addressing the nontrivial challenges of pursuing these goals. In that respect, the current paper targets three pieces of this puzzle: *methodological* integration and advancement, *measurement* development and selection, and *theoretical* integration and grounding.

First, methodological and measurement integration is key for structuring investigations in a way that is consistent with theoretical goals. Research on individual retrieval organization is very much rooted in basic memory paradigms that concentrate on the individual (Crowder, 1976/2014; Murphy & Puff, 1982). While the methods employed in studies of collective memory are quite variable (Beim, 2007; Rajaram, 2022; Wertsch & Roediger, 2008), a widely used method in cognitive research—the collaborative memory paradigm—is well suited to the assessment of retrieval organization (Basden et al., 1997; Choi et al., 2014; Congleton & Rajaram, 2014; Greeley et al., 2022; Rajaram, 2022; Weldon & Bellinger, 1997). Such experiments are procedurally flexible and allow for staging controlled social interactions *in tandem with* basic procedures (e.g., encoding and retrieval of word lists). Further, measurement integration is key for quantifying collective retrieval organization in a way that (a) appropriately characterizes the organization/overlap of interest and (b) works with the procedure and stimuli of a given investigation. This is an incredible technical challenge; not only do most metrics used for quantifying retrieval organization stem from research on individuals (Bousfield et al., 1954; Sternberg & Tulving, 1977), these metrics often target specific phenomena (e.g., semantic clustering) and are not concerned with quantifying similarity across participants. As such, gaining insight into similarities in retrieval organization across participants necessitates that we develop new quantitative metrics.

Finally, theoretical integration is key for the eventual guiding of goals. On the one hand, research on individual retrieval organization is deeply theory driven; retrieval patterns are robust across tasks and, therefore, provide a set of target phenomena that theories of memory must explain, and current theories, and the models that instantiate them, have been quite successful (e.g., Polyn et al., 2009). On the other hand, theoretical accounts of collective memory (within cognitive psychology) are less developed, largely because of how recently interest in the topic has emerged. So far, studies of collective memory have focused primarily on documenting effects rather than explaining them, as empirical data are needed to ignite theorizing (Murdock, 1985). But now, with data in hand, there are robust effects to explain, for example, greater collective memory/collective retrieval organization following group collaboration compared to conditions where there is no collaboration (Barber et al., 2012; Choi et al., 2014, 2017; Congleton & Rajaram, 2014; Greeley et al., 2022; Harris et al., 2008). How can theories and models from the individual side help with this task? Before

addressing this question, it is important to consider how methods and metrics from research on individual and collective memory can be integrated to move towards that goal.

4 | INTEGRATING METHOD AND METRICS: FROM INDIVIDUAL TO COLLECTIVE

The methods used to explore retrieval organization in individual memory as defined here overwhelmingly involve the use of one or more *free recall* tasks. As we described below, the reason this is the go-to task is straightforward—when participants complete a free recall task, they are free to recall material in *any order they prefer*, a feature that allows the capture of the participant's way of structuring what they remember. Pivoting to the cognitive-centric study of collective memory, this research can be grouped into two general categories: controlled experiments involving collaborative recall that often involve free recall (e.g., the collaborative memory paradigm—Weldon & Bellinger, 1997) and survey-based research (e.g., Roediger III & Abel, 2015; Roediger III & DeSoto, 2014). Here, we consider each of these general approaches and highlight their considerable overlap. While a complete review of free recall methodology, the collaborative memory literature, and the measurement of retrieval organization is beyond the scope of the current paper, we concentrate on those features most central to work on collaborative remembering and collective memory.

4.1 | Methods targeting individual retrieval organization

The use of free recall is critical for the assessment of retrieval organization because the whole point is to quantify and compare the ways in which responses are produced in a free-flowing, naturalistic style (see below for a selection of metrics). For example, in a typical free recall study, participants might study a list of 20 unrelated nouns—one at a time—before being asked to recall as many words as they can in any order (e.g., by writing them down). Asking participants to recall material in a specific order (as in serial recall), asking participants to tag items as old or new (as in recognition tasks), or providing cues at the point of retrieval (as in cued recall) forgoes the opportunity to characterize natural, self-initiated retrieval patterns. Several manipulations are especially relevant when considering the analysis of retrieval organization; restricting coverage to the free recall of words, two critical manipulations include varying stimuli characteristics (such as semantic relatedness) and the number of tests (single or repeated testing).

First, consider stimuli characteristics, namely whether or not the to-be-recalled material is semantically related. Early work on retrieval organization focused on how semantically related material was recalled (Bousfield et al., 1954; Bousfield & Sedgewick, 1944; Glanzer et al., 1972). This approach affords the assessment of how participants might naturally *cluster items belonging to the same category* (Patterson et al., 1971; Pollio et al., 1969). Another central feature of free recall studies is that they often afford repeated recall attempts for the same material. Including repeated recall attempts allows one to examine how intra-participant retrieval organization *change and/or stabilize* (e.g., Congleton & Rajaram, 2012; Tulving, 1962; Zaromb & Roediger III, 2010), in addition to other phenomena (e.g., hypermnesia—or an increase in the quantity of recall with repeated attempts following a single study opportunity; Payne et al., 1993).

4.2 | Methods targeting collective memory: Cognitive paradigms

With respect to studying social memory and socially modified retrieval organization, two approaches are particularly relevant—the collaborative memory paradigm and survey-based free recall studies assessing memory (e.g., recall of presidents, events, and locations). As other data-driven approaches target general trends that align with the sociological definition of collective memory (Candia et al., 2019; Frank, 2019), these are not discussed here.

4.2.1 | The collaborative memory paradigm

Largely relying on the free recall procedures described above, the collaborative paradigm involves having small groups of participants collaborate to recall material (Basden et al., 1997; Weldon & Bellinger, 1997). The basic procedure typically involves having participants individually study to-be-recalled material, often a list of words. After this study phase,

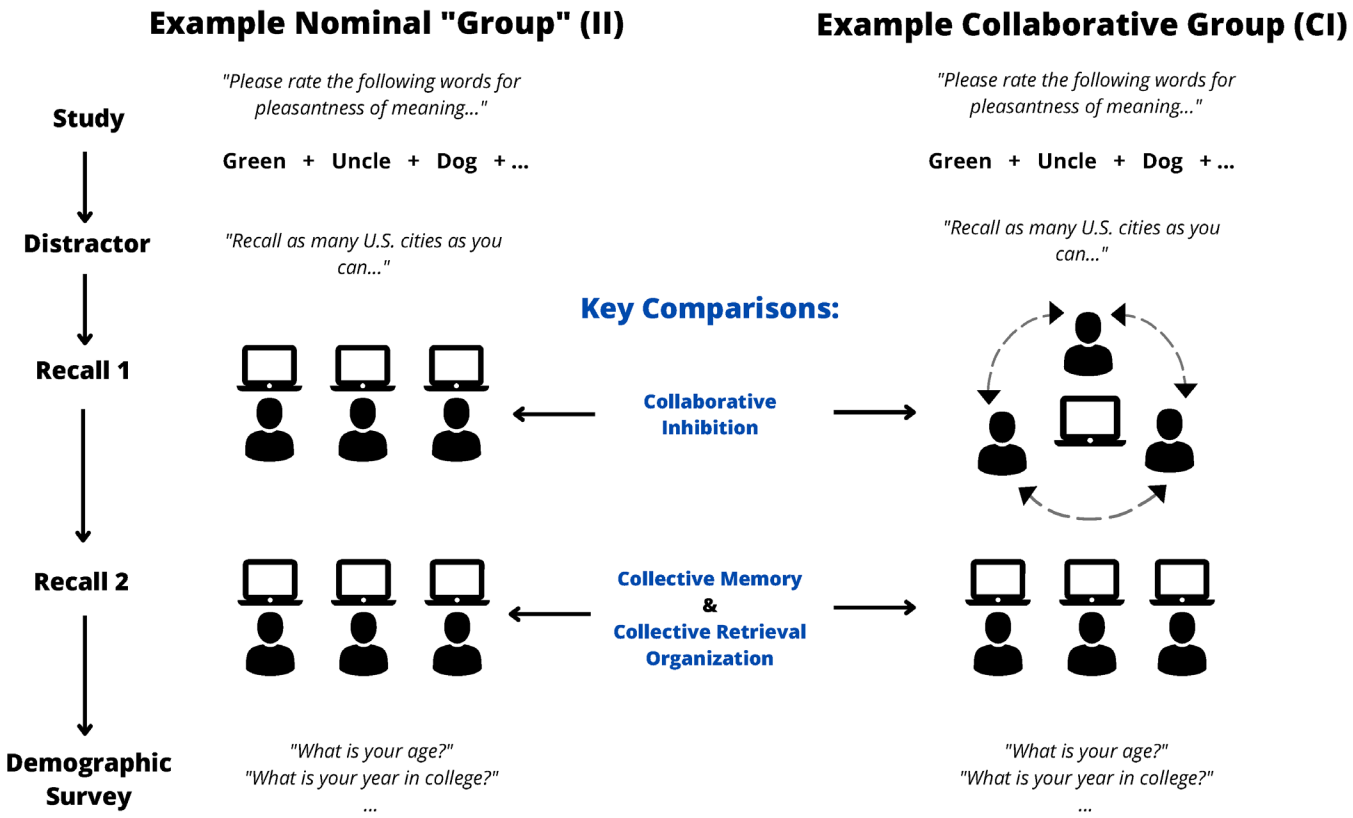

FIGURE 1 Example of collaborative memory procedure and where key measurements take place. Example collaborative memory experiment, with indicators where collaborative inhibition, collective memory, and collective retrieval organization would be assessed. After a study phase and a brief distractor task, nominal participants work alone to complete back-to-back free recall tasks; their nonredundant responses are later pooled for a fair comparison to collaborative groups. Collaborative participants work together at Recall 1 and individually at Recall 2. Following the collaboration, former collaborative group members tend to recall more of the same material—and do so in a more similar fashion—than nominal "groups" that never collaborated. CI, collaborative-individual; II, individual–individual

the procedure differs by condition. Some participants complete one or more recalls in small, *collaborative groups* (typically dyads [groups of two] or triads [groups of three]; Marion & Thorley, 2016; Rajaram & Pereira-Pasarin, 2010). The group recall procedure may involve free-for-all collaboration (participants can discuss/debate and contribute freely, in any order) or turn-taking (participants must follow an experimenter-defined order). Other participants complete one or more free recalls alone, and the nonredundant responses from the same number of participants within collaborative groups are pooled. The formation of such *nominal groups*, or groups in name only, is essential when assessing recall levels because groups will typically outperform even the best individuals (see Marion & Thorley, 2016 for a review).

Critical to the study of collective memory within this framework is the inclusion of at least one, always individual, postcollaborative recall (Choi et al., 2014, 2017; Congleton & Rajaram, 2014; Cuc et al., 2006; Harris et al., 2008; Maswood et al., 2019). As collective memory in this context is typically operationalized as the number of responses recalled by all, or at least some, members of a group (e.g., Barnier & Sutton, 2008; Hirst & Manier, 2008; Olick, 1999), participants must be given an opportunity to recall on their own following collaboration. This design feature is also central to the assessment of collective retrieval organization; to determine the degree to which former collaborators converge on common retrieval sequences, they must be given a chance to recall independently. Whether or not collaborative memory studies have explicitly focused on this measure, many experiments include such postcollaborative recall phases (e.g., Basden et al., 1997; Blumen & Rajaram, 2008; Blumen et al., 2014; Harris et al., 2008; Weldon & Bellinger, 1997; Weldon et al., 2000; Weldon, 2000; Wissman & Rawson, 2015; also see Rajaram, 2022). An example collaborative memory procedure is depicted in Figure 1.

An example case

Congleton and Rajaram (2014) report an experiment that exemplifies both the collaborative memory paradigm and the assessment of collective memory organization. Participants studied a relatively long, 120-item word list before

completing a series of free recall tasks. In the control condition, participants completed five individual recall phases—four back-to-back recalls and one more a week later. The experiment included three different collaborative conditions, in which participants collaborated early (at Recall 2), late (at Recall 3), or multiple times (at Recall 2 and 3) in a sequence of five recall phases. Critically, all participants recalled individually at the fourth and fifth recall phases. This allowed the authors to assess collective memory and collective retrieval organization both shortly after *and* a week following collaboration. This design, combined with a novel metric (discussed in detail below), provided a host of insights relating to all aspects of socially modified retrieval organization. Other extensions of the traditional collaborative memory paradigm are also beginning to shed light on the emergence of collective memory organization. For example, we recently re-analyzed the situation from Choi et al. (2014) where successive recalls occur across reconfigured groups from one recall to the next to see how changing recall partners influenced group and downstream individual memory (Greeley et al., in Press). We elaborate on these findings in the section below on *Measuring Collective Retrieval Organization*.

The importance of retrieval in shaping memory

Most studies leveraging the collaborative memory paradigm focus on how memory is influenced by retrieval processes. However, from a broader cognitive perspective, memory can be studied at a variety of stages (Tulving, 1983). Various factors might influence memory at the *encoding* stage—the context in which new information is encountered, how the information is processed, and the attributes of the information itself may influence memory downstream. Once information is encoded, a myriad of factors may impact *storage* or more appropriately, *consolidation*, or the integrity of the representation; for example, prior knowledge or interference from other sources may bias or contaminate what is eventually remembered. Finally, the *retrieval* stage is critical (Rajaram & Barber, 2008; Roediger III, 2000). First, retrieval in general is influenced by the presence of other information, such as context and the availability of cues (Roediger & Uner, 2022; Tulving, 1983). Likewise, retrieval itself can improve long-term retention of retrieved material (known as the testing effect; Roediger & Karpicke, 2006), impair memory for nonretrieved material (known as part-list cuing impairment; D. R. Basden & B. H. Basden, 1995; Slamecka, 1969), and guide the subsequent learning of new material (known as test-potentiated new learning; Chan et al., 2018; Wissman et al., 2011). The general importance of retrieval is captured succinctly in a recent chapter by Roediger and Uner (2022). The authors highlight the fact that encoding and storage are ubiquitous memory processes, often occurring automatically in the service of basic day-to-day function. However, the vast majority of what is encoded and stored is eventually rendered inaccessible; it may be available, but barring a particular context or the perfect cue, it is out of reach.

Pivoting specifically to the cognitive-psychological study of social and collective memory, retrieval plays an especially central role. Across experimental paradigms (e.g., collaborative memory paradigm, memory conformity), core results hinge on *what material is retrieved* in a social context. When an individual recalls something in a social context—whether in a small group setting, during a broadcast event, or in a post on social media—other people are exposed to what gets recalled. There are numerous memorial consequences to this happenstance (for a review, see Rajaram & Pereira-Pasarin, 2010). Recalled material may cue others to retrieve particular memories (cross-cuing), or it may disrupt or inhibit access to one's own memories (via disruption, inhibition, or blocking). Retrieving material in a social context—versus privately—also provides an opportunity for correction (error pruning). At the same time, inaccurate information recalled by one individual may be endorsed and adopted by others (social contagion errors). Whether one is interested in how these forces interact to influence individual memory or the memory of the group as a whole, retrieval is key. In fact, direct experimental comparison of collaborating at encoding versus collaborating at retrieval shows that collaboration at retrieval exerts a far greater influence on memory than does collaborating at encoding (Barber et al., 2012).

4.2.2 | Other collective memory methods

Outside of the experimental realm and the collaborative recall paradigm, other studies have attempted to assess collective memory for presidents, cities, and historical events/figures (Abel et al., 2019; Greeley et al., 2021; Roediger III & DeSoto, 2014; Yamashiro & Roediger III, 2021). This research can generally be classified as survey-based or quasi-experimental and, while not concerned with how retrieval organization is shaped by social contexts, this work nonetheless speaks to collective retrieval organization. Despite this work being more closely tied to the sociological/anthropological conception of collective memory, it still primarily targets (a) what material (e.g., people, places) is

recalled by a majority of the group, and (b) *how* that material is recalled. Rather than using word lists and free recall procedures, a collective memory study of this sort probes pre-existing representations.

While not originally framed as a collective memory study, Roediger III and Crowder (1976) had participants recall U.S. presidents. The vast majority of the sample recalled the first two or three presidents (Washington, Adams) and the most recent presidents (with relatively high recall rates going back about 15 years), demonstrating primacy and recency. Presidents in the middle, with the exception of Lincoln, were more likely to be omitted or recalled in the wrong position. More recent follow-up studies found that this effect holds across generations (Roediger III & Abel, 2015; Roediger III & DeSoto, 2014). In collective memory terms, people tend to collectively recall early presidents and recent presidents, but recent presidents will eventually fade from national memory. Notable for our considerations then, we may infer that these findings not only show which presidents were collectively recalled but also the role of the sequential order about/for when their presidency occurred in determining recall, thus shedding light on the collective retrieval organization in this class of memory measures. Other research in this domain has assessed national and community-level collective memories for WWII (Abel et al., 2019; Wertsch, 2008). Whereas these studies have focused on collective memory content, a recent study probed collective memory for U.S. cities, pooling data from five studies conducted between 2011 and 2021 (Greeley et al., 2021). Despite having 7 min to report *any* U.S. cities in *any* order (i.e., unconstrained free recall/generation), cities that were popular overall were reported in similar output positions across subsamples. Thus, not only are there a selection of cities (of thousands to choose from) recalled by many participants, these popular cities are retrieved in a similar manner across time and experimental contexts. This highlights the potential such designs have with respect to the analysis of collective retrieval organization.

4.3 | Metrics: Measuring the structure of individual and collective memory

Having defined a set of fruitful methodologies for studying socially modified retrieval organization, the construct of retrieval organization in this context must be characterized appropriately. Exactly what this means will depend on—and may be constrained by—the aforementioned procedures. Here, we briefly review metrics that target individual retrieval organization and highlight current approaches for assessing collective retrieval organization. Specifically, we concentrate on individual retrieval organization metrics that have been used in collaborative recall contexts and those that have been adapted to capture the extent to which retrieval processes have become synchronized. These metrics are also summarized in Table 2.

4.3.1 | Measuring individual retrieval organization

We will consider here two measures of retrieval organization from individual recall literature that have been utilized in research on collaborative recall as well. One such measure comes from early investigations into retrieval organization that focused on semantic clustering—the propensity to contiguously recall items belonging to the same semantic category (Bousfield, 1953; Bousfield & Sedgewick, 1944). For example, if participants are presented with a 20-target, four-category list (e.g., categories: animals, fruits, vehicles, drinks – with five words per category), they may recall, in order—*lion*, *bear*, *mouse*, *apple*, *orange*, *juice*, *milk*, *tea*, *strawberry*, *car*, *train*, *plane*, *elephant*. The clustering here is clear, such that category exemplars (e.g., lion, bear, mouse) often occur in adjacent output positions, but this needs to

TABLE 2 Individual and collective organization: Highlighted metrics

Organizational pattern of interest	Metric	Canonical reference
Semantic contiguity	Adjusted ratio of clustering (ARC)	Roenker et al. (1971)
Subjective organization	Pair frequency (PF)	Sternberg and Tulving (1977)
Collective retrieval organization	Shared organization metric analysis (SOMA)	Congleton and Rajaram (2014)

Note: Metrics highlighted in the current review, which are those commonly used to examine individual and collective retrieval organization in collaborative memory research. The adjusted ratio of clustering (ARC) and pair frequency (PF) metrics are frequently used, targeting semantic contiguity and subjective organization, respectively. The shared organization metric analysis (SOMA), based on PF, is used to examine how retrieval organization becomes synchronized following collaborative recall. While these metrics are the most prominently applied in experimental studies of social memory, as we note in the article this is not a comprehensive list of organizational metrics in the literature on individual recall.

be quantified. Category clustering today is often quantified by computing the *Adjusted Ratio of Clustering* (commonly abbreviated ARC; Roenker et al., 1971). ARC scores are bound between −1 and 1 and are typically easy to interpret; an ARC score of 0 indicates chance level clustering in the recall sequence, while a score of 1 indicates perfect clustering. The primary difference between ARC and earlier metrics is the consideration of the *expected* number of category repetitions given the number of words per category recalled (Murphy & Puff, 1982).

While category clustering relates to the contiguous recall of semantically related words, a second measure of interest in the present context is subjective organization, which refers to increasingly similar retrieval sequences across repeated recall attempts (Sternberg & Tulving, 1977; Tulving, 1962). That is, participants typically impose structure subjectively; the order of recalled words often becomes more stable on each successive retrieval attempt. Sternberg and Tulving (1977) summarized the frequently applied approaches to date and described *Pair Frequency* (PF), a metric that is still commonly used today (also see Anderson & Watts, 1969). PF considers the number of forward and backward (e.g., bidirectional) word transitions that are present in two separate recall protocols. For example, consider two successive retrieval attempts. If the first recall includes, in order—*apple*, *car*, *house*, *jet*, *banana*—and the second recall includes, in order—*car*, *house*, *banana*, *jet*, *apple*—there is one common forward transition (*jet–banana*) and one common backward transition (*banana–jet*). PF is given by computing the difference between the observed number of pairs and the expected number of pairs (which factors in recall levels and the number of common items).

4.3.2 | Measuring collective retrieval organization

Very few studies have explicitly attempted to quantify collective retrieval organization—how retrieval organization is similar across members of a group (Congleton & Rajaram, 2014; Greeley et al., 2022). This may be due in part to the prioritization of the individual; memory research has often, implicitly or explicitly, examined memory as an individual feat (Crowder, 1976/2014). To the best of our knowledge, Congleton and Rajaram (2014) were the first to explicitly examine collective retrieval organization. Leveraging the collaborative memory paradigm, the authors assessed postcollaborative retrieval similarity at the group level using the *Shared Organization Metric Analysis* (SOMA). This novel metric made use of the PF measure described above. Instead of applying PF the usual way (within-participants, across recalls), SOMA involves computing PF between members of a group. To clarify the logic of SOMA and how it depends on PF, consider a collaborative triad consisting of members A, B, and C. After collaborating to recall a list of words, each of the participants completes a second individual free recall. Computing SOMA involves computing PF between the recall protocols belonging to A and B, B and C, and A and C, then averaging the three PF scores. While PF aims to characterize intra-subject retrieval stability, SOMA aims to characterize the mean inter-subject retrieval stability for a group, and scores can be interpreted similarly to PF.

SOMA has proven incredibly useful with respect to the measurement of postcollaborative retrieval similarity. In their original study, Congleton and Rajaram (2014) found that collaboration reliably contributed to increased SOMA scores; relative to nominal "groups" that never collaborated, collaborating recall synchronized individual retrieval organization downstream. This effect persisted for up to a week following collaboration. We observe a similar convergence in our ongoing work even when groups are reconfigured from one recall to the next; in our reanalysis of data from Choi et al. (2014), we find that despite collaborating with *all new partners* at Recall 1 to Recall 2, postcollaborative (Recall 3) SOMA scores were significantly greater than nominal control "groups." This holds for *both* collaborative groupings (partners from Recall 1 and 2; Greeley et al., in Press). Likewise, this effect is not restricted to groups collaborating face-to-face. Greeley et al. (2022) found elevated SOMA scores following a single, totally virtual, chat-based collaborative recall. Taken together, this evidence suggests that collaborative recall has a powerful pull, synchronizing retrieval organization deployed downstream of the group interaction.

4.3.3 | Measuring organization: General challenges

The measurement of retrieval organization, particularly collective retrieval organization, is not without its challenges. First, each of the aforementioned metrics requires the use of a free recall procedure. That is, participants should be free to produce material in any order they prefer. In general, if cues are provided, organization is no longer determined by the participants' natural retrieval strategy; instead, any observed patterns are determined at least in part by experimenter choices and procedural constraints. Similarly, these metrics rely on the use of word lists. This provides

extraordinary control but is quite contrived and may not reflect how retrieval unfolds in more realistic contexts. The upside is that these quantitative tools capture in detail a number of basic retrieval patterns that may underpin the recall of more naturalistic content and offer insights for developing quantitative tools in the future that can capture the organization of recall for natural content.

When focusing more specifically on assessing collective retrieval organization, different challenges arise. First, SOMA puts constraints on notions of similarity. Specifically, because SOMA is based on PF (which factors in word-to-word transitions), it is a *local* measure. Retrieval outputs produced by former collaborators may be similar at more general levels without necessarily having many overlapping item transitions. Capturing broader conceptions of similarity and common retrieval structure demands methodological and computational creativity (Heusser & Manning, 2018). Likewise, there are a number of dimensions on which memories can be similar or dissimilar.

4.3.4 | A summary of methods and metrics

In the current review, we connect research on retrieval organization in individual performance to research on collective memory, asking how downstream retrieval organization is synchronized by collaborative recall. To that end, we considered *methodological* ties and the nature and application of different *metrics* across individual and collective outcomes.

Considering first the integration of methods, significant work has already been done. The collaborative memory paradigm often involves free recall and is firmly grounded by basic research principles (Crowder, 1976/2014; Rajaram, 2022). That is, many of the same design features necessary for examining individual retrieval organization (e.g., repeated free recall of word lists) are present in designs geared toward assessing collective retrieval organization (e.g., Congleton & Rajaram, 2014). With respect to the measurement and quantification of collective retrieval organization, or how group members converge on similar retrieval strategies, SOMA has already proven incredibly useful—a collection of studies now indicate that collaboration has a powerful normalizing effect on not only what people recall downstream, but how material is retrieved (Congleton & Rajaram, 2014; Greeley et al., 2022). At the same time, SOMA is just one metric, and individual retrieval organization can be richly characterized in a variety of ways. To this end, future work should be directed towards assessing the extent to which other metrics, that typically target individual retrieval organization, be modified to characterize collective retrieval organization. Such measures would help provide "mini-cultural tools" for assessing the nature of collective narratives (Congleton & Rajaram, 2014; Rajaram et al., 2022) and help bridge the gap between laboratory-based and ecologically based investigations of collective memory. Finally, going beyond such applications of metrics from the literature on individual retrieval organization, future work should also seek novel measures of collective memory organization that address the recall of laboratory-style stimuli as well as of more ecologically based stimuli such as those used in educational settings or community- and national-level collective narratives, points to which we return below.

5 | THEORETICAL CONSIDERATIONS

Research on collective retrieval organization has already raised important theoretical considerations, and future research on the topic will continue to do so. Critically, theoretical implications are not necessarily bound to contents of collective memory; if individuals converge on the use of similar retrieval strategies following collaboration, this means a range of fundamental memory processes are shaped by social contexts. Not only do people converge on *what* they remember, but *how* they remember. If memory is often socially situated, and if memory often serves a social function, how social contexts shape and mold individual memory processes is critical to understanding memory in general. That is, the extent to which retrieval processes depend on our interactions with others is not a piece of some additional cognitive puzzle. Instead, such dependence is part of a more basic understanding of human memory processes.

Moreover, individuals do not arrive at social interactions (such as collaborative recall) as blank slates; people may push and pull interactions in a way that is consistent with a particular history, strategy, or narrative. Thus, the assessment of socially modified retrieval organization may provide a mechanism to test the *individual contribution* to group retrieval organization and group-level synchrony. Similarly, consider shared history or a common expertise, both factors known to protect against the deleterious effects of collaboration (Harris et al., 2017; Nokes-Malach et al., 2012). Here, precollaborative organizational and/or retrieval strategy overlap, forged through years of shared experiences or strong common referent (e.g., expertise), could help explain *why* collaborative recall is disruptive or not. In general, as we

noted in an earlier section, a broad key message to take away from this new area of research is that the act of retrieval plays a powerful role in shaping collective memory content and organization.

Finally, research on collective organization is key to a deeper understanding of the emergence and maintenance of collective memory. The characterization of retrieval organization in individual recall has been central to forming and vetting theories of memory; characterizing how retrieval organization changes and synchronizes following collaboration should play a similar role as the field develops theoretical accounts of collective memory. Research has already suggested that postcollaborative collective retrieval organization is related to the disruption experienced during group recall (Congleton & Rajaram, 2014). Moreover, individual retrieval organization following group recall remains synchronized after a week (Congleton & Rajaram, 2014) and even when individuals collaborate in online settings (Greeley et al., 2022). Further exploring the relationship between collective retrieval organization and other phenomena—such as collaborative inhibition—will be essential to building robust accounts of why and how collaborative recall gives rise to collective memory.

6 | BROADER IMPLICATIONS

While retrieval organization in the context of a memory experiment is typically tied to the sequencing of responses (a relatively low-level phenomenon), the order in which material comes to mind and/or is communicated to others is clearly of broader importance. Specifically, changes in retrieval organization may have ripple effects at several levels, potentially implicating belief and attitude formation (Wyer & Albarracín, 2005), informing identity (Wilson & Ross, 2003), and moderating decision making and problem solving (Wittenbaum & Park, 2001). At the level of the group or collective, synchronized retrieval organization may be especially important for building and maintaining shared, cultural narratives (Congleton & Rajaram, 2014; Rajaram et al., 2022; Wertsch, 2008).

First, the information available via memory when one makes a judgment or forms a belief is critical (Tversky & Kahneman, 1973; also see Wang et al., 2022)—what comes to mind most efficiently may introduce bias. If memory and retrieval organization have been synchronized, it follows that judgments, beliefs, and attitudes that are based on memory could all be impacted. More broadly, this implicates how an individual or group *uses* memory; if the information set and retrieval process shifts, this will impact how memory is applied, for example, to form a belief. Documenting this empirically would be an interesting avenue for future research. On a different note, consider the case of education (Congleton & Rajaram, 2014; Wissman & Rawson, 2015). Within a classroom, students engage with the same material and may often collaborate together to discuss and recall information. Similar processes apply in professional environments (e.g., lab meetings) or on social media platforms where users may interact with a similar group of people on a regular basis. These circumstances provide both a common reference—a communal information well from which individuals can draw—and regular access to the interpersonal processes that could form and nurture common memories and strategies. How might this impact creative problem-solving or the formation of novel ideas, such as scientific hypotheses? (Congleton & Rajaram, 2014). On the one hand, synchronized retrieval organization, in the form of an aligned representation of the problem (Reiter-Palmon et al., 1997), might be a necessary condition for navigating complex goals and problem spaces. On the other hand, too much of such alignment could be a hindrance, constraining each individual's ability to present novel or divergent solutions, or exert a pull towards a singular voice where this may or may not be to the advantage of the individual or the collective.

Zooming out further yet, how might the social shaping and reshaping of retrieval organization inform the development and maintenance of collective narratives? (Wertsch, 2002, 2008). For example, Wertsch (2008) concept of "schematic narrative templates" (p. 122) speaks to the importance of how narratives are constructed in a top-down fashion, touching on the importance of structure. Beyond historical narratives, this a central feature of fake news in the modern era (Polletta & Callahan, 2017). Media messaging, which often comes with a political or ideological slant, shapes how we understand complicated topics and events (Pennycook & Rand, 2021), and how we integrate strands of information as well as myriad details. Even if one is not consuming news from a particular outlet, people share news and experiences frequently and in diverse ways (Mahr & Csibra, 2018; Nelson, 2003; Picone et al., 2016; also see Wang et al., 2017). Further, in the process of sharing stories, people may adopt others' narratives and experiences as their own (Prins et al., 2013). The careful study of how social contexts (e.g., collaborative recall) shape and synchronize retrieval organization has the potential to provide a window into the socio-cognitive mechanisms that underpin these dynamic, consequential processes.

To speculate further on this issue—that is, about how synchronized retrieval in small groups or networks might scaffold the emergence of shared cultural narratives—it is worth mentioning related research on the relationship between autobiographical memory and narratives (e.g., Fivush et al., 2006, 2011; Wang, 2021). It is clear from this work that factors such as culture and parent–child interaction dynamics inform the manner in which children and adolescents construct their own autobiographical narratives. For example, more elaborative maternal reminiscing styles (e.g., including feedback and a range of questions) seems to scaffold the subsequent use of more effective memory strategies (Fivush et al., 2006; Haden et al., 2001). This speaks to the broader importance of socially situated retrieval and is evidence that small-scale but repeated interactions can have potent downstream effects. Another concept in this literature—one that may be especially critical when considering synchronized retrieval organization at broader levels—is the notion of *narrative coherence*, which Reese et al. (2011) characterize in terms of context (where and when), chronology (order of events), and theme (point or message). Connecting this idea of narrative coherence and our conception collective retrieval organization may provide one way to capture retrieval similarity at the level of shared narratives.

7 | CONCLUDING THOUGHTS

Remembering with others changes not only *what*, but *how* we remember the past. Since the launch of the collaborative memory paradigm 25 years ago, the assessment of retrieval organization has been central to building and testing accounts of collaborative inhibition. We contend that the importance of examining collective retrieval organization goes much deeper and wider. Drawing from decades of work on individual retrieval organization, we highlight how key methodological features, organizational metrics, and theoretical frameworks connect to research on social and collaborative memory. In doing so, we outline how retrieval organization is modified by collaborative remembering, concentrating on how collaborative recall synchronizes downstream individual retrieval—giving rise to collective retrieval organization. Given the deep theoretical implications and broader significance of research at this intersection, we believe this has been—and will continue to be—a valuable pursuit.

AUTHOR CONTRIBUTIONS

Garrett D. Greeley: Conceptualization (equal); visualization (lead); writing – original draft (lead); writing – review and editing (equal). **Suparna Rajaram:** Conceptualization (equal); funding acquisition (lead); supervision (lead); writing – original draft (supporting); writing – review and editing (equal).

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The authors declare no conflict of interest.

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Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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ENDNOTE

[1] This is also referred to as *retrieval dynamics* at times (e.g., Kahana, 2012). However, retrieval dynamics may also encompass the assessment and modeling of time-based outcomes, such as inter-response times (Kahana, 2012; Wixted & Rohrer, 1994), which are not considered here. Further, retrieval "organization" is more commonly used in the context of social memory experiments (e.g., Basden et al., 1997), so we remain consistent with that literature.

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