Social Remembering in the Digital Age:

Implications for Virtual Study, Work, and Social Engagement

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Abstract

Technology has transformed how people interact with one another. According to two recent Pew Research Center surveys (2021), 97% of U.S. adults have a cell phone, 85% have a smartphone, 93% use the Internet, and 77% have broadband Internet access at home. The Internet has opened countless doors by providing unprecedented access to information and connecting people. While we know from laboratory research that context and collaboration can influence memory, little is known about how virtual collaboration affects memory and whether in-person studies generalize to virtual contexts. In this article, we discuss the challenges, value, and broader relevance of extending laboratory-based memory research to online platforms. In doing so, we report a *virtual collaborative memory paradigm*, where we examine individual and social remembering in a fully online, chat-based setting, and present data from two completely virtual experiments. In Experiment 1, online participants studied a word list and, in a chatroom, recalled the words either alone (as controls) or with two other participants. Surprisingly, collaborative inhibition - the robust finding of lower recall in collaborative groups than controls - disappeared. This outcome occurred because participants who worked alone recalled less than what we see in in-person studies. In Experiment 2, where instructions were modified and an experimenter was present, individual performance improved, resulting in collaborative inhibition. We reflect on the contextualized nature of this effect in online settings, for both collaborative and individual remembering, and on the implications for the study of memory in the digital age.

Keywords: collaborative memory, collaborative inhibition, virtual collaborative recall, collective memory

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Modern technology provides access to a plethora of contexts where remembering may take place: a full inbox, a morning video conference, an instant message from a friend, a quick scroll on a social media timeline. These environments, for better or for worse, dominate day-to-day life for many people, especially after the onset of the COVID-19 pandemic when face-to-face interactions became limited. While there is enormous variance in the look, feel, and utility of such contexts, they all fundamentally facilitate some sort of virtual social interaction and have influences on memory (Marsh & Rajaram, 2019). A recent surge in cognitive-experimental research has examined how social remembering shapes memory, but this work has focused on in-person situations, leaving questions open about how virtual social remembering takes shape and whether it has the same properties as its in-person counterpart. With the prolific use of technology to share information, we ask - how does social remembering in this new, digital age impact memory? Beyond the influence on the individual, how does digital social remembering shape the formation of collective memory (Barnier & Sutton, 2008; Hirst & Echterhoff, 2012; Wertsch & Roediger, 2008)? And how can psychological research illuminate the influence of online medium for social sharing on memory construction? We approach this question by leveraging an online paradigm to study the patterns of individual versus social remembering in a totally virtual, chat-based setting.

In this article, we discuss through a cognitive-experimental lens the importance and challenges inherent in examining social remembering in completely online settings (Echterhoff, 2013). Further, we demonstrate with experimental data that social memory research - with equal parts care and creativity - can be advanced to online settings. While previous research has

assessed computer-mediated collaborative remembering in chat environments, this work has taken place in the laboratory and therefore in a standard physical environment, often including face-to-face interactions with other participants and the experimenters (e.g., Ekeocha & Brennan, 2008; Guazzini et al., 2020; Hinds & Payne, 2016; 2018; but see Gates et al., 2021). However, many virtual platforms, from social media sites to messaging apps, present a completely different context for assessing fully online group remembering. With this framework in mind, we launch a *virtual collaborative memory paradigm* for online experiments, aimed at implementing a classic, social memory paradigm into a completely virtual environment. We note that this paradigm can also serve well to study individual remembering online, as we show in Experiment 2.

We present two experiments in which the participants joined the experiment remotely and completed all tasks – including collaborative recall - online from their respective, remote locations. To contextualize this approach, we touch on some potential conceptualizations of online social remembering across academic fields. We then review a classic approach used in cognitive psychology - the collaborative memory paradigm. In doing so, we discuss how this cognitive paradigm can inform research across disciplines despite surface-level differences. Finally, we survey prior work on *lab-based* collaborative remembering and collective memory, highlighting the relationship between collaboration and collective memory, and the critical role collaboration plays in grounding other group-level processes.

Online Social Remembering

Social interactions, beyond just social remembering, have been completely altered due to the onset of online platforms. In the digital age, people have exponentially more access to the Internet, social networking, and mobile communication, a phenomenon coined the *triple revolution* (Rainie & Wellman, 2012). This triple revolution is a global phenomenon, one that

has facilitated social interactions at a scale never seen before in human history. People now can connect with others across the globe at any time and exchange information (Marsh & Rajaram, 2019). Additionally, the accessibility and availability of mobile devices allows people to be constantly connected to their mobile devices and, in turn, to the Internet and social media accounts (Barnier, 2010; Baron, 2010). Now more than ever, people can connect with others, including strangers, beyond their offline social circles, engage with online social platforms at any moment, and exchange information that normally would not be accessible to them (Chayko, 2014). This mass expansion of digital media has also been coined the connective turn, which has shifted memory in numerous ways (Hoskins, 2011).

The digital age has clear influences on how social interactions are facilitated, and consequently, must have implications for online social remembering (e.g., Hoskins, 2017; Stone & Wang, 2018). Online, or technology-mediated, social remembering can be framed in a variety of ways, making it a rich topic of study across disciplines (Barnier & Hoskins, 2018). In cognitive psychology, for example, we may explore if joint remembering on different platforms (e.g., text vs. video conferencing) affects memory performance and, if so, what mechanisms are responsible. At the same time, a political scientist might be interested in how online groups translate virtual engagement into real-world mobilization (e.g., Twyman et al., 2017). Likewise, an anthropologist might consider digital landscapes to be areas capable of sustaining broad cultural narratives over relatively long timespans, while a sociologist may focus on how digital artifacts contribute to social cohesion among group members (Agger, 2004; Pertierra, 2018).

The study of memory in the digital age from a cognitive psychology perspective is relatively new, and it has sparked a profound debate about exactly how the Internet, for better or for worse, has impacted human memory (e.g., Carr, 2008; Schacter, 2022). While there is a

plethora of studies that have revealed the nature of human memory, and social memory, most of these studies have been conducted in-person outside the context of the Internet and technology (Rajaram & Marsh, 2019). Therefore, it is unclear exactly how these studies map onto the nature of everyday memory that often is associated with technology (Storm & Soares, 2021; Wang, 2019; Yamashiro & Roediger, 2019). Research comparing how memory is studied in the physical laboratory and the expression of memory in the digital world is still in its infancy, motivating many questions about how the Internet influences memory.

Here, it is critical to recognize that there are considerable obstacles that cognitive psychologists must contend with to examine online social remembering. To start, offline memory studies facilitate precise experimental control to help isolate the influence of the experimental manipulation. Virtual studies, however, do not always have that degree of experimental control as participants can be anywhere with access to the Internet throughout the study. Additionally, offline studies typically have an experimenter present to facilitate the session and address questions where online studies do not have an experimenter physically or continuously present to ensure participants are completing tasks correctly. While these are valid concerns with virtual studies that prevent researchers from being able to readily investigate memory processes online, there are also ways to address these issues and conduct experimentally solid studies on virtual platforms (Sauter et al., 2020). For example, experimenters can add instruction checks, add attention checks, and shorten the length of the experimental session. These methods have proven successful in some cases, with some classic studies replicated online (e.g., Horton et al., 2010). The challenges of online experimentation notwithstanding, given that online social networking has become "a way of life", with people having constant, almost unlimited access to online social networks, the time is upon us to examine the properties and consequences of online social

remembering. This sentiment has been echoed in recent, related work focusing on the relationship between memory and the self in the age of social media (Wang, 2022)

Our aim was to ask whether online remembering, both social and individual, encompasses the same properties as the offline counterparts. We briefly discuss the collaborative memory paradigm that we leveraged to create its virtual counterpart, and how its application has contributed to our understanding of social remembering and its downstream impacts on memory. In describing the paradigm, we aim to demonstrate its relevance to research questions in other domains, especially those just described, namely, that the control and flexibility of this paradigm affords insight into the bottom-up processes that shape individual and collective memory.

Collaborative Recall and Collective Memory

Historically, most of human memory research has focused on the individual (Ebbinghaus, 1885). This focus contributed to the development of influential theoretical frameworks that attempt to explain how *individuals*, working in isolation, remember information (Suprenant & Neath, 2009). Bartlett's (1932) pioneering work on social memory is an early example of diverging from this path. In many now famous descriptive experiments, Bartlett demonstrated that human memory is subject to social influence. In other fields, such as anthropology and sociology, how societies and groups remember the past has been an active focus of research for many years (Olick, 1999), whereas in cognitive psychology and cognitive science more broadly, this focus has evolved over time. While influential lines of research have reported on how others may contaminate our memories (e.g., Bartlett, 1932; Gabbert et al., 2004; Loftus, 1992; Roediger et al., 2001), *groups and collectives* as the unit of measurement have emerged much more recently in cognitive science (Barnier & Sutton, 2008; Rajaram, 2011; Weldon, 2000).

The relatively recent surge of interest within cognitive psychology in assessing collective cognition can simultaneously draw from and inform research across disciplines (Harris et al., 2008; Hirst & Manier, 2008; Wertsch & Roediger, 2008). In cognitive psychology, definitions of collective memory have focused on operationalization in terms of the number of overlapping items recalled independently by all former members of a group. Psychologists have also assessed collective memory with data showing that people from different countries overclaim the role of their nation for the same historic event such as World War II (Roediger et al., 2019). Anthropologists have approached the concept of collective memory at a societal level, examining how groups remember their collective past and how these memories are passed down through generations. For example, Cole (2001) had conducted fieldwork in East Madagascar examining how Betsimisaraka villagers' social practices preserved memories of their French colonial time period. Similarly, historical studies examine how nations (or cultures) may remember their past (e.g., Russia and Georgia's contrasting narratives of the war of August 2008, Wertsch & Karumidze, 2009; Jewish people remembering the origins of their culture, Dudai, 2022; for a broader commentary, see Wertsch, 2012) or, in sociology, some researchers are interested in examining how sub-groups within nations come to have contrasting perspectives of their nation's past atrocities (e.g., Olick, 2007; Simko, 2022).

To address the issue of collective memory through a cognitive lens and analyze the bottom-up process that gives rise to shared memory representations, we leverage a collaborative recall framework (for a review, see Rajaram & Pereira-Pasarin, 2010; Rajaram, 2017; for a meta-analysis, see Marion & Thorley, 2016). This approach draws from the collaborative memory paradigm, established in the 1990s by a series of cognitive studies (Basden et al., 1997; Meudell et al., 1992; 1995; Weldon & Bellinger, 1997), where a standard collaborative recall experiment

typically entails the following procedure: (1) participants study materials, (2) complete a filler task, (3) recall the study material working individually or in a group, and oftentimes (4) recall the study material again individually. This paradigm offers flexibility for researchers to explore the influence of different study materials, group sizes, and collaboration styles. Moreover, the paradigm can provide insight into how group recall influences subsequent individual memory, affording assessments of post-collaborative memory performance and the emergence of collective memory (Choi et al., 2014; Congleton & Rajaram, 2014; Rajaram & Maswood, 2018). Finally, the collaborative memory paradigm provides a large degree of control over a variety of factors, allowing research to pinpoint the social and cognitive explanations.

Weldon and Bellinger (1997) were among the first to employ this paradigm in their canonical study. Their key comparisons focused on collaborative versus nominal group recall. *Nominal groups* - or groups in name only - serve as the baseline and are formed by pooling the non-redundant responses from participants who had worked alone. This provides a fair comparison and is standard practice in this research domain (Basden et al., 1997). One of the most notable findings from this study – of central interest here - was that collaborative groups recalled less than the nominal groups. This effect, referred to as *collaborative inhibition*, has since been replicated many times in a variety of contexts.

Beyond the collaboration stage itself, collaborative remembering can have a lasting impact on individual memory. Several studies that have implemented post-collaborative, individual recall phases have found that an initial collaborative recall can improve downstream memory (e.g., Choi et al., 2014; Congleton & Rajaram, 2011; 2014). This improvement is larger than what would be expected if the only mechanism at play is hypermnesia - or improvement in individual recall performance across repeated retrieval attempts (Congleton & Rajaram, 2012;

Payne, 1987; Roediger & Butler, 2011; Rowland, 2014). One explanation for improved recall following collaboration, over and above standard hypermnesia (Payne, 1987), is re-exposure. That is, group members can strengthen memories for information reintroduced during collaboration. This can act as a second encoding phase, and this improves recall performance in later retrieval recall attempts (Blumen & Rajaram, 2008). Some studies show that group members can also impair memory, producing persistent forgetting evident in later individual memory (Barber et al., 2015; also see Cuc et al., 2006 for an example of such evidence from a different approach).

As we just described, the effects of group remembering reach beyond collaboration, having downstream effects on individual memory, thereby shaping the collective memory of former group members (Choi et al., 2014; Congleton & Rajaram, 2014). In cognitive psychology, collective memory is usually indexed by the amount of *overlapping* content recalled by former members of a group (Cuc et al., 2006; Stone et al., 2010). Not only do former collaborators recall similar material, but they also do so in a similar fashion, reporting items in similar output positions (known as *collective organization*, Congleton & Rajaram, 2014). This additional perspective - examining collective organization over and above collective memory content - provides a deeper and likely more enduring window into how collaboration synchronizes memory for a people. Thus, collaboration facilitates the development of collective memory and homogenizes memory structures. In brief, collaboration facilitates the development of collective memory in former group members such that their memories and the structure of those memories become more aligned with one another.

While the aforementioned effects - collaborative inhibition, post-collaborative recall boosts, and the emergence of collective memory content and structure - are robust in face-to-face

collaborative recall settings, we do not know whether collaborative remembering in completely virtual environments would yield similar outcomes. The few studies that include chat-based contexts have reported effects comparable to face-to-face collaborative memory research, including collaborative inhibition, but have found better post-collaborative individual recall in face-to-face groups. This has been attributed to the constraints associated with working in a chat-based environment which, unlike face-to-face collaboration that is laden with non-verbal cues, leads group members to self-filter their responses and/or ignore their partners' contributions and send duplicates (Clark & Wilkes-Gibbs, 1986; Ekeocha & Brennan, 2008; Hinds & Payne, 2016; 2018). Critically, these studies have been situated in lab settings where the use of the electronic chat platform was limited to the individual and collaborative remembering phases. The impact that a fully virtual and remote setting can have on individual and collaborative remembering remains mostly unknown, despite the use of digital platforms that increasingly characterize our educational and social lives.

In light of this background, we explore whether findings from the standard collaborative memory paradigm on the nature of collaborative inhibition, post-collaborative recall, and collective memory for content and structure observed in in-person laboratory settings will generalize to fully online virtual interactions.

The Present Study

We launch virtual collaborative recall, and report two experiments, to explore individual and collaborative recall in a fully online, chat-based environment. In Experiment 1, our method closely followed the in-person method in Peña et al. (2021, Experiment 1) in terms of stimuli, design, and task sequence, with few exceptions other than *all aspects* of the procedure being

conducted online. Experiment 2, which included several changes from Experiment 1, was designed to follow-up on the surprising effects observed in our first experiment.

Drawing from a rich literature on collaborative memory, we developed several hypotheses regarding classic collaborative inhibition, post-collaborative recall, and collective memory. First, based on the reports of the robust findings from in-laboratory collaborative memory experiments, we hypothesized that Collaborative groups would recall less than equal sized Nominal groups (e.g., Basden et al., 1997). The inclusion of a second recall phase in Experiment 1 allowed us to examine how collaborating with others can shape subsequent memory performance. Consistent with previous work, we hypothesized that former Collaborators would recall more than their Nominal counterparts (Blumen & Rajaram, 2008; Weldon & Bellinger, 1997). Continuing with the assessment of post-collaborative recall, we hypothesized that collective memory would be greater among former collaborators compared to those who did not collaborate before. That is, we expected to replicate the findings from in-laboratory settings that collaborating would lead to individuals recalling more of the same content (e.g., Choi et al., 2014; Maswood et al., 2019). Lastly, we assessed whether previous collaborators would have more aligned memory structures as observed in previous studies; here, former group members would not only recall the same information, but they would also organize this information in similar ways when recalling it individually (Congleton & Rajaram, 2014).

Experiment 1

Method

Participants

Our sample included 96 Stony Brook University undergraduates (M = 19 years, SD = 1.90 years, *Range* = 17-27 years). Participants were recruited using the Psychology Department's

subject pool platform (SONA) and received course credit for their time. This sample size was

selected to achieve power of .98 based on the collaborative inhibition effect reported in Peña et

al. (2021), from which our method was drawn, with an effect size of 1.52 (Cohen's *d*; Cohen,

1992). To prepare for the possibility that the relatively noisier, online testing environment would

reduce the effect size, we selected for more power.

Design and Procedure

The experiment consisted of two (Recall Condition: Collaborative and Nominal) fully

between subjects levels with 48 participants (i.e., 16 groups) randomly assigned to each

condition. This design and procedure are the standard approach used in collaborative memory

studies (e.g., Barber & Rajaram, 2011).

The entire experimental session was conducted online via Qualtrics. After providing

consent, participants read instructions for the study phase. Participants were given incidental

study instructions such that they were not informed about later memory tests for the words (e.g.,

Barber et al., 2012; Harris et al., 2013). Participants were told to rate each word for pleasantness

of meaning (1-very unpleasant to 5-very pleasant; Craik & Lockhart, 1972). At study, each word

was presented for 6-seconds, with an asterisk fixation between each word for 1-second. If

participants missed a word, the screen automatically advanced. Participants studied a list which

consisted of a 90-exemplar list taken from Congleton & Rajaram (2011) who had drawn the

items from Van Overschelde et al. (2004). After the study phase, participants completed a

distractor task that required them to list as many United States cities as they could for 7 minutes.

After completing the distractor task, participants received recall instructions to remember

items from the study list. Nominal participants worked alone and were instructed to recall as

many words presented earlier as possible, in any order they prefer, in an online chat room for 10

minutes. Collaborative participants were instructed to complete the same task but were informed they would be working with group members, again all of them online at their respective locations, to recall the studied information. Additionally, Collaborative participants were told to monitor messages from group members to avoid sending duplicate responses. Once all participants of a given triad arrived in the online chat room, they were able to collaborate freely via a chat box for 10 minutes.

Participants had a 3-minute break after the first recall task. After the break, all participants completed a second, individual free recall task for all the studied items (including words recalled during the previous task) for 10 minutes. Participants were then asked to answer demographic and technology usage questions that were not directly related to the main research question of this study, and therefore will not be discussed. The entire experiment lasted approximately 1-hour[1].

Results

In this experiment, we assessed individual and collaborative remembering in a totally online, chat-based context. In doing so, we largely co-opted hypotheses from in-person experiments, and expected to replicate laboratory findings. Specifically, we hypothesized that (1) Collaborative groups would recall less than equal sized Nominal groups, (2) collaboration would boost post-collaborative individual recall, relative to those that never collaborate, and (3) collaboration would contribute to the emergence of collective memory content and structure.

For all analyses in this and the next experiment, we chose a cutoff of +/- 2 SDs for the exclusion of outliers. Our choice was motivated by the online environment; in the laboratory, when participants can be monitored, relatively fringe performance can be classified as reasonable

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[1] Supplementary Materials contain additional information about the sample characteristics and procedure for both experiments.

(i.e., by confirming no cheating, no intermittent checking of social media). In our experiments, this was not possible. For each analysis, such exclusions were low and did not change the general pattern of results. For all analyses, alpha was set at .05 (two-tailed) and Cohen's *d* (Cohen, 1992) was used to assess effect size.

Recall 1 - Group Recall

To examine if collaborative inhibition persists in a totally online, chat-based context, we compared the proportion of correct items recalled between Collaborative and Nominal groups. Nominal groups were computed by aggregating the non-redundant recall of three Control participants. An independent sample *t*-test revealed no significant difference between the conditions, $t(28) = 0.17$, $p = .8661$, Difference 95% CI [-5.72% - 6.76%], $d = 0.06$, *d* 95% CI [-0.69 - 0.81]. Collaborative group recall ($M = 48.74\%$, $SD = 7.96\%$, $n = 15$) and Nominal group recall ($M = 48.22\%$, $SD = 8.72\%$, $n = 15$) were essentially equivalent – see **Figure 1**. This result - a lack of collaborative inhibition - was surprising and diverged from a large body of work in the collaborative memory literature (Marion & Thorley, 2016). As we note with a reference line in **Figure 1**, the Collaborative group performance was on par with an in-person study using identical stimuli and procedure (Peña et al., 2021) and other similar in-person research using categorized stimuli (Congleton & Rajaram, 2011). In other words, the online platform did not change the levels of collaborative recall compared to the typical levels reported for in-person studies; the impact was seen in the decline of individual recall levels that constituted the Nominal group performance.

Figure 1

Experiment 1 Recall 1: Group-Level Recall (Percent of Correct Words Recalled)
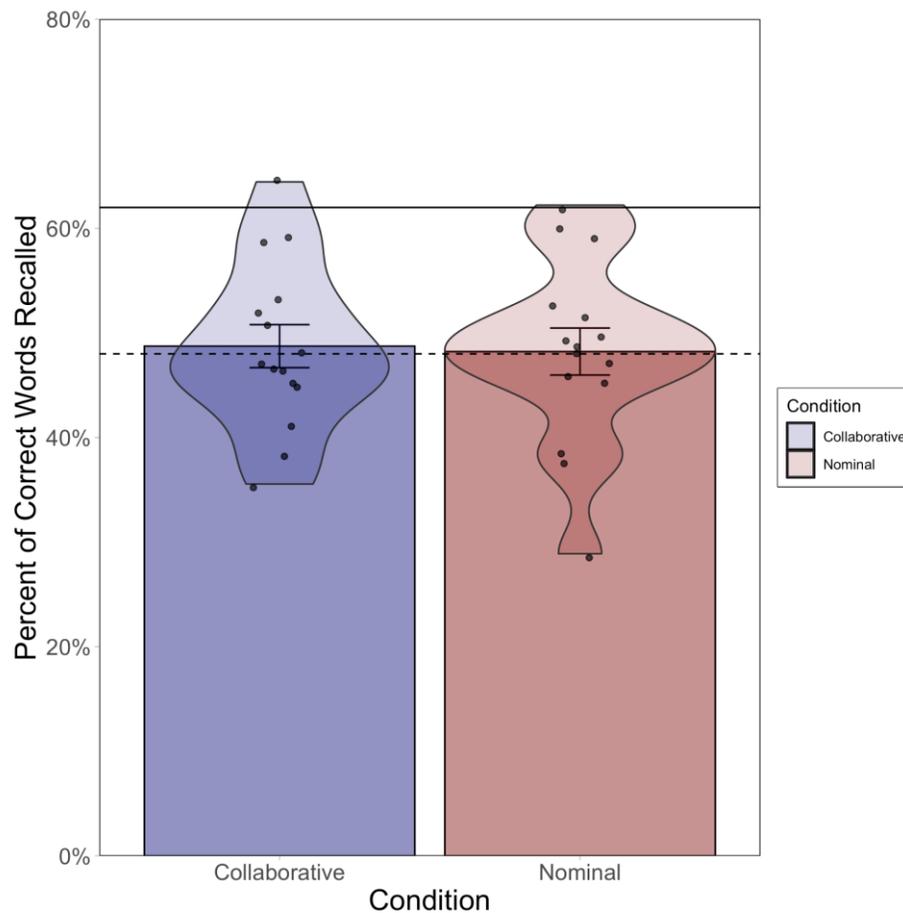
Note: The *y*-axis is the percent correct, out of 90 studied words. Bars are at mean and error bars are *SEM*. Individual points and the overlaid distributions represent the underlying data (*n* = 15 triads of participants in each condition). Horizontal reference lines are from an in-person experiment using the same stimuli and procedure where we observed collaborative inhibition (Peña et al., 2021). The dashed line is collaborative performance from that study, black solid line is Nominal performance. Note that Collaborative group recall is nearly even with levels observed using the same procedure in the laboratory, while Nominal recall is well below laboratory performance.

Recall 2 - Individual Recall

We also wanted to see how online collaboration affects memory downstream. We found that former collaborators recalled more correct items ($M = 32.49\%$, $SD = 10.57\%$, $n = 45$) than those that never collaborated ($M = 22.41\%$, $SD = 9.85\%$, $n = 47$). This difference was statistically significant (independent samples t-test: $t(90) = 4.74$, $p < .001$, Difference 95% CI [5.85% - 14.31%], $d = 0.99$, d 95% CI [0.55 - 1.43]). This finding, depicted in **Figure 2**, is consistent with previous work demonstrating that collaboration can boost subsequent individual recall performance (e.g., Bärthel et al., 2017; Blumen & Rajaram, 2008; Nie et al., 2019; Weldon & Bellinger, 1997).

Figure 2

Experiment 1 Recall 2: Individual-Level Recall (Percent of Correct Words Recalled)
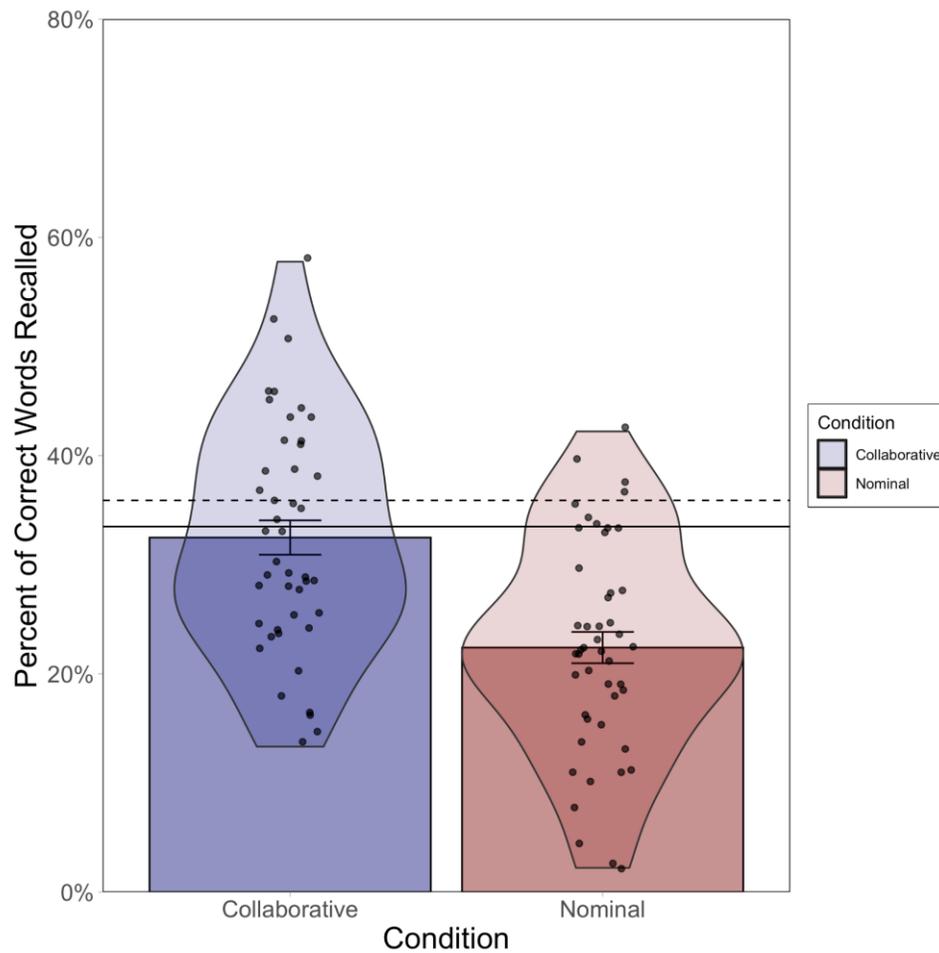
Note: The *y*-axis is the percent correct, out of 90 studied words. Bars are at mean and error bars

are *SEM*. Individual points and the overlaid distributions represent the underlying data

(Collaborative *n* = 45; Nominal *n* = 47). Horizontal reference lines are from an in-person

experiment using the same stimuli and procedure (Peña et al., 2021). The dashed line is former

collaborative individual performance from that study, solid line is Nominal individual

performance.

Nominal Participant Hypermnesia

To further assess the low recall performance during the first recall in the Nominal condition, we analyzed the within-subject change from Recall 1 to Recall 2. If low performance was driven largely by a failure to follow task instructions rather than by lowered engagement, we would expect little change between the two phases. However, if recall performance improved between phases, a small improvement of hypermnesia typically observed in successive recalls (hypermnesia; Payne, 1987), it means that participants did not entirely ignore the task but instead that they were not fully engaged. Indeed, performance improved from Recall 1 ($M = 18.91\%$, $SD = 8.09\%$, $n = 45$) to Recall 2 ($M = 21.80\%$, $SD = 9.61\%$, $n = 45$), and this improvement was statistically significant (paired-samples t-test: $t(44) = -3.96$, $p < .001$, Difference 95% CI [-4.36% - -1.42%], $d = -0.31$, d 95% CI [-0.47 - -0.15]). These results suggest that Nominal participants do not perform at their normal standard as they would in the lab despite this small boost in performance.
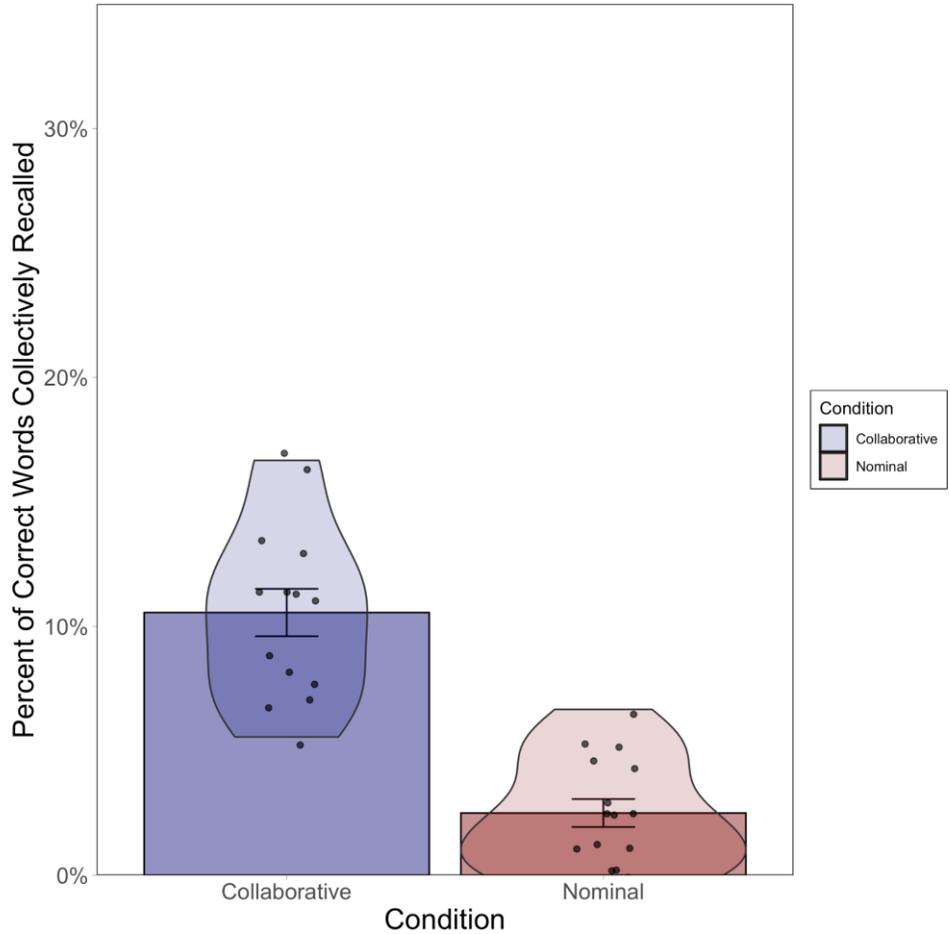
Collective Memory - Content

Including a second recall phase allowed us to examine collective memory. To assess this, we calculated the overlap in recall, i.e., items recalled by all former members of a group (Congleton & Rajaram, 2014). Former collaborators, i.e., participants who were collaborative group members earlier, recalled more of the same material ($M = 10.56\%$, $SD = 3.56\%$, $n = 14$) than did members of Nominal groups ($M = 2.50\%$, $SD = 2.24\%$, $n = 16$). This difference was statistically significant, $t(28) = 7.52$, $p < .001$, Difference 95% CI [5.86% - 10.25%], $d = 2.75$, d 95% CI [1.71 - 3.80]. This finding is depicted in **Figure 3** and replicates the in-person finding that collaboration promotes collective remembering (Congleton & Rajaram, 2014; Peña et al., 2021).[2]

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[2] We also computed collective forgetting - the number of items forgotten by all former members of a group, and found no difference between members who were earlier in Collaborative groups ($M = 47.70\%$, $SD = 10.10\%$, $n = 15$) versus in Nominal

Figure 3

Experiment 1 Recall 2: Collective Recollection (Percent of Correct Words Collectively Recalled)

Note: Collective memory was calculated by dividing the total number of items remembered by all previous group members during their second, individual recall by the number of items possible (90). Bars are at the group means, error bars represent *SEM*, individual points are group-level proportions, and the overlaid shapes describe the distribution of the data in each group.

Collective Memory - Structure

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groups, $M = 49.56\%$, $SD = 7.90\%$, $n = 15$, $t(28) = -0.56$, $p = .5804$, 95% CI [-8.64% - 4.93%], $d = -0.20$, d 95% CI [-0.95 - 0.55]. This result is not surprising because of a long study list as well as below-lab performance in the Nominal condition.

We used the Shared Organization Metric Analysis (SOMA - see Congleton & Rajaram, 2014 for a detailed treatment) to assess the collective similarity in how former group members organized their later individual recall. SOMA, based on Pair Frequency (*PF* - Sternberg & Tulving, 1977), assesses the number of adjacent forward and backward word pairs reported by previous group members in subsequent, individual recall phases. A score of 0 indicates a chance number of pairs across group members. Former collaborative group members exhibited more similarity in the way they organized their recall ($M = 2.07$, $SD = 1.17$, $n = 15$) than Nominal group members that never collaborated, ($M = 0.46$, $SD = 0.55$, $n = 16$). Because of restricted variance in the Nominal condition (scores clustered around 0; Levene's test for equal variances: $F(1,29) = 6.64$, $p = .0153$, we used a Welch two-sample *t*-test to compare conditions, which was statistically significant, $t(19.64) = 4.84$, $p < .001$, Difference 95% CI [0.91 - 2.29], $d = 1.78$, d 95% CI [0.91 - 2.64]. This relationship is depicted in **Figure 4**.

Figure 4

Experiment 1 Recall 2: Collective Memory Structure Measured with Shared Organization Metric Analysis (SOMA)
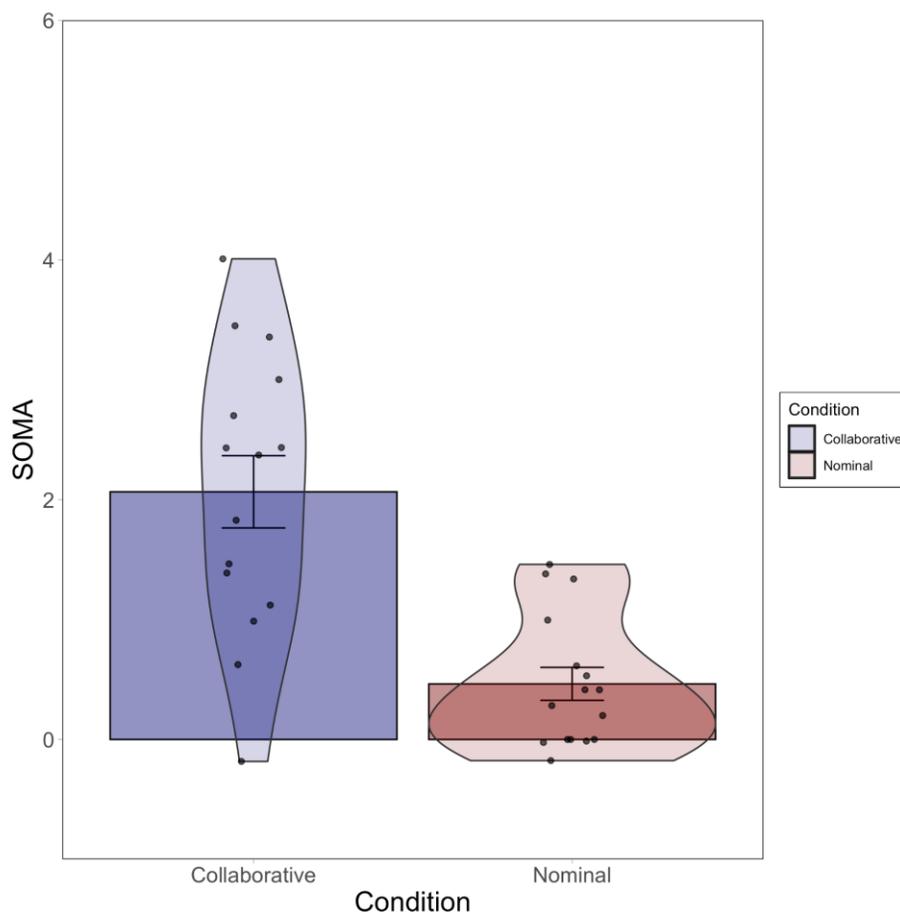
Note: SOMA scores in each condition, as defined by Congleton and Rajaram (2014). A score of 0 indicates chance level shared organization whereas higher scores indicate greater shared organization. Bars are at the group means, error bars represent *SEM*, individual points are group-level scores, and the overlaid shapes describe the distribution of the data in each group.

Discussion

How does a fully online, chat-based environment shape the nature of collaborative remembering and emergence of collective memory? We launched *a virtual collaborative memory paradigm* in a fully online environment to explore this question. Building from a rich history of in-person collaborative memory research, we hypothesized that (1) Collaborative groups would recall less than equal sized Nominal groups, (2) collaboration would boost post-

collaborative individual recall, relative to those that never collaborated, and (3) collaboration

would contribute to the emergence of collective memory and collective organization.

Surprisingly, we did not observe collaborative inhibition when comparing the recall of

Collaborative groups to the Nominal groups. This finding diverges from the previous literature

that reports a robust, collaborative inhibition effect in studies conducted in the laboratory

(Marion & Thorley, 2016). Why did we observe this null effect? First, Collaborative participants

could have been paying less attention to their group members' items throughout the collaborative

session than typically the case in in-person situations which caused less impairment in their own

recall. This explanation is not supported, however, because Collaborative participants exhibited

re-exposure benefits gained during collaboration in their second, individual recall as evidenced

by higher recall by those who collaborated earlier compared to those who did not (Blumen &

Rajaram, 2008). Second, the remote environment could have encouraged shallower learning

during the presentation of the study words than the in-person context, which made collaboration

less disruptive than we typically would observe in the laboratory (Pereira-Pasarin & Rajaram,

2011). We ruled out this explanation because the recall performance of our collaborative triads

was comparable to the recall performance of the in-person collaborative triads reported in a study

with the same method that we conducted in person in the laboratory for a different purpose (Peña

et al., 2021). Lastly, it is possible that Nominal participants - working alone - were less engaged

with this remote setting, which lowered their recall. This final explanation is the most likely

considering our chat-based Nominal groups recalled far less than in-person Nominal groups that

recalled the same stimuli (Peña et al., 2021). Specifically, this explanation is supported by

previous work using the same study materials and procedure which found that Nominal

individuals recall approximately 30% of the study list – whereas our Experiment 1 Nominal

groups recalled about 18.92% of the study list (Peña et al., 2021). This indicates that *individual* memory performance, not collaborative group performance, is most impacted by the fully online, chat-based environment. We follow up on this explanation in Experiment 2.

We examined differences in Recall 2 both at the individual and collective levels, to examine the nature of post-collaborative performance in online settings. Participants who collaborated earlier outperformed Nominal participants in their individual recall performance in Recall 2 which suggests that they benefited from re-exposure benefits. Additionally, consistent with previous research (Choi et al., 2014; Congleton & Rajaram, 2014), former collaborators recalled more of the same items than participants that never collaborated. This indicates that virtual collaboration contributes to the development of collective memory, just like face-to-face collaborative recall.

In sum, our findings reveal that some properties of fully online, chat-based collaboration are the same as laboratory-based collaboration while other properties are different. Like previous studies, we observed that collaboration can homogenize memory representations and structures of previous group members which leads to the emergence of collective memory for content. What is novel to our study is that our control participants recalled less than what we typically observe in-person, which diluted collaborative inhibition. So, then, it seems that the question is not, how does remote, chat-based collaboration differ from standard collaborative remembering, but how does remote, chat-based individual remembering differ from standard individual remembering? This insight about the impact of the digital world on individual and collective memory was illuminating. We followed up this question in our next experiment.

Experiment 2

Our candidate explanation for the lack of collaborative inhibition in Experiment was that Nominal participants were less motivated to complete the task alone under online conditions and, therefore, did not complete it to their full potential. In laboratory contexts, all distractions would be removed, and the experimenter would be physically present to encourage engagement with the task at hand. These factors do not feature in standard remote, online situations and were not present in the current study for those participants who had to perform the task working individually. We tested this explanation by creating conditions where participants would be more motivated to sufficiently complete the recall task while working individually.

This idea of reduced motivation is similar to the notion of social loafing in which people defer responsibility to others and put forth less effort (Latané et al., 1979). Weldon et al. (2000, Experiment 2) tested a possible role of social loafing during collaborative recall by creating conditions in which participants would have higher expectations for their own recall performance and, in turn, would be less likely to coast through the task. Specifically, participants were given information about other participant's "typical performance" which was actually 2.5 times the typical performance the authors observed in their Experiment 1 and were told that they should take their best guess to reach that recall threshold. This "forced recall" task (Erdelyi et al., 1989; McKelvie, 2001) aimed to reduce social loafing and evaluation apprehension (Diehl & Stroebe, 1987) by providing participants with a high criterion for performance and encouraging guessing. These instructions improved individual recall for participants in their control, Nominal condition while leaving the performance of participants in the collaborative condition unaffected and still elicited collaborative inhibition in group recall. For present purposes, these results also show a way to increase motivation for Nominal participants.

We built off the work done by Weldon and colleagues (2000) to test if lack of motivation influenced low Nominal performance in our first experiment. We made the following modifications to ensure that participants were sufficiently motivated to complete the task to their full potential: (1) participants were given "forced" recall instructions adapted from Weldon et al. at the start of the recall phase which provides "other participants' typical performance"; (2) participants were told at study that they would eventually complete an unspecified memory task; (3) the experimenter established presence by re-sending the recall instructions at the start of each recall in the chatroom; and (4) participants studied a shorter word list. Therefore, if our initial null findings for group recall were caused by lack of motivation in the Nominal condition, then we expect to observe collaborative inhibition under these modified conditions.

Method

Participants

Our final sample included a new group of 90 Stony Brook University undergraduates (*M* = 20.1 years, *Range* = 17 - 30 years. This sample size was selected to achieve power of .95 based on the collaborative inhibition effect reported in Choi et al. (2014; the project from which our study list was drawn) with an effect size of *d* = 1.38. Participants were recruited using the Stony Brook University Psychology Department's subject pool website and received course credit or Amazon Gift-Cards ($5) for their time.

Design and Procedure

As in Experiment 1, we implemented a 2-level (Recall Condition: Collaborative and Nominal) between subjects design with 45 participants (i.e., 15 groups) per condition.

After providing consent, participants were given instructions for the study phase. The instructions for the study task matched Experiment 1 in all respects except participants received

intentional study instructions where they were informed that there would be a memory test for the words as this more closely matched the instructions from Weldon and colleagues (2000). Participants independently studied 50 unrelated nouns (two primacy buffers, two recency buffers, and 46 targets), a shorter study list compared to Experiment 1, which were drawn from another in-person study on collaborative recall we have conducted (Choi et al., 2014). These words were originally selected from Clark and Paivio (2004). Participants next performed a distractor task that lasted three minutes. For this task, we chose the online Snake game (Pepe et al., 2021) so as to differentiate further than before the task demands between this task and the subsequent recall task of interest.

Like Experiment 1, participants either completed an individual free recall task or a collaborative recall task after the distractor phase. The instructions for both conditions were the same as Experiment 1, with one important change. Participants in both conditions were asked to recall the studied items in any order that they prefer, but the Nominal participants were told that people typically recall at least 24 items and Collaborative participants, who worked in groups of three, were told that groups typically recall at least 35 words. These numbers translated to 1.5 times the items recalled on average in these conditions in Choi et al. (2014). These instructions are modeled after the instructions used in Weldon and colleagues' (2000) Experiment 2 to encourage more engagement.[3] At the start of the recall session, all participants received their respective set of instructions on the screen and as a message from the experimenter at the start of the recall phase. Participants completed their respective task either individually or collaboratively for 10 minutes. Given the goals of Experiment 2 that focused on examining

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[3] While Weldon et al. (2000) used 2.5 times their Experiment 1 average, applying the same rule to our stimuli using the means from Choi et al. (2014) would have exceeded the number of study words available for recall. Our 1.5 rule was proportionally equivalent (% of words possible) to Weldon et al. (2000).

collaborative recall per se, we included only one recall session. Participants then completed the

same set of survey questions as in Experiment 1, and were then debriefed and compensated. The

entire procedure lasted approximately 30-minutes.

Results and Discussion

The goal of this experiment was to examine how collaboration influences memory

performance when engagement, likely lower in online settings, is increased. We addressed this

goal by setting a high standard for performance for participants working individually in a remote,

chat-based environment.

An independent samples *t*-test to examine group recall performance revealed a

significant difference between Nominal groups ($M = 63.77\%$, $SD = 9.81\%$, $n = 15$) and

Collaborative groups ($M = 54.64\%$, $SD = 12.80\%$, $n = 15$), $t(28) = -2.20$, $p = .037$, Difference

95% CI [-17.66% - -0.60%], $d = -0.80$, d 95% CI [-1.58 - -0.02] (see **Figure 5**). In summary, we

found that with improving the conditions for engagement, with the combination of intentional

encoding instructions, setting a high-performance standard for recall, and adding experimenter

presence at recall, restored collaborative inhibition in chat-based, remote environments.

Figure 5

Experiment 2: Group-Level Recall
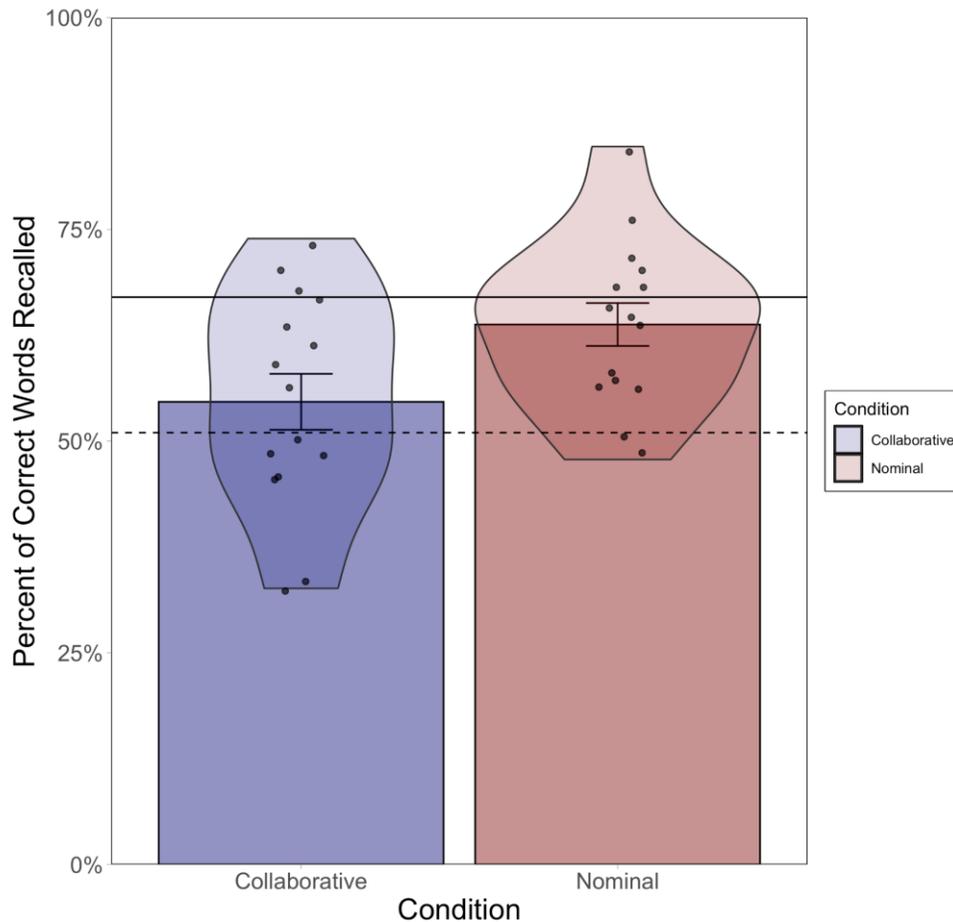
Note: The *y*-axis is the percent correct, out of 46 studied words. Bars are at mean and error bars

are *SEM*. Individual points and distributions represent underlying data (*n* = 15 in each

condition). Horizontal reference lines are from an in-person experiment using the same stimuli

and a similar procedure (Choi et al., 2014 - Recall 1). The dashed line is collaborative group

performance from that study, and the solid line is Nominal performance.

Discussion

We found that a collaborative inhibition effect also emerges in a remote, chat-based

environment, which is in line with previous research using the instructions we implemented in

this study (Weldon et al., 2000), along with additional measures to promote engagement. These

findings support our initial explanation that control participants, working alone in a remote environment, were simply putting forth less effort into the free recall task which diluted our group comparisons in Experiment 1. Further, these results are consistent with in-person research using similar stimuli (Blumen & Rajaram, 2008; Choi et al., 2014). While we cannot isolate which manipulation(s) from Experiment 1 to Experiment 2 led to the jump in control performance, it is clear that some or all of the carefully considered changes to increase task engagement that we implemented are needed to calibrate individual performance in online settings - a shorter study list, intentional study for a later test, removing the overlap in the demands of an intervening task and the target memory task, setting a higher bar for recall, and experimenter presence in the chatrooms. Our results are intuitive and support the reasoning about decreased motivation underlying the poor control performance in remote settings when people work alone. Nonetheless, given the variable nature of online performance, evolving online platforms, and the current work-from-home demands, we recommend interpreting these results with caution as well as replication to ascertain the reliability of online remembering.

General Discussion

In this study, we launched the collaborative recall paradigm into a completely virtual, chat-based setting. Novel to the current study, we found that remote, chat-based collaboration can facilitate the emergence of collective memory, similar to in-person collaborative remembering. Likewise, collaborative memory performance in general was similar to in-laboratory performance and former collaborators exhibited the expected post-collaborative recall boost. By contrast, control recall, that entailed individuals recalling alone instead of in groups, was numerically lower in Experiment 1 than in an in-person study using the same stimuli and general procedure (Peña et al., 2021).

Perhaps the most striking finding we report is the vanishing - and reappearance - of collaborative inhibition across the two experiments. In Experiment 1, collaborating groups performed equally well as in-person collaborative groups recalling the same stimuli (Peña et al., 2021). However, control performance suffered. In fact, relative to Peña et al. and Congleton and Rajaram (2011), individual recall performance was a full standard deviation below in-laboratory performance. We posit that motivation, generally defined, was reduced in this context for those working alone to perform the recall task, and that this reduction could stem from a variety of sources (e.g., task length, lack of supervision), and Experiment 2 supports this idea. We designed our second experiment to address a range of factors that could be responsible for such a reduction (i.e., intentional encoding, "forced" recall instructions, shorter word list, and experimenter presence). With these procedural adjustments, individual/Nominal group recall returned to levels consistent with laboratory-based research (Choi et al., 2014).

Why would there be a differential motivation reduction between conditions? Given that in both experiments Collaborative recall was approximately even with in-person performance we have observed in other, in-person studies, it is possible that the social component - being told just before recall that one will be working in a group - increased engagement and motivation. Conversely, when working individually in a remote and perhaps isolated context, there may be little incentive to recall more than a handful of items. This would amount to a *reverse social loafing effect*. Such an effect would also be exacerbated, though not completely explained, by completing longer and/or more intensive tasks virtually. If task length/intensity was solely at play, Collaborative performance would have suffered as well. In Experiment 2, designed specifically for ease and to afford individuals every opportunity to perform to their full potential, we observed collaborative inhibition. Our explanation of a reverse social loafing effect is

consistent with evaluations of the ways in which constant access to online media and digital technology can create memory lapses and distortions where, for example, media multitasking can produce attentional lapses and undermine memory for target information (Marsh & Rajaram, 2019; Schacter, 2022; Wammes et al., 2019)

In addition to providing an approach to assess collaborative inhibition online, we examined the emergence of collective memory. Several in-laboratory studies have established the role collaboration plays in reshaping individual memory such that, following collaboration, former group members recall more of the same information (Choi et al., 2014; Congleton & Rajaram, 2014). Experiment 1 extended this finding to a totally virtual, online setting. These findings suggest that online studies do, to some extent, are informed by offline memory studies but not entirely.

Concluding Thoughts

Online Socialization and Social Remembering

People socialize for many reasons online. Beyond education, social media and other platforms offer users the opportunity to connect and engage with others - to share news, seek information, debate, express opinions, and more. Our findings relating to collective memory may have implications for such general online engagement. While we examined collective memory for basic stimuli following collaboration between strangers, it is possible that similar effects will emerge naturally in existing social networks. For example, if one is repeatedly engaging with the same individuals online, it is possible that they will come to remember similar material. If collective memory is predictive of individual or group-level attitude formation, decision making, or other outcomes, understanding the mechanisms by which these memories emerge and evolve is critical (Rajaram et al., 2022; Garagozov, 2022).

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Applied Implications for Remote Education and Work

The data presented here shed light on the social and cognitive factors that underpin many virtual learning tasks. While the COVID-19 pandemic has forced the abrupt adoption of remote learning and education, virtual learning is not new (Farrell, 1999). Likewise, while many institutions are transitioning back to face-to-face instruction at the time of this writing, virtual education will continue to supplement curriculums. Finally, beyond formal academic settings, independent learners have and will continue to harness the Internet to pursue knowledge in many domains.

Our findings suggest that learning in virtual settings may be sensitive not only to collaboration, but other aspects of the experience that may be less critical in-person. For example, Experiment 1 revealed that - unlike in face-to-face contexts - Nominal group memory performance may drop. Conversely, Experiment 2 results suggest that individual memory performance can parallel in-person performance, given the right combination of factors. Directly assessing what these results mean for educational outcomes would require conceptual replication with more naturalistic materials, and the present study provides a prototype for such exploration. As such, the present study illustrates how basic collaborative memory research can extend to virtual settings where this learning takes place. Our findings suggest the possibility that collaboration may serve as an even more important pedagogical practice in online learning than for in-person learning (Pociask & Rajaram, 2014).

Beyond educational pedagogy, the assessment of virtual collaboration demands attention to how it is distinct from face-to-face collaboration for a variety of reasons. Assessment of the nature of virtual collaboration, and virtual learning in general, applies not only to platform-specific features that constrain communication in different ways (Kraut et al., 2002), but also to

why people are collaborating. That is, over and above technical affordances, virtual collaboration

may have different goals than face-to-face collaboration, such as time constraints for people with

financial or family obligations, disabled individuals who may thrive in online but not in-person

learning environments, geographic lack of local access to the same learning opportunities as

those available online, and beyond.

Similarly, communication preferences may influence the way people use online platforms

to collaborate with others. For example, while people across the adult lifespan now use mobile

messaging apps, younger adults exhibit a stronger preference for such texting compared to older

adults (Pew Research Center, 2015). Research shows differences in the manner of usage as well:

Children commonly use textese and textism (omission of words and nonstandard, abbreviated

use of words) when communicating with others through online texting, although this usage does

not have a negative impact on their grammar and other literacy abilities, or executive function

abilities (Plester et al., 2009; van Dijk et al., 2016; Wood et al., 2014). Older adults often prefer

specific addressee details and no emoticons (Kuerbis et al., 2017). How age differences for these

and other online communication preferences can impact memory across age would be interesting

to explore.

In the contexts we just described, what constitutes "successful" collaboration may come

down to what collaborative groups aim to optimize. For example, face-to-face collaboration

studies report that groups collaborate to optimize recall accuracy levels (Harris et al., 2012;

Weldon et al., 2000 Experiment 1), or they may focus on regulating the emotions they felt

towards the to-be-remembered information (Maswood et al., 2019). The variety of reasons

people may collaborate in virtual settings and the goals they prioritize when doing so may differ

in similar ways, making investigations about the memory consequences in virtual settings a

fruitful topic for future research.

More generally, we take note of several advantages of examining social remembering in

virtual environments. Notably, the collaborative recall paradigm is robust and allows us to isolate

the influences of specific cognitive mechanisms. Furthermore, while striking findings such as

collaborative inhibition, have been largely tested in laboratory settings with controlled learning

materials and procedures, this phenomenon has been also observed for more naturalistic to-be-

remembered information such as movies and real-life incidents (Wessel et al., 2015; Yaron-

Antor & Nachson, 2006) and in more naturalistic conditions involving life experiences (e.g.,

married couples remembering shared trips, Harris et al., 2017). As such, understanding this as

well as a range of social memory phenomena on virtual platforms holds considerable promise. In

this vein, future research should consider not only the technical features of virtual collaboration

and virtual learning in general, but also the motivational and task-specific features that can make

both the individual and collaborative performance online distinct from their face-to-face

counterparts. Given the dimensions on which these online versus face-to-face features can vary,

such explorations will benefit from a coordinated, interdisciplinary approach.

Going Beyond Chat-Based Recall and Scaling Up to Social Network Platforms

We explored chat-based social remembering in a fully online context, but exploring other

communication mediums would have both basic and applied value. In a basic research context,

examining the timing, availability, and medium of group member input could reveal more about

how information disrupts or potentiates cognitive processes. In an applied context, understanding

how individual and group memory changes on different platforms would be valuable in many

domains. For example, modern video conferencing provides a range of features and options. One

can join a meeting or class with or without video, use only chat, record for later viewing,

generate a transcript for later review, and display subtitles to supplement audio. The novel

approach we present here is flexible enough to be adapted to a variety of paradigms. Future work

can leverage this flexibility to widen the exploratory scope. For instance, access to social media

trace-data allows researchers to "scale up" research and the unit of analysis (Marsh & Rajaram,

2019; Risko, 2019). Alternatively, researchers can map established paradigms onto these new

environments incrementally. The methods we introduce here provide an experimental approach

that is grounded by cognitive theory to explore these options.

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