Cognition 202 (2020) 104279

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/cognit

Reviews

When social influences reduce false recognition memory: A case of categorically related information

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ARTICLE INFO

Keywords:
Collaborative memory
False memory
Recognition memory
Category-exemplar information

ABSTRACT

Social interactions create opportunities for reminiscence and memory rehearsal but can also lead to memory errors. We tested how the type of information people remember can influence the magnitude of memory errors they make following collaborative discussion. Past findings show that unrelated item lists and emotional salient items reduce false alarms and improve memory discrimination, respectively, on an individual recognition test after collaborative discussion compared to no prior collaboration. In contrast, for associatively related materials with high relatedness (e.g., *bed, rest, awake, tired, dream,* etc.) collaboration increases false recognition memory for the critical lures (e.g., *sleep*) on a later individual test. We tested whether the error-pruning benefits of collaboration are restricted to unrelated and emotional information or can also occur for other classes of related information that produce high memory errors. Using categorized stimuli, we created conditions that produced high or low memory errors for the same targets (12 versus 2 target exemplars per category across study lists of equal length). Replicating past research, collaboration increased the accuracy of recognition memory and large category size decreased it. The critical novel finding showed that collaboration pruned individual recognition errors by reducing false alarms not only in the low memory error condition but also the high memory error condition. This study delineates the conditions where collaboration can prune memory errors for related information.

Social interactions frequently involve conversations about past events. Family members, friends and coworkers talk about a movie they saw, a vacation they recently took, or a public event they heard about. Because people often remember information in social settings, it is important to ask whether and how conversations alter memories. In the cognitive psychological arena, considerable research has emerged in recent years on the effects of such collaborative discussions with the goal to understand the nature of collaborative memory (Rajaram & Pereira-Pasarin, 2010). In this article, we focus on the impact of collaborative remembering on individual memory. In asking questions about how collaboration changes individual memory, it is important to consider that in collaborative remembering people are exposed to not only accurate memories but also false memories that others might report. The question then is, does collaboration increase memory errors, and if so, what key factors contribute to such errors in individual memory.

Two candidate factors have received attention in recent studies on the impact of collaboration on memory errors. One factor is the type of interactions during collaborative retrieval, and its influence has been mainly investigated in group recall. When people engage in free-flowing conversations that enable them to go back and forth in the discussion, they make no more or even fewer false intrusions compared to the pooled items reported by a nominal group composed of the same number of individuals who recalled alone (e.g., Congleton & Rajaram, 2011; Maki, Weigold & Arellano, 2008; Pereira-Pasarin & Rajaram, 2011; Weigold, Russell & Natera, 2014; Thorley & Dewhurst, 2007; Weldon & Bellinger, 1997). In contrast, when participants are asked to take turns while retrieving information with other members in the group, where no discussion or feedback is possible such that group members cannot correct one another's errors, memory errors increase in group recall (Basden, Basden, Bryner, & Thomas III, 1997; Thorley & Dewhurst, 2007). Given that collaboration style influences false memory during group discussion, this is a relevant procedural feature to keep in mind when asking questions about how collaboration influences post-collaboration memory errors.

A second candidate factor that can influence memory errors is the type of information people study and later remember. We focus on this factor in the current investigation. Across different reports that we will elaborate below, findings show that when people study and remember unrelated information or emotionally salient information, collaborative

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https://doi.org/10.1016/j.cognition.2020.104279
Received 1 August 2019; Received in revised form 26 March 2020; Accepted 27 March 2020
0010-0277/

retrieval curtails false alarms on an individual recognition test. By contrast, when people study related information (e.g., associatively related words such as *bed, rest, awake, tired, dream,* etc.) collaborative retrieval increases false alarms to critical lures (e.g., *sleep*) in individual recognition judgements. We sought to test the generality of this relatedness effect by selecting another class of related information, namely categorized lists of words. We compared the effects of collaboration on individual recognition memory under conditions where study information was either high in relatedness or low in relatedness, while ensuring that the target items to remember were held constant across these two conditions. By delineating conditions where collaboration amplifies or prunes individual false memory for related information, our aim is to contribute to the understanding of the real-life situations where we can expect social influences to increase or decrease memory errors.

In considering the influence of collaboration on memory errors, collaboration confers a net gain in individual recognition memory for at least two classes of information - unrelated word lists and emotionally salient information (Kensinger, Choi, Murray, & Rajaram, 2016; Rajaram & Pereira-Pasarin, 2007). In research where unrelated information was used, individual participants first studied a list of unrelated words (e.g., *cat, toaster, chair, shirt, guitar,* etc.), and then performed a recognition task either working alone or in collaborative triads. The collaborative members engaged in free-flowing discussion of each item (studied or nonstudied) and made an individual recognition judgment on it, before proceeding to the next item for the same cycle of discussion and individual recognition judgment. The accuracy of individual recognition judgements improved for participants who engaged in collaborative discussion compared to those who did not collaborate (Rajaram & Pereira-Pasarin, 2007). This benefit occurred across study-test delays that spanned 1 h, 48 h, or one week, and the error-pruning benefits of collaboration were driven by a significant reduction in the false alarm rates after delays of 1 h and one week. These findings are striking because collaboration can presumably increase both hits and false alarms. Yet, collaboration continued to curtail false alarms even when the overall memory sensitivity declined after one week, demonstrating that collaboration does not necessarily increase memory errors whenever there is a reduction in memory sensitivity. Findings from another study that used a very similar procedure showed that collaboration also reduces false alarms on an individual recognition task for emotionally salient information such as picture-word pairs that were positive (e.g., wedding), negative (e.g., funeral), or neutral (e.g., astronomy) in valence (Kensinger et al., 2016, Experiment 1).

These collaborative facilitation effects in recognition memory are especially striking in light of other evidence showing that collaboration amplifies false memory for related information. In these studies, participants studied associatively-related items (e.g., *bed, rest, awake, tired, dream,* etc.) that are known to induce robust false memory for never presented, critical lures (e.g., *sleep*) in individual recall and recognition tasks (Deese, 1959; Roediger & McDermott, 1995). In one study on the effects of collaboration, participants studied a set of DRM lists and then performed a sequence of memory tasks (Basden, Reysen, & Basden, 2002). The first task included a condition of perceived group recall where participants believed they were working in a group and where they were exposed to computer-generated studied words and critical lures during collaborative recall. This condition is similar to one where a confederate provides exposure to studied items and lures during a collaborative session. On the follow-up individual recall and individual recognition tests, participants exhibited false memory for the critical lures to the same level as accurate memory for studied words. In this vein, false recall of schema-consistent errors for previously studied household scenes have been also reported on a later individual recall task that followed collaboration with a confederate who inserted schema-consistent errors (Roediger, Meade, & Bergman, 2001).

It turns out that for associative related information, collaboration styles that typically inflates memory errors, i.e., a confederate-style procedure or a turn-taking procedure, are not necessary for observing an increase in false alarms to critical lures. In Thorley and Dewhurst (2009), participants studied associatively related lists and later performed a sequence of memory tasks. Participants first completed a recognition task working alone, in dyads, in triads, or in groups of four, using a free-flowing procedure in conditions that involved collaboration, and then performed an individual recognition task. False recognition of critical lures increased both during and following collaboration and this false memory effect increased as the group size increased. Furthermore, an earlier report that collaboration did not increase false memory for the critical lures (Basden, Basden, Thomas, & Souphasith, 1998, Experiment 1) was later clarified to show that associatively related DRM lists with high associative strength (Stadler, Roediger, & McDermott, 1999) reliably increase this effect (Thorley & Dewhurst, 2007). In sum, across the series of studies where associatively related information was used for study, findings show that collaboration reliably increased false recognition memory for critical lures even when group members engage in a free-flowing collaboration while performing the recognition tasks.

Taken together, one conclusion to draw from this series of studies is that social interactions reduce memory errors for unrelated or emotionally salient information and increase memory errors when the studied lists consist of related information that by default yields high memory errors. The aim of the present study was to test the generalizability of this conclusion by testing the effects of collaboration on individual recognition memory for a different class of related information that also yield high memory errors. We selected categorically related information for this test because these materials are also known to yield high memory errors due to the categorical relationships among the studied items. Using these stimuli, we sought to answer the following question: Does collaboration amplify false memory errors in individual performance under any condition that yields high individual recognition errors?

Categorized lists lend themselves nicely to testing the issue at hand for several reasons. One, people commonly use categorized information in daily life and researchers have widely studied and used category-exemplar materials to understand the nature of memory and cognition. Indeed, a sizeable literature on collaborative recall includes categorized words lists as study and test materials. The use of these materials has been particularly useful to probe a counterintuitive phenomenon known as collaborative inhibition where the recall of studied items by collaborating groups is found to be lower than the nonredundant, pooled recall by an equal number of individuals who worked alone (Basden et al., 1997; Weldon & Bellinger, 1997). The related nature of categorized lists helps reveal that collaboration disrupts the extent to which people organize their recall by categorical content (Bousfield, 1953). Collaboration disrupts each individual member's idiosyncratic organization of studied information, and this disruption lowers each group member's recall and consequently the recall of the collaborating group (Basden et al., 1997). Current evidence on collaborative recall of categorized lists does not adjudicate the present question of interest as to whether collaboration influences false alarms for all types of related information in recognition memory. But the individual propensity to cluster categorized items in memory suggests that this clustering can promote false endorsement of related exemplars where the related, nonstudied exemplars could be confused with studied items in the clustered categories in memory. The extent to which collaboration that precedes individual recognition judgements influences such false endorsement of related nonstudied exemplars will test the question of present interest.

Two, consistent with the reasoning outlined above, prior research on individual memory has shown that as category size increases within a study list, hits remain constant on a later recognition memory task, but false alarms increase (Shiffrin, Huber, & Marinelli, 1995). Thus, categorized lists are particularly useful for arranging conditions that produce low versus high relatedness among stimuli, and concomitantly, low versus high memory errors within the same design for a direct comparison. Three, by manipulating low versus high memory errors through the nature of materials, it is possible to eliminate confederates or the turn-taking style during collaboration for generating memory errors. This approach allows the use of the more naturalistic, free-flowing collaboration style across both the low and high error conditions.

Four, the use of categorized stimuli provides a window into the conceptual structure of false memories and thereby makes it possible to assess the role of the nature of materials on the efficacy of error-pruning through collaboration. Research on false memories using individual memory paradigms shows that the cognitive mechanisms that elicit false memory differ for associatively-related lists and categorized lists. False memory for associatively-related items depends on backward associative strength (BAS), thus increasing retrieval of critical lures (Roediger, Watson, McDermott, & Gallo, 2001; Smith, Gerkens, Pierce, & Choi, 2002; also see McEvoy, Nelson, & Komatsu, 1999). Associatively-related lists consist of items that are conceptually related to a critical item that is not presented at study. For example, participants may be presented with a list of words such as *sour, candy, sugar, bitter, good, taste, tooth, nice, honey, soda, chocolate, heart, cake, tart, pie*, but the critical item *sweet* is not presented (Roediger & McDermott, 1995). The likelihood that an associatively-related list will induce false memory for the critical nonpresented item is measured by the degree of BAS between each studied item and the critical nonpresented item (Roediger, Watson, et al., 2001). In brief, in an associatively-related list each item activates the non-presented critical lure.

In contrast to associatively-related lures, false memory for categorized lists depends on a superordinate-to-subordinate structure of items. This relationship does not selectively increase the retrieval of any specific exemplar lure, but it gives rise to a general increase in false alarms to all related exemplars (Mandler, 1979; Park, Shobe, & Kihlstrom, 2005). Comparisons of associatively related lists and categorically related lists show that false memory in individual recall and recognition occurs for both types of lists (Knott, Dewhurst, & Howe, 2012; Park et al., 2005). When both types of lists possess high backward associative strength, the false memory effect is bigger for associatively related lists than for categorically related lists if the critical lure for the latter consisted of a category name (e.g., *bird*; Park et al., 2005) but equivalent when the critical lure consists of another, nonstudied exemplar (e.g., *robin*, for a studied list of *cardinal, blue jay, humming bird,* etc.; Knott et al., 2012).

In brief, false recognition of critical, nonpresented items for the associative lists occurs because each list item activates the same nonpresented, critical lure, whereas categorically related stimuli increase the overall activation of nonpresented related lures but each item within a list does not specifically activate the same exemplar lure, as in the case of associatively related lists. Together, these lines of evidence suggest that categorically related lists offer a useful case for testing the impact of collaboration on false memory errors for a new class of related stimuli. These stimuli also offer a unique opportunity to test this question because the relatedness of study stimuli can be manipulated by moving from small to large categorized lists while holding the target study and lure items constant across low and high related conditions, respectively, as well as using the same naturalistic, collaboration style (free-flowing) in both conditions.

How might collaboration influence individual recognition errors for categorized lists? We found one study (Basden et al., 1998) where a turn-taking style of collaborative recall of categorized lists led to higher false recall of critical, nonpresented lures (e.g., a nonstudied exemplar such as *robin*, for a list of studied bird names such as *cardinal, blue jay, humming bird,* etc.) compared to non-collaborative, nominal group recall. This pattern was also observed on a later, individual recognition task. These findings suggest that collaboration can increase false alarms to categorized lures on later individual recognition judgements. However, the collaboration procedure in this study consisted of turn taking and thus created conditions where the collaboration style itself can increase false alarms, regardless of the type of information retrieved. Therefore, the key question remains whether collaboration will increase or decrease false alarms, going from low to high relatedness of the categorized lists, when participants engage in free-flowing collaboration. The free-flowing collaboration style also provides a direct comparison to studies that used this collaboration method and reported the divergent false recognition memory effects for unrelated versus related information that motivate the present study, i.e., reduced false alarms and better memory discriminability for unrelated words (Rajaram & Pereira-Pasarin, 2007) and emotionally salient information (Kensinger et al., 2016), respectively, and by contrast, increased false alarms for associatively related information (Thorley & Dewhurst, 2009).

In the present study with categorized study lists, although the superordinate-to-subordinate level of activation of critical lures to studied items would increase errors in general, the activation is less likely to converge on the same critical lure for all group members. This lack of convergence on one item is expected to reduce the overlap of incorrect responses across all the group members. Under these circumstances, the group members can correct each other's recognition errors. Our aim is to assess whether as a result, and somewhat counterintuitively, prior collaboration can *lower* individual false recognition for categorically related stimuli.

In summary, with respect to the overall level of performance across small and large categorized lists, prior work predicts that large categorized lists will increase false alarm rates for individual recognition compared to small categorized lists and that corrected recognition (hits minus false alarm rates) will increase for small categorized lists compared to large categorized lists. The novel critical question is whether collaboration can act as an error-pruning mechanism, such that prior collaboration will increase corrected recognition for individual members for both *small and large* categorized lists compared to no collaboration.

1. Method

1.1. Participants and design

One hundred and twenty Stony Brook University undergraduates participated for research credit. Thirty participants were assigned to each of the four between-subjects conditions by crossing the independent variables of Collaboration (Collaborative versus Noncollaborative) and Category size (Large versus Small). Sample size was aligned to past reports using similar methodology (Rajaram & Pereira-Pasarin, 2007) where 30–36 participants were assigned in each condition across different experimental designs (Experiments 1 and 2). Assignment of 60 participants per collaboration/noncollaboration condition in the present design was consistent with a power analysis using the effect size for collaboration in that study ($d = 0.545$; Rajaram & Pereira-Pasarin, 2007), an alpha level of 0.05, and two-tailed significance tests that suggested that a sample size of 54 participants per collaboration condition (Collaborative, Noncollaborative) would be needed to ensure power of 0.80. The dependent variables in the present study consisted of hits and false alarms in individual recognition memory from which corrected recognition (hits minus false alarms), d' and β values were calculated. The d' and β values were included to provide measures of memory sensitivity and bias in recognition memory performance, respectively, in line with the common practice in the literature and previous reports using similar methodology.

1.2. Materials

Items were selected from three categorized word norms (Battig & Montague, 1969; Van Overschelde, Rawson, & Dunlosky, 2004; Yoon

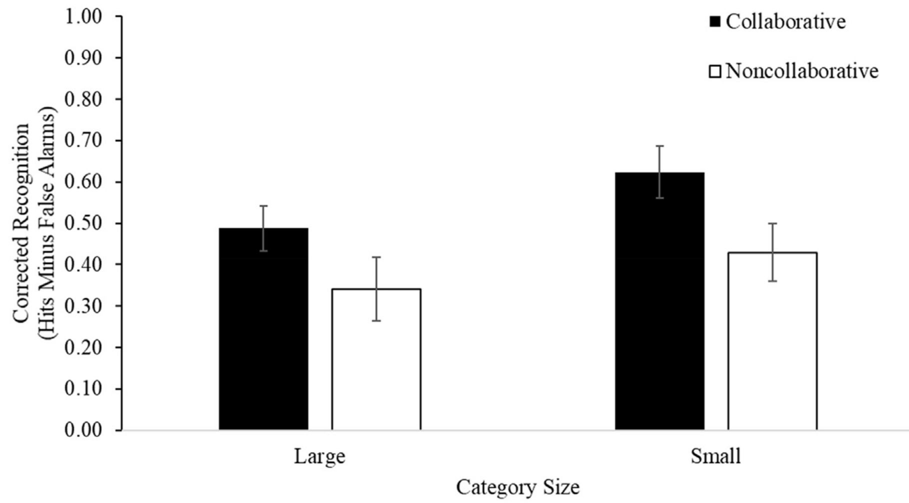

Fig. 1. Mean proportion of corrected recognition (hits minus false alarms) as a function of collaboration and category size. Error bars represent 95% confidence intervals.

et al., 2004). Four critical exemplars were selected from 12 categories, yielding a set of 48 critical exemplars. These critical exemplars represented the study and test items that were of interest and that served as the units of dependent measures on the recognition memory test. From this set, 24 critical exemplars (2 per category) were used in the study list for both the Large and Small Category Size conditions. In the Large Category Size condition, category size was manipulated by including 10 additional exemplars from each of the 12 critical categories. The means of the 48 critical exemplars and 120 filler exemplars were equated on word length of five to ten letters ($M = 6.43$, $F < 1$) and category rank of three to six ($M = 4.54$, $F < 1$)[1]. In the Small Category Size condition, category size was manipulated by including 2 exemplars each from 60 additional categories, separate from the 12 critical categories**.** The means of the 48 critical exemplars and 120 filler exemplars were equated on word length of five to ten letters ($M = 6.31$, $F < 1$) and category rank of three to six ($M = 4.53$, $F < 1$). Six buffers (each item from a separate category) were selected from six different categorized lists**.** The buffers and 48 critical exemplars were equated on word length of five to ten letters ($M = 6.41$, $F < 1$) and category rank of three to six ($M = 4.50$, $F = 1.6$). Thus, each study list consisted of a total of 148 items, where 24 items served as critical studied exemplars, two items served as buffers at the start and end of the list, and 120 items served as filler exemplars to manipulate category size across conditions. The two remaining critical exemplars from each of the 12 critical categories (thus, 24 remaining critical exemplars) were used as nonstudied items in the recognition memory test for both conditions of category size. Critical exemplars were counterbalanced for study status across study lists to appear as studied or nonstudied on a later recognition task and to appear in the small versus large categorized list. Counterbalancing of exemplar type (i.e., critical studied versus nonstudied) resulted in two study lists for each condition of category size for a total of four study lists.

A test booklet with instructions and 48 critical exemplars (24 studied and 24 nonstudied), plus four buffers (two studied and two nonstudied), was used in the recognition memory test. The critical exemplars were presented in a randomized order and the buffer items were presented in a randomized order as the first four items on the test booklet. Two test booklets were constructed to counterbalance the study status of the critical exemplars.

1.3. Procedure

The main features of the procedure were adapted from Rajaram and Pereira-Pasarin (2007) and Kensinger et al. (2016, Experiment 1) in order to keep the procedure very similar to these past studies where effects of collaboration on individual recognition accuracy and errors were tested for unrelated items (Rajaram & Pereira-Pasarin, 2007) or emotionally valenced items (Kensinger et al., 2016, Experiment 1). In the study phase, items were presented on the computer screen for 1 s with a 2 s inter-stimulus interval. Participants were instructed to read each item carefully for a subsequent memory test. All participants worked individually at study. Study items were presented in a randomized order with respect to category membership in each category size condition. At the completion of the study phase, participants left the laboratory and returned in 1 h.

At test, participants performed either a collaborative recognition memory test with three members working together or a noncollaborative recognition memory test in which individuals worked alone. Participants were instructed to read each item carefully and to indicate whether the item was presented during the study phase by circling "Y" (for "Yes") or "N" (for "No"). Participants in the collaborative condition were instructed to discuss each item on the test list. After the discussion, participants indicated individually whether or not they recognized the item from the study list before discussing the next item on the test list. It was emphasized that the experimenters were interested in each participants' final individual response *regardless* of whether their final response agreed with the group discussion. The recognition test was self-paced. Participants in the noncollaborative condition worked individually. Based on pilot data, participants in the noncollaborative condition were allocated 6 s to work on each item (indicated by a "beep" after every 6 s) to equate the total time of about 10 min taken to perform the recognition test across conditions.

2. Results

The mean proportion of corrected recognition (hits minus false alarms), false alarms and hits were analyzed using 2 (Collaborative Condition, Noncollaborative Condition) x 2 (Large Category Size, Small Category Size) ANOVAs. As predicted, a significant effect of category size was observed such that individual corrected recognition was better in the small category size condition ($M = 0.53$, $SD = 0.20$) than in the large category size condition ($M = 0.42$, $SD = 0.19$), $F(1, 116) = 11.77$, $MSe = 0.03$, $p = .001$, $\eta^2 = 0.09$; $p_{\text{BIC}}(\text{H}_0|\text{D}) = 0.03$ (Masson, 2011) (Fig. 1). Replicating past findings on the effects of list length (Shiffrin et al., 1995), false alarm rates were significantly higher in the large category size condition ($M = 0.27$, $SD = 0.16$) than in the small category size condition ($M = 0.19$, $SD = 0.13$), $F(1, 116) = 10.55$, $MSe = 0.02$, $p = .002$, $\eta^2 = 0.08$, $p_{\text{BIC}}(\text{H}_0|\text{D}) = 0.06$,

Table 1
Mean proportion of hits, false alarms, d prime (d′) and beta (β) as a function of large versus small category size and collaborative versus noncollaborative conditions. Standard deviations are shown in parentheses and 95% confidence intervals for the mean values are shown below the means.

	Hits		False Alarms		d′		β	
	Category		Category		Category		Category	
	Large	Small	Large	Small	Large	Small	Large	Small
Collaborative	0.70 (0.15)	0.75 (0.18)	0.21(0.12)	0.13(0.08)	1.45(0.50)	2.02(0.62)	1.54(1.34)	2.10(2.05)
	[0.64,0.76]	[0.69,0.82]	[0.17,0.26]	[0.10,0.16]	[1.27, 1.64]	[1.78,2.25]	[1.04, 2.04]	[1.33, 2.86]
Noncollaborative	0.67 (0.13)	0.68(0.15)	0.33(0.18)	0.26(0.14)	0.96(0.59)	1.26(0.62)	1.15(0.46)	1.56(1.69)
	[0.62,0.72]	[0.63,0.74]	[0.27,0.40]	[0.20,0.31]	[0.74, 1.19]	[1.03, 1.49]	[0.98, 1.32]	[0.93, 2.19]

whereas the hit rates were equivalent across the small category size ($M = 0.72$, $SD = 0.17$) and large category size ($M = 0.69$, $SD = 0.14$) conditions, $F(1, 116) = 1.18$, $MSe = 0.02$, $p = .28$, $\eta^2 = 0.01$, $p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) = 0.86$ (Table 1).

The present findings are also consistent with the past findings on the effects of collaboration on subsequent individual recognition (Rajaram & Pereira-Pasarin, 2007) such that there was a significant benefit of collaboration on individual recognition accuracy in the present study. Specifically, individual corrected recognition was better in the collaborative condition ($M = 0.56$, $SD = 0.17$) than in the noncollaborative condition ($M = 0.39$, $SD = 0.20$), $F(1, 116) = 27.65$, $MSe = 0.03$, $p < .001$, $\eta^2 = 0.19$, $p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) < 0.001$. This benefit of collaboration was once again driven by a significant reduction in false alarms rates in the collaborative condition ($M = 0.17$, $SD = 0.11$) compared to the noncollaborative condition ($M = 0.29$, $SD = 0.17$), $F(1, 116) = 24.33$, $MSe = 0.02$, $p < .001$, $\eta^2 = 0.17$, $p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) < 0.001$. Finally, hit rates were not reduced by collaboration, and if anything, were marginally higher (collaborative, $M = 0.73$, $SD = 0.17$; noncollaborative, $M = 0.68$, $SD = 0.14$), $F(1, 116) = 3.06$, $MSe = 0.02$, $p = .08$, $\eta^2 = 0.03$, $p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) = 0.69$.

Turning now to the key question in this study, the interaction between collaboration and category size for corrected recognition (hits minus false alarms) was not significant, $F(1, 116) < 1$, $p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) = 0.89$. Thus, the benefit of collaboration on individual recognition occurred in both the small and large category size conditions such that participants in the collaborative group significantly outperformed participants in the noncollaborative group in both the small category size condition (collaborative, $M = 0.62$, $SD = 0.17$; noncollaborative, $M = 0.43$, $SD = 0.19$), $t(58) = -4.24$, $SE = 0.05$, $p < .001$, $d = 1.05$, and in the large category size condition (collaborative, $M = 0.49$, $SD = 0.15$; noncollaborative, $M = 0.34$, $SD = 0.20$), $t(58) = -3.20$, $SE = 0.05$, $p = .002$, $d = 0.85$. This benefit was driven by a reduction in false alarms rates across both conditions of category size. Participants in the collaborative condition reported significantly fewer false alarms than participants in the noncollaborative condition in both the small category size condition (collaborative, $M = 0.13$, $SD = 0.08$; noncollaborative, $M = 0.26$, $SD = 0.14$), $t(58) = 4.20$, $SE = 0.03$, $p < .001$, $d = 1.14$, and in the large category size condition (collaborative, $M = 0.21$, $SD = 0.12$; noncollaborative, $M = 0.33$, $SD = 0.18$), $t(58) = 3.02$, $SE = 0.04$, $p = .004$, $d = 0.78$. Planned comparisons for hit rates indicated that the benefit of collaboration on individual recognition was mainly due to the false alarm effects as hit rates did not differ between the collaborative and noncollaborative conditions in the small category size condition (collaborative, $M = 0.75$, $SD = 0.18$; noncollaborative, $M = 0.68$, $SD = 0.15$), $t(58) = -1.66$, $SE = 0.04$, $p = .101$, $d = 0.42$, or in the large category size condition, (collaborative, $M = 0.70$, $SD = 0.15$; noncollaborative, $M = 0.67$, $SD = 0.13$), $t(58) = -0.75$, $SE = 0.04$, $p = .46$, $d = 0.21$. The interactions between collaboration and category size for false alarms and hit rates were not significant, $F(1, 116) < 1$ ($p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) = 0.92$, $p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) = 0.89$, respectively).

Analyses for the d prime (d') rates revealed a similar pattern of results). We replicated a main effect for category size, such that as predicted, memory performance was better in the small category size condition ($M = 1.64$, $SD = 0.72$) than in the large category size condition ($M = 1.21$, $SD = 0.60$), $F(1, 116) = 16.31$, $MSe = 0.34$, $p < .001$, $\eta^2 = 0.12$, $p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) = 0.004$. The benefit of prior collaboration on individual recognition was also observed for d' rates, such that individual recognition was better in the collaborative condition ($M = 1.73$, $SD = 0.62$) compared to the noncollaborative condition ($M = 1.11$, $SD = 0.62$), $F(1, 116) = 33.80$, $MSe = 0.34$, $p < .001$, $\eta^2 = 0.23$, $p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) < 0.001$. Importantly, the analyses for the interaction effects between collaboration and category size for d' mirrored the results for corrected individual recognition as the interaction was not significant $F(1, 116) = 1.53$, $MSe = 0.34$, $p = .22$, $\eta^2 = 0.01$, $p_{\mathrm{BIC}}(\mathrm{H_0}|\mathrm{D}) = 0.83$. Critical to our aims, the benefit of collaboration on individual recognition occurred in both the small and large category size conditions such that participants in the collaborative group significantly outperformed participants in the noncollaborative group in both the small category size condition (collaborative, $M = 2.02$, $SD = 0.62$; noncollaborative, $M = 1.26$, $SD = 0.62$), $t(58) = -4.70$, $SE = 0.16$, $p < .001$, $d = 1.23$, and in the large category size condition (collaborative, $M = 1.45$, $SD = 0.50$; noncollaborative, $M = 0.96$, $SD = 0.59$), $t(58) = -3.46$, $SE = 0.14$, $p = .001$, d = 0.90. Finally, the beta analyses (β) did not reveal significant differences. Participants did not use a liberal decision criterion in any of the conditions of category size and collaboration (see also Rajaram & Pereira-Pasarin, 2007 for similar results). For reasons of economy, the means for the β values in each condition are reported in Table 1.

3. Discussion

This study aimed to test the generalizability of the influence of collaboration on individual recognition for information that yields high memory errors. We tested this question by using categorically related stimuli during study and test. Prior findings show that for unrelated stimuli (Rajaram & Pereira-Pasarin, 2007) and emotionally salient information (Kensinger et al., 2016) that produce low memory errors individual memory, collaboration reduces false alarms in individual recognition. However, for associatively-related stimuli that produce high memory errors for critical lures in individual memory, collaboration increases individual errors (Basden et al., 2002; Thorley & Dewhurst, 2009). Using another class of related stimuli that also yield high memory errors in individual recognition, namely categorically related word lists, we tested whether collaboration increases false recognition for any type of information that yields high individual recognition errors.

We used categorically related stimuli because these stimuli have superordinate-to-subordinate associations instead of coordinate associations noted for associatively related stimuli. As such, categorical relationships can activate all related lures and drive up false alarms to nonstudied related exemplars following the study of a large rather than a small set of exemplars from a given category but categorized list items are not expected to activate the same critical lure as is considered to be the case for associated lists. In line with this reasoning, we manipulated category size to create both low and high memory error conditions while holding constant the particular items that served as critical studied and lure exemplars as well as using the naturalistic, free-flowing collaboration style in both conditions.

The findings showed that the increase in false memory following collaboration previously reported for associatively related information is not ubiquitous for all related information that yield high memory error. Even though large category size lists increase false alarms in general, under these conditions collaboration nonetheless reduced the false alarms in individual recognition memory compared to the condition where no collaborative discussion took place. These novel patterns were observed in the context of replicating previous findings on the effects of list length on false alarm rates; false alarms were higher in the large category size condition compared to the small category size condition. In other words, even when overall false alarms increased, collaboration nonetheless pruned individual recognition errors. These findings indicate that memory errors following collaboration depend on the mechanisms that drive the processing of related information. Unlike the case for associatively related information, the same nonstudied exemplar is likely not activated for all participants after the study of categorically related words. As a consequence, collaboration can prune false alarms compared to no collaboration when making individual recognition judgements for both large and small category size lists.

Some past findings provide indirect support for our findings that collaboration can prune errors for related information. For instance, in group recall older couples collaboratively produced lower errors for related items, such as items on a shopping list in the supermarket (Ross, Spencer, Linardatos, Lam, & Perunovic, 2004), and produced fewer critical lures (inserted through computer generated responses) in the recall of everyday scenes (Ross, Spencer, Blatz, & Restorick, 2008) when compared to nominal group recall calculated by pooling the recall of two individuals. This reduction in group recall errors was attributed to error pruning during collaboration where for a false memory to be accepted as studied it must be remembered by both members of the dyad (see also Ross et al., 2004); otherwise, the item is rejected. Extending this idea to the present study, superordinate-to-subordinate relationships among category exemplars lower the chances that the same critical lure would be most highly activated for all group members and, therefore, can be subject to error pruning. The recognition task (used here) provides nonstudied lures rather than depending on participants to generate them (as with recall). As such, the recognition task in the current study presents an important benchmark to determine whether the error-pruning mechanism of collaboration would be effective even when stimuli that induce high memory errors are made available during test and under circumstances where the final decision rests with the individual rather than the group.

In brief, the present study shows that the error-pruning effects of collaboration extend to individual recognition for categorically related stimuli. By using the superordinate-to-subordinate structure as opposed to the coordinate structure of the related stimuli, this study reveals the novel finding that under conditions of both low and high relatedness among events, collaboration can boost individual recognition memory performance by curbing the propensity for false alarms. While harmful effects of collaboration on individual memory can clearly occur as evident from previous studies in the literature, the present study delineates conditions where collaboration can prune individual false memory for related information. Specifically, past research using associatively related items (i.e., DRM lists) shows the underlying processes that give rise to memory errors for related information and the current findings using categorized lists show the processes that can curb these memory errors. Given that a great deal of real-life information comes from categories and given that people generally show a propensity to cluster incoming information (Gates, 1917; Tulving, 1962), these findings contribute to our understanding of the real-life conditions where we can expect social influences to increase or decrease memory errors.

Author note

Preparation of this manuscript was supported by the National Science Foundation Grant 1456928. We thank Nicholas Pepe and Tori Peña for their feedback on an earlier version of the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cognition.2020.104279.

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