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Shared Encoding and the Costs and Benefits of Collaborative Recall

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We often remember in the company of others. In particular, we routinely collaborate with friends, family, or colleagues to remember shared experiences. But surprisingly, in the experimental collaborative recall paradigm, collaborative groups remember less than their potential, an effect termed *collaborative inhibition*. Rajaram and Pereira-Pasarin (2010) argued that the effects of collaboration on recall are determined by "pre-collaborative" factors. We studied the role of 2 pre-collaborative factors—shared encoding and group relationship—in determining the costs and benefits of collaborative recall. In Experiment 1, we compared groups of strangers who encoded alone versus together, before collaborating to recall. In Experiment 2, we compared groups of friends who encoded alone versus together, before collaborating to recall. We found that shared encoding abolished collaborative inhibition in both Experiments 1 and 2. But prior relationship did not influence collaborative inhibition over and above the effects of shared encoding. Regardless of encoding condition, collaborative group recall contained fewer intrusions than nominal group recall, and these benefits continued in subsequent individual recall. Our findings demonstrate that pre-collaborative factors—specifically shared encoding—have flow-on benefits for group and individual recall amount, but not recall accuracy. We discuss these findings in terms of self- and cross-cuing in collaborative recall.

Keywords: collaborative recall, cross-cuing, collaborative inhibition, social memory

We often remember in the company of others, such that "sharing memory is our default" (Campbell, 2008, p. 43). For this reason, our social contexts may be an important component of what and how we remember (Barnier, Sutton, Harris, & Wilson, 2008; Boyer & Wertsch, 2009; Harris, Barnier, Sutton, & Keil, 2010; Tollefsen, 2006). Cognitive theories such as Wegner's (1987) transactive memory, and research in other disciplines such as sociology and philosophy, describe how remembering is shared in groups and predict clear benefits of remembering with others (see Barnier et al., 2008; Harris, Keil, Sutton, Barnier, & McIlwain, 2011; Harris, Paterson, & Kemp, 2008; Sutton, Harris, Keil, & Barnier, 2010; Tollefsen, 2006). More recently, cognitive psychology has contributed to the concerted interdisciplinary push to understand how individual memory fits within a broader picture of social and collective memory (Boyer & Wertsch, 2009; Harris et al., 2008; Hirst & Echterhoff, 2008, 2012; Hirst & Manier, 2008; Rajaram & Pereira-Pasarin, 2010; Wertsch & Roediger, 2008).

In cognitive psychology, the dominant experimental paradigm used to assess the costs and benefits of remembering with others is *collaborative recall* (Basden, Basden, Bryner, & Thomas, 1997; Basden, Basden, & Henry, 2000; Rajaram, 2011; Rajaram & Pereira-Pasarin, 2010; Weldon & Bellinger, 1997). This paradigm can be used to test the influence of remembering with others both during the collaboration itself and on subsequent individual recall. During collaboration, the recall output of collaborative groups is compared to a nominal group control, indexed by the pooled recall output of participants who remember alone. Collaborative groups typically remember less than nominal groups, an effect termed *collaborative inhibition* (Harris et al., 2008; Weldon & Bellinger, 1997). Collaborative inhibition is extremely robust and has been demonstrated for a range of stimuli including lists of unrelated words (e.g., Weldon & Bellinger, Experiment 1), categorized lists (e.g., Basden et al., 2000; Meudell, Hitch, & Boyle, 1995), pictures (e.g., Weldon & Bellinger, 1997, Experiment 1), stories (e.g., Weldon & Bellinger, 1997, Experiment 2), and historical details (e.g., Yaron-Antar & Nachson, 2006). After collaboration, the recall output of individuals who have previously collaborated is compared to the recall output of individuals who previously remembered alone. Individuals who previously collaborated generally recall more than individuals who previously remembered alone (Blumen & Rajaram, 2008, 2009); in particular, they pick up items mentioned by other group members during discussion (Basden et al., 2000). That is, collaboration has reexposure benefits for subsequent individual recall (Blumen & Rajaram, 2008).

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In the collaborative recall paradigm, research has yielded inconsistent results regarding the effects of collaboration on the number of intrusions or errors in recall (e.g., see conflicting results from Basden et al., 1997; Ross, Spencer, Blatz, & Restorick, 2008; Takahashi, 2007; Weldon & Bellinger, 1997). In our own research, we clarified these inconsistencies by demonstrating that intrusion rates depended on the nature of the group interaction during collaboration (Harris, Barnier, & Sutton, 2012). Groups who discussed each item as it was recalled and reached a consensus about its accuracy included very few intrusions in their recall compared to those who simply took turns to recall during collaboration. This collaborative error checking had flow-on benefits: It also reduced intrusions on subsequent individual recall (Harris et al., 2012; see also Thorley & Dewhurst, 2007).

The most consistent finding from the collaborative recall paradigm has been the counterintuitive collaborative inhibition effect, and the best supported explanation for collaborative inhibition is retrieval disruption (Basden et al., 1997). By this explanation, because members of collaborative groups each develop an idiosyncratic cognitive organization for remembering the material, being exposed to items recalled by other group members disrupts each individual's recall during collaboration (Basden et al., 1997). Thus, collaborative inhibition is seen as related to part–set cuing (Andersson, Hitch, & Meudell, 2006), where exposure to some items from a list inhibits recall for the remaining items (see Roediger, 1973). Research has supported this explanation by showing that participants who focus on their own separate retrieval strategies (rather than engaging with group recall) experience less strategy disruption and less collaborative inhibition. For example, if each group member recalls a different part of the list (Basden et al., 1997), or if group members cannot see or hear each other's recall (while still engaging in turn-taking; Wright & Klumpp, 2004), collaborative inhibition is abolished. These experiments reduce collaborative inhibition by altering the process of collaboration to keep individual recall separate, thus reducing the disruption of individual retrieval strategies. However, in essence, these experiments reduce collaborative inhibition by reducing the "collaborative" nature of the group interaction.

While the experiments reviewed above focused on manipulations at retrieval, collaborative inhibition can also be reduced by manipulations of the encoding context or the nature of the group. For instance, Basden et al. (1997) demonstrated that when categories that people study are small, such that individual idiosyncratic organizations are likely to be more similar, collaborative inhibition is abolished. Additionally, Meade, Nokes, and Morrow (2009) found that expert pilots collaborating to remember aviation-relevant material demonstrated collaborative facilitation rather than inhibition. Meade et al. concluded that because of their expertise, "[expert pilots] encoded information in similar ways, which minimized the disruptive effects of the collaborative memory task" (Meade et al., 2009, p. 46). These findings suggest that pre-collaborative factors—factors that occur prior to the collaborative recall test—contribute to collaborative inhibition. That is, aspects of the group and aspects of the study phase create a set of circumstances that flow on to produce costs and benefits for recall. Despite the theorized central contribution of these pre-collaborative factors, most research that has attempted to overturn collaborative inhibition has tested the influence of manipulations at recall (e.g., type of recall task, keeping people separate), and much less research has focused on manipulations prior to recall (for an exception, see Pereira-Pasarin & Rajaram, 2011).

Recognizing this imbalance, Rajaram and Pereira-Pasarin (2010) recently developed a model to predict the costs and benefits of collaboration for memory, both during collaboration and afterward, and in terms of both recall amount and recall accuracy. In this model, each individual in a collaborating group brings with him or her an individual preexisting cognitive structure, which means that after studying the material alone, each individual develops an idiosyncratic cognitive organization of the stimuli. This model predicts that these two distinct features of the pre-collaborative context then set up the conditions for collaborative inhibition (Rajaram & Pereira-Pasarin, 2010). In the current research, we directly tested this prediction by measuring the effects of two manipulations of the pre-collaborative context on amount recalled and recall accuracy, both during and after collaboration. First, we manipulated whether groups shared or did not share the encoding of the material. Second, we manipulated the relationship between group members.

When group members collaborate at the encoding phase, they may develop more similar cognitive organization of the to-be-remembered material. Thus, we predicted that shared encoding would reduce or abolish collaborative inhibition. Those prior experiments that have manipulated encoding have yielded conflicting findings. Andersson and Rönnberg (1995) found that participants who discussed a 32-min video (after they had viewed it in silence) subsequently showed stronger collaborative inhibition than those who had not discussed the video. They concluded that shared encoding is detrimental for collaborative recall. However, their shared encoding task was actually an initial collaborative recall, since it occurred after exposure to the stimuli, and there would be no reason to expect this task to make idiosyncratic cognitive organization more similar. In contrast with Andersson and Rönnberg (1995), Finlay, Hitch, and Meudell (2000) found that participants who engaged in a shared incidental encoding where they jointly searched for target animals in pictures subsequently showed no collaborative inhibition. Finally, Barber, Rajaram, and Aron (2010) found that individuals who engaged in a collaborative encoding task, where they took turns to generate sentences containing target words, subsequently performed more poorly on an individual recall test. However, they did not examine the outcomes in terms of the costs and benefits for collaborative recall. Across these three experiments, the methodologies, the definition of shared encoding, and the level of interaction in the shared encoding task were different. Also, all three experiments used dyads, where collaborative inhibition is typically less robust than it is in larger groups (see Basden et al., 2000). Thus, prior research has been inconclusive about the effects of shared encoding on collaborative recall.

The second pre-collaborative factor that we focused on was group relationship. We tested groups of friends and made the shared encoding task relevant to their shared experiences. If the level of retrieval disruption during collaboration depends on idiosyncratic individual preexisting cognitive structures, then we would expect that, for intimate groups, these preexisting structures would be more similar and collaborative inhibition would thus be reduced or abolished, just as when Meade et al.'s (2009) expert pilots collaborated to remember aviation-relevant stimuli. Experiments that have manipulated relationship also have yielded conflicting findings. Andersson and Rönnberg (1996) found that groups of friends exhibited less collaborative inhibition than groups of strangers. In contrast, Gould, Osborn, Krein, and Mortenson (2002) found no difference in collaborative recall between married and unacquainted dyads (although they did not include a nominal comparison), and Peker and Tekcan (2009) also found similar levels of collaborative inhibition for groups of friends and strangers. Despite these inconclusive findings, Rajaram and Pereira-Pasarin (2010) suggested that collaborative inhibition might be reduced in intimate groups, perhaps due to "transactive memory" (see also Wegner, 1987; Wegner, Giuliano, & Hertel, 1985), but the effects of relationship on collaborative recall are not yet clear.

We expected these pre-collaborative factors to influence recall processes both during and after collaboration. We expected that retrieval disruption—the claimed source of collaborative inhibition (Basden et al., 1997)—would be reduced by our manipulations, because group members would develop more similar cognitive organization of the material (see also Rajaram & Pereira-Pasarin, 2010). But we also expected that these pre-collaborative factors would increase *cross-cuing*, or group-level coordinated strategies during collaboration that are a potential positive influence on recall. Although cross-cuing during collaboration has been a hypothesized benefit of remembering in a group, there has so far been little evidence suggesting that this is possible (see Meudell et al., 1995), and Rajaram and Pereira-Pasarin (2010) did not include it in their model of processes that influence collaborative recall. But perhaps it is not surprising that groups of strangers collaborating to remember relatively arbitrary material after individual encoding do not cue each other or coordinate their recall.

We had a number of reasons to expect that our two manipulations of the pre-collaborative context would enhance cross-cuing among group members during collaboration. Previous research has indicated that *self-generated* cues are particularly effective for recall, compared with *other-generated* cues (Mäntylä, 1994; Mäntylä & Nilsson, 1983). Greenwald and Banaji (1989) found that participants remembered target nouns better when they were linked to friends' names that they had generated themselves, rather than to friends' names generated by other participants. However, other-generated cues can be effective when they are more generic, such that they overlap with one's self-generated cues and are based on shared knowledge (for instance, "what happened at the meeting on Friday?"; Hunt & Smith, 1996, p. 217; see also Mäntylä & Nilsson, 1983). In terms of shared encoding, we expected that *group-generated* cues may be effective for cross-cuing during collaborative recall, because they combine the features of idiosyncratic self-generated cues with the shared nature of effective other-generated cues. For instance, in a recent study conducted in our lab, Priddis (2011) found that older couples used shared, idiosyncratic cues—cues that could not be provided by an experimenter—to remind each other of shared autobiographical events:

> *Wife:* Remember that?
>
> *Husband:* No.
>
> *Wife:* No? That was the most recent. You remember Nel?
>
> *Husband:* Oh yes. Yes. Where was it?
>
> *Wife:* Hobart.
>
> *Husband:* Oh!
>
> *Wife:* That one. Remember?
>
> *Husband:* Can't remember which one was called Mona.
>
> *Wife:* It was that very modern one that was just being built. And we had to keep going down, down. . . . We went there with the group on that holiday in Tasmania.
>
> *Husband:* I remember now. I remember arriving. Departing. Eating tea and whatever.

That is, when people experience events together, they may be able to cue each other's recall in beneficial ways. In the current study, we used a shared encoding task that involved groups generating idiosyncratic cues for the study list to determine the effects of group-generated cues on collaborative recall.

In terms of group relationship, Andersson and Rönnberg (1997) argued that collaborative inhibition was largely due to reduced cue effectiveness and that members of intimate groups could provide more effective cues for each other's recall (see also Andersson & Rönnberg, 1996). Thus it seems reasonable to predict that groups of friends may generate more overlapping, effective cues for each other, even when they generate and encode them individually. In our previous research on collaborative recall in older, long-married couples, we found that, for some couples, collaboration facilitated (rather than inhibited) recall, and couples' use of cuing and communication strategies accounted for 84% of the variance in their collaborative performance (Harris et al., 2011). In the current studies, we measured self-cuing and cross-cuing by asking participants to report their recall strategies. We studied whether these strategies were associated with collaborative recall performance and whether their use was influenced by shared encoding or group relationship.

Experiment 1

In Experiment 1 we examined the impact of unshared versus shared encoding on the costs and benefits of collaborative recall. We compared groups where individuals learned the stimuli in an individual, unshared encoding task versus groups where participants learned the stimuli in an interactive, shared encoding task. And we compared the output of collaborative groups versus nominal groups. We hypothesized that unshared encoding would result in collaborative inhibition: Collaborative groups would recall less than nominal groups. However, we hypothesized that shared encoding would reduce collaborative inhibition, such that collaborative groups would recall a similar amount to nominal groups or even show facilitation. We hypothesized that shared encoding would benefit collaborative recall by increasing the new items gained during collaboration and decreasing the items lost during collaboration, compared to unshared encoding. We also hypothesized that collaborative recall would reduce intrusions in recall, both during and after collaboration. Finally, we predicted that shared encoding would result in more reported cross-cuing strategies during collaboration.

Method

Participants. One hundred and twenty-nine undergraduate students (age $M = 22.24$ years, $SD = 6.07$) at Macquarie University, Sydney, Australia (96 women, 33 men) participated in this study in return for payment of AU $15 per hour. Of these 129 participants, 60 (44 women, 16 men) participated as members of 20 three-member collaborative groups, and 69 (52 women, 17 men) participated as individuals, making up 23 three-member nominal groups. Twenty-one groups consisted of 3 women, 1 group consisted of 3 men, and 21 groups consisted of a mixture of men and women. The design was 2 (encoding task: unshared vs. shared) × 2 (recall group: nominal vs. collaborative) × 3 (recall occasion: 1 vs. 2 vs. 3).

Materials. Participants viewed a list of 30 words sequentially on a computer screen. These words were a subset of a list of personality trait words sourced from Anderson (1968) and normed for likeability.[1] The words were *angry*, *boring*, *careless*, *cheerful*, *critical*, *dependable*, *depressed*, *friendly*, *good-natured*, *honest*, *imaginative*, *impulsive*, *inattentive*, *intelligent*, *irritating*, *lonesome*, *open-minded*, *overconfident*, *perfectionistic*, *persistent*, *polite*, *quiet*, *restless*, *self-centered*, *serious*, *shy*, *talkative*, *unconventional*, *understanding*, and *untidy*.

Procedure. Experiment 1 consisted of seven phases conducted by a single experimenter: (a) Incidental Encoding Task; (b) Recall 1; (c) Distraction 1; (d) Recall 2; (e) Distraction 2; (f) Recall 3; and (g) Postexperimental Inquiry. Manipulation of encoding occurred during the incidental encoding task, and manipulation of retrieval occurred during Recall 2.

Incidental encoding task: Unshared encoding condition. Participants sat at individual computers, where they could not see the stimuli presented to other participants. The experimenter told participants that the experiment aimed to examine how people perceive other people's personalities. She explained that they would be presented with a series of personality trait words, and for each one, they should think of a celebrity who had that personality trait (for instance, "Hugh Jackman" in response to the word "friendly"). Participants viewed 30 personality trait words on the computer for 60 s each, in a fixed, random order. Participants could not respond to the word during the 60 s, and the experimenter instructed participants to use this time to decide which celebrity name they would type into the computer for that word. The computer displayed a "countdown," so participants knew how long they had to decide on their response. Once participants had viewed each word for 60 s, an instruction appeared telling them to type the name of the celebrity. The experimenter emphasized to participants that it was very important that they respond as quickly as they could once they saw the instruction to type in the name. This procedure was designed to standardize the encoding time across words and across participants.

Incidental encoding task: Shared encoding condition. The instructions and procedure for the shared encoding task were identical to those for the unshared encoding task, with two exceptions. First, participants sat in a group of three around a single computer, where they could all see the screen and the experimenter instructed participants to talk together and to come to an agreement about which celebrity name they would type into the computer for that word. Second, one group member, selected by the group, typed the agreed-on name into the computer.

Recall 1. Once the list was complete, participants immediately completed an individual free recall task where they spent 4 min writing down the words they could remember (Recall 1). The experimenter told participants to keep trying to recall words from the list until instructed to stop. After 4 min, the experimenter told participants that time was up and collected their responses.

Distraction 1. After Recall 1, participants in nominal groups completed a distractor task alone, where they spent 10 min attempting to solve a Sudoku number puzzle. Participants in collaborative groups moved to sit together around a central table and spent 10 min attempting to solve the puzzle as a group. This group distraction phase was designed so that all participants in the collaborative recall conditions had experience working together prior to collaboration, even those who had not participated in shared encoding, and controlled for any effect of rapport building during the shared encoding task.

Recall 2. Following the distraction, participants in nominal groups completed an individual free recall task identical to Recall 1 (Recall 2). Participants in collaborative groups worked as a group to recall as many words from the list as possible (Recall 2). The experimenter instructed participants in collaborative groups to reach a consensus about each item: that they could write an item down on the list only if they all agreed it was on the study list (based on our prior work; Harris et al., 2012). Collaborative groups were allowed to recall until they could not remember any more, but once recall appeared blocked, the experimenter asked them if they were finished and collected their responses.

Distraction 2. All participants completed a 10-min individual distraction phase, where they identified whether pairs of number strings were the same or different.

Recall 3. Participants in all conditions completed an individual free recall task identical to Recall 1 (Recall 3).

Postexperimental inquiry. Finally, participants completed a postexperimental inquiry depending on which condition they were in. We asked participants in all conditions whether they had used a self-cuing strategy: that is, whether they had thought of the associated celebrity name to cue recall of the personality trait words. We also asked participants in collaborative groups whether their group had used any strategies to remember together, how included they felt in the collaborative encoding and/or recall tasks, and how well they knew the other members of the group. Participants were given a chance to ask questions and were fully debriefed and thanked for their participation.

Results

Table 1 presents the percentage of the study list correctly recalled and the percentage of intrusions on each recall occasion by participants across the four conditions: unshared encoding followed by nominal versus collaborative group recall, and shared

[1] Anderson (1968) calculated likeability scores for 555 personality trait words by having 100 participants rate each word on a scale of 0 (*least favorable*) to 6 (*most favorable*) and then summing these ratings. Thus, the highest possible likeability score is 600, and the lowest is 0. For the current experiment, we selected 15 positive (likeability $M = 525.13$, $SD = 23.73$), 15 neutral (likeability $M = 328.00$, $SD = 34.43$), and 15 negative (likeability $M = 92.67$, $SD = 15.31$) personality trait words. The effects of valence were not reliable, and we do not report them here.

Table 1
Experiment 1: Percentage of the List Recalled, Intrusions, and Items Gained and Lost for Nominal and Collaborative Groups in the Unshared and Shared Encoding Conditions on Recalls 1, 2, and 3

Recall condition	Encoding task	Recall group	Percentage of list recalled	Percentage inaccuracy	Percentage items gained	Percentage items lost
Recall 1 (*n* = 30–39 individuals)	Unshared	Nominal	51.93 (12.94)	4.39 (5.19)		
		Collaborative	47.33 (12.55)	6.30 (9.99)		
	Shared	Nominal	46.44 (12.89)	9.24 (11.75)		
		Collaborative	47.33 (11.56)	5.13 (7.52)		
Recall 2 (*n* = 10–13 groups)	Unshared	Nominal	87.95 (9.38)	9.62 (5.87)	7.32 (5.61)	4.82 (4.94)
		Collaborative	68.67 (12.69)	0.56 (1.76)	5.31 (6.08)	22.80 (12.13)
	Shared	Nominal	83.00 (7.93)	14.32 (8.97)	9.66 (8.44)	6.28 (4.98)
		Collaborative	80.67 (8.58)	0.83 (2.64)	9.68 (5.29)	7.55 (4.02)
Recall 3 (*n* = 10–13 groups)	Unshared	Nominal	57.39 (10.20)	6.36 (3.18)		
		Collaborative	54.22 (11.76)	4.68 (4.65)		
	Shared	Nominal	52.33 (8.94)	8.43 (6.50)		
		Collaborative	62.00 (8.30)	3.67 (4.50)		

Note. Values for each variable are means, with standard deviations in parentheses.

encoding followed by nominal versus collaborative group recall. For Recall 1, which was baseline individual recall, we compared future members of nominal and collaborative groups (following either unshared or shared encoding); the sample size was 30–39 individuals per cell. For Recall 2, which tested the costs and benefits during collaboration, we compared nominal and collaborative groups (following either unshared or shared encoding); the sample size was 10–13 groups per cell. We calculated nominal group recall by pooling the nonredundant items recalled by the three individuals assigned to each nominal group (as in Weldon & Bellinger, 1997).[2] For Recall 3, which focused on costs and benefits after collaboration, we compared former members of nominal and collaborative groups (following either unshared or shared encoding), but to control for possible interdependence in their responses, we analyzed them as groups by averaging across the three individuals in each group; the sample size was 10–13 groups per cell.

Recall performance before collaboration (Recall 1). We conducted a 2 (encoding task) × 2 (recall group) between-groups analysis of variance (ANOVA) on the percentage of the 30-word list recalled. This analysis yielded no main effects or interactions (all Fs < 1.52, all ps $> .22$). That is, we found no evidence that encoding condition influenced baseline individual recall, and prior to collaboration, there was no evidence of differences between members of nominal groups and collaborative groups. Overall, average recall was 48.49% ($SD = 12.58$) on Recall 1 (see Table 1).

We were interested in whether encoding type influenced the content of individual recall, and particularly, whether shared encoding made group members' individual recall output more similar to each other. For each group, we scored the number of "shared" items: items recalled in common by all three group members in a group. We then calculated a shared recall score for each group: items that were common to all group members as a percentage of the total pooled recall of the three individuals. A 2 (encoding task) × 2 (recall group) between-groups ANOVA on the percentage of shared items yielded no main or interaction effects (all Fs $<$ 2.10, all ps $> .15$). On average, about half ($M = 55.40\%$, $SD =$ 11.49) of recalled words were remembered in common by all three group members.

We also calculated Recall 1 intrusions (i.e., recalled items that did not appear on the original study list) as a percentage of total output and conducted a 2 (encoding task) × 2 (recall group) between-groups ANOVA on intrusions to determine whether there were any preexisting differences between groups. This analysis yielded a marginal interaction between encoding task and recall group, $F(1, 124) = 3.72$, $p = .056$, $\eta_p^2 = .03$, but follow-up tests comparing individuals assigned to nominal and collaborative groups separately for each encoding task yielded no significant differences (all ts < 1.62, all ps $> .112$). The main effects were not significant (all Fs < 1.39, all ps $> .24$). Overall, participants' intrusions on Recall 1 averaged 6.15% ($SD = 8.86$) of total output (see Table 1). From the means, it appeared that participants who shared encoding and were assigned to the nominal condition may have had the most intrusions in recall. Because of this potential preexisting difference (given the marginal interaction), we used Recall 1 scores as a covariate in all subsequent analyses of intrusions.

Costs and benefits during collaboration (Recall 2). We conducted a 2 (encoding task) × 2 (recall group) between-groups ANOVA on the percentage of the 30 words recalled by nominal groups and collaborative groups. This analysis yielded a main effect of recall group, $F(1, 39) = 12.95$, $p = .001$, $\eta_p^2 = .25$, but no main effect of encoding task, $F(1, 39) = 1.38$, $p = .248$. However, this was moderated by an interaction between encoding task and recall group, $F(1, 39) = 7.96$, $p = .007$, $\eta_p^2 = .17$. We

[2] Wright (2007) offered an alternative method of forming nominal groups by creating multiple random combinations of individuals. This method increases power but was inappropriate in the current experiments, because each group of three participants saw the word list in the same unique random order as each other, regardless of whether they were a collaborative or a nominal group and regardless of whether encoding was unshared or shared. This was done to prevent confounding shared encoding with simply shared stimulus presentation order.

followed up this interaction by comparing nominal and collaborative groups separately for each encoding task (α = .05/2, with a Bonferroni correction for multiple comparisons). When encoding was unshared, there was a standard collaborative inhibition effect: Nominal groups recalled more items than collaborative groups, $t(21) = 4.18$, $p < .001$ (see Table 1). However, when encoding was shared, there was no evidence for a collaborative inhibition effect: Nominal groups and collaborative groups recalled a similar number of items, $t(18) = 0.63$, $p = .55$ (see Table 1). That is, shared encoding abolished collaborative inhibition.

We also calculated intrusions on Recall 2 as a percentage of total output and conducted a 2 (encoding task) × 2 (recall group) between-groups ANOVA on intrusions, with average Recall 1 intrusions for each group as the covariate. This analysis yielded only a significant main effect of recall group, $F(1, 37) = 53.62$, $p < .001$, $\eta_p^2 = .59$: The effect of the covariate was also significant, $F(1, 37) = 18.16$, $p < .001$, $\eta_p^2 = .33$. Regardless of encoding task, nominal groups (M = 11.75%, SD = 7.63) produced more intrusions than collaborative groups (M = 0.69%, SD = 2.18). No other main effects or interactions were significant (all Fs < 0.65, all ps > .42). Overall, collaboration had benefits for recall accuracy: Collaborative group recall contained virtually no intrusions (see Table 1). Encoding condition did not influence intrusion rates, although the effect of the covariate indicates that higher intrusions on Recall 1 were associated with higher intrusions on Recall 2.

Items lost and gained. To investigate the mechanisms by which shared encoding benefited collaborative recall, we scored items lost and gained during collaboration. We scored the percentage of items that were recalled by at least one group member on Recall 1 and then not recalled by the group on Recall 2. We called these "lost" items and used them to index the disruption of individual retrieval strategies in collaborative groups compared to nominal groups. Groups failed to recall an average of 9.98% (SD = 9.97) of items recalled by at least one person on Recall 1. A 2 (encoding task) × 2 (recall group) between-groups ANOVA on items lost yielded a main effect of encoding task, $F(1, 39) = 9.90$, $p = .003$, $\eta_p^2 = .20$, and a main effect of recall group, $F(1, 39) = 19.32$, $p < .001$, $\eta_p^2 = .33$. These main effects were moderated by an interaction between encoding task and recall group, $F(1, 39) = 14.56$, $p < .001$, $\eta_p^2 = .27$. We followed up this interaction by comparing prior members of nominal and collaborative groups separately for each encoding task (α = .05/2). When encoding was unshared, collaboration resulted in the forgetting of previously remembered items, $t(21) = 4.41$, $p = .001$—collaborative groups lost more items than nominal groups. However when encoding was shared, collaboration did not result in the forgetting of previously remembered items, $t(18) = 0.63$, $p = .538$—collaborative groups lost a similarly small number of items as nominal groups. That is, shared encoding benefited collaborative recall because it prevented the loss of items during collaboration.

We scored the percentage of Recall 2 items that had not been recalled by any individual on Recall 1. We called these "gained" items and used them to index the production of new memories in collaborative groups compared to nominal groups. For collaborative groups, gained items might indicate cross-cuing (cf. Meudell et al., 1995), and for nominal groups, gained items would indicate a hypermnesia baseline (Roediger & Payne, 1982), the number of new items recalled simply because of repeated testing. Groups recalled an average of 7.95% (SD = 6.43) of items on Recall 2 that no individual recalled on Recall 1. A 2 (encoding task) × 2 (recall group) between-groups ANOVA of these data yielded only a marginal main effect of encoding task, $F(1, 39) = 2.90$, $p = .096$, $\eta_p^2 = .07$, and no other significant effects (all Fs < 0.26, ps > .615; see Table 1). Thus, there was a weak, nonsignificant trend such that that people who shared encoding tended to produce more new items on Recall 2 than people who did not share encoding, regardless of whether they recalled in a collaborative or nominal group.

Costs and benefits after collaboration (Recall 3). To examine the ongoing effects of collaboration, we conducted a 2 (encoding task) × 2 (recall group) between-groups ANOVA on the percentage of the 30-word list recalled, averaged across the three individuals in the group. We included averaged Recall 1 scores as a covariate. This analysis yielded significant main effects of encoding task, $F(1, 38) = 5.86$, $p = .020$, $\eta_p^2 = .134$, and recall task, $F(1, 38) = 8.64$, $p = .006$, $\eta_p^2 = .19$, qualified by a marginal interaction between them, $F(1, 38) = 3.52$, $p = .068$, $\eta_p^2 = .09$; the effect of the covariate was strongly significant, $F(1, 38) = 76.38$, $p < .001$, $\eta_p^2 = .67$. We followed up the interaction by comparing prior members of nominal and collaborative groups separately for each encoding task (α = .05/2), with averaged Recall 1 scores as the covariate. When encoding was unshared, there was no significant difference between prior members of nominal and collaborative groups, $F(1, 20) = 1.11$, $p = .31$. However, when encoding was shared, prior members of collaborative groups recalled more than prior members of nominal groups, $F(1, 17) = 10.46$, $p = .005$ (see Table 1). The covariate was significant in both comparisons (all Fs > 18.99, all ps < .001). That is, collaboration had benefits for subsequent individual recall, but only after shared encoding. These findings indicate that the effects of the encoding task flowed on to subsequent individual and group recall tasks.

We also scored intrusions on Recall 3 as a percentage of total recall output and conducted a 2 (encoding task) × 2 (recall group) between-groups ANOVA on intrusions, with Recall 1 intrusions as a covariate. This analysis yielded only a significant main effect of recall group, $F(1, 38) = 6.54$, $p = .015$, $\eta_p^2 = .15$; the effect of the covariate was also significant, $F(1, 38) = 55.24$, $p < .001$, $\eta_p^2 = .59$. Regardless of encoding task, the Recall 3 output of prior members of nominal groups (M = 7.26%, SD = 4.89) contained almost twice as many intrusions as the Recall 3 output of prior members of collaborative groups (M = 4.18%, SD = 4.49). No other main effects or interactions were significant (all Fs < 0.97, all ps > .33). Overall, the error correction that occurred during collaboration continued to benefit subsequent individual recall (see Table 1).

Individual and group strategies. We were interested in whether encoding task or recall group influenced participants' use of similar individual recall strategies. We asked participants in all conditions whether, to cue their own memory, they used a self-cuing strategy of thinking of the associated celebrity name to remind them of the personality trait words. Most (72.09%) participants reported using this strategy to cue their individual recall. Separate (recall group) chi-square analyses for each encoding condition indicated that there were differences in the patterns of strategy use across conditions. When encoding was unshared, members of collaborative groups (50.00%) were less likely than members of nominal groups (76.92%) to use an individual recall strategy, $\chi^2(1, N = 69) = 5.42$, $p = .020$. However, when encoding was shared, members of collaborative (83.33%) and nominal groups (77.77%) were equally likely to use this self-cuing strategy, $\chi^2(1, N = 60) = 0.417$, $p = .52$. That is, shared encoding promoted the adoption of an effective, self-cuing strategy for members of collaborative groups.

We also asked participants in both collaborative conditions to describe any strategies that their group used to recall together. Overall, 47.90% of participants in the collaborative groups reported a group strategy. A chi-square analysis indicated that there were differences in group strategies depending on encoding condition, $\chi^2(1, N = 48) = 12.47$, $p = .001$. When encoding was unshared, only 32.00% of participants reported that their group used a strategy during collaborative recall. When encoding was shared, 82.61% of participants reported that their group used a strategy during collaborative recall. That is, shared encoding promoted the use of group recall strategies during collaboration. The most commonly reported group strategy was cross-cuing: using associated celebrity names to cue each other's recall for the personality trait words, an interpersonal version of the effective self-cuing strategy.

To investigate how group strategy use impacted collaborative recall output, we calculated a "group strategy" score between 0 and 3 for each group, indicating the number of individuals in each group who reported that their group used a strategy. A Pearson's correlation between group strategy scores and proportion of items recalled during collaborative recall ($r = .516$, $p = .041$) indicated that the more individuals reported that their group used this cross-cuing strategy, the better the group's collaborative recall performance.[3]

Summary

Shared encoding had a range of benefits for collaborative recall. Most important, it abolished collaborative inhibition and prevented the loss of items from Recall 1. This suggests that shared encoding reduced disruption of individual retrieval strategies during collaboration by making group members' retrieval organization more similar. Shared encoding also had ongoing benefits for individual recall after collaboration: Prior members of collaborative groups recalled more on final individual recall than prior members of nominal groups, but only after shared encoding. Collaboration (with a consensus instruction) reduced intrusions, both during collaboration and afterward. Notably, shared encoding did not influence accuracy. Following shared encoding, individuals in collaborative groups were more likely to use a self-cuing recall strategy and to report that their group adopted an interpersonal cross-cuing strategy. This reported cross-cuing was successful: It was associated with better collaborative recall performance.

Experiment 2

In Experiment 2, we tested the effect of another precollaborative factor: relationship between group members. We studied the independent effect of group relationship, as well as its effect in combination with shared encoding. We were interested in whether shared group-relevant encoding in groups of friends would further increase collaborative recall output, because these group members might have more overlap in their cues or be able to more effectively cue each other's recall (cf. Andersson & Rönnberg, 1997; Hunt & Smith, 1996; Mäntylä & Nilsson, 1983). Moreover, even when they engaged in unshared encoding, groups of friends may have more similar cognitive organization of the group-relevant material and thus develop effective shared cues.

In Experiment 2, we compared groups of friends who learned the stimuli in an individual, unshared, group-relevant encoding task versus groups of friends who learned the stimuli in an interactive, shared, group-relevant encoding task. And we compared the output of collaborative groups versus nominal groups. The design and materials of Experiment 2 were identical to those of Experiment 1. The only differences were that groups consisted of three friends, and the encoding task was designed to make the information relevant to the shared knowledge and experiences of these groups of friends. We hypothesized that, because of the group relevance of the stimuli, friendship would abolish collaborative inhibition even after unshared encoding. We hypothesized that shared encoding would further enhance collaborative recall, such that collaborative groups of friends would recall more than nominal groups and demonstrate collaborative facilitation (cf. Harris et al., 2011; Meade et al., 2009; Wegner, 1987). We hypothesized that friends would gain more new items during collaboration and lose fewer items during collaboration, particularly following shared encoding. We also hypothesized that collaborative recall would reduce intrusions in recall, both during and after collaboration. Finally, we predicted that friends would adopt more cross-cuing, even when encoding was unshared.

Method

Participants. One hundred and twenty undergraduate students (age $M = 21.25$ years, $SD = 2.64$) at Macquarie University, Sydney, Australia (59 women, 61 men) participated in this experiment in return for payment of AU $15 per hour. We recruited groups of three friends by posting signs on campus. We required that groups had known each other for at least 6 months and regularly spent time together. Participants indicated how long they had known each of the other group members by selecting one of six categories: (a) 6 months (18.00%); (b) 6 months–1 year (25.30%); (c) 1–2 years (18.60%); (d) 2–3 years (6.70%); (e) 3–5 years (18.00%); or (f) 5+ years (12.40%). That is, the majority (61.90%) of participants had known each other for between 6 months and 2 years.[4] Participants also indicated how many days a week (out of 7) they normally spent time together. On average, participants spent time together on 4.36 days ($SD = 2.35$). Participants were most commonly university friends but also included

[3] There were individual differences in the extent to which group members actively participated in the encoding task. The consensus requirement forced at least minimal participation on the part of all group members—they had to at least agree on the chosen name. In the postexperimental questionnaire, we asked participants to rate on a scale how included they felt in the shared encoding task and in the collaborative recall task. For collaborative groups, we calculated an "inclusion score" and obtained correlations between these scores and group recall scores. However, there was no significant relationship between rated inclusion and the number of words recalled by the group (all rs $< .131$, all ps $> .719$).

[4] For each group, we calculated the average reported length of time that the participants had known each other and obtained correlations between relationship length and collaborative recall output (separately for each encoding condition). This analysis indicated no significant relationship between relationship length and collaborative recall performance (all rs $< .254$, all ps $> .480$).

housemates, high school friends, and romantic partners. Of the 120 participants, 60 (29 women, 31 men) participated as members of 20 three-member collaborative groups, and 60 (30 women, 30 men) participated as individuals, making up 20 three-member nominal groups. Sixteen groups consisted of 3 women, 12 groups consisted of 3 men, and 12 groups consisted of a mixture of men and women. The design was 2 (encoding task: unshared vs. shared) × 2 (recall group: nominal vs. collaborative) × 3 (recall occasion: 1 vs. 2 vs. 3).

Materials. Stimuli were 30 personality trait words, identical to those of Experiment 1.

Procedure. The procedure for Experiment 2 was similar to that of Experiment 1, except that the incidental encoding task was modified to make it group-relevant. During the incidental encoding task participants in both the unshared and shared encoding conditions were told that they would see personality trait words on the computer screen and that for each word they should think of someone with that personality trait that they all knew in common. That is, rather than relate the personality words to celebrities, participants related the personality words to members of their mutual social group. In the unshared encoding condition, participants did this individually, and in the shared encoding condition participants discussed each word and agreed on who they would write down for that word (as in Experiment 1). All other aspects of the encoding task, and all other phases of the experiment were identical to Experiment 1.

Results

Table 2 presents the percentage of words correctly recalled and the percentage of intrusions on each recall occasion by participants across the four conditions: unshared encoding followed by nominal versus collaborative group recall, and shared encoding followed by nominal versus collaborative group recall. We calculated group and individual recall scores across tasks as in Experiment 1.

Recall performance before collaboration (Recall 1). We conducted a 2 (encoding task) × 2 (recall group) between-groups ANOVA on the percentage of the 30-word list recalled. This analysis yielded no significant main effects or interactions (all Fs < 3.25, all ps $> .074$). That is, we found no evidence that encoding condition influenced baseline individual recall, and prior to collaboration, there was no evidence of differences between members of nominal groups and collaborative groups. Overall, average recall was 51.64% ($SD = 12.07$) on Recall 1 (see Table 2).

As in Experiment 1, we calculated a shared recall score. A 2 (encoding task) × 2 (recall group) between-groups ANOVA of the percentage of shared items yielded no main or interaction effects (all Fs < 2.03, all ps $> .163$). On average, about two thirds ($M = 63.44\%$, $SD = 11.49$) of recalled words were remembered in common by all three group members.

We also conducted a 2 (encoding task) × 2 (recall group) between-groups ANOVA on percentage intrusions to determine whether there were any preexisting differences between groups. This analysis yielded no significant main effects or interactions (all Fs < 0.73, all ps $> .392$). Overall, participants recalled very few incorrect items on Recall 1, on average only 3.48% ($SD = 5.76$; see Table 2).

Costs and benefits during collaboration (Recall 2). A 2 (encoding task) × 2 (recall group) between-groups ANOVA on the percentage of the 30-word list recalled yielded a main effect of recall group, $F(1, 36) = 5.99$, $p = .019$, $\eta_p^2 = .14$, such that collaborative groups ($M = 81.17$, $SD = 9.69$) recalled less overall than nominal groups ($M = 87.17$, $SD = 6.24$); there was no main effect of encoding task, $F(1, 36) = 0.02$, $p = .893$. That is, we found an overall collaborative inhibition effect. However, this was moderated by an interaction between encoding task and recall group, $F(1, 36) = 5.99$, $p = .019$, $\eta_p^2 = .14$. We followed up this interaction by comparing nominal and collaborative groups separately for each encoding task ($\alpha = .05/2$). When encoding was unshared, there was a standard collaborative inhibition effect: Collaborative groups recalled less than nominal groups, $t(18) = 2.96$, $p = .008$ (see Table 2). However, when encoding was shared, there was no collaborative inhibition effect: Collaborative groups recalled a similar amount as nominal groups, $t(18) = 0.00$, $p =$

Table 2
Experiment 2: Percentage of the List Recalled, Intrusions, and Items Gained and Lost for Nominal and Collaborative Groups in the Unshared and Shared Encoding Conditions on Recalls 1, 2, and 3

Recall condition	Encoding task	Recall group	Percentage of list recalled	Percentage inaccuracy	Percentage items gained	Percentage items lost
Recall 1 ($n = 30$ individuals)	Unshared	Nominal	55.33 (11.53)	3.51 (5.28)		
		Collaborative	50.33 (12.20)	4.01 (5.89)		
	Shared	Nominal	49.00 (10.87)	3.85 (7.36)		
		Collaborative	51.89 (13.21)	2.54 (4.23)		
Recall 2 ($n = 10$ groups)	Unshared	Nominal	90.33 (5.97)	6.11 (4.46)	6.60 (7.09)	2.29 (2.57)
		Collaborative	78.33 (11.36)	1.05 (3.33)	6.82 (5.60)	22.66 (28.56)
	Shared	Nominal	84.00 (4.92)	6.69 (5.51)	10.49 (6.13)	3.40 (3.65)
		Collaborative	84.00 (7.17)	0.43 (1.38)	10.39 (6.08)	7.81 (6.46)
Recall 3 ($n = 10$ groups)	Unshared	Nominal	63.11 (9.38)	3.34 (2.10)		
		Collaborative	59.67 (11.64)	2.82 (4.08)		
	Shared	Nominal	57.33 (7.45)	4.08 (3.98)		
		Collaborative	64.44 (9.92)	1.84 (2.36)		

Note. Values for each variable are means, with standard deviations in parentheses.

1.000 (see Table 2). That is, we replicated the main finding from Experiment 1: Shared encoding abolished collaborative inhibition.

We also conducted a 2 (encoding task) × 2 (recall group) between-groups ANOVA on percentage intrusions, with average Recall 1 intrusions for the group as the covariate.[5] This analysis yielded a significant main effect of recall group, $F(1, 35) = 30.94$, $p < .001$, $\eta_p^2 = .47$; the effect of the covariate was also significant, $F(1, 35) = 30.83$, $p < .001$, $\eta_p^2 = .47$. Regardless of encoding condition, nominal groups ($M = 6.40\%$, $SD = 4.89$) produced more intrusions than collaborative groups ($M = 0.74\%$, $SD = 2.50$). No other main effects or interactions were significant (all Fs < 0.40, all ps $> .53$). Overall, as in Experiment 1, collaborative groups were very unlikely to produce intrusions (see Table 2), and encoding condition did not influence intrusion rates.

Items lost and gained. As in Experiment 1, we scored the percentage of lost and gained items on Recall 2. Groups failed to recall an average of 9.04% ($SD = 16.44$) of the items that were recalled by at least one person on Recall 1. A 2 (encoding task) × 2 (recall group) between-groups ANOVA on items lost yielded a main effect of recall group, $F(1, 36) = 7.00$, $p = .012$, $\eta_p^2 = .16$, and a nonsignificant trend for an interaction between encoding task and recall group, $F(1, 36) = 2.91$, $p = .097$, $\eta_p^2 = .08$. The main effect of encoding was not significant, $F(1, 36) = 2.15$, $p = .151$, $\eta_p^2 = .06$. Collaboration resulted in the forgetting of previously remembered items—regardless of encoding task, collaborative groups lost more items ($M = 15.23\%$, $SD = 21.54$) than nominal groups ($M = 2.84\%$, $SD = 3.12$). Although the interaction did not reach significance, the pattern of means for lost items was very similar to Experiment 1 (see Table 2), suggesting that shared encoding prevented the loss of items during collaboration. However, in Experiment 2 with groups of friends remembering group-relevant stimuli, there was a great deal more variance in the items lost, particularly by collaborative groups after unshared encoding (the group that lost the most items in Experiment 1; see Table 2).

Groups' Recall 2 output contained an average of 8.58% ($SD = 6.30$) of items that no individual recalled on Recall 1. A 2 (encoding task) × 2 (recall group) between-groups ANOVA on gained items yielded a trend for an encoding main effect, $F(1, 36) = 3.56$, $p = .067$, $\eta_p^2 = .09$, and no other significant effects (all Fs < 0.01, $p > .93$). As in Experiment 1, there was a nonsignificant trend such that people who shared encoding tended to produce more new items on Recall 2 than people who did not share encoding, regardless of whether they recalled in a collaborative or nominal group.

Costs and benefits after collaboration (Recall 3). A 2 (encoding task) × 2 (recall group) between-groups ANOVA (with group Recall 1 average as a covariate) on the percentage recalled yielded no significant main effects or interactions (all Fs < 2.56, all ps $> .094$), except for the effect of the covariate, $F(1, 35) = 73.17$, $p < .001$, $\eta_p^2 = .68$ (see Table 2). That is, unlike Experiment 1, there was no evidence of post-collaborative benefits for individual recall, regardless of encoding task.

We also conducted a 2 (encoding task) × 2 (recall group) between-groups ANOVA on percentage intrusions (average for the three individuals in each group), with average Recall 1 intrusions for the group as a covariate (see footnote 5). This analysis yielded no significant main effects or interactions (all Fs < 1.55, all ps $> .221$), apart from the significant effect of the covariate, $F(1, 35) = 19.79$, $p < .001$, $\eta_p^2 = .36$, although the pattern of means suggested similar benefits from collaboration as in Experiment 1. Overall, in Experiment 2, intrusion rates across groups of friends ($M = 3.02\%$, $SD = 3.24$) appeared to be lower than they were for the groups of strangers in Experiment 1 —perhaps due to alterations in the procedure—and so the error correction that occurred during collaboration did not appear to have strong benefits for subsequent individual recall, perhaps due to a floor effect (see Table 2).

Individual and group strategies. As in Experiment 1, we asked participants whether they had used a self-cuing strategy of thinking back to the associated friends' names. The vast majority (91.67%) of participants reported that they had used this strategy to cue their own recall. Separate 2 (recall group) chi-square analyses for each encoding condition indicated that individual strategy use did not differ across recall groups for both unshared and shared encoding, $\chi^2(1, N = 60) = 1.46$, $p = .283$, and $\chi^2(1, N = 60) = 0.35$, $p = .554$, respectively.

We also asked participants in the collaborative group condition to describe any strategies that their group used to recall together. Overall, 40.68% of participants in the collaborative groups reported that their group used a strategy to assist group recall, 40.00% in the shared encoding condition and 41.38% in the unshared encoding condition. A chi-square analysis indicated that group strategy use did not differ depending on encoding condition, $\chi^2(1, N = 60) = 0.01$, $p = .914$. As in Experiment 1, the most commonly reported group strategy was cross-cuing: using associated friends' names to cue each other's recall for the personality trait words.

To investigate how group strategy use impacted collaborative recall, we again calculated a "group strategy" score between 0 and 3 for each group, indicating the number of group members who reported that their group used a strategy. In contrast with Experiment 1, the correlation between group strategy scores and proportion of items recalled during collaborative recall was positive but not significant ($r = .41$, $p = .076$), although it tended in the same direction.

Summary

We replicated our most important finding from Experiment 1: Shared encoding abolished collaborative inhibition. However, we still found collaborative inhibition when encoding was unshared. That is, contrary to expectations, groups of friends collaborating to remember group-relevant information were not immune from collaborative inhibition. Regarding the other findings from Experiment 1, generally similar patterns were present in the means, but the effects were not as strong in Experiment 2, suggesting that changes in procedure and/or group relationship did influence effect sizes or individual variation. Particularly, in contrast with Experiment 1, shared encoding appeared not to impact the development of explicit cross-cuing strategies.

General Discussion

In two experiments, we tested the effects of pre-collaborative factors on the costs and benefits of collaborative recall. In line with

[5] We used Recall 1 intrusions as a covariate in analyses of Recall 2 and Recall 3 intrusions to be consistent with the analyses in Experiment 1, even though there was no evidence for baseline Recall 1 differences between conditions in Experiment 2. We also analyzed this without the covariate and the results were essentially the same, with the same significant effects.

Rajaram and Pereira-Pasarin's (2010) model of collaborative recall, we aimed to influence both the similarity of individual cognitive structures and the idiosyncratic organization of the material by manipulating the encoding task and the relationship between group members. We were interested in flow-on effects of these factors on group and individual recall, in terms of both amount recalled and recall accuracy. We were also interested in the effects of self-cuing and cross-cuing and whether the development of such individual and group strategies depended on pre-collaborative factors. Our most important finding—replicated across both experiments—was that shared encoding reliably eliminated collaborative inhibition. This is a notable finding, because collaborative inhibition is a remarkably robust effect that is rarely eliminated in groups actively and interactively collaborating (Harris et al., 2008; Rajaram & Pereira-Pasarin, 2010). In groups of strangers but not in groups of friends, shared encoding also increased post-collaborative individual recall and facilitated the development of self- and cross-cuing strategies. Prior relationship between group members did not influence the effects of collaboration on recall over and above the effects of shared encoding.

First and foremost, across two experiments, we demonstrated that shared encoding abolishes collaborative inhibition. Our findings clarify a number of conflicting findings in the collaborative recall literature (see Andersson & Rönnberg, 1995, vs. Finlay et al., 2000) and support Rajaram and Pereira-Pasarin's (2010) model by indicating the importance of pre-collaborative factors in determining the outcomes of collaborative recall (see also Pereira-Pasarin & Rajaram, 2011). We also focused on the details of the collaborative process to study the specific group and individual processes that were influenced by our pre-collaborative manipulations. We were interested in whether the benefits of shared encoding came about by reducing disruption to individual retrieval strategies—one major cause of collaborative inhibition (Rajaram & Pereira-Pasarin, 2010)—or by facilitating the development of effective self-cuing or cross-cuing. Across measures, we found evidence for both processes. Shared encoding led to more effective collaboration by reducing the loss of items over time, implying that after shared encoding, members of these collaborative groups did not disrupt each other's recall since item loss is one way of operationalizing retrieval disruption (Finlay et al., 2000). When scoring gained items, which have been used to index cross-cuing in the past (Meudell et al., 1995), we found hints that shared encoding in general increased gained items, but it did not interact with the effects of collaboration. Using this operationalization of the processes of collaboration—items lost versus items gained—shared encoding seemed to benefit collaborative recall by reducing disruption to individual retrieval strategies, rather than by increasing the production of new memories in the group.

However, when we asked participants about the strategies that their groups used, participants' self-report indicated that both explicit self-cuing and cross-cuing strategies were common. Importantly, self-reported cross-cuing strategies emerged after shared encoding (at least for strangers) and were associated with better collaborative recall performance. In friends, explicit cross-cuing strategies were reported less often, regardless of encoding condition, and were not as strongly associated with collaborative success. This fits with prior research suggesting that people with existing relationships can adopt both implicit and explicit strategies to effectively collaborate (see Harris et al., 2011) and that in intimate groups, explicit strategies are not necessarily effective for group recall (Hollingshead, 1998).

Most prior research has found that collaboration is more successful when participants focus on their own individual recall strategies and do not engage with the group recall (e.g., Basden et al., 1997; Wright & Klumpp, 2004). However, our results suggest the importance of a distinction between self-cuing and cross-cuing strategies and the potential benefits of each—in isolation or in combination—for collaborative recall. Future research should focus on the interaction between self- and cross-cuing strategies and the circumstances in which both kinds of strategies emerge successfully. In the current studies, we have identified shared encoding as one condition that leads to both self- and cross-cuing. And Meade et al.'s (2009) groundbreaking study of expert pilots shows that—even after individual encoding—their shared expertise means that they too use effective communication strategies to cue each other's recall, which suggests expertise as another condition that leads to effective cross-cuing.

Our encoding task had particular features that may have enhanced its benefits for collaborative recall. Specifically, during encoding, individuals or groups generated their own, idiosyncratic cues for the study list, meaning that encoding was distinctive (cf. Hunt & Smith, 1996). Prior research demonstrates that self-generated cues are particularly powerful for recall and that other-generated cues (at least, when the "other" is a stranger) are not effective (Greenwald & Banaji, 1989; Mäntylä & Nilsson, 1983). In previous research, cross-cuing has been encouraged by using categorized word lists (Meudell et al., 1995), which would be expected to enhance relational processing (Klein, Loftus, Kihlstrom, & Aseron, 1989). This was done so that group members had readily available and salient shared general cues to cue each other. However, Meudell et al. (1995) found that participants did not cross-cue each other in these circumstances. In the current research, we developed an encoding task where participants generated shared cues that were unique and idiosyncratic for each to-be-remembered item, which provides a closer model of the rich, interpersonal cuing we observed when older couples reminisce about shared autobiographical events (Harris et al., 2011). The current research suggests that when group members share encoding, such that they develop shared, idiosyncratic, distinctive cues rather than general, relational cues (Hunt & Smith, 1996), then their attempts to cue each other during collaboration are successful.

Our findings regarding items lost and gained during collaboration also support the interpretation of group-generated cues as providing a combination of idiosyncratic and generic memory cues during collaboration. We found that shared encoding resulted in a tendency to gain items across recall occasions and protected from item losses during collaboration. Klein et al. (1989) found that when encoding involved item-specific processing, higher recall on subsequent memory tests (or *hypermnesia*) was driven by gains over recall occasions. However, when encoding involved relational processing, hypermnesia resulted from fewer losses over recall occasions. In the current research, it could be argued that our encoding task involved both item-specific processing—since each target had a unique cue generated—and relational processing—since all study items belonged to the same semantic category of personality traits (see also Hunt & McDaniel, 1993, and Mulligan, 2001, for discussion of tasks that combine item-specific and relational processing), and this argument is supported by our finding that shared encoding resulted in both more gains and fewer losses. It is also possible that some individuals or groups engaged in more item-specific processing and others in more relational processing, resulting in individual differences in items gained and lost. Because our encoding task was not designed to specifically assess this issue, it is difficult to tease apart these factors and their relationship to shared encoding, collaborative recall, and to items lost and gained across tests. But our results suggest that the specific nature of encoding can influence the mechanisms by which the costs and benefits of collaborative recall come about.

Shared encoding was also important in determining the ongoing costs and benefits of collaboration. We found that, in strangers, collaboration enhanced subsequent individual recall, but only after shared encoding. In friends, we found no overall post-collaborative benefits. These findings add to prior research suggesting that collaboration can—at least under some circumstances—benefit subsequent individual recall because of the reexposure that occurs during collaborative recall (Basden et al., 2000; Blumen & Rajaram, 2008). Our findings suggest that pre-collaborative factors are an important determinant of these ongoing collaborative benefits. The important role of encoding factors (cf. Barnier et al., 2008) fits with prior research on the role of encoding cues on subsequent, repeated individual recall tests. For instance, Otani, Widner, Whiteman, and St. Louis (1999) found that encoding conditions that provided multiple cues for each target resulted in more item gains across tests. In the current research, our encoding task, where target items and the appropriate cue relationship were thought about or discussed in the group for 60 s, presumably generated a rich set of multiple cues that could be used during individual and group retrieval. The particular benefits of shared encoding and collaboration for subsequent individual recall suggest that an interactive, shared encoding task generates rich cues that are reinstated by a collaborative recall task. Surprisingly, we did not find post-collaborative benefits for groups of friends in Experiment 2. We cannot be sure why this occurred, because of differences in both the participants and the encoding task between experiments. Overall, our results emphasize the importance of the cues developed at encoding for post-collaboration benefits and suggest one possible reason why these benefits are not found in all collaborative recall experiments as well as avenues for future research (see also Blumen & Rajaram, 2008; Congleton & Rajaram, 2011).

The social nature of encoding can be conceptualized as existing on a continuum, ranging from completely unshared to completely shared (see also Barnier et al., 2008). On this continuum, our shared encoding task ranked relatively highly, since it was an interactive task that required discussion between group members and involved linking each word to the groups' existing shared knowledge and an agreed-upon cue. However, more meaningful and deliberately shared joint activities might promote even stronger collaborative benefits (Barnier et al., 2008; Sutton et al., 2010). Future research could examine the specific features of the encoding task—including how interactive it is, whether it involves consensus cue generation or not, and whether it involves distinctive versus relational encoding—to determine the specific parameters that enhance or reduce the benefits of shared encoding for collaborative and post-collaborative recall.

Prior research has yielded mixed findings about the influence of group relationship on collaborative recall (see Andersson & Rönnberg, 1997, vs. Gould et al., 2002). Our findings indicated that friends experienced similar levels of collaborative inhibition to strangers, even when recalling group relevant information. We expected that groups of friends would be immune from collaborative inhibition even when encoding was unshared, because friends might have more similar preexisting cognitive structures for group-relevant information (Rajaram & Pereira-Pasarin, 2010) or be able to generate effective cues for each other based on their prior history (Andersson & Rönnberg, 1997). We also expected that groups of friends would particularly benefit from shared encoding, so that they might even show collaborative facilitation (see Harris et al., 2011; Meade et al., 2009). Friends did in general experience benefits from this group-relevant task. They recalled more words in general and had lower intrusion rates than strangers. However, in terms of collaborative recall, we still saw a similar pattern of costs and benefits for friends as for strangers, in that groups of friends experienced collaborative inhibition when encoding was unshared and did not experience collaborative inhibition when encoding was shared. A number of our other effects were more muted in groups of friends or had greater variation (see Table 1 vs. Table 2). Our results suggest that group relationship and the relevance of the material may be one dimension that influences aspects of recall, but relationship alone is insufficient to abolish collaborative inhibition.

One benefit of collaboration that was not influenced by shared encoding was recall accuracy. Across two experiments, collaborative groups (all of whom were told to reach a consensus when collaborating) included very few intrusions in their recall output. Moreover, this elimination of errors had ongoing benefits: In Experiment 1, prior members of collaborative groups continued to recall fewer errors even on subsequent recall. In Experiment 2, error rates were very low, and so no significant ongoing benefits were evident, although the means tended in the same direction. Thus, the group retrieval context was particularly important in determining the effects of collaboration on memory errors, and encoding condition did not influence these effects. Although research in other paradigms has emphasized the potential for social interaction to create memory errors (Gabbert, Memon, & Allan, 2003; Roediger, Meade, & Bergman, 2001), our findings in this study and in earlier work (Harris et al., 2012) indicate that social influences on recall accuracy are more complex and may depend on the goals of social interaction. That is, given the right instructions or the right goals during retrieval, groups can eliminate intrusions, and this leads to fewer intrusions in each individual's later recall.

In summary, our major aim was to test the hypothesized role of pre-collaborative factors in determining the costs and benefits of collaboration, for both group and individual recall. Our results supported Rajaram and Pereira-Pasarin's (2010) emphasis on the importance of these factors: Shared encoding had flow-on effects on the amount recalled by groups during collaboration and by individuals on post-collaborative recall. In contrast, pre-collaborative factors appeared less important for recall accuracy: Shared encoding did not influence the accuracy of collaborative recall. Instead, accuracy was influenced by the processes of the group collaboration itself, and this group recall had benefits for subsequent individual recall (see also Harris et al., 2012). While our findings support Rajaram and Pereira-Pasarin's model, they also suggest a potential extension. We found that reported group cross-cuing enhanced collaborative recall, and this additional positive process that operated during collaboration is not represented in their model and has not been found in previous research with a more narrow operationalization. Our results indicated that pre-collaborative factors—and specifically, shared, distinctive encoding that involves group generation of cues—was particularly important in determining the costs and benefits of collaborative recall, independent of the prior relationship among group members. This finding is also consistent with our previous research, demonstrating that long-married couples did not invariably collaborate effectively, and showed benefits of collaboration only when they adopted effective cuing and coordination strategies (Harris et al., 2011).

Our results clarify and extend previous empirical findings by demonstrating that shared encoding has a flow-on effect on the outcomes of collaboration. Our results suggest that shared encoding has a range of benefits for group and individual recall: It abolishes collaborative inhibition and increases post-collaborative recall. Shared encoding encourages the development of self- and cross-cuing strategies (at least in groups of strangers), which suggests one mechanism by which these benefits come about. If group members have a prior relationship, they can adopt self- and cross- strategies even after unshared encoding, but prior relationship alone does not eliminate the costs of collaboration (at least not in the kinds of groups we tested). Overall, the results of this research suggest a more nuanced view of the social nature of remembering and highlight that costs and benefits may depend on a number of dimensions, including aspects of the group and its interaction, aspects of the encoding context, and aspects of the retrieval context. These findings add to a number of empirical and theoretical literatures on the outcomes of remembering with others and provide clear directions for future research, particularly into the dimensions of shared encoding and the development of strategies in individuals and groups. The way that we experience and talk about the past in our various groups, with our partners and families, and with our colleagues and friends, is a crucial component of the content and processes of remembering.

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