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The effect of information distribution on collaborative inhibition

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Two experiments examined collaborative memory for information that was studied by all group members (shared items) and information that was studied by only a subset of group members (unshared items). In both experiments significant collaborative inhibition (reduced output of the collaborative groups relative to the pooled output of individuals) was obtained for both shared and unshared information. In Experiment 1 the magnitude of collaborative inhibition was larger for unshared items than for shared items, possibly because unshared items were less likely to be acknowledged and thus incorporated into the groups' recall. In Experiment 2 the magnitude of collaborative inhibition for shared and unshared information was equivalent once all participants were provided with the category name associated with the shared and unshared items. The results of the experiments are discussed in relation to the retrieval strategy disruption hypothesis of collaborative inhibition and the role of social process variables, such as acknowledgement, in influencing collaborative inhibition across situations involving memory of shared and unshared information.

Keywords: Collaborative inhibition; Information distribution.

Collaborative inhibition refers to the finding that each individual in a collaborative group recalls less than would be predicted by pooling the unique responses of individuals working alone into a nominal group (e.g., Weldon & Bellinger, 1997; see Harris, Paterson, & Kemp, 2008, for a review). Importantly, collaborative inhibition research has primarily focused on memory for shared events, or episodes for which each collaborator has access to identical information. For example, faculty members may jointly reconstruct a job candidate's research talk at which that they were all present. The current study examines the somewhat atypical case of collaborative memory when, in addition to shared information, group members are aware that each collaborator also has access to some unique, or unshared information about the event (e.g., information that the job candidate shared with some, but not all, faculty members). When reconstructing events of the job candidate visit, does the magnitude of collaborative inhibition differ between shared information and unshared information? More generally, what are the effects of information distribution among group members on collaborative inhibition? To answer such questions the current experiments blend methods and hypotheses from the collaborative inhibition literature and the group decision-making literature.

Information distribution is relevant to the retrieval strategy disruption hypothesis of collaborative inhibition (Basden, Basden, Bryner, & Thomas, 1997). According to the retrieval strategy disruption hypothesis, collaborative inhibition can be explained by the fact that each individual working in a group has his/her idiosyncratic

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strategy for remembering the presented information, which is different from the strategy of one's partner(s). At the time of output, the items produced by one's partner(s) interfere with the order in which an individual had planned to output the information, and so disrupt his/her strategy and reduce output. More specifically, the disruption occurs when participants abandon their own strategy to recall an item either because their partner's response cues them to think of a different item or because their partner responded with the item they had planned to recall. Regarding collaborative recall of shared vs. unshared information, then, one interpretation of the retrieval strategy disruption hypothesis is that, if an item is not encoded in the first place, it cannot be part of one's strategy and so should be relatively less disruptive, thus resulting in smaller collaborative inhibition effects for unshared information. Unshared items could still be potentially disruptive to individual retrieval strategies if, for example, the item elicits extra discussion or results in a collaborator switching categories. However, because the item itself does not overlap with items in another group members' retrieval organisation, the relative retrieval disruption for unshared items may be less than for shared items.

Basden et al.'s (1997) Experiment 3 provided evidence that when collaborating group members were asked to recall non-overlapping parts of the study list, thus ensuring no disruption at the item level or category level, collaborative inhibition was not obtained. Participants in this experiment studied the same six categorised word lists and were asked to recall either individually or in collaborating groups of three. Critically, half of the participants were asked to recall from all six lists (whole list condition) and half of the participants were asked to recall from only two lists (part list condition) such that participants each recalled from separate categories. Participants in the whole list condition demonstrated collaborative inhibition, but participants in the part list condition did not demonstrate collaborative inhibition, suggesting that items recalled by others may be more or less disruptive to recall depending on how relevant they are to one's retrieval strategy. However, the study manipulated item overlap only after participants had studied the same information, and so cannot answer questions related to how collaborative inhibition is influenced by information that is unshared at encoding. The current experiments further explore the parameters of the retrieval strategy disruption hypothesis by manipulating shared vs. unshared information at encoding so that individuals study some information that all group members see and they also study some unique or unshared information.

The hypotheses regarding the effect of shared and unshared information on collaborative inhibition can be further informed by the group decision-making literature. Briefly, decision-making research has demonstrated a *common knowledge effect*, showing that participants do not effectively pool together unshared information but instead focus their group discussion primarily on the information shared between all group members (Stasser & Titus, 1985, 1987; Gigone & Hastie, 1993; for reviews see Gigone, 2010; Wittenbaum & Stasser, 1996). Most relevant to the current study is the finding that participants in group decision-making tasks are more likely to reiterate shared information (e.g., Stasser & Titus, 1987), thus potentially acknowledging that the contribution has been incorporated into the group discussion (cf. Clark & Wilkes- Gibbs, 1986; Wittenbaum, Hubbell, & Zuckerman, 1999). Regarding collaborative inhibition for shared and unshared information, then, one hypothesis derived from the decision-making literature is that when a group member proposes an item from a shared category, other group members may explicitly acknowledge the contribution, or tacitly acknowledge the contribution by proposing another item from the category, so that an individual may then offer subsequent items from that category. In contrast, when a group member proposes an item from an unshared category, other group members may not acknowledge the item (because they never studied it), and so an individual may be less likely to volunteer an additional exemplar from an unshared category (cf. Stasser & Titus, 2003). Such a process would result in greater collaborative inhibition for unshared items because, in addition to any retrieval disruption (cf. Basden et al., 1997), unshared information would be less likely to be produced in a collaborative setting due to group process factors such as a lack of acknowledgement.

Several additional group process factors identified through group decision-making studies may be relevant to collaborative inhibition effects and so have been incorporated into the current studies. Specifically, group decision-making studies have manipulated whether information that was critical to making the correct decision was shared or unshared among group members.

The current study adapted this idea by varying categorical relatedness: participants studied categorised word lists and information distribution was manipulated at the category level, exemplar level, or both, so participants saw some of the same categories with the same exemplars as their partners, they saw some of the same categories as their partners but with different exemplars, and they saw some different categories from their partners (along with necessarily different exemplars). According to the retrieval strategy disruption hypothesis, the magnitude of collaborative inhibition should vary in relation to how related one collaborator's recall output is to another's; thus collaborative inhibition might be greater in the shared category shared exemplar and the shared category unshared exemplar conditions than in the unshared category unshared exemplar condition. Alternatively, if group members are less likely to produce additional items from categories not acknowledged or repeated by the group (cf. Stasser & Titus, 2003), it may be that collaborative inhibition effects are largest for the unshared category unshared exemplar condition because a given group member will be less likely to continue to offer forth categorically relevant items without some acknowledgement from the group.

Group decision-making research has also demonstrated that, if participants are held accountable for the process through which they derived a decision, the common knowledge effect is minimised (Stasser, Vaughan, & Stewart, 2000). While only roughly equivalent, the current study manipulated penalties against guessing so as to hold participants accountable for items they truly remembered. Based on previous research in individual memory paradigms (e.g., Gallo, Roberts, & Seamon, 1997), it was expected that memory errors should be reduced when participants were explicitly instructed to minimise errors. Further based on previous research on collaborative memory, it was predicted that collaborative groups should be especially skilled at reducing errors because they can correct each other (Ross, Spencer, Blatz, & Restorick, et al., 2008; Ross, Spencer, Linardatos, Lam, & Perunovic, 2004). Finally, a penalty against guessing might have a greater effect on unshared information because the group might be less likely to write down on their final recall sheets items that they were not in agreement had been presented on the study list.

Of course task demands are relevant, and it remains an empirical question whether or not group processes relevant to decision-making tasks may generalise to memory tasks. As noted by Stewart, Stewart, Tyson, Vinci, and Fioti (2004), group memory tasks require an exhaustive search to produce all relevant items, whereas decision-making tasks require only that groups produce enough information to reach a consensus (for discussions of task demands across various group tasks see also Clark, Hori, Putnam, & Martin, 2000; Gigone & Hastie, 1997; Wright & Klumpp, 2004). That said, there is recent evidence that group process variables, including acknowledgements, may influence collaborative inhibition. Ekeocha and Brennan (2008) demonstrated that collaborative memory is influenced by both self filtering (individual members withholding responses) and group filtering (the group failing to incorporate an individual's response). Meade, Nokes, and Morrow (2009) showed that experts who explicitly acknowledged partner contributions on a memory task derived the largest benefit from collaboration. Importantly, both of these studies examined collaborative inhibition for shared information only. Of interest to the current study is whether the group process variables shown to differentially influence shared and unshared information in decision-making tasks also differentially influence shared and unshared information in memory tasks.

Based on research in related paradigms, we anticipate that information distribution will influence memory tasks. Specifically, previous research has demonstrated that shared information is more likely to be recalled on individual memory tasks than unshared information (Stasser et al., 2000; Stewart et al., 2004), although no prior studies included a pooled individual comparison group so it remains unknown what impact shared vs unshared information at encoding exerts on the collaborative inhibition effect.

Related research has also examined the optimal distribution of information across group members on a memory task (for a review see Ohtsubo, 2005). Tindale and Sheffey (2002) found that five-person groups demonstrated better recall when different information was shared between two of five group members than when all information was shared between all five group members. In other words, group memory is optimal when some information is shared and some is unshared, rather than when all

information is shared. Research on transactive memory (e.g., Wegner, Erber, & Raymond, 1991) has demonstrated similar findings showing that distributing information across well-acquainted group members reduces the amount of information for which each group member is responsible, and so improves memory. Critically, studies examining optimal information distribution among group members and transactive memory do not always equate study. For example, in the Tindale and Sheffey study, participants in groups with distributed information each studied 19-item lists, while participants in groups with fully shared information studied 47-item lists. Transactive memory studies also typically delegate responsibility to various group members, thus essentially reducing the amount of information each member is responsible for (although see Johansson, Andersson, & Ronnberg, 2005, for evidence that with study lists equated, effective coordination of information between long-term married spouses improves collaborative memory performance; and see Theiner, Allen, & Goldstone, 2010, for further discussion of the relationship between transactive memory and collaborative inhibition). The current study utilises unacquainted dyads, and equates study list length such that individuals in the nominal and pooled groups each study the same amount of shared and unshared information, thus controlling for pre-experimental familiarity of partners (cf. Andersson & Ronnberg, 1995) and individual memory differences between conditions.

Finally, memory conformity studies often show participants an event that has some shared information and also some information unique to each participant (e.g., Schneider & Watkins, 1996; Wright, Self, & Justice, 2000) and so have examined memory for both shared and unshared information. However, the unshared information is often contradictory (e.g., seeing an accomplice to a crime vs seeing no accomplice) and again, such studies do not include nominal and collaborative group comparisons and so do not address potential differences in the magnitude of the collaborative inhibition effect.

Based on the above studies, we hypothesise that memory for shared information will be greater than memory for unshared information. The novel contribution of the current experiment is to examine how such an effect influences the magnitude of collaborative inhibition as the current study is the first to compare nominal and collaborative group memory for information that is shared and unshared at encoding. Further, we explored the influence of relatedness on any information distribution effects. Participants were presented with categorised word lists that were either shared at the category and exemplar levels, shared at the category level (but unshared at the exemplar level) and were unshared at the category and, necessarily, the exemplar level. Following study, participants were asked to recall either individually or in groups of three with or without a penalty against guessing. Of interest was whether collaborative inhibition would be differentially influenced by shared and unshared information, relatedness of information, and penalties against guessing.

EXPERIMENT 1

Method

Participants. The participants were 144 undergraduates from Montana State University who participated in the experiment for partial fulfilment of a class requirement.

Design. The experiment consisted of a 2 (retrieval condition: individual or collaborative) $\times 2$ (information distribution: shared or unshared items) $\times 2$ (penalty: penalty for guessing or no penalty for guessing) mixed-participants design. Retrieval condition and penalty were manipulated between participants while information distribution was manipulated within participants. The primary dependent variable was veridical recall of shared and unshared items.

Materials. Battig and Montague's (1969) category norms were used to construct 20-item study lists that each contained 5 exemplars from 4 categories. Several different versions of each study list were created so that 10 study items were shared between group members (each group member saw the same exemplars from the same categories) and 10 study items were unshared (5 items on each study list were unshared at the exemplar level [each group member studied different exemplars from the same category]; 5 items on each study list were unshared at the category level [each group member studied a different category with necessarily different exemplars]). Taxonomic frequency of categorical exemplars was roughly equated between conditions, and two versions of each list were

created to control for guessing (for a similar methods see Meade & Roediger, 2009; Roediger, 1973).

Procedure. Participants completed the experiment either individually or with two additional participants. All participants were presented with a list of 20 items (10 shared and 10 unshared). Items were presented one at a time for 1500 ms each, with an interstimulus interval (ISI) of 500 ms. Participants were told to study the list in preparation for a later memory test. Consistent with most collaborative inhibition research, participants in the collaborative groups were told that they would be tested later as a group. Additionally, participants in the collaborative groups were told that some information was shared between group members and some information was unshared between group members (individual participants were not given these instructions because they were not relevant). Informing participants that some information was shared and some was unshared is important because it differs from other paradigms, such as memory conformity paradigms, where participants are not aware they are studying different stimuli. Each participant was seated at a separate computer so all study lists were encoded individually. Following study, participants were asked to complete a 1-minute mathematical filler task to prevent rehearsal in short-term memory. Then participants were asked to recall the word list either individually or in collaboration with two additional participants (group of three). In the individual condition participants recorded their own recall; in the collaborative condition the experimenter always selected the participant sitting in the middle of the group to record the group's recall. Collaborating group instructions were unstructured so participants were given no special instructions on how to coordinate recall, manage speaking turns, or resolve disagreements. Half of the participants in both the individual and the collaborative group conditions received instructions against guessing specifically warning them that there was a penalty for guessing. The other half of the participants in each condition were told there was no penalty for guessing. Recall sessions were tape-recorded.

The experiment consisted of five study–test trials so that following the recall test (and a subsequent recognition test, not reported here due to ceiling effects), participants were presented with a new study list and asked to complete the procedure again. Five study–test trials were included to provide multiple observations and for counterbalancing purposes (i.e., the shared category for one group served as an unshared category for another group). At the completion of all five trials, participants were thanked and debriefed.

Results

Recall. The mean proportions of shared and unshared items recalled are presented in Table 1. Data are presented at the group level to allow a test of collaborative inhibition; the collaborative data reflect items recalled by the co-acting, or collaborative group, and nominal group data reflect the pooled unique responses of three individuals who recalled alone. Across analyses, no differences were obtained between the two classes of unshared items (unshared exemplars from a shared category vs unshared exemplars from unshared categories), and so data are collapsed across these conditions. Statistical significance is set at $p < .05$ unless otherwise noted. Effect sizes (R^2) indicate partial eta squared.

Correct recall. A 2 (individual or collaborative recall) $\times$ 2 (shared or unshared information) $\times$ 2 (penalty or no penalty) mixed-factor ANOVA computed on accurate recall revealed significant collaborative inhibition, $F(1, 44) = 22.31$, $MSE = 0.24$, $R^2 = .34$ and also showed that shared information was better remembered than unshared information, $F(1, 44) = 726.87$, $MSE = 2.91$, $R^2 = .94$. Critically, the interaction between these two factors was marginally significant, $F(1, 44) = 3.58$, $p = .06$, $R^2 = .08$, suggesting that the magnitude of the collaborative inhibition effect varied as a function of information distribution among group members. Specifically, collaborative inhibition ($M = .13$) was larger for

TABLE 1
Mean proportion of shared and unshared items recalled as a function of individual or collaborative recall and penalty or no penalty for guessing

	Shared		*Unshared*	
	Penalty	*No penalty*	*Penalty*	*No penalty*
Nominal	.88	.84	.55	.52
Collaborative	.80	.76	.43	.39

Experiment 1; $N = 144$.

unshared items than for shared items ($M = 0.08$). Accurate recall was not influenced by a penalty against guessing, nor did penalty interact with other factors, Fs < 3.0, ps $> .05$.

Verbal codings. Tape-recordings of each experimental session were coded to determine the type of feedback, if any, provided by the group for shared or unshared items. The verbal protocols were meant to provide descriptive, complimentary evidence to the more traditional accuracy data reported above. The coding scheme was based on that developed by Meade et al. (2009; cf. Clark & Wilkes-Gibbs, 1986). Specifically, for each word recalled, we coded whether the group members responded with silence, an indication that they did not remember the word, or an acknowledgement that the word was presented. Looking first at statements indicating that participants did not remember a word, examples include statements such as "Was that item there?", "I don't remember that item" or "That wasn't there". There were too few observations per cell to examine the various refutations individually, so data were collapsed across all verbal codings that indicated participants did not remember the word. Examining group discussions or member disputes regarding shared and unshared items is important because one possible explanation for greater inhibition for unshared items is that the unshared items caused greater controversy or discussion regarding their veracity, and this additional discussion disrupted retrieval strategies. Interestingly, the verbal codings revealed no difference between shared and unshared items in how likely participants were to question or to refute an item, ts < 1.0, ps $> .05$, suggesting that greater inhibition for unshared items cannot be explained by greater disruption resulting from discussion or controversy over reported unshared items.

Examples of possible acknowledgements that a word was presented include statements such as "Yeah, OK", "What else was in that category?", "I saw that/me too", or repeating the word back. Again there were not enough observations in each separate condition to warrant independent examinations of each type of acknowledgement, so data reported were collapsed across all verbal codes classified as acknowledgments. Determining whether or not the group differentially acknowledged shared items and unshared items is relevant to an alternative explanation for why the collaborative inhibition effect was larger for unshared items. Namely that unshared items received less acknowledgement from the group and so were less likely to be incorporated into group recall, thus resulting in greater collaborative inhibition for unshared items (cf. Clark & Wilkes-Gibbs, 1986; Meade et al., 2009). Consistent with this explanation, acknowledgment codings from the current study revealed that collaborative groups were significantly more likely to acknowledge shared items ($M = 0.25$) than unshared items ($M = 0.15$), $t(15) = 2.66$, $SEM = 0.04$.

Verbal protocols were also examined to determine if the difference in acknowledgement was related to group-level filtering (e.g., a participant produced the unshared items, but the group did not incorporate the items on the written recall) and/or individual-level filtering (e.g., a participant produced the unshared items, but the group did not acknowledge the items and so the individual was less likely to produce additional exemplars from that given category; cf. Ekeocha & Brennan, 2008). Of the responses recorded on the audio tapes, 98% were incorporated into the groups' written recall test, suggesting that unshared items were not being produced and then rejected by the group.

Recall errors. The mean number of recall errors, or items recalled that were not actually presented in the study list, are presented in Table 2. Numbers are reported rather than proportions to account for the variation in content and total number of errors produced. As is evident in the table the error rate was quite low overall (participants recalled an average of 24.3 items per list across conditions; on average, 1.96 of these were errors), although it did differ by condition. Specifically, error rates were higher in nominal groups than collaborative groups, $F(1, 44) = 35.20$, $MSE = 34.94$, $R^2 = .44$, a finding consistent with previous research suggesting that collaborative groups are relatively more accurate than

TABLE 2
Mean number of errors produced on the recall test as a function of collaborative or individual recall and penalty or no penalty for guessing

	Penalty	*No penalty*
Nominal	1.75	3.88
Collaborative	.55	1.68

Experiment 1; $N = 144$.

nominal groups (Ross et al., 2008). Error rates were also lower when participants were given a penalty against guessing than when they were given no penalty, $F(1, 44) = 32.17$, $MSE = 31.93$, $R^2 = .42$. Interestingly, participants in the nominal group showed a relatively larger reduction in errors under the penalty condition than did participants in the collaborative group, as evidenced by a marginally significant collaboration × penalty interaction, $F(1, 44) = 3.05$, $MSE = 3.03$, $p = .09$, $R^2 = .06$. Because the error rate in the current study was so low, there were unfortunately not enough observations to allow the errors to be split into shared categories vs unshared categories.

EXPERIMENT 2

One of the most interesting findings from Experiment 1 was that the magnitude of collaborative inhibition was larger for unshared items than for shared items. Further, participants were more likely to acknowledge a shared word than an unshared word as evident in the verbal coding results. Considered together these two findings suggest that one possible mechanism underlying larger collaborative inhibition effects for unshared items may be that participants produced the unshared items, but because they were not acknowledged they were less likely to produce additional items from the unshared categories. Such a process could inflate the collaborative inhibition effect for unshared items. However, no difference was obtained in Experiment 1 between the two unshared items conditions (unshared items from shared categories and unshared items from unshared categories). Given that producing an unshared item from a shared category should elicit greater acknowledgement than producing an unshared item from an unshared category, finding no difference in collaborative inhibition between these two conditions may be problematic for conclusions regarding differential acknowledgements for shared and unshared items.

To further examine the role of acknowledgement in Experiment 2 we initiated a stronger manipulation of acknowledgement by including category labels on the recall test. Category labels on the test offer an explicit acknowledgement of categories studied and so finding equivalent collaborative inhibition for shared and unshared items once category labels are provided would offer conceptually converging evidence that a lack of acknowledgement drove the relatively larger collaborative inhibition effects for unshared items obtained in Experiment 1. On the other hand, finding that greater collaborative inhibition for unshared items persists in spite of a stronger manipulation of acknowledgement would disprove the role of acknowledgement in explaining the relatively greater collaborative inhibition effects for unshared items.

Of course, identifying the categories studied makes the recall test in Experiment 2 a cued recall test while the test in Experiment 1 was free recall. Importantly, both Basden et al. (1997), and Meade and Roediger (2009) demonstrated significant collaborative inhibition effects for categorised word lists when participants were provided with category names as cues (for further discussion see Meade & Roediger, 2009), so we anticipate category cues will allow significant collaborative inhibition effects. The current study differs from previous demonstrations of collaborative inhibition on cued recall tests because it is the first to examine the effect of shared and unshared items during encoding on such an effect. Further, overall recall should improve with cued recall relative to free recall (cf. Tulving & Pearlstone, 1966), however the pattern of interest in Experiment 2 is not overall recall per se, but any difference in magnitude between collaborative inhibition effects for shared and unshared items.

Experiment 2 also examined the influence of personal accountability on the magnitude of collaborative inhibition for shared and unshared items. Previous research in group decision making has determined that participants are more likely to discuss unshared information when the group is aware which members have access to which information (Stasser et al., 2000), specifically because group members are more likely to volunteer unshared information when the group holds them accountable for it. In Experiment 2 half of the participants were told which group member studied each category, and half of the participants were not told. Assuming findings from the decision-making literature transfer to memory tasks and personal accountability influences collaborative inhibition for unshared items, we hypothesise that identifying to the entire group which group members studied each category should eliminate any differences in the magnitude of collaborative inhibition for shared and unshared items. In contrast, the participants who were not informed which group member

studied each category should still demonstrate relatively larger collaborative inhibition effects for unshared information.

Method

Participants. The participants were 96 undergraduates from Montana State University who participated in the experiment for partial fulfilment of a class requirement.

Design. The experiment consisted of a 2 (retrieval condition: individual or collaborative) $\times 2$ (information distribution: shared or unshared items) $\times 2$ (identification: groups were told which group members studied each category or groups were not told which group members studied each category) mixed-participants design. Retrieval condition and member identification were manipulated between participants while information distribution was manipulated within participants. The primary dependent variable was veridical recall of shared and unshared items.

Materials. The materials used in Experiment 1 were modified slightly for use in Experiment 2. Specifically, all categories in Experiment 2 were fully shared or fully unshared between participants (i.e., we removed the condition from Experiment 1 in which participants studied unshared exemplars of a shared category). Further, some of the categories used in Experiment 1 were removed because the counterbalance used in Experiment 2 required only four study–test cycles (as opposed to five study–test cycles in Experiment 1). The recall sheets used in the current study were also modified so that they included the category name and, depending on condition, also contained a participant identification.

Procedure. The procedure of Experiment 2 was similar to the no penalty condition of Experiment 1 (penalty was not manipulated in Experiment 2 since it had minimal effect in Experiment 1). Participants studied lists that contained some shared and unshared categories and then were asked to recall the lists individually or in collaboration with two other participants. The most critical change adopted in Experiment 2 involved the recall test. For this test all participants were presented with the category labels. Half of the participants were presented only with the category label (the no identification group) and half of the participants were presented with the category label and additional information regarding which participant studied each category (the identification condition). Specifically, the recall sheets for participants in the identification condition listed ''participant 1'', ''participant 2'', or ''participant 3'' underneath each category label. Corresponding participant labels were also placed on each desk in the testing room for easy identification of who was participant 1, etc. Again all participants were told that some of the information was shared between group members and some of the information was unshared. The identification group was further informed specifically which categories had been studied by each group member. In the individual identification condition participants were presented with the same recall sheets, but were told to recall only from the categories they had studied as designated by participant number. At the completion of all four study–test trials, participants were thanked and debriefed.

Results

Correct recall. The mean proportions of shared and unshared items recalled are presented in Table 3. As in Experiment 1, collaborative data reflect items recalled by the collaborative group, and nominal group data reflect the pooled unique responses of three individuals who recalled alone. A 2 (individual or collaborative recall) $\times 2$ (shared or unshared information) $\times 2$ (identification or no identification) mixed-factor ANOVA computed on accurate recall revealed significant collaborative inhibition, $F(1, 32) = 7.37$, $MSE = 0.01$, $R^2 = .19$. The ANOVA also revealed that shared information was better remembered than unshared information, $F(1, 32) = 426.17$, $MSE = 0.001$, $R^2 = .93$. Interestingly, the interaction between collaboration and information distribution was not significant, $F < 1.0$, $p > .05$,

TABLE 3
Mean proportion of shared and unshared items recalled as a function of individual or collaborative recall and participant identification or no participant identification

	Shared		*Unshared*	
	ID	*No ID*	*ID*	*No ID*
Nominal	.85	.84	.53	.55
Collaborative	.79	.77	.46	.46

Experiment 2; $N = 96$.

TABLE 4
Mean number of errors produced on the recall test as a function of collaborative or individual recall and participant identification or no participant identification

	ID	*No ID*
Nominal	8.88	7.88
Collaborative	4.13	3.73

Experiment 2; $N = 96$.

suggesting that the magnitude of collaborative inhibition did not vary for shared and unshared information. This finding is different than that obtained in Experiment 1 and is most likely due to the fact that the category labels provided acknowledgement to participants that unshared items were legitimate. Given that accurate recall was not influenced by participant identification (nor did participant identification interact with other variables), Fs < 1.0, ps $> .05$, the data suggest that the category names alone provided enough acknowledgment that items produced by individual members had been studied. As a side note, our finding that identifying which participants had studied each category did not eliminate the collaborative inhibition effect offers a nice replication of previous research demonstrating that social loafing alone cannot account for collaborative inhibition (Weldon, Blair, & Huebsch, 2000; cf. Latané, Williams, & Harkins, 1979).

Recall errors. The mean number of recall errors are presented in Table 4. Replicating Experiment 1, the overall error rate was low and participants in the collaborative groups produced fewer errors than participants in the nominal groups, $F(1, 32) = 20.96$, $MSE = 8.40$, $R^2 = .40$. No other main effects or interactions were significant, Fs < 1.0, ps $> .05$, suggesting that, across conditions, collaborative groups were more accurate than nominal groups (cf. Ross et al., 2008).

GENERAL DISCUSSION

The current study provides a novel comparison of collaborative inhibition effects for shared and unshared information. Across experiments, significant collaborative inhibition was obtained for both shared and unshared items. Importantly, the results of Experiment 1 indicated greater collaborative inhibition for unshared items than for shared items. This difference was eliminated in Experiment 2 by identifying the categories studied. Considered together, the results of the current studies suggest that distribution of information across group members may differentially impact the magnitude of collaborative inhibition on recall, possibly because shared items are more readily integrated into the collaborative groups' recall.

The collaborative inhibition effects for shared and unshared items (obtained in both experiments) can be interpreted within the framework of retrieval strategy disruption (Basden et al., 1997). Specifically, retrieval disruption easily accounts for collaborative inhibition for shared items, as it may be that the order in which another group member output memory items interfered with another's idiosyncratic strategy for output of those same items. Retrieval strategy disruption can also account for collaborative inhibition for unshared items, as strategy disruption may occur by hearing other's recall of different items. Specifically, for different items from the same category, retrieval disruption could result if an item produced by another group member cues one to retrieve an item from the same category out of order from one's retrieval strategy. For unshared items from different categories, retrieval disruption could result in category switching, for example if a participant began recalling from an unshared category and then switched to recall from a shared category.

Interestingly, however, retrieval strategy disruption alone does not easily account for the difference in magnitude of collaborative inhibition for shared and unshared items obtained in Experiment 1. Collaborative memory for unshared information is somewhat atypical, as the task requires that that an individual essentially convince the other group members to trust his/her memory (which the group members cannot independently verify based on their own experiences). This type of setting in which the response of one person differs from the responses of others may inflate the importance of group processes (cf. Clark, Abbe, & Larson, 2006). It seems very likely, then, that in addition to retrieval strategy disruption, collaborative inhibition for unshared items is especially influenced by group process variables.

Group process variables in collaborative memory studies refer to the factors underlying the exchange of information in a collaborative group and factors that influence whether the group incorporates contributions from an individual

group member. Group process factors, including social loafing, monetary incentive, and group cohesion, have been determined to be ineffective determinates of collaborative inhibition effects (Weldon et al., 2000) and under typical collaborative memory situations involving shared information we agree group process factors may be minimal, or at least less influential than strategy disruption. Further, group process factors alone cannot account for previous findings in the literature demonstrating collaborative inhibition on tasks employing a turn taking procedure. Turn-taking collaborative tasks require participants to trade off in offering items remembered and typically do not allow for much participant interaction (for discussions see Thorley & Dewhurst, 2007; Meade & Roediger, 2009). Since participants' acknowledgements are not at play in such situations that nonetheless produce collaborative inhibition, group process factors alone cannot fully account for collaborative inhibition effects (for a review see Weldon, 2001).

Nonetheless, there is growing evidence that group process variables, or the nature of the group interaction, do indeed exert some influence on collaborative inhibition effects. Clark et al. (2000) distinguished group process variables (e.g., pooling resources) from collaborative process variables necessitating an interactive exchange of information. More recently, Ekeocha and Brennan (2008) demonstrated that the effort involved in coordinating the group product influences memory recall and distinguished between self filtering (an individual withholding a response from the group) and group filtering (the group failing to incorporate a response). Further, they showed that collaborative processes vary depending on situational factors, including collaborating in a face-to-face group or in an electronic group. Ross et al. (2008) demonstrated that both young and older adult dyads actively corrected memory errors once they were offered to the group. Finally, Meade et al. (2009) showed that aviation experts who explicitly acknowledged each other's contributions and elaborated on previous statements derived a relatively greater benefit on collaborative memory tests (cf. Clark & Wilkes-Gibbs, 1986). Such process factors are critical in creating a more complete explanation of factors that may influence successful collaboration and, when considered in conjunction with strategy disruption, offer a sound explanation of the results of the current study.

One possible explanation for why participants in Experiment 1 demonstrated larger collaborative inhibition effects for unshared items than shared items is that unshared items were less likely to be acknowledged by the group and so were less likely to be incorporated into group recall. Consistent with this interpretation, participants in Experiment 1 were less likely to acknowledge unshared items than they were to acknowledge shared items. Further, once category cues were included on the test, thus acknowledging the various shared and unshared categories that had been studied, the difference in the magnitude of collaborative inhibition between shared and unshared items was eliminated (Experiment 2). Including category labels on the recall test thus minimised the role of fellow group members in acknowledging an unshared item, because the category cues provided acknowledgement to the entire group that the unshared item was indeed part of one person's study list (cf. Stasser & Titus, 2003).

The goal of the current study was to compare possible differences in the magnitude of collaborative inhibition for shared and unshared information. Significant collaborative inhibition was obtained for shared and unshared information across two experiments. The magnitude of collaborative inhibition was larger for unshared information in Experiment 1 under free recall conditions possibly because group members were less likely to acknowledge unshared items. The magnitude of collaborative inhibition for shared and unshared information was equivalent in Experiment 2 once all participants were provided with the category name of all shared and unshared items, presumably because the cued test thus provided acknowledgment that the unshared items were studied. Considered together, the results suggest that the retrieval strategy disruption hypothesis of collaborative inhibition applies to both shared and unshared information. In addition, group process factors, such as the role of acknowledgement may be especially important to the somewhat atypical social situation investigated here where groups are asked to remember unshared information.

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REFERENCES

Andersson, J., & Ronnberg, J. (1995). Recall suffers from collaboration: Joint recall effects of friendship and task complexity. *Applied Cognitive Psychology*, *9*, 199–211.

Andersson, J., & Ronnberg, J. (1996). Collaboration and memory: Effects of dyadic retrieval on different memory tasks. *Applied Cognitive Psychology*, *10*, 171–181.

Basden, B. H., Basden, D. R., Bryner, S., & Thomas, R. L. III. (1997). A comparison of group and individual remembering: Does collaboration disrupt retrieval strategies? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 1176–1189.

Basden, B. H., Basden, D. R., & Henry, S. (2000). Costs and benefits of collaborative remembering. *Applied Cognitive Psychology*, *14*, 497–507.

Battig, W. F., & Montague, W. E. (1969). Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monograph*, *80*, 1–45.

Clark, H. H., & Wilkes-Gibbs, D. (1986). Referring as a collaborative process. *Cognition*, *22*, 1–39.

Clark, S. E., Abbe, A., & Larson, R. P. (2006). Collaboration in associative recognition memory: Using recalled information to defend ''new'' judgments. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *32*, 1266–1273.

Clark, S. E., Hori, A., Putnam, A., & Martin, T. P. (2000). Group collaboration in recognition memory. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *26*, 1578–1588.

Ekeocha, J. O., & Brennan, S. E. (2008). Collaborative recall in face-to-face and electronic groups. *Memory*, *16*, 245–261.

Gallo, D. A., Roberts, M. J., & Seamon, J. G. (1997). Remembering words not presented in lists: Can we avoid creating false memories? *Psychonomic Bulletin & Review*, *4*, 271–276.

Gigone, D. (2010). Common knowledge effect. In J. M. Levine & M. A. Hogg (Eds.), *Encyclopedia of group processes and intergroup relations*. Thousand Oaks, CA: SAGE Publications.

Gigone, D., & Hastie, R. (1993). The common knowledge effect: Information sharing and group judgment. *Journal of Personality and Social Psychology*, *65*, 959–974.

Gigone, D., & Hastie, R. (1997). The impact of information on small group choice. *Journal of Personality and Social Psychology*, *72*, 132–140.

Harris, C. B., Paterson, H. M., & Kemp, R. I. (2008). Collaborative recall and collective memory: What happens when we remember together? *Memory*, *16*, 213–230.

Johansson, N. O., Andersson, J., & Ronnberg, J. (2005). Compensating strategies in collaborative remembering in very old couples. *Scandinavian Journal of Psychology*, *46*, 349–359.

Latané, B., Williams, K., & Harkins, S. (1979). Many hands make light work: The causes and consequences of social loafing. *Journal of Personality & Social Psychology*, *37*, 822–832.

Meade, M. L., Nokes, T. J., & Morrow, D. G. (2009). Expertise promotes facilitation on a collaborative memory task. *Memory*, *17*, 39–48.

Meade, M. L., & Roediger, H. L. III. (2009). Age differences in collaborative memory: The role of retrieval manipulations. *Memory & Cognition*, *37*, 962–975.

Ohtsubo, Y. (2005). Should information be redundantly distributed among group members? Effective use of group memory in collaborative problem solving. *Applied Cognitive Psychology*, *19*, 1219–1233.

Roediger, H. L. III. (1973). Inhibition in recall from cueing with recall targets. *Journal of Verbal Learning and Verbal Behavior*, *12*, 644–657.

Ross, M., Spencer, S. J., Blatz, C. W., & Restorick, E. (2008). Collaboration reduces the frequency of false memories in older and younger adults. *Psychology and Aging*, *23*, 85–92.

Ross, M., Spencer, S. J., Linardatos, L., Lam, K. C. H., & Perunovic, M. (2004). Going shopping and identifying landmarks: Does collaboration improve older people's memory? *Applied Cognitive Psychology*, *18*, 683–696.

Schneider, D. M., & Watkins, M. J. (1996). Response conformity in recognition testing. *Psychonomic Bulletin & Review*, *3*, 481–485.

Stasser, G., & Titus, W. (1985). Pooling of unshared information in group decision-making: Biased information sampling during discussion. *Journal of Personality and Social Psychology*, *48*, 1467–1478.

Stasser, G., & Titus, W. (1987). Effects of information load and percentage of shared information on the dissemination of unshared information during group discussion. *Journal of Personality and Social Psychology*, *53*, 81–93.

Stasser, G., Vaughan, S. I., & Stewart, D. D. (2000). Pooling unshared information: The benefits of knowing how access to information is distributed among group members. *Organisational Behavior and Human Decision Processes*, *82*, 102–116.

Stasser, G., & Titus, W. (2003). Hidden profiles: A brief history. *Psychological Inquiry*, *14*, 304–313.

Stewart, D. D., Stewart, C. B., Tyson, C., Vinci, G., & Fioti, T. (2004). Serial position effects and the picture-superiority effect in the group recall of shared information. *Group Dynamics: Theory, Researchand Practice*, *8*, 166–181.

Theiner, G., Allen, C., & Goldstone, R. L. (2010). Recognizing group cognition. *Cognitive Systems Research*, *11*, 378–395.

Thorley, C., & Dewhurst, S. A. (2007). Collaborative false recall in the DRM procedure: Effects of group size and group pressure. *European Journal of Cognitive Psychology*, *19*, 867–881.

Tindale, R. S., & Sheffey, S. (2002). Shared information, cognitive load, and group memory. *Group Processes & Intergroup Relations*, *5*, 5–18.

Tulving, E., & Pearlstone, Z. (1966). Availability versus accessibility of information in memory for words. *Journal of Verbal Learning & Verbal Behavior*, *5*, 381–391.

Wegner, D. M, Erber, R., & Raymond, P. (1991). Transactive memory in close relationships. *Journal of Personality and Social Psychology*, *61*, 923–929.

Weldon, M. S. (2001). Remembering as a social process. In D. L. Medin (Ed.), *The psychology of learning and motivation: Advances in research and theory,Vol. 40* (pp. 67–120). San Diego, CA: Academic Press.

Weldon, M. S., & Bellinger, K. D. (1997). Collective memory: Collaborative and individual processes in remembering. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *23*, 1160–1175.

Weldon, M. S., Blair, C., & Huebsch, D. (2000). Group remembering: Does social loafing underlie collaborative inhibition? *Journal of Experimental Psychology: Learning, Memory and Cognition*, *26*, 1568–1577.

Wittenbaum, G. M., Hubbell, A. P., & Zuckerman, C. (1999). Mutual enhancement: Toward an understanding of the collective preference for shared information. *Journal of Personality and Social Psychology*, *77*, 967–978.

Wittenbaum, G. M., & Stasser, G. (1996). Management of information in small groups. In J. L. Nye & A. M. Brower (Eds.), *What's social about social cognition: Research on socially shared cognition in small groups* (pp. 3–28). Thousand Oaks, CA: Sage.

Wright, D. B., & Klumpp, A. (2004). Collaborative inhibition is due to the product, not the process, of recalling in groups. *Psychonomic Bulletin & Review*, *11*, 1081–1083.

Wright, D. B., Self, G., & Justice, C. (2000). Memory conformity: Exploring misinformation effects when presented by another person. *British Journal of Psychology*, *91*, 189–202.