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Empirical article

Collaborative Remembering in Ethnically Uniform and Diverse Group Settings

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In collaborative memory research, effects of ethnic diversity have not been reported despite the prevalence of ethnically diverse versus uniform groups in everyday collaborations. We compared these groups to examine three key phenomena: the counterintuitive effect known as collaborative inhibition, the more intuitive downstream memory benefits of collaborative recall, and emergence of collective memory. We also examined source memory of former collaborators. Collaborative inhibition and collective memory were comparable between ethnically Diverse triads (one Asian, Black/African American, White each) and Uniform triads (three White members). At the same time, in diverse groups Black/African American members contributed less during collaboration and did not show post-collaborative recall benefits. Ethnicity differences did not emerge within nominal diverse groups, demonstrating for the first time the negative impact of stereotype threat in collaborative remembering. Uniform groups exhibited better source memory, suggesting homophily. Our findings have applied relevance for groups in academic and workplace settings.

General audience summary

Nearly every facet of our lives—family, friendships, classrooms, workplace, social media interactions—is imbued with remembering with others. Here we ask how group composition in terms of ethnic diversity influences memory. This question has increasing applied significance as our work and social environments become global. Recent cognitive research has revealed important insights into the nature of collaborative memory but has not addressed how ethnic diversity in groups influences memory performance. In diverse groups, kaleidoscopic thinking can increase idea generation, but it can also increase conflict and memory disruption. Alternately, homophily, whereby members of same ethnicity align with one another compared to members of different ethnicity, can influence memory. Memory performance in groups can also become susceptible to stereotype threat, a possibility not yet tested in collaborative memory. We focused on three key collaborative memory outcomes: collaborative inhibition, a counterintuitive

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phenomenon where collaborative groups recall less than nominal groups (where individuals work alone); post-collaboration gains arising from exposure to others' recall; and emergence of collective memory in the form of recall overlap among former collaborators. We also examined the accuracy of attributing recalled information to the source—self or others. Uniform groups had three participants who identified as White, and Diverse groups had three participants where each self-identified as Asian, Black/African American, or White. Key findings showed that (a) group diversity did not influence collaborative inhibition or collective memory, (b) within diverse groups Black/African American members contributed less during collaboration and recalled less after collaboration, demonstrating for the first time the negative impact of stereotype threat in collaborative remembering, and (c) uniform groups exhibited better source memory, suggesting an influence of homophily. By initiating an investigation on the influence of ethnic diversity, we aim to direct the field towards questions about how culture influences collaborative memory.

Keywords: Group Composition, Ethnic Diversity, Collaborative Inhibition, Collective Memory, Source Memory, Stereotype Threat

Collaborative Remembering in Ethnically Uniform and Diverse Group Settings

Our lives are filled with daily exchanges of knowledge and memories. We reminisce with family and friends, retrieve knowledge with peers in classrooms, and share news with our in-person and online social connections. While experimental research in human memory has historically focused on principles of memory developed from studying individuals working in isolation (Ebbinghaus, 1885), more recent research has been particularly fruitful towards understanding how individual and group memories are shaped (e.g., see Maswood & Rajaram, 2019; Rajaram & Pereira-Pasarin, 2010, for reviews). Furthermore, there has been considerable interest in how individuals' ethnic-cultural backgrounds influence the social exchange of information and shape our memories (Bartlett, 1932; see Wang, 2013; in press, for reviews). In this context, we report an experimental study on the influence of group composition—ethnically uniform and diverse groups—on individual and group memory.

Collaborative Memory

Researchers have studied memory formation in group settings, namely, collaborative memory, using a well-established paradigm in which a comparison is made between collaborative and nominal groups Basden, Basden, Bryner, & Thomas, 1997; Weldon & Bellinger, 1997). First, participants individually study information such as a list of words, pictures, narratives, or film. After a distractor period that follows, participants in the collaborative condition work in small groups of two to three to collaboratively recall the studied information. Nominal groups are composed of an equal number of members, where each participant recalls alone, and the pooled, non-redundant responses of these participants serve as the baseline against which collaborative group recall is compared (Basden et al., 1997; Weldon & Bellinger, 1997). This comparison reliably yields a highly counterintuitive outcome, whereby collaborative recall is lower than nominal group recall, a phenomenon called *collaborative inhibition* (Weldon & Bellinger, 1997). A sizeable literature has replicated this finding using a variety of study stimuli and group sizes (see Marion & Thorley, 2016; Rajaram & Pereira-Pasarin, 2010).

Collaborative recall also produces downstream effects on later individual memory. Post-collaborative tests of individual recall show that participants who previously recalled with others have better memory for studied information than those who previously recalled alone. This memory advantage is attributed to re-exposure to information that one may have forgotten but others recalled during collaboration, and to cross-cuing where others' recall prompted retrieval of additional items (Rajaram & Pereira-Pasarin, 2010). Furthermore, group members come to align their memories with one another (Hirst & Manier, 2008; Wertsch & Henry, 2008) such that they show an increase in the collective memory for the studied information in later individual recall compared to those who never collaborated (e.g., Blumen & Rajaram, 2008; Choi, Blumen, Congleton, & Rajaram, 2014; Cuc, Koppel, & Hirst, 2007).

The Influence of Group Composition

While collaborative inhibition in recall and post-collaborative effects on individual memory are well established, these effects may be sensitive to the composition of the group. For example, groups can differ in terms of who talks to whom. When people repeatedly collaborate with the same partners, collaborative inhibition persists (Blumen & Rajaram, 2008; Choi et al., 2014). By contrast, if group composition changes across repeated collaborations such that a person collaborates with two partners in one round and two other partners in the next, collaborative inhibition disappears as the diversity of partners increases (Choi et al., 2014). Prior familiarity between collaborating members (e.g., friends versus strangers; Andersson, 2001) or expertise of members (e.g., expert pilots vs. novices; Meade, Nokes, & Morrow, 2009) improve common ground, cohesion of knowledge, and coordination between partners, which reduces or reverses collaborative inhibition.

Group composition can also vary based on the ethnic-cultural characteristics of the group members. In our multicultural world, social interactions in ethnically diverse groups are increasingly commonplace. Individuals from diverse ethnic-cultural backgrounds bring to the group pre-existing cognitive structures, knowledge, and approaches to tasks that can influence their performance in collaborative recall settings. No study to date

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has examined the effect of group ethnic diversity on collaborative remembering. A few studies on group diversity for other participant characteristics have yielded interesting findings. For example, young adults were more likely to resist their partner's recalled items (i.e., social contagion) if their partner was presumed to be an older adult rather than a young adult (Davis & Meade, 2013; Meade, McNabb, Lindeman, & Smith, 2017). Similarly, participants discounted false input from a presumed out-group member rather than an in-group member (Andrews & Rapp, 2014). While these studies tapped into the effects of group uniformity or diversity, they did not address collaborative recall in face-to-face interactions among ethnically diverse members.

Group diversity in non-memory tasks has shown a range of effects. On one hand, working in diverse groups can increase the factual statements discussed during juror deliberation (Sommers, 2006) and the production of more effective and feasible solutions during brainstorming (McLeod, Lobel, & Cox, 1996). These outcomes of group diversity may reflect *kaleidoscope thinking*, which is the notion that a variety of perspectives can stimulate further idea production (Kanter, 1986). On the other hand, increased diversity in functional backgrounds in the workplace is correlated with increased task conflict, and increased racial diversity tends to be associated with increased inter-group emotional conflict in workplace-related team projects (Pelled, Eisenhardt, & Xin, 1999). Thus, diverse perspectives may contribute to idea generation but increase conflict when people defend their perspectives.

Different cognitive and communication styles among people of diverse ethnic-cultural backgrounds may further influence group collaboration. For example, European Americans exhibit an analytical cognitive style, focusing on discrete objects in processing and remembering information. In contrast, Asians exhibit a dominant holistic cognitive style, processing and remembering objects as well as their backgrounds as interrelated (e.g., Masuda & Nisbett, 2001). Also, during task-related communication, European Americans tend to focus on task content, whereas Asians emphasize equal contributions, good communication, and team performance (Nguyen & Fussell, 2014). Furthermore, Black/African American individuals often experience stereotype threat and show reduced performance in learning and testing contexts (see Nguyen and Ryan, 2008, for a meta-analytical review). These cultural elements can introduce additional complexity to collaborative remembering in diverse group settings.

The Present Study

We examined the effects of group ethnic diversity, in comparison to uniform groups, on collaborative memory, and measured the memory of the group and of each group member, the emergent collective memory, and individual source memory. Uniform groups consisted of three White students and diverse groups consisted of one Asian, one Black/African American, and one White student. Given the paucity of research on this variable, we designed our study as exploratory with non-directional hypotheses while taking into account the following considerations.

The notion of homophily suggests that individuals associate with people who are similar to them more than people who are different (Allport, 1954; Apfelbaum, Phillips, & Richeson, 2014; Struch & Schwartz, 1989). Accordingly, members in ethnically homogenous groups may share similar cognitive styles and experience a sense of familiarity, which could then contribute to the cohesion of knowledge and communication styles, and reduced collaborative inhibition (e.g., Andersson, 2001; Meade et al., 2009). Yet, for the same reason, diverse groups could exhibit reduced collaborative inhibition because collaborators here are less likely to take each other's perspectives and therefore would be less susceptible to disruption during recall. The notion of kaleidoscope thinking further suggests that diversity in groups could lead to more nonoverlapping items being recalled during collaboration and thus less collaborative inhibition. However, an increase in the variety of items recalled could also increase disruptions to idiosyncratic retrieval strategies, a process known to underlie collaborative inhibition (Basden et al., 1997). As such, an increase in the variety of items produced during collaboration could maintain the magnitude of collaborative inhibition in diverse groups. In the end, these processes might cancel out differences between diverse and uniform groups in collaborative inhibition.

Turning to collective memory, both reduced homophily and increased kaleidoscopic thinking in diverse groups could lower convergence in their post-collaborative recall. That is, the overlap of items in post-collaborative individual recall would be smaller in diverse groups than in uniform groups. We also tested participants' source memory judgments by asking them to indicate whether the items they recalled later by themselves were recalled during collaboration by them, by another group member, or not recalled. Homophily could lead participants in uniform groups to exhibit better source memory. Alternatively, the physical distinctiveness of each group member in diverse groups might aid retrieval of the source.

Research on stereotype threat (Nguyen & Ryan, 2008; Schmader, Johns, & Forbes, 2008; Shapiro & Neuberg, 2007; Steele, 1997) is also relevant here as it shows that situational cues can activate stereotype threat among individuals of negatively stereotyped groups (Inzlicht & Ben-Zeev, 2000; Murphy, Steele, & Gross, 2007; Smith, 2004). For example, when female participants performed verbal or math tasks in groups of three, their performance on math tasks declined as the number of male members in the group increased (Inzlicht & Ben-Zeev, 2000). Thus, working in a diverse group setting might selectively hinder the performance of Black/African American participants such that they would recall fewer correct items during collaborative recall and exhibit less post-collaborative memory benefits than would Asians and Whites.

While we considered the various processes that might affect collaborative memory in different group compositions, we reiterate the exploratory nature of our study due to the paucity of experimental memory research on this topic, emphasize its value as a critical first step for stimulating research on this question, and underscore its applied value for understanding the role of group composition on memory performance in academic and work settings.

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Method

Participants

A sample of 96 triads (288 volunteer participants) was recruited from Stony Brook University for course credit. This sample was evenly divided into 24 triads per condition. A recent meta-analytic review of collaborative inhibition by Marion and Thorley (2016) reported a conservative estimate of the general effect size for collaborative inhibition as $d = .56$. Based on this estimate for the effect size, to achieve power of .80 in a two-tailed test of significance with an alpha value of .05, approximately 17 triads would be required per condition. Similarly, past research with 16 triads per condition has reported reliable collaboration inhibition effects (e.g. Barber & Rajaram, 2011; Basden, Basden, Bryner, & Thomas, 1997; Weldon & Bellinger, 1997). As our exploratory design additionally included a novel variable, group composition, we recruited 24 triads per condition to achieve sufficient power. This is in line with previous research that investigated exploratory interaction effects in collaborative memory (e.g., Choi, Kensinger, & Rajaram, 2017).

Participants' ethnicity information was based on the ethnic identities self-reported in the online participant recruitment system. In the overall sample, 48 participants self-identified as Asian, 48 as Black/African American, and 192 as White. In total, there were 72 White participants in the uniform nominal condition, 72 White participants in the uniform collaborative condition, 72 participants with 24 of each ethnicity in the diverse nominal condition, and 72 participants with 24 of each ethnicity in the diverse collaborative condition.

Stimuli and Design

The study list consisted of a 120-exemplar list taken from Congleton and Rajaram (2014), with 15 exemplars each from eight categories (Van Overschelde, Rawson, & Dunlosky, 2004). The response frequencies were balanced across the eight categories, with the top two or three exemplars from each category being excluded from the study list.

The experiment consisted of 2 (Group Composition: uniform, diverse) x 2 (Collaboration: collaborative, nominal) fully between-subject design. Ethnicity, unlike deep-form diversities such as religious associations or socioeconomic status, is overt and requires no disclosure for creating diverse versus uniform groups (Harrison, Price, & Bell, 1998). We therefore did not include any instructions to instantiate this manipulation. Additionally, since ethnic diversity is increasingly prevalent in classroom and work settings, this approach added to the ecological validity of our design. The uniform groups in our study consisted of three White participants and diverse groups in which each participant was of different ethnicity—Asian, Black/African American, and White. In the collaborative condition, groups consisted of three participants who worked together during the first recall task whereas the nominal condition groups consisted of three participants who completed this task individually. Nominal groups were in name only and "group" performance in this condition was derived by randomly assigning three participants into a group according to the group composition variable and pooling their nonredundant recall.

Procedure

Upon arriving in the lab, participants were assigned to either the collaborative or nominal recall condition, and their self-reported ethnic identities determined their assignment to the uniform or diverse group conditions. The procedure utilized the standard features of past collaborative recall studies (e.g., Congleton & Rajaram, 2011, 2014). For the initial, study phase, each participant sat at an individual computer and viewed the 120-word list presented in a randomized order using E-Prime 2.0 software to control the presentation. Each trial consisted of a one-second fixation asterisk followed by the presentation of a word. Participants were informed that they would receive a memory test later for these words and were instructed to rate the pleasantness of each word on a scale ranging for 1 to 5 (1 representing *very unpleasant*, 3 being *neutral*, and 5 being *very pleasant*). The word remained in view for five seconds even if a participant rated the word before the five seconds had elapsed. The study phase was followed by a 7-minute delay where participants selected to play one of two computer games (Solitaire or Snake).

Two consecutive recall phases followed next where all participants recalled as many studied words as possible in any order for seven minutes in each recall phase. In the first recall, the procedure diverged in the following way for participants in the nominal versus collaborative group conditions. Participants in the nominal condition remained at their computer and completed free recall alone. Participants in the collaborative condition gathered around one computer and worked together as a group to recall the studied items. They were instructed that they could use any method or strategy to do this task and did not need to reach consensus for including the words (free-for-all collaboration; Maswood, Rasmussen, & Rajaram, 2019; Rajaram & Pereira-Pasarin, 2010; Weldon & Bellinger, 1997). All participants who were requested to serve the scribe for their respective groups agreed to do so, and the scribe typed the group's recall into an Excel spreadsheet (Blumen & Rajaram, 2009). In diverse collaborative groups, the scribe ethnicity was similarly distributed (37.5% Asian, 33.33% Black/African American, 29.17% White). The group recall session was audio-recorded beginning with each member speaking aloud their participant ID as well as the day of the week to provide a clear voice sample for calculating the contributions of each group member. Five minutes after the completion of the first recall task, a second free recall task followed in which all participants, regardless of condition, worked individually. They were instructed to once again recall the studied words, including words reported during the first recall task.

After completing the second recall, participants from the collaborative condition performed a source monitoring task on items they had recalled on the second individual recall task. Each participant worked individually to determine whether each item they recalled was also recalled during the collaborative recall session, and if so which group member had recalled it. They

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indicated this by marking "I" for self, "O" for another member, the participant ID if they knew which member had recalled it, or "Study" if the word had not been recalled by anyone during the collaboration session. Participants were provided as much time as needed to complete this task. The entire experimental session took approximately 40 to 45 minutes depending on condition and concluded with participant debriefing.

Results

Effects of Collaboration in Group Recall (Recall 1)

We observed the standard collaborative inhibition effect in recall such that the collaborative triads (M = 67.90, SE = 1.19) recalled significantly fewer studied words than the pooled recall of the nominal triads (M = 78.15, SE = 1.46), $F(1, 92) = 29.16$, $p < .001$, $\eta_p^2 = .241$. The group composition, uniform (M = 73.63, SE = 1.58) versus diverse (M = 72.42, SE = 1.45), did not influence recall, $F(1, 92) = .405$, $p = 0.526$, $\eta_p^2 = .004$, and the interaction between these two variables was also not significant, $F(1, 92) = .069$, $p = .793$, $\eta_p^2 = .001$. These findings suggest that regardless of the level of diversity present in collaborative triads, collaborative inhibition reliably occurs and is of comparable magnitude across group compositions (Fig. 1, left panel).

There were very few intrusion items (M = 1.30), and 29.83% of the intrusions were the top 2 to 3 exemplars excluded from experimental stimuli. Both groups recalled a minimum of 7 of the 8 categories (uniform collaborative groups: M = 7.75, SE = .08; and diverse collaborative groups: M = 7.83, SE = .09), with 75% of uniform and 83.33% of diverse groups recalling all 8 categories.

Effects of Collaboration on Collective Memory (Recall 2)

The design of our study provided an opportunity to also examine formation of collective memory. We computed collective memory using the standard approach in the literature, by summing the items in the second recall that were collectively remembered (the number of studied items recalled by all three individuals within a group, collaborative or nominal) and the items that were collectively forgotten (the number of studied items forgotten by all three group members) (Choi et al., 2014; Congleton & Rajaram, 2014; Stone, Barnier, Sutton, & Hirst, 2010). Participants who had previously collaborated (M = 59.71, SE = 1.40) showed significantly more overlap in their second, individual recall compared to those who were previously in nominal groups (M = 44.19, SE = 1.12), $F(1, 92) = 73.05$, $p < .001$, $\eta_p^2 = .443$. The extent of overlap in the second recall did not differ as a function of group composition, uniform (M = 51.77, SE = 1.78) or diverse (M = 52.13, SE = 1.61), $F(1, 92) = .038$, $p = 0.846$, $\eta_p^2 < .001$, and the interaction between these two variables was not significant, $F(1, 92) = .428$, $p = .515$, $\eta_p^2 = .005$ (Fig. 1, right panel).

Effects of Collaboration on Later Individual Recall (Recall 2)

On the second, individual recall, those who previously worked in collaborative groups recalled significantly more studied words than those in the nominal groups; $F(1, 284) = 40.10$, $p < .001$, $\eta_p^2 = .124$. This pattern replicates several past studies and supports the evidence that collaboration affords re-exposure to studied items when listening to others' recall and promotes cross-cuing where others' recalled items activate recall of additional items (e.g., Basden, Basden, & Henry, 2000; Blumen & Rajaram, 2008; Congleton & Rajaram, 2011, 2014; Thorley & Dewhurst, 2007; Weldon & Bellinger, 1997). These re-exposure and cross-cuing advantages enhance later individual memory for those who participated in earlier collaborative recall.

Next, we tested the main effect of prior group composition on second, individual recall. For this analysis, within each group composition condition (diverse or uniform) we computed the average recall scores for participants of each ethnicity in the nominal group condition to obtain the baseline. We subtracted this measure from the individual recall scores of each participant of the same ethnicity in the collaborative group condition for diverse as well as uniform groups. In the baseline, nominal group condition, Asian (M = 38.92, SE = 3.06) and Black/African American (M = 38.79, SE = 3.13) participants recalled numerically fewer words compared to White participants (M = 45.63, SE = 2.42), but these differences were not statistically significant, $F(2, 69) = 1.82$, $p = .169$, $\eta_p^2 = 0.05$. The second, individual recall of participants who were previously in the collaboration conditions did not differ as a function of group composition demonstrating that members from diverse (M = 9.65, SE = 1.26) and uniform (M = 8.55, SE = 1.40) collaborative groups exhibited similar downstream effects of prior collaboration; $t(142) = 0.582$, $p = .561$, $d = .09$, 95% CI [-7.12, .28].

Effects of Collaboration on Source Monitoring (Recall 2)

Finally, participants who were in collaborative groups during the first recall reported source memory for the items they recalled in the second, individual recall. In this source monitoring task, each participant who had previously worked in collaborative groups indicated for each recalled word whether it was recalled by them, by another group member, or not produced during collaboration.

The data were scored in two ways, strict scoring and lenient scoring. For the strict measures, a response of "Other" was scored as being incorrect if the participant could not identify which group member recalled the word during collaboration. For the lenient measures, if the participant noted that another group member recalled the word during collaboration but could not identify the group member, a response of "Other" was marked as correct. The strict scoring method did not produce any significant effects and is not reported for reasons of economy. Findings from the lenient scoring method are reported below.

Each type of correct source memory judgment made—correct attributions to self, correct attribution to others, correct attribution to the study list—was normalized as a function of total number of source judgments made for that response type. A small number of participants made zero attributions to self (less than 1%) or study (less than 5%), these responses could not be normalized and were not entered into analysis.

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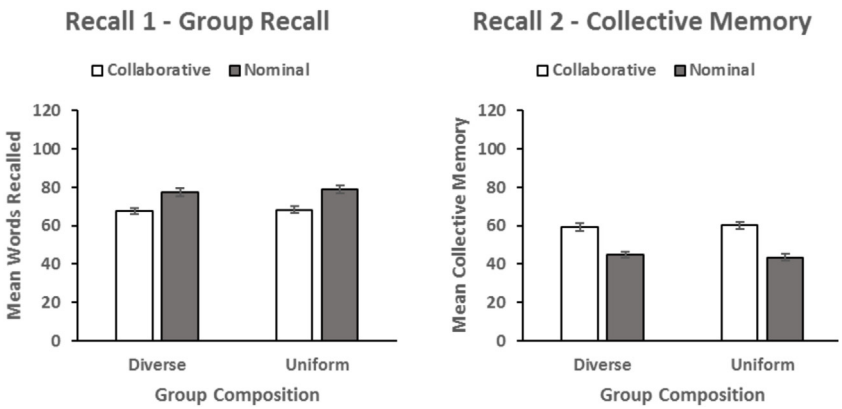

Fig. 1. Collaborative inhibition across group compositions. The left panel in the figure depicts mean number of words recalled by groups in Recall 1 and the right panel depicts the number of overlapping words individually recalled and forgotten by former group members in Recall 2. Error bars represent standard errors.

Table 1
Source Monitoring Performance by Group Composition at Recall 2.

Proportion Correct	Uniform	Diverse
Total attributions	.73 (.014)	.67 (.014)
Group member attributions	.68 (.019)	.63 (.015)
Self attributions	.79 (.020)	.72 (.020)
Study attributions	.84 (.025)	.82 (.031)

Note. The average (and standard error) of the proportion of correct source attributions made in post-collaborative individual recall per group composition condition.

Participants who were earlier in uniform collaborative groups consistently exhibited more accurate source judgments compared to those in the diverse collaborative groups. Those in the uniform condition were more accurate overall at attributing sources to their recall compared to those in the diverse condition; $t(142) = -2.91$, $p = .004$, $d = 0.49$, 95% CI [-.099, .019]. This pattern was evident both in the accurate attributions made to other group members and accurate attributions made to oneself. Those in the uniform condition were more accurate at identifying responses that were produced by other members of the group (group member attributions; Table 1) compared to those in the diverse condition; $t(142) = -2.03$, $p = .044$, $d = 0.33$, 95% CI = [-.099, .001], and also more accurate at attributing recalled items to themselves (self-attributions; Table 1) than those in diverse groups, $t(141) = -2.34$, $p = .02$, $d = 0.17$, 95% CI [-.126, -.010]. Source memory accuracy for the uniform and diverse groups did not differ for study items that were not produced during collaboration but were produced in their second recall (study-attributions; Table 1), $t(137) = -0.59$, $p = .555$, $d = 0.08$, 95% CI [-.102, .055].

As before, we explored the effects of ethnicity by focusing on the performance of only those members who had been in diverse triads during collaboration, and found that source memory accuracy did not differ as a function of ethnicity for overall accurate attributions, $F(2, 69) = 1.53$, $p = .223$, $\eta_p^2 = .043$, accurate group member attributions, $F(2, 69) = 0.61$, $p = .554$, $\eta_p^2 = .017$, or accurate self-attributions, $F(2, 68) = 2.36$, $p = .102$, $\eta_p^2 = .065$.

In brief, the source monitoring findings suggest that collaboration in Uniform groups improved accurate source attributions for words produced both by others during collaboration and by themselves. This effect emerged only in lenient scoring such that attributions that require identification of a specific member's contributions were not detectably different as a function of group composition. Additionally, these findings suggest this difference was not specific to particular ethnicities and instead reflects the effects of collaboration among diverse groups compared to uniform groups.

Effects of Ethnicity on Contributions during Collaborative Recall (Recall 1)

In the next analysis, we examined if the individual contributions made by each group member during collaborative recall varied for members of the diverse groups. To assess this effect of ethnicity in diverse groups, we computed the number of studied items recalled by each individual member during collaboration (or in the baseline, nominal condition) in the first recall. Participant ethnicity in the diverse nominal condition (where no collaboration took place during recall), did not have a significant effect on recall (Asian: $M = 36.71$, $SE = 2.30$; Black/African American: $M = 35.29$, $SE = 2.80$; White: $M = 39.83$, $SE = 2.46$), $F(2, 69) = .844$, $p = .434$, $\eta_p^2 = .024$. In the diverse collaboration condition, however, Black/African American participants ($M = 17.62$, $SE = 1.34$) contributed significantly less accurate words during collaboration than both Asian ($M = 24.71$, $SE = 1.58$) and White ($M = 25.25$, $SE = 1.27$) participants in the diverse collaborative triads; $F(2, 69) = 9.11$, $p < .001$, $\eta_p^2 = .209$. Follow-up comparisons reveal that both Asian and White participants made significantly more contributions than Black/African American participants; $t(46) = -3.40$, $p = .001$, $d = .98$, 95% CI [-11.27, -2.89], $t(46) = -4.11$, $p < .001$, $d = 1.18$, 95% CI [-11.35, -3.89] respectively. The contributions made during collaboration by the Asian and White participants did not significantly differ; $t(46) = -0.26$, $p = .792$, $d = .07$, 95% CI [-4.64, 3.56].

These patterns of results suggest that the effect of ethnicity on recall contributions during collaboration is not a function of baseline performance between ethnicities but instead an indication of the effects of collaboration (Table 2). These differences are consistent with the effects of stereotype threat reported for performance on other cognitive tasks (Schmader et al., 2008;

Table 2
Individual Contributions during Collaboration by Ethnicity in Collaborative Groups at Recall 2.

Ethnicity	Uniform	Diverse
Asian	-	24.71 (1.58)
Black/African American	-	17.63 (1.34)
White	22.75 (0.99)	25.25 (1.27)
Ethnicities collapsed	22.75 (0.99)	22.53 (0.90)

Note. The average (and standard error) of accurate words contributed during collaboration by ethnicity. Ëthnicities collapsedr̈epresents the overall average contribution of a group member in each condition regardless of ethnicity.

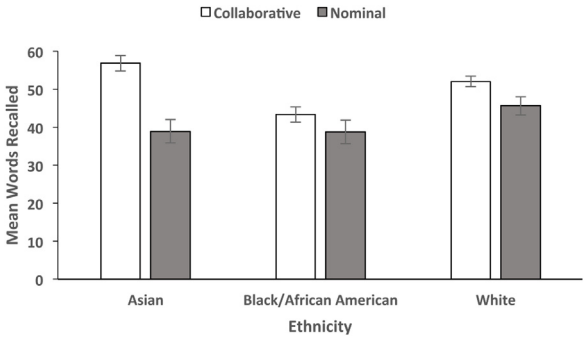

Fig. 2. Individual Recall by Ethnicity for those from prior Diverse groups (Recall 2). Error bars represent standard errors.

Steele, 1997) and will be addressed further in the discussion section.

Effects of Ethnicity in Post-collaborative Recall (Recall 2)

Although an effect of diversity on later recall was not evident in a comparison between diverse and uniform groups, effects of ethnicity on post-collaborative recall became evident for participants within diverse groups. This comparison focused on participants' second individual recall between those who had earlier worked in diverse collaborative groups and those in the diverse nominal groups. Both Asian and White participants showed memory benefits of prior collaboration ($M = 56.88$, $SE = 2.05$; $M = 52.04$, $SE = 1.39$, respectively) such that they recalled significantly more studied words on the second recall compared to participants matched for ethnicity in the diverse nominal condition, who did not collaborate ($M = 38.92$, $SE = 3.06$; $M = 45.63$, $SE = 2.42$, respectively), $t(46) = 4.86$, $p < .001$, $d = 1.4$, 95% CI [10.52, .25.39], and $t(46) = 2.29$, $p = .027$, $d = .66$, 95% CI [0.77, 12.05] respectively. Black/African American participants' performance in the second individual recall task did not significantly differ, regardless of whether they had collaborated earlier ($M = 43.38$, $SE = 2.01$) or had not collaborated ($M = 38.79$, $SE = 3.13$), $t(46) = 1.22$, $p = .225$, $d = .35$, 95% CI [-2.92, 12.08]. These patterns of findings suggest that Black/African American participants did not exhibit significant memory benefits from prior collaborative experience as did the participants of other two ethnicities (Fig. 2).

Taken together, findings from Recall 1 (group recall) and Recall 2 (individual recall) show that the collaborative inhibition effect is comparable across ethnically uniform versus diverse groups, and post-collaborative recall also does not differ in general when assessed as a function of group composition. But the group collaborative context did influence performance as a function of the participants' ethnicity when performance was assessed separately for each ethnicity within diverse groups. Asian and White participants exhibited higher recall during collaboration compared to Black/African American participants. These differences were not present for participants in the nominal condition. Asian and White participants also exhibited post-collaborative memory benefits that were not evident for Black/African American participants. Again, these differences in recall as a function of ethnicity were specific to the collaborative conditions and were not evident in the Nominal conditions.

Discussion

This study is the first to examine the effect of ethnic diversity in group composition on collaborative memory. Although exploratory, the study yielded informative findings that we hope will inspire additional studies on this topic of considerable practical significance.

Most importantly, we observed comparable collective inhibition (Basden, Basden, Bryner, & Thomas, 1997; Marion & Thorley, 2016; Rajaram & Pereira-Pasarin, 2010; Weldon & Bellinger, 1997) across ethnically diverse and uniform groups, with both types of collaborative triads recalling fewer words than nominal triads. The downstream effect of collaboration on later individual recall (Blumen & Rajaram, 2008; Rajaram & Pereira-Pasarin, 2010) was also comparable for ethnically diverse and uniform groups, whereby former collaborators showed better memory than those who previously recalled alone. Furthermore, regardless of group diversity composition, collective memory emerged among former collaborators who recalled more overlapping information in subsequent individual recall than those who previously recalled alone (Choi et al., 2014; Congleton & Rajaram, 2014; Cuc et al., 2007).

As we noted earlier, factors such as homophily and kaleidoscope thinking may affect collaborative memory in diverse and uniform groups. These factors, however, generate competing hypotheses, which suggest that a lack of effect of group diversity composition in our study requires follow-up research to isolate how these factors influence memory outcomes. For example, categorized words used in this study grounded our novel questions to the existing literature on collaborative recall (e.g., Congleton & Rajaram, 2014). In future research, more complex and richer study materials may reveal ethnic differences related to kaleidoscope thinking. Also, to ensure ecological validity, the diverse groups in our study were formed without explicitly drawing the participants' attention to their ethnicity (Harrison et al., 1998). However, making individuals' cultural-ethnic identities salient can significantly influence their cognition and memory (e.g., Apfelbaum et al., 2014; Shih, Pittinsky, & Ambady, 1999; Wang, 2008; Wang & Ross, 2005), and this consideration may guide future studies on the effects of homogeneity and diversity on collaborative memory.

Interestingly, collaboration in ethnically uniform groups facilitated source memory, with participants making more accu-

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rate source attributions for words produced both by others and by themselves during collaboration than those in diverse groups. This finding might seem counterintuitive given that the physical distinctiveness of the members of the diverse groups could serve as additional cues for the memory source. Yet, due to homophily and the related perception of comfort and cohesion in uniform groups (Allport, 1954; Apfelbaum et al., 2014; Struch & Schwartz, 1989), participants in these groups might have been more attentive to other group members and their contributions during collaboration, thus exhibiting better recollection later for each item's contributor. Additional research should directly examine the effect of subjective sense of comfort and cohesion on memory performance in group settings.

In line with the literature on stereotype threat (Nguyen & Ryan, 2008; Schmader et al., 2008; Shapiro & Neuberg, 2007; Steele, 1997), we found that Black/African American participants contributed fewer correct words during collaboration than did Asian and White participants, and they did not show post-collaborative memory benefits as Asian and White participants did. Critically, these ethnicity effects only occurred in the collaborative conditions, thus reflecting the influence of the diversity group context rather than individuals' baseline performance as indexed in the nominal conditions. These findings extend previous research on stereotype threat and demonstrate for the first time the negative impact of stereotype threat on cognitive performance in the collaborative remembering context.

In sum, our study offers novel insights into the role of ethnic diversity in collaborative memory, while replicating key findings in past research. Our findings have implications for learning and memory performance in diverse settings such as classrooms and workplace in contemporary society.

Author Contributions

This project emerged from substantive discussions between Suparna Rajaram and Qi Wang, and Nicholas Pepe joined the project in his first year of graduate training to pursue his interests in research on culture and memory. The three authors collaborated to design and refine the experimental method. In consultation with Suparna Rajaram, Nicholas Pepe led the implementation and execution of the project, data collection, and data processing, and performed all the data analyses. The three authors worked together to interpret the findings. Nicholas Pepe drafted the first version of the manuscript in consultation with Suparna Rajaram, after which all three authors contributed to the manuscript preparation and submission process in a collaborative fashion.

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