learning (Weldon et al., 2000; Nokes-Malach et al., 2015). But there is still a gap between highlight on motives and experimental evidence. It had been found that social loaf-

of input between the two participants. Then each participant completed two blocks of collaborative retrieval task. One block was with the in-group member whom he/she had just cooperated with, and another with a random out-group member. Each experimental block consisted of three stages: encoding, delayed interval, and retrieval test (Rajaram & Maswood, 2017). During encoding, items were presented one at a time for 2000 ms at the center of each computer screen in a pseudorandom order, followed by an inter-stimulus interval of 1000 ms. Two participants in one room were asked to independently study word list on their own computers for an unspecified memory test. When list presentation was complete, participants worked on an unrelated calculation test (addition and subtraction of two-digit numbers) for 1 min to reduce the recency effect (Wright & Klumpp, 2004).

At retrieval test, participants were asked to recall their previously studied list. Participants in the collaborative groups worked together with their partners. They were asked to type in the answer box on their respective computers in turn, so that each of them had an equal opportunity to contribute. In order to distinguish the contributor of each response, the answer box had two columns, with each for one participant respectively. Participants could only type words in their own column while being able to see their partner's input in another column at the same time. Free discussion was allowed during their recall. In nominal groups, participants were provided with same answer screens, but they were asked to work alone and type their individual responses. Discussion was not allowed, nor could they see their partners' responses. Collaborative groups had 8 min and nominal groups had 4 min to recall. All groups had adequate time for recall or discussion.

After first block, participants had one min to rest before the second block began. The procedures of two blocks were identical, except that participants were paired with partners exchange ¢

displayed on the answer screen of each computer. If two participants belonged to the same team, the team name would be displayed in the corresponding color at the top of the screen, such as "Red Team" in red or "Blue Team" in blue. If two participants belonged to different teams, the team name of each participant would be displayed in a corresponding color at the top of each one's answer column.

Measures of subjective social identity For subjective social identity, we focused on whether participants felt as part of the red and blue teams during collaborative retrieval task. In order to reflect the context relevance of subjective social identity (Meyer et al., 2011), participants were asked to evaluate their membership during collaborative retrieval at the end of the task ("When you recalled the words, which team do you think you belonged to? Red team/blue team/not belonged to any team"). Participants who reported that they belonged to their own team in the recall task indicated that their social identity was salient and would be therefore defined as people with subjective social identity. Participants who reported that they did not belong to either team were defined as individuals without subjective social identity. None of the participants reported belonging to an out-group. In order to tentatively explore the potential mechanisms of subjective social identity effect, participants with subjective social identity were asked to respond to an open-ended question, in which they could report their thoughts or feelings in the group recall. Once the experiment was completed, all participants were thanked and fully debriefed.

Results

Manipulation check and individual di□erences To assess the effectiveness of group formation, we compared each participant's identification with in-group and out-group as well as their social distance from the in-group partner and the out-group partner. A paired sample t-test revealed a significant difference between in-group and out-group identities. Social identity with in-group (8.06 ± 1.21) was higher than that with out-group (3.51 ± 2.32), $t\ (79) = 15.17$, $p < 0.001$, $d = 1.71$. Participants also reported closer social distance from the in-group partner (5.28 ± 1.38) than that from the out-group partner (3.35 ± 1.40), $t\ (79) = 11.76$, $p < 0.001$, $d = 1.33$. Results showed that group formation effectively forms an in-group and an out-group for each participant.

For the individual differences related to social identity, we averaged the self-construal scores of two members in each group as a group score. A 2 (retrieval: collaboration vs. nominal, 4.91 ± 0.50 vs. 5.04 ± 0.42) × 2 (objective social identity: in-group vs. out-group, 5.01 ± 0.46 vs. 4.94 ± 0.46)

al., 2016). Therefore, we used the interdependence of goals as the manipulation of social identity, to stimulate participants' social motives in Experiment 2.

Interdependence of goals can be manipulated by the allocation of reward (Nyberg et al., 2018). The reward distributed to all members triggers cooperation among group members, while the reward given to the best performer triggers competition. In Experiment 2, we set both cooperative and competitive contexts by manipulating the allocation of reward to stimulate individuals' social motive to cooperate or compete.

Another goal in Experiment 2 was to focus on epistemic motive. Social identity elicits the need to gain epistemic certainty (Kopietz & Echterhoff, 2014), which may play a role in collaborative recall. Without epistemic motive, cooperative exchange between in-group members may lead to shallow information processing (e.g., applying simple heuristics such as majority rules) and poor performance on cognitive task (Halevy, 2008). Previous research suggests that how much cooperation affected group outcomes depends on epistemic motivation level (De dreu et al., 2006). Experiment 2 therefore measured both the social and epistemic motives in the cooperative and competitive contexts respectively, and investigated how motivational factors influenced the performance of group recall.

Method

Participants

An a-priori power analysis advised 68 participants for sufficient test power (1 - $\beta = 0.80$; $\alpha = 0.05$, two-tailed) to detect a medium-sized effect ($f^2 = 0.15$) in a linear multiple regression. Since we included a two-level between-subjects variable, we multiplied this number by two. One hundred and sixty Chinese university students (56 males, 104 females, mean ± *SD* age = 22.72 ± 2.51 years) were randomly recruited. They received a fixed reward of ¥35(~$5) and a floating bonus up to ¥10 based on their performance in the experiment. All participants reported as native Chinese speakers with normal or corrected-to-normal vision. Strangers of the same gender took part in the experiment in dyads. They voluntarily participated in this experiment and gave informed consent before participation. This study was approved by the Committee for Protecting Human and Animal Subjects in the School of the Psychological and Cognitive Sciences, Peking University, and was performed in accordance with the ethical standards laid down in the Declaration of Helsinki.

Materials

The materials were the same as in Experiment 1.

Design

The experiment had a 2 (goal interdependence: cooperation, competition) × 2 (retrieval: collaborative, nominal) mixed-factorial design. The first factor goal interdependence was manipulated between subjects. In the cooperation context, participants tried to win an inter-group competition by jointly recalling as many of the materials as possible with their partners. In the competition context, participants tried to win an intra-group competition by recalling as many materials as possible compared to their partners. The second factor retrieval was manipulated within participants. All groups completed a block of collaborative retrieval and a block of nominal retrieval. Participants recalled together with their partners in the collaborative retrieval, while they recalled independently in the nominal retrieval. The dependent variables were the number of correct recalls and the number of errors of dyads.

Procedure, manipulations, and measures

Measures of individual differences To control individual differences on cooperative and competitive tendency, participants were asked to complete the scale of cooperative and competitive personality (CCPS; Xie et al., 2006) one day before the experiment. Twenty-three items were used to measure cooperative personality (13 items, such as "at work, I like to work with others") and competitive personality (10 items, such as "I love the challenge that comes with competing with others"). CCPS responses were rated on a Likert-type scale from 1 (strongly disagree) to 9(strongly agree). Subscale scores were combined as an indicator of cooperative personality (Cronbach's $\alpha = 0.91$) and competitive personality (Cronbach's $\alpha = 0.83$), respectively.

Experimental sessions The experiment consisted of two blocks of collaborative retrieval task. The procedure of encoding and delayed interval were the same as Experiment 1. In retrieval test, cooperation or competition contexts were manipulated by instructions, which were given at the beginning of the experiment and each block of test. Following Nyberg et al. (2018), in cooperative condition, group as a whole was rewarded for good performance. Participants were told that if their group recalled more correct words than the average of all groups in this experiment, they would share an extra ¥5 bonus. If they failed, there would be no extra bonus. In competitive condition, participants were told that they would compete with their group partners

were asked to assess "To what extent did you want to recall correct words in the recall task?". Higher scores indicated that the participants were more epistemically motivated by the studied materials. Participants responded above items on a 9-point Likert scale (1 = very little; 9 = very much). These motive-measuring items served as indicators of participants' social and epistemic motives in the experiment. Then the experiment ended, all participants were debriefed and rewarded with the possible extra rewards received in the experiment.

Results

Manipulation check and individual differences To assess the effectiveness of context manipulation, we compared the scores of the cooperative and the competitive groups on the items of manipulation check. A two-sample t-test showed that there was a significant difference between the cooperative and the competitive groups. Participants in the cooperative group (2.88 ± 2.43) were more likely to think of themselves as cooperative with their partners than those in the competition group (5.60 ± 2.13), $t(158) = 5.33$, p

The main effect of goal interdependence and the interaction between goal interdependence and retrieval were not significant ($ps > 0.67$). The results did not show an effect of cooperative reward or competitive reward on the correct group recall.

We primarily focused on how social and epistemic motives influenced collaborative inhibition in different contexts. We defined collaborative inhibition score as the difference between the number of correct recalls in the nominal groups and in the collaborative groups, which indicated the impairment of the correct recall by collaboration. The higher the collaborative inhibition score, the severer the impairment on group recall. We averaged the social and epistemic motive scores of two members in each group as a group indicator. We included collaborative inhibition score, social and epistemic motives of group into a hierarchical regression analysis. The first step of this regression included goal interdependences (0 = competitive, 1 = cooperative), social motive, and epistemic motive (continuous variables were centered, the same below). The second step of the model included all two-way respectively. We split the data between the cooperation context and the competition context, and included collaborative inhibition score into a hierarchical regression analysis. The first step included social motive and epistemic motive. The second step included the two-way interaction. In cooperative condition, the first step of the model yielded no significant effect (all $ps \geq 0.09$). The second step of the regression yielded a significant interaction between social motive and epistemic motive, $t(36) = -3.37$, $p = 0.002$, $\beta = -0.52$, 95% CI = [-0.95, −0.24] (all other $ps \geq 0.15$). This model had a $\Delta R^2 = 0.22$, $F(3, 36) = 5.11$, $p = 0.005$. In competitive condition, there was no significant main effect of social motive or epistemic motive, nor of their interaction ($ps \geq 0.37$). To examine the interaction in cooperative condition, we divided groups into high epistemic motivated and low epistemic motivated ones on the basis of median splits, and performed separate simple slope tests. For groups with high epistemic motive ($M = 8.19$, $SD = 0.49$), the social motive of cooperation reduced the collaborative inhibition, $t(36) = -2.22$, $p = 0.04$, $\beta = -0.45$, 95% CI = [-3.13, -0.09]. For groups with low epistemic motive ($M = 8.19$, $SD = 0.49$), the social motive of cooperation had no significant effect on the collaborative inhibition, $t(36) = 0.50$, $p = 0.63$, $\beta = 0.12$, 95% CI = [-0.84, 1.36]. Figure 3 shows the regression lines in two experimental conditions at high and low levels of epistemic motive.

Error pruning: the number of errors that the collaborative group had lower than the nominal group We first analyzed the effect of context manipulation on group recall error. A 2 (goal interdependence: cooperative reward vs. competitive reward) × 2 (retrieval: collaborative vs. nominal) repeated-measures ANOVA yielded only a main effect of retrieval, $F(1,78) = 117.31$, $p < 0.001$, $\eta_p^2 = 0.42$. The number of errors of the collaborative groups ($M = 4.50$, $SD = 3.00$) was

lower than that of the nominal groups ($M = 6.21$, $SD = 2.66$), indicating an error pruning effect. The main effect of goal interdependence and the interaction between goal interdependence and retrieval were not significant ($ps \geq 0.21$). The results did not show an effect of cooperative reward and competitive reward on the group recall error.

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(all other $ps \geq 0.06$). This model had a $\Delta R^2 = 0.16$, $F(6, 73) = 2.94$, $p = 0.13$. The third step of the regression had no significant three-way interaction, $p = 0.42$.

To further examine the interaction between social motive and goal interdependence, we performed regressions on social motives in cooperative and competitive contexts respectively. Figure 4 shows the regression lines of social motives in two conditions. The social motive of cooperation increased the error pruning, $t(38) = 3.32$, $p = 0.002$, $\beta = 0.47$, 95% CI = [0.34, 1.39]. The model had a $\Delta R^2 = 0.22$, $F(1, 38) = 10.99$, $p = 0.002$. However, the social motive of competition had no significant effect on the error pruning, $t(38) = -1.41$, $p = 0.17$, $\beta = -0.22$, 95% CI = [-0.56, 0.10].

Discussion

This study investigated the effect of social identity on collaborative memory in a motivational approach. The results supported a key role of subjective social identity in that regard. Subjective social identity eliminated the inhibition effect of collaborative retrieval and produced error pruning when people worked with in-group members. This study also examined the social and epistemic motive that social

highlights the pervasive role of motivational basis that plays in most phenomena, such as memory (Higgins et al., 2021). From this perspective, when we re-examine the “collabora-

used cognitive mechanisms to explain the effects of social relationship on group memory (Browning et al., 2018), suggesting that group members interrupted others' preferred retrieval strategies in collaboration (strategy disruption hypothesis; Basden et al., 1997

the results of the open-ended question in Experiment 1, where the participants reported their motives in the group recall as cooperation with in-group members or competition with out-group members. Since goal interdependence may be a stronger way to manipulate in-group and out-group identity (Adachi et al., 2016), we used it as manipulation of group identities in Experiment 2. Second, social identity correlates with epistemic needs (Shah et al., 1998), so we examined the role of epistemic motive. After all, this study is a tentative attempt to investigate the influence of social identity on collaborative memory, and future research can delve deeper into the change of collaborative memory in the dimensions of multiple group identities such as group relationship, cooperation or epistemic trust.

Conclusion

The present study investigated the effects exercised by social identity and its motivational components on the performance of group recall. Our findings suggest that perceived social identity could benefit group recall by both eliminating the negative effect and producing the positive effect of collaboration. This benefit might be explained by the pursuit of a shared goal and information certainty by group members. These findings fill a significant gap of previous studies by scrutinizing different forms and motivational factors of social identity, providing insights for better understanding of the social and motivational process underlying collaborative memory. These results also suggest practical applications on increasing collaborative benefts in certain workplaces or scenarios, such as co-witness discussion, interview panels assessment, and cognitive aging interventions.

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Authors' contribution All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Xiaoshu Li. The first draft of the manuscript was written by Xiaoshu Li. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability and Code availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval This study was approved by the Committee for Protecting Human and Animal Subjects in the School of the Psychological and Cognitive Sciences, Peking University.

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