How Collaboration Reduces Memory Errors: A Meta-Analysis Study

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Abstract

To investigate the stability and influencing factors of the error pruning effect in collaborative memory, a meta-analysis was conducted on 64 independent samples from 38 collaborative memory studies (total sample size N = 6225) through literature search and screening. The results revealed that both error pruning and collaborative inhibition stably emerged in collaborative memory; moderation analysis indicated that collaborative approach could moderate error pruning but did not affect the collaborative inhibition effect; material type had no significant effect on the error pruning effect, but episodic materials showed higher levels of collaborative inhibition; familiar relationships enhanced the error pruning effect and attenuated collaborative inhibition. These results suggest that collaboration can stably suppress the number of errors and improve the accuracy of collaborative memory, but is moderated to some extent by factors such as collaborative approach and relationship type.

Full Text

How Collaboration Reduces Memory Errors: A Meta-Analytic Study

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Abstract

To investigate the stability and influencing factors of the error pruning effect in collaborative memory, we conducted a meta-analysis of 38 collaborative memory studies comprising 64 independent samples (total N = 6,225) following systematic literature search and screening. Results revealed that both error pruning

and collaborative inhibition consistently emerged in collaborative memory. Moderator analyses indicated that collaborative approach significantly moderated error pruning but did not affect collaborative inhibition. Material type showed no significant influence on error pruning, though episodic materials produced higher levels of collaborative inhibition. Familiar relationships enhanced error pruning while attenuating collaborative inhibition. These findings demonstrate that collaboration reliably suppresses error rates and improves recall accuracy, though these effects are moderated by factors such as collaborative approach and relationship type.

Keywords: collaborative memory, meta-analysis, error pruning, collaborative inhibition, moderating effect
Classification Number: B842

Collaborative memory refers to memory processes in which two or more individuals jointly retrieve information (Barber et al., 2012; Nie et al., 2021). Research on collaborative memory typically employs the classic encoding-retrieval paradigm. During the encoding phase, participants study materials individually. During the retrieval phase, participants are divided into two equally sized groups: a collaborative group and a nominal group. Collaborative group members recall information together, whereas nominal group members recall individually. Collaborative memory performance is measured as the total number of correctly recalled items produced by the collaborative group, while each nominal group's score represents the non-overlapping sum of correctly recalled items from the same number of participants recalling individually (Nie et al., 2019, 2021; Rajaram, 2011). The collaborative retrieval effect is determined by the difference in correct recall between collaborative and nominal groups. If the collaborative group outperforms the nominal group, the effect is considered positive, producing collaborative enhancement; conversely, if collaboration impairs information retrieval, this constitutes collaborative inhibition.

Most existing studies find that collaborative groups recall fewer correct items than nominal groups, indicating that collaborative inhibition is a relatively stable collaborative retrieval effect, a conclusion supported by meta-analytic research (Marion & Thorley, 2016). Among theoretical models explaining collaborative inhibition, the retrieval strategy disruption hypothesis has received the widest acceptance. This hypothesis posits that collaborative inhibition arises because group members' retrieval strategies are disrupted and interfered with by others during recall (Basden et al., 1997), whereas nominal group members can freely rely on their optimal individual retrieval strategies, resulting in higher recall rates than collaborative groups (Rajaram & Pereira-Pasarin, 2010). The retrieval strategy disruption hypothesis has received empirical support. For example, studies have found that when collaborative groups use free recall, they must rely on personalized organization of encoded information, making collaborative inhibition more pronounced (Barber et al., 2012); whereas cued recall or recognition-based retrieval methods, which depend less on individual organizational strategies, produce weaker collaborative inhibition (Clark et al., 2000;

Finlay et al., 2000). Some researchers have proposed the retrieval inhibition hypothesis to explain collaborative inhibition, suggesting that recall outputs from collaborative group members may inhibit the representation and activation of unrecalled information in other members, essentially manifesting as socially shared retrieval-induced forgetting (Coman et al., 2009). For instance, in Barber et al. (2015), collaborative group members completed an individual recall task after collaborative recall (secondary retrieval), and results showed that due to the influence of partners' recall outputs, collaborative group members performed worse than nominal groups during secondary retrieval (Barber et al., 2015).

Collaborative retrieval effects have traditionally been based on the number of correctly recalled items by collaborative versus nominal groups. However, some researchers have also examined error rates as an indicator, discovering that collaborative groups produce fewer recall errors than nominal groups (Nie et al., 2021; Maswood et al., 2022; Vredeveldt et al., 2019), a phenomenon termed "error pruning." Some researchers argue that error pruning can offset retrieval quantity losses caused by collaboration by reducing memory errors (Harris et al., 2012). Several studies have found that collaborative recall simultaneously exhibits both collaborative inhibition and error pruning (Nie et al., 2021; Vredeveldt & Van Koppen, 2018), while other studies have not found both effects coexisting (Harris et al., 2013; Vredeveldt et al., 2017; Whillock et al., 2020). Therefore, does error pruning consistently appear in collaborative memory? What is its relationship with collaborative retrieval effects based on correct recall (collaborative inhibition and facilitation)? What factors moderate error pruning? On one hand, meta-analysis can provide empirical answers to these questions through reanalysis of similar studies with large sample sizes and integrated conclusions. On the other hand, only one previous meta-analysis has quantitatively examined collaborative memory—this study included 64 effect sizes and confirmed the stability of collaborative inhibition but did not investigate collaborative effects on error rates (Marion & Thorley, 2016). In summary, this study presents the first meta-analysis of error pruning and its moderating factors, building on psychological mechanisms and potential moderators of error pruning. We also meta-analyze collaborative retrieval effects from included studies, comparing both meta-analytic results to provide insights into clarifying the processing mechanisms of collaborative memory.

1.1 Psychological Mechanisms of the Error Pruning Effect

Based on existing research, two main explanations have been proposed for the error pruning effect. First, collaboration inhibits error production. According to the social motivation hypothesis, individuals' social motivation influences their engagement in collaborative processes (Weldon et al., 2000). Due to diffusion of responsibility, group members are more concerned with meeting social expectations, gaining approval, and avoiding negative evaluation, resulting in lower motivation to contribute (Ekeocha & Brennan, 2008). Specifically, in collabora-

tive memory, if group members are uncertain about their recall, they will rely on partners' memory information, thereby suppressing inaccurate recall (Andrews et al., 2015). For example, Ross et al. (2008) analyzed conversations during collaborative recall and found that when participants proposed uncertain answers, they would actively delete them during subsequent discussion even when other members agreed to retain them, and most deleted items were erroneous recalls. This tendency to suppress uncertain recall primarily stems from avoiding negative evaluation from others (Weldon et al., 2000; Andrews et al., 2015). Second, collaboration increases opportunities for error correction. According to the source monitoring hypothesis, memory retrieval is a decision-making process that activates encoded information and attributes it to specific sources; influencing this decision-making process affects monitoring accuracy (Johnson et al., 1993). In collaborative memory, evaluation and decision-making about activated memory information are completed jointly by group members, and individuals' judgments (especially erroneous ones) are often overturned by the group; whereas memory retrieval in individual contexts lacks this opportunity for examination, thus retaining more erroneous judgments (Saraiva et al., 2017). Specifically, during collaborative retrieval, group members can communicate to check recalled items and evaluate accuracy, controlling recall quality by rejecting erroneous information (Ross et al., 2008). Research shows that free communication during retrieval makes error pruning more pronounced (Bärthel et al., 2017; Rossi-Arnaud et al., 2019), while prohibiting discussion weakens or even eliminates error pruning (Harris et al., 2012).

Thus, under normal circumstances, collaborative groups are more likely to reduce errors during recall than nominal groups. Based on this, we propose Hypothesis 1: Collaborative groups produce fewer memory errors than nominal groups, demonstrating a stable error pruning effect.

Error pruning and collaborative inhibition are common outcomes of collaborative memory. Previous research has primarily used the retrieval strategy disruption hypothesis to explain collaborative retrieval effects dominated by collaborative inhibition. However, existing studies have found that both correct and erroneous items are often suppressed during collaborative retrieval (Ekeocha & Brennan, 2008). Combined with previous empirical and meta-analytic research on collaborative retrieval effects based on correct recall (Marion et al., 2016), collaborative inhibition consistently appears in collaborative retrieval, and factors that promote error pruning, such as sufficient communication and information exchange, also strengthen retrieval strategy disruption, thereby enhancing collaborative inhibition. We therefore propose Hypothesis 2: Collaboration reduces both erroneous and correct recall, meaning error pruning and collaborative inhibition are both stable effects of collaborative memory.

1.2 Moderating Variables of the Error Pruning Effect

Based on relevant research findings, various factors in collaborative memory processes can moderate error pruning. In previous collaborative memory studies,

collaborative approach, material type, and collaborative relationship type are the most frequently examined moderating factors, and meta-analytic research has explored the effects of these three moderators on collaborative retrieval effects (Marion et al., 2016). Considering these factors and the moderators included in existing error pruning research on collaborative memory, this meta-analysis also selected these three moderating variables.

1.2.1 Collaborative Approach In existing research, the main collaborative approaches during retrieval are free recall, consensus building, and turn-taking recall. Free recall requires collaborative group members to discuss freely and resolve disagreements autonomously without specific requirements (Hyman et al., 2013). In consensus building, group members can also communicate freely but must reach agreement on recall outputs (Harris et al., 2012). Turn-taking recall requires each member to recall one item at a time in a fixed order, with discussion prohibited (Maswood et al., 2022). Previous research using correct recall as an indicator found that free recall or consensus building allows individuals to retrieve items in a free order according to personalized strategies, resulting in less strategy disruption (Harris et al., 2012), whereas turn-taking recall disrupts and interferes with individuals' retrieval strategies, making collaborative inhibition more likely.

Research using error recall as an indicator shows that collaborative groups using free recall and consensus building produce fewer recall errors than nominal groups (Harris et al., 2012; Whillock et al., 2020). Some researchers believe consensus building more accurately rejects non-presented items (Rajaram & Pereira-Pasarin, 2010), while turn-taking recall prevents communication, lacks opportunities for mutual error correction (Peker & Tekcan, 2009), and may increase pressure on group members, leading to more intrusion of erroneous information (Thorley & Dewhurst, 2007). An eyewitness interview study also showed that discussion within groups positively affects memory accuracy (Vredeveldt et al., 2016). In summary, communication and discussion appear to be key factors enabling collaborative group members to reject erroneous items. We therefore propose Hypothesis 3: Compared with turn-taking recall, free recall and consensus building collaborative approaches are more conducive to enhancing error pruning.

1.2.2 Material Type Collaborative memory research typically uses three types of materials: categorized items, uncategorized items, and episodic materials (Marion et al., 2016). Categorized items refer to words, pictures, or other items belonging to one or several categories, whereas uncategorized items are unrelated brief items across categories. Episodic materials include short stories, film clips, and scenes. Previous research found that collaborative inhibition effects exist across various material types, particularly pronounced for categorized items requiring unique encoding approaches. Episodic materials have strong logical coherence, and collaborative group members use similar information organization methods, making retrieval strategies less susceptible to disruption,

thus weakening or eliminating collaborative inhibition (张环 et al., 2021).

Existing research also shows that different material types differentially affect error pruning. For example, Nie et al. (2021) used categorized two-character word lists and found that collaborative groups produced less erroneous information than nominal groups, with collaboration enhancing item retrieval accuracy. Additionally, Zhang (2017) used 90 unrelated neutral words (uncategorized items) and found no significant error pruning effect. Other studies using episodic materials found that collaborative groups recalled fewer errors than nominal groups, showing lower suggestibility (Rossi-Arnaud et al., 2019). Some researchers argue that categorized items and episodic materials have strong logical cues, facilitating discussion of specific items or details and thus benefiting error correction, whereas uncategorized items encounter more obstacles during discussion and error correction (Marion et al., 2016). In summary, we propose Hypothesis 4: Error pruning effects are stronger for categorized items and episodic materials than for uncategorized items.

1.2.3 Relationship Type Previous research on collaborative retrieval effects shows that married couples achieve clear, stable retrieval advantages (Barnier et al., 2018), and friendships can also reduce collaborative inhibition (Takahashi, 2007) while benefiting individuals in subsequent individual recall (Harris et al., 2013). This is primarily because higher mutual understanding and closer relationships among collaborative group members enable more active management of item retrieval (Browning et al., 2018).

However, few studies have examined collaborative retrieval errors from an interpersonal relationship perspective. One study with older married couples found that collaborative groups made fewer errors than nominal groups when recalling film content viewed one week earlier (Vredeveldt et al., 2016). According to transactive memory system theory (Wegner, 1987), group members can develop an efficient memory system for sharing information encoding, storage, and retrieval through mutual familiarity and shared experiences. This not only reduces collaborative retrieval inhibition but also decreases false memory through cross-cuing. In summary, we propose Hypothesis 5: Compared with stranger relationships, familiar relationships among collaborative group members enhance error pruning in collaborative retrieval.

2.1 Literature Search and Screening

Chinese literature was sourced from CNKI (including journal full-text database, master's and doctoral dissertation database, and conference proceedings database), Wanfang Data Knowledge Service Platform, and VIP Chinese Journal Service Platform, using search keywords including "协作记忆" (collaborative memory), "合作记忆" (cooperative memory), "协作抑制" (collaborative inhibition), "协作促进" (collaborative facilitation), "错误修剪" (error pruning), and "协作提取" (collaborative retrieval). English literature was obtained from Web of Science, Science Direct, EBSCO, and ProQuest (dissertation) databases,

using search keywords including “collaborative memory,” “collaborative recall,” “collaborative inhibition,” “collaborative facilitation,” “error pruning,” and “collaborative retrieval.” Literature searches were conducted twice, in June 2022 and April 2023. After removing duplicates, 390 collaborative memory studies published between 1997 and 2023 were obtained. One conference paper on error pruning in collaborative memory was identified, but the authors did not respond to contact attempts.

To examine error pruning effects in collaborative memory, the following criteria were applied to screen the 390 studies for final inclusion in the meta-analysis: (1) Exclude non-empirical studies such as reviews and meta-analyses; (2) Report error recall quantities for both collaborative and nominal groups, or provide data from which error recall quantities could be calculated; (3) If a dissertation was subsequently published as a journal article, only the journal article was included. After screening, 38 studies were included in the meta-analysis, comprising 64 independent effect sizes with a total sample size of 6,225. The literature search and screening process is shown in Figure 1 [Figure 1: see original paper].

2.2 Literature Coding

Following Wilson and Lipsey (2001), studies were coded for: publication information (author name, publication year), sample size, publication type (journal vs. dissertation), collaborative approach (free recall, consensus building vs. turn-taking), task material type (categorized items, uncategorized items vs. episodic materials), and collaborative group relationship type (stranger vs. familiar). Each independent sample was coded once; if a single article contained multiple independent samples, each was coded separately. The coding process involved: group discussion to develop a coding manual, followed by independent coding by two team members with cross-checking. Disagreements were resolved through group discussion until consensus was reached. In terms of publication type, the included literature comprised dissertations, SSCI journals, and CSSCI journals, indicating guaranteed literature quality (张亚利 et al., 2019) (see Table 1).

2.3 Meta-Analytic Procedure

Comprehensive Meta-Analysis software (CMA 3.3) (Borenstein et al., 2014) was used for data management and analysis. The meta-analytic procedure involved: first testing for publication bias after obtaining each study’s effect size; second, conducting heterogeneity tests to determine whether to use fixed-effect or random-effects models; and finally, testing main and moderator effects. Moderator analyses used subgroup analysis to test categorical variables.

2.3.1 Effect Size Calculation The error pruning effect measures the difference in error recall quantities between nominal and collaborative groups. Therefore, we used standardized mean difference (Hedges’ g) as the meta-analytic effect size index. Hedges’ g is a correction of Cohen’s d that provides more accurate estimates for small sample data (Borenstein et al., 2009).

During coding, if included studies did not report d values, they were calculated from sample sizes, means, and standard deviations:

$$d = (M_1 - M_2)/s_{pooled},$$

where

$$s_{pooled} = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}.$$

If studies did not report sample sizes, means, and standard deviations, F or t values were converted using appropriate formulas:

$$d = 2\sqrt{F(n_1 + n_2)/n_{1n}2},$$

$$d = t\sqrt{(n_1 + n_2)/n_{1n}2}$$

(Goulden, 2006).

Additionally, collaborative retrieval effect—the difference in correct recall between nominal and collaborative groups—is the most basic dependent variable indicator in almost every collaborative memory study. Examining the relationship between collaborative retrieval and error pruning effects can provide insights into collaborative memory processing mechanisms. Therefore, this meta-analysis also included standardized mean differences for collaborative retrieval effects.

2.3.2 Publication Bias Assessment Publication bias occurs when included literature does not comprehensively represent the total research in a field (Rothstein et al., 2005). We used classic fail-safe N, funnel plots, and trim-and-fill methods to assess publication bias.

The fail-safe N indicates how many additional studies would be needed to render the results non-significant. When this value exceeds 5k + 10 (where k is the number of effect sizes), significant publication bias is unlikely (Rothstein et al., 2005). Calculations revealed fail-safe N values of 5,755 for error pruning and 5,214 for collaborative retrieval, both far exceeding critical values. Funnel plots visualize effect sizes as scatter plots; if no publication bias exists, data should be symmetrically distributed, concentrated in the upper middle region, forming an approximately symmetrical inverted funnel shape (Light & Pillemer, 1984). Our funnel plots (Figure 2 [Figure 2: see original paper], Figure 3 [Figure 3: see original paper]) show that effect size values for both error pruning and collaborative retrieval were primarily distributed in the upper middle region, roughly symmetrical left and right. To confirm these results, we also used the trim-and-fill method, which assumes publication bias causes funnel plot asymmetry and

uses a "trim then fill" approach to achieve symmetrical distribution around the mean effect size and re-estimate the pooled effect. Trim-and-fill analysis for error pruning revealed that after trimming 11 studies from the left side, the main effect remained significant with an effect size of 0.62, 95% CI [0.49, 0.75], $p < 0.001$. Analysis of collaborative retrieval showed that 0 studies were added after trimming, and the effect size remained unchanged. These results indicate no substantial publication bias.

2.3.3 Model Selection and Heterogeneity Testing Meta-analytic methods for calculating effect sizes include fixed-effect and random-effects models. Model selection depends on whether included studies share a common effect size and the purpose of analysis: if study objects and methods are identical across studies and results are not generalized beyond the sample population, fixed-effect models are appropriate; otherwise, random-effects models should be used when a common effect size cannot be assumed (Borenstein et al., 2009).

To determine the appropriate model, Q and I^2 tests were conducted. If the Q test is statistically significant ($p < 0.05$), heterogeneity exists among studies. I^2 measures the percentage of total variation due to true effect size differences; values above 75% indicate high heterogeneity, warranting random-effects models when Q is significant, otherwise fixed-effect models are appropriate (Higgins et al., 2003).

The Q test for error pruning was significant, $Q(63) = 162.40$, $p < 0.001$, indicating heterogeneity among effect sizes. The I^2 value was 61.21%, approaching the high heterogeneity threshold of 75%, meaning 61.21% of observed variation was due to true effect size differences and 38.79% to random error. This indicates substantial between-study heterogeneity, so we adopted a random-effects model. Additionally, effect size heterogeneity suggests potential moderating variables influencing collaborative effects on error pruning, necessitating further moderator analysis.

Since this study also meta-analyzed collaborative retrieval effects, we conducted Q tests on standardized mean differences between nominal and collaborative groups for correct recall. Results were significant, $Q(63) = 203.52$, $p < 0.001$, with $I^2 = 69.04\%$, again approaching the high heterogeneity threshold. This indicates heterogeneity among effect sizes for collaborative retrieval and substantial between-study variation.

3.1 Main Effect Analysis

This meta-analysis included 38 studies (7 Chinese, 31 English) with 64 independent effect sizes and a total sample of 6,225.

The main effect of collaboration on error pruning was significant, $Z = 11.89$, $p < 0.001$, with an effect size of 0.74 (Figure 4 [Figure 4: see original paper]). According to Cohen's (1992) criteria for effect size d (large: 0.8, medium: 0.5, small: 0.2), this represents a large effect size. Additionally, the main effect for

collaborative retrieval was significant, Z = –10.11, p < 0.001, with an effect size of –0.71, indicating collaborative inhibition. See Table 2 for details.

Sensitivity analyses showed that after excluding any single study, total effect sizes for error pruning and collaborative retrieval fluctuated between 0.72–0.76 and –0.72 to –0.68, respectively. These results indicate robust and stable error pruning effects in the included studies, along with collaborative inhibition effects. Therefore, Hypotheses 1 and 2 are supported.

3.2 Moderator Analysis

Subgroup analysis for collaborative approach (free recall, consensus building, and turn-taking) was significant, Q(between) = 45.00, p < 0.001. This indicates that collaborative approach significantly moderates error pruning: free recall (g = 0.77) and consensus building (g = 0.90) showed significant error pruning effects, whereas turn-taking (g = –0.05) did not (p = 0.360). Thus, Hypothesis 3 is supported. Collaborative approach did not significantly moderate collaborative retrieval, Q(between) = 3.74, p = 0.154.

Material type (episodic materials, categorized items, and uncategorized items) did not significantly moderate error pruning, Q(between) = 3.89, p = 0.143, so Hypothesis 4 was not supported. However, material type significantly moderated collaborative retrieval, Q(between) = 10.29, p = 0.006. Episodic materials showed the strongest collaborative inhibition (g = –0.83), followed by categorized items (g = –0.62) and uncategorized items (g = –0.47).

For relationship type moderation on error pruning, three studies with mixed relationship types were excluded. Based on relationship characteristics and study counts, married couples and friends were combined into a familiar relationship category, yielding 61 effect sizes for familiar and stranger relationships. Results showed marginally significant moderation by relationship type, Q(between) = 3.07, p = 0.067. The effect size for familiar relationships (g = 0.85) was higher than for stranger relationships (g = 0.68), indicating that familiar relationships facilitate error pruning. Therefore, Hypothesis 5 is supported. Additionally, relationship type significantly moderated collaborative retrieval, Q(between) = 9.79, p = 0.005. Stranger relationships (g = –0.73) showed significantly stronger collaborative inhibition than familiar relationships (g = –0.48). See Tables 3 and 4 for details.

4.1 Stability and Mechanisms of Error Pruning

Main effect results demonstrate that error pruning is a stable effect in collaborative memory. Analysis of collaborative retrieval effect sizes also yielded consistent results with Marion et al.'s (2016) meta-analysis, showing stable collaborative inhibition across these studies. Collaboration simultaneously reduces both correct and erroneous recall, highlighting the advantages of collaboration in memory retrieval. Previous research has primarily used the retrieval strategy disruption hypothesis to explain collaborative retrieval effects dominated

by collaborative inhibition, but this hypothesis lacks explanatory power for our finding that collaborative inhibition co-occurs with reduced error rates, and previous studies often ignored error pruning when explaining collaborative inhibition (Blumen et al., 2014; Harris et al., 2017; Pepe et al., 2021).

As noted, stable error pruning in collaborative retrieval primarily stems from group members identifying errors in their own and others' recall through communication and mutual cuing (Maswood et al., 2022). Our finding that collaboration reduces both erroneous recall (error pruning) and correct recall (collaborative inhibition) suggests that communication, feedback, and cuing among group members are more effective for deleting erroneous items than for correctly retrieving old items. This is because deleting errors during item retrieval primarily involves judging the correctness of others' recall outputs, requiring only familiarity-based processing (feeling of knowing, FOK) that is less affected by retrieval strategies (Isingrini et al., 2016). Furthermore, in most collaborative memory retrieval tasks across studies, regardless of collaborative approach, recall rather than recognition tasks were used, especially for episodic materials (Nie et al., 2021; Thorley, 2018). That is, collaborative retrieval effect indicators are primarily based on recall of old items requiring high-level encoding and strategic processing, making them more vulnerable to strategy disruption during collaborative retrieval.

4.2.1 Moderating Effects of Collaborative Approach

Meta-analytic results show that collaborative approach significantly moderates error pruning. Free recall and consensus building produced stable error pruning effects, whereas turn-taking did not.

Differences in collaborative retrieval approaches essentially reflect different modes of communication and interaction among group members. Both free recall and consensus building involve discussion among members, while turn-taking does not. As noted, member communication is more effective for error deletion, whereas turn-taking restricts communication, prevents verbal correction of partners' errors, and increases individual pressure, raising the probability of erroneous information intrusion (Thorley et al., 2007).

However, collaborative approach did not significantly moderate collaborative retrieval effects, with stable collaborative inhibition occurring across all approaches. Previous experimental studies have reported similar results, such as comparable effects of free recall and turn-taking on collaborative inhibition (Thorley et al., 2007) and both consensus building and turn-taking significantly strengthening collaborative inhibition (Harris et al., 2012). Marion et al.'s (2016) meta-analysis, however, found that turn-taking produced stronger collaborative inhibition than free recall, a result that may differ from ours due to our inclusion of consensus building as a collaborative approach. Consensus building only emphasizes final agreement on recall outputs, which generally promotes deeper processing of item retrieval (Harris et al., 2012), but in practice, groups may

adopt approaches closer to turn-taking or more similar to free recall. Thus, including consensus building in our meta-analysis may have reduced differences between free recall and turn-taking in collaborative inhibition magnitude.

4.2.2 Moderating Effects of Material Type

Subgroup analyses showed that material type did not significantly moderate error pruning, indicating stable and similar strength of error pruning across material types.

Previous research lacks direct comparisons of error pruning across different material types. However, even for the same material type, particularly episodic materials, multiple collaborative memory studies have yielded different error pruning results. For example, some studies found that collaboration improved recall accuracy for story materials (Bärthel et al., 2017), while others using the same materials found no accuracy differences between collaborative and nominal groups (Vredeveldt et al., 2018), and Thorley (2018) found no significant error pruning using crime-related films. These findings at least suggest that error pruning is weakly associated with specific material types.

Combined with our finding of no material type differences in error pruning, we speculate that the mechanism lies in different encoding cues used by different material types: episodic material retrieval primarily relies on episodic cues, while categorized items have category cues absent in uncategorized items. However, as noted, error pruning is achieved through "error rejection," primarily based on familiarity judgments of partners' recall outputs, which is less associated with different retrieval cues across material types, thus showing consistency across materials.

Our meta-analysis of collaborative retrieval effects, however, showed significant moderation by material type. Compared with categorized and uncategorized items, episodic materials enhanced collaborative inhibition, producing the lowest correct recall rates. Earlier meta-analytic research found that episodic materials weakened collaborative inhibition, with researchers attributing this to the clear internal logical structure of episodic materials leading to similar encoding and retrieval strategies and thus minimal strategy disruption (Marion et al., 2016). By the same logic, if episodic materials have complex plots, rich details, or high self-relevance, they require more elaborate encoding and diverse retrieval strategies (Harris et al., 2017; 张环 et al., 2021), making collaborative inhibition more likely (Vredeveldt & Van Koppen, 2018). Overall, collaborative retrieval effects for episodic materials may depend on specific characteristics such as plot complexity and information load rather than material type per se.

4.2.3 Moderating Effects of Relationship Type

Subgroup analyses revealed that relationship type significantly moderated error pruning. Error pruning effects were stronger in familiar relationship groups

than stranger groups, indicating that relationship type is an important factor influencing error pruning.

In collaborative memory, the key factor underlying relationship type is differences in communication, feedback patterns, and strategies resulting from familiarity. According to transactive memory theory, familiar group members better understand each other's knowledge bases and retrieval strategies, including common errors during information retrieval, enabling more effective, targeted communication that enhances overall collaborative memory capacity and makes error pruning more pronounced (Meade & Roediger, 2009). For example, research shows that familiar relationship members use more communication strategies during joint retrieval, including elaboration, correction, confirmation, and restatement, promoting shared attention to relevant information (Selwood et al., 2020).

Regarding collaborative retrieval effects, relationship type also significantly moderated results. The direction of moderation was consistent with error pruning: stranger relationships showed the strongest collaborative inhibition, while friends and married couples showed weaker effects, though collaborative inhibition did not disappear entirely. This aligns with Marion et al.'s (2016) meta-analysis showing that relationship type moderates collaborative retrieval, with stranger relationships showing stronger inhibition than familiar relationships.

4.3 Limitations and Future Directions

This study has several limitations: (1) Meta-analyses require comprehensive literature inclusion, but some collaborative memory studies did not record collaborative group error quantities (error rates), preventing their inclusion, and some unpublished literature could not be obtained, resulting in data omissions. (2) Some subgroups had substantially different numbers of effect sizes, which may influence results; confirmation of subgroup analysis stability awaits more studies in relevant subgroups. (3) Many factors influence collaborative retrieval and error pruning, but due to limited numbers of included studies, this meta-analysis only examined three factors: retrieval approach, material type, and interpersonal relationship type; other potential moderators were not included.

This meta-analysis of error pruning in collaborative retrieval preliminarily clarifies the stability and main moderators of error pruning. Some studies have found that arranging for collaborative group members to recall individually after a delay following collaborative recall (i.e., secondary retrieval) may produce "post-collaborative benefits" where more correct items are recalled than nominal groups (Nie et al., 2021). Researchers attribute this to relearning of items through partners' recall during the collaborative (primary retrieval) phase (Congleton & Rajaram, 2011), while others explain this memory rebound through release from strategy disruption (Blumen & Rajaram, 2008). Future meta-analytic research could examine whether error pruning effects also appear in secondary retrieval for collaborative versus nominal groups and their relationship with pri-

mary retrieval error pruning and collaborative retrieval effects, exploring the continuity and stability of error pruning effects to provide evidence for determining the processing mechanisms through which collaboration affects memory retrieval quality.

Our meta-analytic findings indicate: (1) Error pruning is a relatively stable effect in collaborative retrieval, often accompanying collaborative inhibition. Error reduction in collaborative retrieval depends on conditions for error pruning, which primarily involves source judgments of partners' recall as "old items" or "false memories" based on familiarity processing; collaborative retrieval effects depend on strategy-based recall requiring higher processing levels. (2) Free recall and consensus building produce greater error pruning than turn-taking, as these approaches facilitate familiarity judgments and sufficient communication about partners' recall. (3) Error pruning effects are not influenced by material type because retrieval across different material types is less sensitive to processing levels and strategies. (4) Familiar relationships enable members to better understand each other's retrieval errors and correct them more effectively, enhancing error pruning effects.

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How Collaboration Reduces Memory Errors: A Meta-Analysis Review

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Abstract

In collaborative memory, the memory performances of collaborative and equal-sized nominal groups were measured by the number of correctly recalled items. By comparing the correct recall results between the two groups, collaboration during the retrieval phase is seen to possibly result in collaborative inhibition and collaborative facilitation. However, recall error items were also essential indicators of collaboration. Several studies have considered error recall items as indicators to show that collaboration is beneficial in reducing errors. The phenomenon of collaborative groups recording significantly fewer recall errors than nominal groups is referred to as the "error pruning effect." The mechanisms and moderators of the collaborative inhibition effect have been explored in several previous studies, but evidence on the mechanism of the "error pruning effect" is scarce. This meta-analysis aimed to investigate the robustness of error pruning in collaborative memory and to examine the potential mechanisms and moderators.

Studies were identified with several keywords, including "collaborative memory," "collaborative recall," "collaborative inhibition," and "collaborative facilitation." English language databases, including Web of Science, Science Direct, EBSCO, and ProQuest, as well as the Chinese language database CNKI, were searched. From 38 empirical studies (from a total sample N = 6,225), 64 independent samples were included. We chose the random-effect model to conduct the meta-analysis using CMA3.3. The 64 independent samples showed considerable heterogeneity. Moreover, no substantial publication bias was found in the studies, which was confirmed by the funnel plot, fail-safe number, and trim and fill methods.

Standardized mean differences measured by Hedges' g were used as the effect size index in the meta-analysis. The main effect showed a large and robust error pruning effect and collaborative inhibition effect in the results. Moreover, the results indicated that the collaborative inhibition effect commonly accompanies the error pruning effect. Further analysis revealed that collaborative approaches and interpersonal relationships moderate the error pruning effect. In particular, collaboration of free-flowing and consensus building enhanced the error pruning effect, while collaboration had no significant effect on the inhibition effect. The

type of material had no significant effect on error pruning, while story material increased collaborative inhibition. Familiar relationships increased the error pruning effect, but they weakened collaborative inhibition.

Overall, the study results demonstrated the effect of collaborative recall on inhibiting error and improving accuracy. Collaboration and interpersonal relationships may act as important moderating variables in the process. Although error pruning resulted from a feeling of knowing through recall from collaborative partners, it required a relatively low level of processing. Lastly, efficient error correction could be easily achieved through sufficient communication.

Key words: collaborative memory, meta-analysis, error pruning, collaborative inhibition, moderating effect

Note: Figure translations are in progress. See original paper for figures.