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Title:

Does Retrieval Strategy Disruption Cause General and Specific Collaborative
Inhibition?

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Abstract

The purpose of the experiment on collaborative memory was to investigate if the collaborative inhibition is due to collaborating pair's disruption of each others' retrieval strategies (the retrieval strategy disruption hypothesis, RSD). The participants' ($N = 36$) task was to recall a list of 60 words individually and collaboratively. Retrieval strategies were manipulated by presenting word lists organized either by categories or by country of origin and adoption of retrieval strategies were examined by the adjusted ratio of clustering score. Half of the dyads received word lists organized by the same strategy and half of the dyads received word lists organized by different strategies. The results revealed a main effect of collaboration, i.e. collaborative recalled items were significantly fewer than the sum of the non-redundant individually recalled items. Both conditions (same strategies vs. different strategies) suffered to the same extent from collaboration, which did not support the RSD hypothesis. However, focusing on words recalled individually but not collaboratively, dyads with different strategies, as predicted by the RSD, forgot more items during collaboration than did dyads with the same strategy. Additional results suggest that collaborative forgetting is mainly manifested by forgetting of non-overlapping items (as measured by individual recalls).

Does Retrieval Strategy Disruption Cause General and Specific Collaborative Inhibition?

Research on memory has traditionally studied individuals recalling alone. In real life, however, people often recall together with others. Recognizing this, researchers have started to take interest in memory as a group activity. For example, in an attempt to examine the social facilitation of memories, Meudell, Hitch and Kirby (1992) had subjects recall twice; the first time individually and the second time either in dyads or individually. The results were the same in all four experiments; two people recalling together do not produce more new items (i.e. items recalled in the second but not in the first recall) than individuals do alone, suggesting that collaboration may not have a facilitating effect on recall. On the contrary, several studies have reported an – in terms of quantity – *inhibiting* effect of collaboration on recall. Thus, compared to the nominal recall (i.e. non-redundant recall of n individuals recalling alone) the collaborative recall (i.e. recall from an n -sized group) often does not reach the same level of performance (e.g. Andersson & Rönnerberg, 1995; 1996; 1997). This inhibiting effect, which is the topic of this paper, is called *collaborative inhibition* (Weldon & Bellinger, 1997) or the *net negative effect of collaboration* (e.g. Andersson & Rönnerberg, 1997).

Presence of collaborative inhibition

The phenomenon of collaborative inhibition is fairly robust and has been observed in groups consisting of two (e.g. Andersson & Rönnerberg, 1996), three (e.g. Weldon & Bellinger, 1997), as well as four individuals (e.g. Basden, Basden & Henry, 2000). It has also been observed in different ages; for children (e.g. Andersson, 2001), adults (e.g. Andersson & Rönnerberg, 1995; Meade & Roediger, 2009), as well as for elderly people (e.g. Ross, Spencer, Linardator, Lam & Perunovic, 2004). It has also been observed for experts

versus non- experts by Meade, Nokes & Morrow (2009) who showed that experienced pilots showed a benefit of collaboration while non-pilots and novices were relatively disrupted by collaboration when recalling presented aviation scenarios. Further, it has also been shown that friends sometimes suffer less from collaboration than non-friends do (Andersson, 2001; Andersson & Rönnerberg, 1995; 1996).

Collaborative inhibition has been found with a range of different stimuli including for example categorized sets of words (Basden, Basden, Bryner & Thomas III, 1997), unrelated words (Finlay, Hitch & Meudell, 2000), lists of words semantically associated to critical lures (Thorley & Dewhurst, 2007), stories (Andersson & Rönnerberg, 1995; Takahashi & Saito, 2004; Weldon & Bellinger, 1997), a videotaped lecture (Andersson & Rönnerberg, 1995), a short clip from a movie (Ekeocha & Brennan, 2008), and pictures (Finlay et al., 2000; Weldon & Bellinger, 1997).

The effect has been shown in different types of memory tasks. This includes prospective memory tasks as well as retrospective memory tasks including episodic memory tasks (Johansson, Andersson & Rönnerberg, 2000). Collaboration does not; however, seem to influence performance in tasks tapping implicit memory (Andersson & Rönnerberg, 1996) or in semantic tasks (Andersson & Rönnerberg, 1996; Johansson, Andersson & Rönnerberg, 2005). Performance seems to be affected by collaboration both when learning has been intentional as well as incidental (Finlay et al., 2000; Weldon & Bellinger, 1997). Although mostly studied in the laboratory, collaborative inhibition has also been reported in a more ecological setting where older participants attempted to recall items from shopping lists while shopping in a supermarket (Ross et al., 2004).

Theories of collaborative inhibition

In a series of five experiments, Weldon, Blair and Huebsch (2000) examined the role of motivational factors in collaborative memory by using for example monetary incentives, increasing personal accountability, or increasing group cohesion. As inhibition was not eliminated, it was concluded that motivational factors play little if any role in collaborative inhibition.

The *retrieval strategy disruption hypothesis* (RSD) has received a relatively great deal of attention in the literature on collaborative inhibition (Harris, Paterson & Kemp, 2008). According to RSD, collaborative recall is inhibited because hearing recall of others interferes with one's own retrieval strategy. Thus, the group deficit is due to "the presence of responses of others in a non-optimal order" (Basden et al., 1997, p. 1177). The order is thought to be non-optimal because people have more or less idiosyncratic strategies (Basden et al., 1997). This explanation is rooted in research on the so called part-list cuing effect, which has shown that presentation of target items during recall impairs recall of the remaining targets (e.g. Sloman, Bower & Rohrer, 1991).

There is some evidence to support RSD. Wright and Klumpp (2004), employing a turn-taking procedure where collaborators recall one item at a time, compared recall performance of groups where recall was either overt or covert. The result showed that inhibition was observed only for groups with overt recall. This is in accordance with the assumption of RSD that inhibition is caused by the exposure of overtly recalled items. Basden et al. (1997; 2000) also provided evidence in support of RSD using a similar turn-taking procedure. It could however be argued that it is unclear what these three studies have to say about collaborative recall, since the collaboration in such turn-taking procedures can be questioned.

Finlay et al. (2000) conducted three experiments to test the plausibility of RSD without employing a turn-taking procedure. In the first experiment it was shown that dyads who encoded together produced more similar individual recall – suggesting more similar retrieval strategies – compared to dyads who encoded individually, and that groups suffered from collaboration only when they had encoded individually. In the second and third experiments, recalling dyads were shown the words either in the same or in different order at encoding. Results suggest that when participants were presented with words in the same order individual recalls were more alike and the collaborative inhibition was smaller compared to when participants were presented with words in different order.

Another possible explanation, suggested by Diehl and Strobe (1987, 1991), and also shown by Andersson, Hitch, and Meudell (2006), is that “production blocking” processes impair group performance. Production blocking occurs when a group member tend not to speak while others are speaking and therefore may forget what they were going to say when finally the opportunity comes.

Most studies on collaborative inhibition calculate collaborative recall as correctly recalled items as compared to the stimulus material. When in the next step calculating the collaborative inhibition (nominal score minus collaborative score), items that are forgotten from nominal recall as well as items recalled only during collaborative recall, influence the result. Collaborative inhibition in that sense will include true collaborative inhibition (the collaboratively forgotten items) as well as true collaborative excitation (the items correctly recalled collaboratively but not otherwise). In this study, the term general collaborative inhibition will refer to the sum of true collaborative inhibition and true collaborative excitation, while the term specific collaborative inhibition will refer only to the true collaborative inhibition.

To conclude, although some findings lend support to the RSD hypothesis, more evidence is needed before it can be concluded that collaborative inhibition, general as well as specific, is (partly or wholly) due to collaborators disrupting each other's retrieval strategies. The aim of the present study was to test the RSD hypothesis by manipulating the similarity of retrieval strategies and thus the degree to which collaborators disrupt each other's strategies. Another aim was to examine whether overlapping (i.e. target items recalled by both members in a dyad during individual recall) and non-overlapping items differ in likelihood of being recalled during collaboration.

Methods

Participants

Thirty-eight students were recruited. Participants in one of the dyads discovered that they had been presented with different types of word lists, and were therefore excluded from the study. This meant that 36 students (10 males and 26 females) with a mean age of 23.92 ($SD = 4.84$) were included in the study. The task was completed in pairs (dyads) and all but one of participating dyads signed up as a pair.

Tasks and Material

The task was to recall word lists both individually and collaboratively in a dyad. Retrieval strategies were manipulated by presenting word lists organized either by categories or by country of origin. Each participant was presented with the same 60 words. The words were names that were linked to one of nine different countries (Denmark, England, France, Germany, Italy, Russia, Spain, Sweden, USA) and at the same time to one of nine different categories (Athletes, Authors, Brands, Cars, Dishes, Models, Music bands, Politicians, Sports teams). A pilot study where 14 students or former students were instructed

to type down the first example that came to their mind of each of the 81 different combinations of country of origin and categories resulted in 60 words that were mentioned by at least three students. For example, ‘tapas’ was chosen to represent a Spanish dish, ‘meatballs’ was chosen to represent a Swedish dish, ‘FC Barcelona’ was chosen to represent a Spanish sports team, but there was no Swedish sports team mentioned at least three times. In the main study experiment there were four word lists that each contained the 60 words from the pilot study; two word lists organized by categories and two word lists organized by country of origin. The nine countries of origin or the nine categories were organized in blocks as a 3x3 table on an A4 sheet of paper. Each such block contained five words (German words, models) to eight words (e.g. English words, authors). The order of the blocks and the order of the words within each block were randomized for each of the four word lists. Half of the dyads received word lists organized by the same strategy and half of the dyads received word lists organized by different strategies. The distribution of the four word lists was balanced over dyads. When participants within a dyad were provided with similar manipulations, the word lists were always of different randomized order. A4 sheets of paper with two columns containing lines numbered 1-21 (first column) and 22-42 (second column) were used as recall protocols.

Procedure

Participants were organized into pairs and each pair was sitting opposite each other during the test. They were informed that they were to be presented with a list of words to be recalled twice and were thereafter handed a paper presenting the same 60 target items to be studied for three minutes. After a three minutes mathematical distraction task, participants were asked to individually write down as many as possible of the previously presented items (in any order they liked, but starting to write them down on line 1, continuing with line 2, and

so on) in five minutes. Another three minutes mathematical distraction task was followed by a five minutes recall, this time undertaken collaboratively. For the collaborative recall, participants were asked to sit next to each other and one participant was given the role of secretary (secretary appointments were balanced over the dyads). No specific instructions were given on how to collaborate or how to solve disagreements.

Measures and Scoring

The number of correctly remembered items for individual recall was measured both for the individuals and for the dyads. Nominal recall refers to the number of target items recalled during individual recall by at least one individual in the dyad. Collaborative recall was measured both generally and specifically. General collaborative recall refers to the total number of correctly recalled items that were presented in the original lists. Specific collaborative recall refers to the total number of correct recalled items that were also present in nominal recall.

For each dyad, recalled items were also classified as non-overlapping (i.e. only one person recalled it during nominal recall) or overlapping (i.e. both persons recalled it during nominal recall). Recalled items were regarded as correct even if misspelled or incomplete (e.g. “Fjodorr” was regarded as a correct recall of the target item “Fjodor Dostojevskij”).

To investigate the adoption of retrieval strategy, the adjusted ratio of clustering (ARC) score (Roenker, Thompson & Brown, 1971) was used. The ARC score represents the proportion of actual block repetitions (e.g. repetitions of words belonging to the same country of origin) above chance. Words were pair wise examined in the order recalled and ARC scores were calculated, once for categories and once for countries of origin, both for individual and collaborative recall, resulting in six ARC score measures for each dyad (i.e.

three ARC scores for categories – one for each participant's individual recall and once for collaborative recall – and three ARC scores for countries of origin – again one for each participant's individual recall and once for collaborative recall).

Each participant's individually preferred strategy was identified by the largest ARC score, comparing categories with countries of origin, and in case of identical ARC scores the type of word-list presented was chosen as the strategy. Thereafter each dyad was classified as similar or different depending on whether the participants adopted similar or different strategies during individual recall.

Design

Collaborative inhibition, defined as nominal recall minus collaborative recall, and RSD were examined by a 2×2 mixed ANOVA, using type of recall (nominal vs. general collaborative recall) as within-subjects variable and preferred strategy used (same vs. different) as between-subjects variable. In the present design, a main effect of type of recall should be interpreted as a significant collaborative inhibition. A significant interaction showing no significant differences in nominal recall but significant differences in collaborative recall should be interpreted as support for the RSD hypothesis. The ANOVA was also repeated with specific collaborative recall instead of general collaborative recall.

The amount of overlapping items being recalled were examined by a 2×2 within-subjects ANOVA, using type of recall (nominal vs. specific collaborative recall) as the first within-subjects variable and type of item (non-overlapping vs. overlapping) as the second within-subjects variable. Different amounts of recalled items being overlapping or non-overlapping might be expected, but if some of them are more easily forgotten it should be shown by a significant interaction, for example showing that non-overlapping words are more easily forgotten than overlapping words.

To investigate if word difficulty confounded the results, frequencies of recall for different words were examined by ANOVA. Finally, to compare how strategies were adopted within and between different dyads a series of ANOVAs were performed using type of recall (nominal vs. general collaborative) as independent within-subjects variable.

Results and Discussion

Manipulation

The manipulation of which strategy to use was successful. The preferred strategy corresponded to the type of word list presented for 34 out of the 36 participants. Data is presented for the strategy actually preferred, but the pattern of significant results was similar when data was categorized according to the manipulated strategy.

The dyads were divided into two different groups based on if they had the same or different strategies preferred at individual recall, and means and standard deviations for ARC scores were calculated at individual and collaborative recall (Table 1). The strategy used at collaborative recall was the same as individual recall if both persons within the dyad had the same strategy at individual recall. If they used different strategies at individual recall, the category strategy was preferred at collaborative recall.

Table 1

Mean values for adjusted ratio of clustering (ARC) scores for individual (country of origin (country) and for category for the dominant strategy used) and general collaborative recall (for dyads with different combinations of strategies used individually; similar country, similar category or different strategies).

Strategy and type of recall	<i>n</i>	ARC score Country	ARC score Category
Individual			
Country	17	.51 (.23)	.04 (.12)
Category	19	-.09 (.10)	.74 (.20)
General collaborative			
Similar Country	4	.63 (.29)	-.04 (.05)
Similar Category	5	-.09 (.03)	.85 (.11)
Different	9	-.01 (.07)	.67 (.22)

Note. Standard deviations are in parentheses.

Retrieval Strategy Disruption and Collaborative Inhibition

Means and standard deviations for recall were calculated for individuals whose preferred strategy was preserved from individual to collaborative recall (Table 2).

There was a significant main effect for type of recall (comparing nominal with general collaborative recall), $F(1, 16) = 13.14, p < .01, r = .67$, with a higher nominal than collaborative recall. In other words, there was a significant general collaborative inhibition effect. There was however no significant interaction. This indicates that dyads with different strategies overall were not more negatively affected by collaboration than were dyads with same strategies. The RSD hypothesis could not be supported by these results. Replacing

Table 2

Mean values for nominal recall, overlapping items, and collaborative recall (general and specific) for dyads with same or different dominant strategies used within the dyad at individual recall.

Dominant strategy	Type of recall			
	Overlapping		General	Specific
	Nominal	items	Collaborative	Collaborative
Same	41.78 (3.60)	12.78 (3.03)	40.44 (4.75)	38.44 (4.25)
Different	38.22 (4.38)	12.89 (3.59)	36.33 (5.48)	33.11 (4.91)

Note. Standard deviations are in parentheses.

general collaborative recall by specific collaborative recall there was still a significant main effect for type of recall, $F(1, 16) = 132.02, p < .001, r = .94$, with a higher nominal than collaborative recall, showing a significant inhibition effect. There was also a significant main effect for the strategy used, $F(1, 16) = 4.95, p < .05, r = .49$, showing a higher performance when participants preferred the same strategy, as well as a significant interaction, $F(1, 16) = 5.85, p < .05, r = .52$. Examining the simple main effects there was a higher performance when the same strategies were adopted. That yielded for collaborative recall, $F(1, 16) = 105.33, p < .001, r = .93$, as well as for nominal recall, $F(1, 16) = 46.81, p < .001, r = .86$. Dyads with different strategies had a significantly weaker performance for specific collaborative recall than for nominal recall, $F(1, 32) = 6.33, p < .05, r = .41$, while there were no significantly weaker performance in specific collaborative recall than for nominal recall for dyads with same strategies. This can be interpreted as support for the RSD hypothesis.

The differences between the results concerning general and collaborative recall in relation to strategy composition in dyads (similar or different) can be explained by the new

generated words included in the general collaborative recall measure. Examination of new words generated collaboratively showed a non-significant tendency that new items are more easily generated in dyads with different strategies preferred individually, on average 3.2 ($SD = 2.2$) words, than in dyads with different strategies preferred individually, on average 2.0 ($SD = 1.4$) words, $t(16) = 1.39, p = .18$. In summary, the results showed that while dyads with the same as well as different preferred strategies both suffered from collaboration, there was no significant difference in amount of general collaborative inhibition. This is not consistent with the RSD hypothesis. On the other hand, the specific collaborative inhibition effect was significantly larger for dyads with different, as compared to dyads with the same, preferred strategies. This is consistent with the RSD hypothesis. Strategy composition in dyads (similar or different) has an effect on collaborative recall. Words are more easily forgotten, but there is also a tendency that new words are more easily generated, when participants in a dyad have different strategies, as compared to similar strategies, preferred individually.

Overlapping vs. Non-overlapping Target Items

Means and standard deviations for overlapping items (both participants recalled the word at nominal recall) divided on nominal and general collaborative recall are presented in Table 3.

The main effects were significant both for type of recall, $F(1, 17) = 102.71, p < .001, r = .93$, with a higher performance in nominal recall, again showing a significant inhibition effect, and for type of item, $F(1, 17) = 93.93, p < .001, r = .92$, showing a larger amount of unique than overlapping items (Table 3).

There were also more non-overlapping items than overlapping items, for nominal, $F(1, 34) = 120.20, p < .001, r = .88$, as well as for collaborative recall, $F(1, 34) = 66.57, p < .001, r = .81$, and also a significant interaction between type of recall and type of

item, $F(1, 17) = 73.46, p < .001, r = .90$. Examination of simple main effects revealed no significant difference between the amount of overlapping items in nominal and collaborative recall, but non-overlapping items were significantly lesser recalled collaboratively than nominally, $F(1, 34) = 174.53, p < .001, r = .91$. This suggests that collaborative inhibition is mainly manifested by failing to (collaboratively) recall non-overlapping items, in this study measured in nominal recall.

Table 3

Mean values for recall frequencies for non-overlapping and overlapping items during nominal and general collaborative recall.

Type of item	Type of recall	
	Nominal	General
Non-overlapping	27.17 (3.71)	23.22 (4.28)
Overlapping	12.83 (3.22)	12.56 (3.35)

Note. Standard deviations are in parentheses.

Strategies

Means and standard deviations for ARC scores depending on strategies adopted and strategy domination are presented in Table 4.

Table 4

Adjusted ratio clustering (ARC) scores for preferred strategies. Mean values for individual and general collaborative recall depending on strategies adopted within dyad (same or different), and depending on strategy deciders (preserving strategy from individual to collaborative recall) or strategy followers for dyads with different strategies adopted as well as for all dyads (any).

Strategy	<i>n</i>	Type of recall	
		General	
		Individual	Collaborative
Same	18	.62 (.21)	.21 (.39)
Different	18	.64 (.26)	-.05 (.09)
Strategy decider ^a	9	.79 (.19)	-.09 (.07)
Strategy follower	9	.48 (.24)	.00 (.08)
Any			
Strategy decider	27	.68 (.21)	.73 (.21)
Strategy follower	9	.48 (.24)	.00 (.08)

Note. Standard deviations are in parentheses.

^aAll strategy deciders adopted to the category strategy during individual recall.

The series of ANOVAs to compare how strategies were adopted within and between different dyads all used ARC score for the individually preferred strategy as dependent variable and type of recall (individual vs. general collaborative) as independent within-subjects variable. In the first ARC score ANOVA, dyads with participants adopting the same strategies were compared with participants adopting different strategies. There was a main effect of this

strategy homogeneity, $F(1, 34) = 6.88, p < .05, r = .41$, and also a significant interaction between strategy homogeneity and type of recall, $F(1, 34) = 19.72, p < .001, r = .61$.

Individuals in dyads with similar preferred strategies strengthened their preferred strategy collaboratively and individuals in dyads with different preferred strategies weakened their preferred strategy collaboratively.

In the second ARC score ANOVA, participants in dyads where different strategies were preferred at individual recall were examined. Nine participants were classified as strategy deciders (when the preferred strategy during individual recall was preserved during collaborative recall) and nine participants were classified as strategy followers (when the preferred strategy during individual recall was not preserved during collaborative recall). The results showed main effects for this strategy preference (decider or follower), $F(1, 16) = 54.19, p < .001, r = .88$, for type of recall, $F(1, 16) = 26.28, p < .001, r = .79$, and also an interaction effect, $F(1, 16) = 9.51, p < .01, r = .61$. In nominal recall, the individually preferred strategy used collaboratively was higher among strategy dominators. This shows that participants with a clear strategy tend to decide the strategy used during collaborative recall. Nevertheless, even though strategy deciders kept their preferred strategy during collaborative recall their ARC scores decreased, but not near as much as the ARC scores for the strategy followers' preferred strategy.

The third ARC score ANOVA focused on the strategy deciders no matter what strategy the other participant within the same dyad adopted. Strategy deciders within dyads where similar strategies were adopted (i.e. both participants in dyads where similar strategies were adopted) were then compared to strategy deciders within dyads where different strategies were adopted. There were no main effects but a significant interaction between type of recall and strategy homogeneity, $F(1, 25) = 5.38, p < .05, r = .42$. ARC scores were higher in collaborative recall when dyads had the same preferred strategy used nominally (ARC

scores of .63 to .75) and decreased for individuals whose collaborative recall partner had a different strategy adopted (ARC scores of .79 to .67).

In summary, dyads with participants adopting the same strategy during individual recall seem to strengthen the use of that strategy during collaborative recall. In dyads with participants adopting different strategies, the participant preserving the strategy from individual to collaborative recall has to weaken it due to collaboration.

Word Difficulty Aspects

There is a possibility that words that are easy to remember more often overlap in nominal recall than words that are difficult to remember. If so, it is not possible to argue that the loss of non-overlapping words during collaborative recall has to do with their non-overlapping character per se, since a possible reason would also be that it has to do with whether they are easy or difficult to remember. To rule out such possible confounding of word difficulty, all words were grouped into two groups with a median split on how many times a word had been recalled. A 2×2 within-subjects ANOVA using difficulty of item (easy-to-remember vs. hard-to-remember) as the first within-subjects variable and type of item (non-overlapping vs. overlapping) as the second within-subjects variable was calculated. The dyads did not show any significant differences according to difficulty of forgotten items, but again, a significant difference between overlapping and non-overlapping items was identified, $F(1, 17) = 61.95, p < .001, r = .89$. There was no significant interaction between word-difficulty and item-type. Excluding extremes and values close to the median yielded similar results. This means that word difficulty most likely did not cause the significant results reported in this study.

General Discussion

The first aim of this paper was to elicit if the retrieval strategy disruption hypothesis is correct in claiming that disruption of retrieval strategies is the reason for collaborative inhibition. If true, participants with more similar individual retrieval strategies would not be as negatively affected by collaboration as participants with less similar such strategies. The results, however, showed that while dyads with similar as well as different strategies adopted both suffered from collaboration, there was no significant difference in the amount of general collaborative inhibition. On the other hand, the specific collaborative inhibition effect was significantly larger when different strategies, as compared to similar ones, were adopted.

These different results between general and specific collaborative recall can be explained by the fact that specific collaborative inhibition focuses on what is forgotten during collaboration while general collaborative inhibition also includes new correctly recalled items. Since the RSD hypothesis tries to explain why forgotten items are forgotten during collaboration, explanation of collaborative inhibition in relation to RSD should focus on specific collaborative inhibition. When doing that, our results support the RSD hypothesis as an explanation for (specific) collaborative inhibition.

However, in contrast to specific collaborative inhibition, general collaborative inhibition focuses both on what is forgotten and on new correctly recalled items. General collaborative recall thereby includes two different effects on recall as compared to nominal recall; collaborative inhibition and collaborative excitation. When examining different causes of collaborative inhibition, the results will be blurred when the measures also include collaborative excitation. Studying the reasons for collaborative excitation was not a major aim in this study, nor can it be explained by the present study design. However, there was a tendency for a larger collaborative excitation when participants in dyads had different

strategies, as compared to similar strategies, preferred individually. This indicates that participants with different preferences tend not only to inhibit each other, but also to excite each other to generate new correctly recalled items.

In summary, when examining *general* collaborative inhibition, the hypothesis that RSD causes an inhibition effect was not supported, although there were tendencies pointing in this direction. On the other hand, the results suggest that the RSD hypothesis can explain the *specific* collaborative inhibition, (i.e. focusing only on the specific items recalled nominally). Differentiating between general and specific collaborative recall in future studies might shed some more light on specific parts underlying collaborative inhibition, i.e. not only the inhibition part (i.e. forgetting memories from first recall) but also on a possible excitation (i.e. production of new memories from original encoding), especially when participants in dyads have different recall strategies.

Support for the idea that retrieval strategy disruption underlies collaborative inhibition was provided by Basden et al. (1997) where participants used categorized sets of words. It was reported that recall was more organized by categories for individuals than for collaborative groups suggesting that participants abandoned their individual strategies during collaboration. The manipulation check in the present study supports those findings. Collaborative recall is more disorganized than individual recalls when strategies differ, but it also suggests that collaborative recall becomes more organized for strategy-homogeneous dyads. In the study by Basden et al. (1997) participants were not allowed to collaborate, but had to recall using a turn-taking procedure. Presumably, this procedure made it somewhat difficult for the collaborating group to adopt a common retrieval strategy. In contrast, participants in Finlay et al. (2000) and participants in the present study were allowed to undertake the collaborative recall as they saw fit. The results from the present study correspond with the results of Finlay et al. (2000). When participants used different strategies,

general collaborative inhibition showed a tendency to increase and specific collaborative inhibition was significantly larger. However, in all of the aforementioned three studies, there was collaborative inhibition for dyads with similar as well as different recall-strategies. This indicates that collaborative inhibition also includes causes not addressed by the RSD hypothesis.

The second aim was to examine differences in the likelihood of words, between overlapping and non-overlapping items in nominal recall, to be recalled collaboratively. Results revealed that the number of non-overlapping items decreased significantly during collaboration compared to nominal recall, but interestingly, the number of overlapping items did not. This suggests that collaborative inhibition is mainly manifested by failure to (collaboratively) recall non-overlapping items, as measured in nominal recall. The finding that overlapping items (in the present study) are not affected by collaboration is in line with previous studies showing that collaborative inhibition is absent for tasks tapping semantic memory (Andersson & Rönnerberg, 1996; Johansson et al., 2005). Andersson and Rönnerberg (1996) argue that episodic memory involves information more peculiar to the individual, whereas semantic memories are taken to be shared memories. Hence, episodic, but not semantic, retrieval relies on efficient cueing between participants, and this, they conclude, explains why semantic memory tasks are unaffected by collaboration. The present finding extends these results. We found that both semantic and episodic information is resistant to collaborative inhibition when shared (i.e. overlapping items). Blumen and Rajaram (2009) discuss two conflicting mechanisms that operate during collaborative retrieval (e.g. re-exposure and retrieval disruption) that are in line with this effect.

If collaborative inhibition is mainly due to non-overlapping items, the amount of redundancy is a factor to be taken into consideration when conducting, or reviewing, such studies. This is particularly true for quasi-experimental designs because it seems likely that

the amount of redundancy is related to group characteristics. More homogeneous groups, like friends rather than strangers, may be more inclined to remember the same things.

The amount of overlapping items in relation to non-overlapping items does matter, since more similar recall between individuals will, *ceteris paribus*, lower the nominal score, thus making it easier for collaborators to achieve their nominal score. Blumen and Rajaram (2008) designed a study of three consecutive recall trials where the first two trials involved different combinations of individual and collaborative recall and the third recall trial was undertaken individually. Their results indicated that there was a net negative effect of collaboration in the first recall. There was also a net negative effect of collaboration in the second recall, except for collaborative groups when participants had recalled in groups initially. The elimination of collaborative inhibition was due not to improved collaborative recall, but rather to a reduction in nominal recall. In turn, the reduced nominal score was not attributable to a reduced individual performance, as the individual levels did not differ in second recall between groups that recalled individually and groups that recalled collaboratively in the first recall trial. Instead, participants in the nominal groups produced more similar recall (i.e. more overlapping items). Thus, this example of elimination of collaborative inhibition is explained by an increased overlap in the (therefore reduced) nominal group recall.

The finding of the present study, paired with the example of the Blumen and Rajaram (2008), should illustrate the need to take redundancy directly into account when choosing a study design. It also points to the importance of reporting the amount of redundancy in nominal recall since such scores add transparency for readers and reviewers and might also prove useful in meta-analyses. Reporting individual scores has also been suggested by other researchers (e.g. Pavitt, 2003). The effect of redundancy needs to be studied in terms of false versus correct collaborative recalls (Ross et al., 2004; Takahasi,

2007) as well. Collaborating pairs seems to be able to reduce the number of falsely recalled items compared to nominal groups, which suggest a facilitated retrieval process in a sense.

A strength of the present study is that the ARC scores makes comparisons of strategies adopted nominally and collaboratively possible. One possible confounding factor underlying the effect of non-overlapping items on collaborative inhibition is the distribution of easy and difficult words recalled nominally. In this study, however, such confounding was ruled out since there was no significant difference in the amount of collaboratively forgotten items (recalled nominally) between easy and difficult words.

The within-subject design chosen does not control for possible reminiscence effects given two consecutive recall attempts. Studies measuring (general) collaborative inhibition using between-subjects designs include inhibition effects (inhibition of what participants would have recalled individually) as well as excitation effects (collaborative stimulations to help participants recall items they would not otherwise have recalled individually) of collaboration in the measures. The only way to separate those effects is to measure what individuals actually recall individually and compare it with what is recalled collaboratively. In other words, using a within-subjects design and defining specific collaborative inhibition as done in the present study. There is thereby a risk that the individual recall might introduce reminiscence effects. Earlier studies have explicitly studied the effect of reminiscence in collaborative recall and showed positive effects of consecutive recall attempts (Andersson & Rönnerberg, 1995). Even if the effect of reminiscence affected the obtained results in the present study, it would as a consequence only reduce the degree of collaborative inhibition. We have no reason to believe the settings in their study are not generalisable to the settings in our study, and thus, the design chosen here is even more conservative in obtaining negative effects of collaboration. Another strength of the within-subjects design is that measures of strategies are not based upon stimuli presented, but rather

upon actual strategies used individually and collaboratively. Finally, examinations of overlapping and non-overlapping items require a within-subjects design. We acknowledge that between-subjects designs cannot assess the amount of overlap and non-overlap from encoding, but nevertheless the effect of the distribution of overlapping and non-overlapping encoded and remembered items might perhaps show similar patterns as in the present within-subjects design study.

The sample was medium-sized with predominantly female students. Larger samples using more randomized sampling methods would possibly yield a more heterogeneous sample ruling out possible random confounders. One assumption is that the present sample is relatively homogeneous because all participants were students at University level, predominantly female, and that all of them but two signed up for the experiment as pairs. Assuming such similarity have implications for retrieval strategies, it is possible that strategies used during collaborative recall were influenced by such quasi-experimental properties. In the present sample, the category strategy was more easily adopted than was the country of origin strategy. Notably, the amount of overlapping and non-overlapping items recalled nominally was not manipulated in the present study, and there is therefore a need to further experimentally examine its causal effect on collaborative inhibition.

Conclusion

The hypothesis that retrieval strategy disruption causes collaborative inhibition was supported. When focusing on forgotten items during collaborative recall, collaborative inhibition was smaller when dyads had similar retrieval strategies adopted. When also including new correctly recalled items during collaborative recall, collaborative inhibition was still smaller when dyads had similar retrieval strategies adopted, but not significant. A major part of the collaborative inhibition was due to forgetting individually non-overlapping target

items. It is suggested to include measures of overlap in individual recall performances when results from studies on collaborative memory are reported. One implication of the present study is that future studies in collaborative memory should differentiate between specific and general collaborative recall and also include a measure of strategy disruption.

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