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# Elimination of collaborative inhibition effect using the Method of Loci

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## Abstract

**Background:** The disruption of retrieval strategies hypothesis (Basden, Basden, Bryner, & Thomas, 1997) has been identified as the main reason for the occurrence of the collaborative inhibition effect. This study aims to test this hypothesis applying the same retrieval strategy to all participants. **Method:** To accomplish this, we compared nominal and collaborative (pairs) performance in a serial recall task in two conditions: use of own strategy vs. use of the method of loci, in a classic experimental paradigm of collaborative memory. **Results:** Results revealed that endowing participants with the same strategy of coding and retrieval of information eliminates the collaborative inhibition effect. **Conclusions:** This result provides evidence for the hypothesis of the retrieval strategies disruption. The method of loci proved to be an effective mnemonic by increasing the amount of recalled information, both in the nominal and collaborative recall, when the information has to be recalled in the order that was presented.

***Keywords:*** Collaborative memory, collaborative inhibition, method of Loci, serial recall.

## Resumen

***Eliminación del efecto de inhibición de colaboración usando el Método de Loci.*** **Antecedentes:** la hipótesis de la interrupción de las estrategias de recuperación (Basden, Basden, Bryner y Thomas, 1997) ha sido identificada como la principal explicación del efecto de inhibición de colaboración. El objetivo del presente estudio era poner a prueba esta hipótesis, para lo cual se instruyó a todos los participantes a emplear una misma estrategia de recuperación. **Método:** concretamente, se compararon el rendimiento nominal y de colaboración (pares) en una tarea de recuerdo serial en dos condiciones (uso de la estrategia espontánea vs. uso del Método de Loci), en un paradigma clásico experimental de la memoria de colaboración. **Resultados:** los resultados revelaron que dotar a los participantes de la misma estrategia de codificación y recuperación de información elimina el efecto de inhibición de colaboración. **Conclusiones:** este resultado es consistente con la hipótesis de la interrupción de las estrategias de recuperación. Al parecer, cuando la información tiene que ser recordada en el orden en el que ha sido presentada, el Método de Loci aumenta la cantidad de información que se recuerda, tanto en el recuerdo nominal como en el recuerdo en colaboración.

***Palabras clave:*** memoria de colaboración, inhibición de colaboración, *Method of Loci*, recuerdo serial.

Over the last years, the study of human memory has focused not only on individual memory processes, but also on individual memory distortions (e.g., false memories). However, often we face the need to recall in collaboration, whether remembering with our family a past Christmas, recalling a special trip with some close friends, or reporting a crime or accident collectively witnessed. In this sense, recent memory studies have revealed a special interest on its collaborative aspects (Basden, Basden, Bryner, & Thomas, 1997; Rajaram & Pereira-Pasarin, 2010; Weldon & Bellinger, 1997). Collaborative memory can be understood as the act of remembering in group, which depends on and influences the dynamics and processes that underlie group functioning (Harris, Paterson, & Kemp, 2008).

Several studies have aimed to understand collaborative memory's benefits (e.g., Rajaram & Pereira-Pasarin, 2010), distortions (e.g., Saraiva, Albuquerque, & Arantes, 2015), and costs (e.g., Blumen & Rajaram, 2008), when compared with individual retrieval. Most studies on collaborative memory have focused on its cost to memory, showing that the biggest one is a phenomenon called collaborative inhibition. This phenomenon is characterized by lower performance in collaborative group's recall, when compared to the potential performance of the group members when they recall information individually, usually designated as nominal group (Weldon & Bellinger, 1997). The amount of information recalled by the nominal group is calculated based on the sum of non-repeated information retrieved by each member of the group.

Collaborative inhibition is a robust effect. This effect has been replicated independently of the number of the group members (e.g., Andersson & Rönnberg, 1996), type of recall (in free recall tasks the collaborative inhibition effect is more salient - Rajaram & Pereira-Pasarin, 2010), type of collaborative retrieval task (turn-taking modality produces more collaborative inhibition - Thorley & Dewhurst, 2007); age (e.g., Andersson, 2001; Meade & Roediger, 2009), and stimuli (e.g., Finlay, Hitch, & Meudell, 2000; Thorley & Dewhurst, 2007).

But why does collaborative inhibition effect occur? Production blocking is one of the possible explanations (Diehl & Strobe, 1987).

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Blocking occurs when, during a collaborative task, one participant cannot recall information while other participant is recalling, and the former forgets information that he otherwise would recall.

Another explanation was proposed by Weldon, Blair and Huebsch (2000), which aimed to understand whether motivational and social factors contribute to the collaborative inhibition effect. Thus they chose to increase the motivation levels of participants through monetary incentives, forcing recall, increasing personal responsibility of each group member, and group cohesion. But, again, collaborative inhibition effect was present, revealing the motivational and social factors are not enough to justify this phenomenon.

However, the most common and accepted explanation for collaborative inhibition effect is the disruption of retrieval strategies hypothesis proposed by Basden et al. (1997). That is, each individual has its own strategy to store appropriately information and, at the moment of recall, he or she uses this idiosyncratic organization to retrieve as much information as possible. When recall is collaborative, each group member uses their own retrieval strategies, but since strategies differ among group members this causes a retrieval disruption not allowing each group members to maximize their individual recall potential, resulting in the collaborative inhibition effect.

Two major facts have contributed to the acceptance of the retrieval disruption as an explanation for collaborative inhibition effect. Firstly, when the cues provided during recall are similar to those used at encoding and the participants are free to use their own retrieval strategies, collaborative inhibition is attenuated (e.g., Basden, Basden, & Stephens, 2002). Secondly, when collaborative recall takes place prior to individual recall, the inhibition turns temporary (Basden et al., 1997). In fact, if after a collaborative recall, the participants are asked to recall the same information individually, they usually recall information that were not able to recall as a group. This indicates that the interruption of retrieval strategies is temporary, i.e. this loss of information only takes place during collaborative recall (collaborative inhibition effect).

As the strongest justification for the occurrence of collaborative inhibition effect is the hypothesis of retrieval strategies disruption, we hypothesize that if the members of a collaborative group are trained with the same retrieval strategy, the collaborative inhibition effect disappears. This is the main goal of the present study.

To accomplish this aim, we decided to use the method of loci. Even considered one of the strongest mnemonics to enhance individual memory tasks (Yates, 1966), this mnemonic has never been used in collaborative memory tasks. This mnemonic consists in the presentation of a list of words to the participants. For each word, participants must create a mental image and associate it with a place (loci) along a route with several places. In the moment of retrieval, the participant mentally traverses the route, and for each place, elicits the image created and accesses the corresponding word (Pinto, 1991; Yates, 1966).

In this sense, we intend to train pairs of participants with the same mnemonic strategy – *Method of Loci* - and understand whether the collaborative inhibition effect disappears when participants apply the same strategy on collaborative recall. As retrieval strategies will be identical for all group members, there is no place to individual strategies disruption. It is well established that the association of images with words and/or events, produces higher levels of recall (Bower, 1970; Yates, 1966).

In sum, the main aims of this study are, therefore: (a) to understand whether the effect of collaborative inhibition is eliminated with mnemonic training; (b) and to contribute to the understanding of the mechanisms involved in collaborative inhibition, namely the retrieval strategies disruption.

## Method

### *Participants*

Fifty-six students from the University of Minho volunteered for this experiment and received course credits for their participation. Participants were randomly paired in 28 dyads that defined the collaborative groups (pairs). In this sample, 49 participants were female (89.2%) and 7 were male (10.8%) with an average age of 21.18 years (SD = 3.85).

### *Instruments*

The stimuli presented were two lists of 30 words each (see Table 1), selected from Marques (2005), with control for frequency, imagery and concreteness. The frequency was taken from the Portuguese database P-PAL entitled "The European Portuguese

*Table 1*
Values of imagery, concreteness, and frequency of the words presented (two sets (A and B)

| Word | Imagery | Concreteness | Frequency |
|---|---|---|---|
| **Set A** | | | |
| Screen | 4,92 | 6,30 | 1,71 |
| Hammer | 6,50 | 6,80 | 5,75 |
| Banana | 6,69 | 6,80 | 5,97 |
| Axe | 6,19 | 6,74 | 7,18 |
| Blade | 5,90 | 6,64 | 4,45 |
| Lock | 5,96 | 6,58 | 2,15 |
| Panic | 3,23 | 2,20 | 16,09 |
| Attic | 5,46 | 6,12 | 2,60 |
| Toaster | 6,42 | 6,82 | 0,29 |
| Mailer | 6,42 | 6,58 | 5,21 |
| Demon | 3,73 | 2,54 | 6,09 |
| Suitcase | 6,08 | 6,66 | 14,10 |
| Pliers | 6,06 | 6,62 | 0,54 |
| Sofa | 6,56 | 6,62 | 5,80 |
| Nun | 5,98 | 5,64 | 5,66 |
| Nose | 6,52 | 6,58 | 13,18 |
| Slave | 5,02 | 4,76 | 11,76 |
| Ark | 5,85 | 6,46 | 3,21 |
| Scissors | 6,54 | 6,76 | 2,30 |
| Crow | 6,21 | 6,72 | 4,28 |
| Sled | 6,08 | 6,60 | 0,99 |
| Carrot | 6,56 | 6,86 | 3,25 |
| Arc | 5,65 | 5,86 | 16,11 |
| Blouse | 6,38 | 6,56 | 1,63 |
| Carpet | 6,25 | 6,58 | 10,59 |
| Seal | 6,33 | 6,54 | 12,82 |
| Brush | 6,37 | 6,62 | 2,27 |
| Hairbrush | 6,19 | 6,56 | 1,50 |
| Onion | 6,44 | 6,78 | 6,76 |
| Judge | 5,62 | 5,28 | 0,07 |
| **Mean** | **5,94** | **6,17** | **5,81** |

lexical database" (Soares et al., 2010). List A had an imagery average of 5.94, concreteness of 6.17 and word frequency of 5.81/million; whereas list B had an average of 5.85 for the imagery, 6.13 for concreteness and 5.79/million for word frequency. To guarantee that both lists were identical concerning imagery, concreteness and frequency we applied independent samples t-tests that revealed that the lists did not differ on imagery, $t(29) = .42$, $p = .68$, 95% CI [-0.32, 0.49], concreteness, $t(29) = .16$, $p = .87$, 95% CI [-0.47, 0.55], and frequency, $t(29) = .02$, $p = .99$, 95% CI [-2.49, 2.53].

To apply the method of loci, 30 places were selected along a 1.5 km route between a city shopping mall (BragaParque) and the University of Minho in Braga, Portugal (see Table 2). As proposed by Pinto (1991), particular attention was directed towards place selection, ensuring these were not too dark, not too big or small, and ensuring they were well-known to all participants in this experiment (students of the University of Minho).

In this study, we used a within-subjects design, as all participants were submitted to the both conditions of the independent variables: test of recall (nominal vs. collaborative), and strategy of recall (own vs. Method of Loci). The dependent variable was the proportion of words correctly recalled in the order they were presented.

*Table 1 (continuación)*
Values of imagery, concreteness, and frequency of the words presented (two sets (A and B)

| Word | Imagery | Concreteness | Frequency |
|---|---|---|---|
| **Set B** | | | |
| Goat | 6,46 | 6,70 | 5,66 |
| Tomato | 6,73 | 6,76 | 9,60 |
| Ice | 5,96 | 6,08 | 13,10 |
| Shell | 5,38 | 6,16 | 4,20 |
| Sconce | 6,42 | 6,56 | 5,79 |
| Yacht | 5,73 | 6,46 | 11,60 |
| Comb | 6,58 | 6,74 | 3,04 |
| Barrel | 6,08 | 6,66 | 9,87 |
| Vessel | 6,29 | 6,66 | 6,47 |
| Watering can | 6,23 | 6,62 | 0,21 |
| Prayer | 3,15 | 2,54 | 12,27 |
| Scooter | 5,96 | 6,58 | 0,04 |
| Back | 5,38 | 6,06 | 5,05 |
| Train | 6,62 | 6,58 | 0,00 |
| Noise | 3,33 | 4,14 | 15,01 |
| Rocket | 5,92 | 6,44 | 8,71 |
| Bookcase | 6,04 | 6,58 | 1,51 |
| Pineapple | 6,48 | 6,78 | 1,15 |
| Pen | 6,81 | 6,68 | 5,50 |
| Asparagus | 5,23 | 6,50 | 0,83 |
| Cup | 6,17 | 6,76 | 2,45 |
| Devil | 4,54 | 2,10 | 13,74 |
| Fire | 6,21 | 5,88 | 12,00 |
| Brain | 4,50 | 5,42 | 0,21 |
| Wardrobe | 6,06 | 6,54 | 0,45 |
| Knife | 6,58 | 6,82 | 12,56 |
| Racket | 6,44 | 6,80 | 0,38 |
| Basket | 6,12 | 6,56 | 7,27 |
| Highchair | 6,13 | 6,24 | 1,23 |
| Motorized | 6,10 | 6,58 | 3,84 |
| **Mean** | **5,85** | **6,13** | **5,79** |

*Table 2*
Route of thirty places used for the method of loci

1. Fnac Braga Parque (*Braga Parque* is a Shopping Mall very well known in the city of Braga.)
2. Zara Braga Parque
3. Escalator
4. Exit Braga Parque
5. D. Chicken Restaurant
6. Stephane Bar
7. Dieci pizzeria
8. Maria Bolacha Confectionery

**9. Security guards the entrance to the University Campus**

10. Statue of Prometheus
11. Lobby interior of CP 2
12. BES CP 2
13. CP Bar 2
14. Field in front of the EPsi and IE
15. Check IE
16. Multimedia auditorium
17. Coffee and food machine

**18. Stairs leading to first floor**

19. Office of a teacher in Epsi
20. Bathroom
21. Laboratory of Human Cognition
22. Elevator
23. Sofas of Epsi

**24. ICS bar**

25. School of Engineering
26. Social Services (SASUM)
27. Canteen
28. Gym

**29. CP 1 / Parking**

30. Academic Services (SAUM)

Note: The bold emphasis correspond to landmarks along the route. These landmark places aim to help participants rediscover the path if they lose any of the breakpoints.
**9th place:** at the entrance to the university campus there are always 9 security guards.
**18th place:** to get to the 1st floor, you need to climb 18 stairs.
**24th place**: inside the ICS bar there are 24 chairs.
**29th place**: the parking lot of the CP1 has 29 parking spots

### *Procedure*

The pairs of participants sat at separate tables, each facing a 17" monitor connected to a networked computer such that stimuli presentation occurred simultaneously to both members of the pair. The words were presented, one at a time, at the centre of the screen and participants were instructed to pay attention because they would be asked to recall the words later. Each word was presented simultaneously with a serial number between 1 and 30 to facilitate the association between words and places. The experiment was programmed in Superlab 4.5 (Cedrus Corporation, San Pedro, CA).

As mentioned before, lists of words were divided into two sets (A and B). The order of presentation of the lists and the modality of recall (individual or collaborative) were counterbalanced. Words were presented at a 5000 ms rate with an interval of 500 ms between them. After presenting the words, participants were asked to do a serial recall task (collaboratively or individually), using their own strategy of recall. That is, participants should write on a sheet of paper with numbers up to 30 (ordered from 1 to 30) as many words as possible, and in the order they were presented. Participants were told that they must begin with the first word, and continue for the following in the order they were presented.

Afterwards, the method of loci was explained to the participants, as well as the advantage of this technique to serial recall. The thirty-places route was presented to the participants, and the mnemonic was illustrated and trained with several words. To promote the association between each word (e.g., *comb*) and a route place (e.g., *Pizzeria Dieci*) more effectively, participants were instructed to form BIC (bizarre, interactive, and comic) mental images (e.g., *imagine you eating a pizza with a comb at the Pizzeria Dieci*). That is, participants should form a funny (comic) and exaggerated (bizarre) image for the word in interaction with the mnemonic place (interactive). The goal of this process is to facilitate retention and subsequent recall of the image and consequently the word associated. Participants had approximately 15 minutes to memorize the route and were then asked about six random numbers that corresponded to places in the route. Participants were also informed the words are presented for 5000 ms and that during that time they should form an image applying the method of loci. In case they were unable to do it in 5 s, the alternative would be to move to the next word and form an image from that word on, avoiding wasting time. Once the training finished, participants were presented with a new set of 30 words, followed by a serial recall task (individual or collaborative), but this time implementing the method of loci. The method of loci was always applied to the second recall.

In the individual recall task, participants had 4 minutes to recall serially all the words they remembered. In the collaborative recall task, participants were asked to recall as many words as they remembered with a turn-taking procedure. Each participant had 10 s to write each word, and the repetition of words was not allowed. Once a participant writes down a word, the turn passes immediately to the other group member, even when the 10 s had not elapsed. When the participant was unable to write a word within 10 s, the turn passed to the other group member. Words were written down by the participants on a sheet of paper and, as mentioned, the recall procedure had a maximum duration of 4 minutes. The task ended after three failed attempts to write down any word. In the recall task, participants had to recall the words in the order they were presented and were not allowed to change them or go back. Participants could not talk to each other and could not repeat the words already recalled.

The total duration of the procedure was of about 50 minutes. At the end of the experiment, participants were thanked, debriefed and dismissed.

*Data analysis*

Data were analysed with SPSS v22 and an alpha level of .05 was used for all inferential analyses. All variables were examined to verify the normality of the distribution as required by parametric tests.

In our study, nominal recall represents the sum of the words retrieved by each group member in the individual recall task, and words repeated by both members of the group were not considered (Weldon & Bellinger, 1997). Collaborative recall represents the sum of non-repeated words recalled by the two elements of the collaborative group. The proportion of words recalled was calculated dividing the number of words correctly recalled participants in each recall test (nominal or collaborative) by the total number of words presented (N = 30).

## Results

An ANOVA for repeated measures 2 (strategy of recall: own vs. method of loci) X 2 (test of recall: nominal vs. collaborative) showed a significant effect of strategy of recall, $F(1, 13) = 35.90$, $p<.001$, $\eta^2 = .73$. This means that more words were recalled when participants use the method of loci ($M_{Loci} = .46$, $SD = .01$) than when they used their own retrieval strategies ($M_{Own} = .25$, $SD = .03$). The results showed no significant main effect of recall test, $F(1, 13) = 3.19$, $p = .10$, $\eta^2 = .20$; that is, the nominal recall ($M_{Nominal} = .39$, $SD = .03$) and the collaborative recall ($M_{Collaborative} = .32$, $SD = .02$) did not differ from each other in amount of recalled words. This result means that the collaborative inhibition effect was not replicated, and this is true when participants used their own strategy ($M_{NomOwn} = .27$, $SD = .07$; $M_{ColOwn} = .23$, $SD = .11$), $t(13) = .93$, $p = .37$, 95% CI [-0.05, 0.14], and when participants used the method of loci ($M_{NomML} = .51$, $SD = .19$; $M_{ColML} = .41$, $SD = .17$), $t(13) = 1.36$, $p = .20$, 95% CI [-0.06, 0.28].

Finally, no significant effect of interaction between strategy of recall and recall test was found, $F(1, 13) = .47$, $p = .51$, $\eta^2 = .04$.

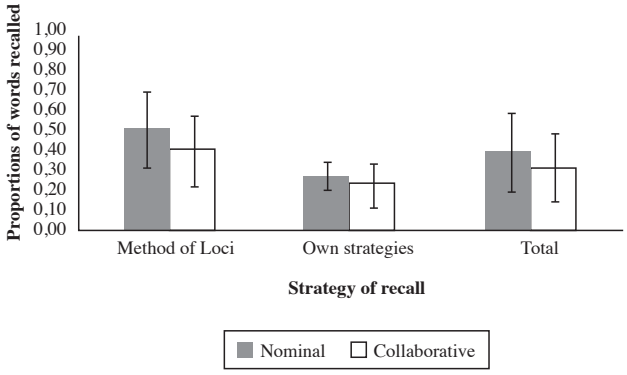


***Figure 1.*** *Proportion of presented words recalled as a function of strategy of serial recall (own vs. method of loci)*

## Discussion

Collaborative inhibition effect refers to the fact that a collaborative recall is significantly lower than a nominal recall. As mentioned before, the most common explanation for the occurrence of this phenomenon is the disruption of retrieval strategies hypothesis proposed by Basden et al. (1997). Thus, to understand the role of individual strategies of recall in collaborative inhibition effect, we decided to train participants on a mnemonic technique – method of loci. We hypothesized that collaborative inhibition would be attenuated when providing participants with the same encoding and recall strategy of information because, as the retrieval strategies are similar, they do not break and should thus mitigate the collaborative inhibition effect. In this sense, the results of the present study revealed the absence of the collaborative inhibition effect. In fact, there were no significant differences on the recall of words between nominal recall and collaborative recall even before the training with the method of loci. Moreover, the authors conducted an experiment to compare a free recall task with a serial recall task, using the same stimuli and procedure of the present study (except the application of method of loci). The results revealed that in the free recall task collaborative inhibition was replicated ($M_{nom} = .71$ and $M_{col} = .54$, $t(21) = 4.46$, $p<.001$, d' =

.97, 95% CI [0.08, 0.23]), showing that the nominal group recalled significantly more words than the collaborative group. However, serial recall task eliminated collaborative inhibition ($M_{nom}$ = .37 and $M_{col}$ = .30, $t(19) = -1.82$, $p = .09$, 95% CI [-0.17, 0.01] (Saraiva, Albuquerque, & Arantes, 2016).

The absence of collaborative inhibition may be related to the nature of the serial recall task. It is known that a serial recall task, when using long lists (e.g., 10 or more items), has worse performance than free recall (Grenfell-Essam & Ward, 2012; Ward, Tan, & Grenfell-Essam, 2010).

As mentioned before, and according to Finlay, Hitch and Meudell (2000), when group members share the encoding of information, collaborative inhibition effect is attenuated. This enables individuals to organize information in the same way, and allow individuals to apply similar recall strategies between each other. As a consequence, the interference between different recall strategies decreases and collaborative inhibition effect is reduced. In the present study, participants were told to encode the information in the order of presentation, because later they would have a serial recall task. This resulted in participants encoding information in the same order, and employing a similar recall strategy. Together with the nature of the serial recall, this could have eliminated the collaborative inhibition effect.

Regarding the retrieval strategy, we found that participants recalled more words when they used the method of loci than when they used their own strategies of recall, a result supported by the encoding specificity principle and distinctiveness (Surprenant & Neath, 2009). This result is expected considering the effectiveness of the method of loci as a powerful mnemonic to retrieve information in the order it was presented. According to Tulving and Thomson (1973), the effectiveness of this method is due to encoding specificity, that is, at the time of recall the cues used to encode information (route and places/loci) are re-instated. Moreover, the distinctiveness of the association cue-target, based on BIC mental images, makes recalling easier and adds a strategy that can be controlled and shared by the participants. In this sense, the method of loci proved to be an effective and powerful mnemonic in the recall of words by the order of presentation, when compared with the words recalled by the participants when their own retrieval strategies are used.

In conclusion, this study provides support to the retrieval disruption hypothesis as a plausible explanation for collaborative inhibition effect as proposed by Basden et al. (1997) and reveals that it is possible to eliminate the robust effect of collaborative inhibition using a serial recall task. It was also possible to observe the benefits of the method of loci, through the increase in the number of words correctly mentioned both at individual and collaborative level. In this sense, it is important that future research searches for the role of mnemonics in collaborative memory tasks using free recall, to understand whether it is possible to eliminate the effect of collaborative inhibition, also in this kind of recall. Finally, the findings regarding the effect of serial recall in collaborative memory tasks may be extended to other types of stimuli, such as DRM lists, to understand the fluctuations of collaborative inhibition effect in this modality of recall.

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