Where Did I Put My Keys? – A ‘We’ Intervention to Promote Memory in Healthy Older Adults: A Controlled Pilot Study

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Key Words

Binding · Social factors · Working memory · Aging

Abstract

Background: Numerous behavioural studies have shown that older adults have more difficulty in binding things together and have underlined the corresponding importance of this function in everyday memory tasks. **Objective:** This study was designed to test a new brief inter-dependent self-knowledge intervention on memory functions in aging. **Methods:** Before engaging in a working memory task based on binding objects and their locations, half of the participants read a series of paragraphs that focused on the individual self and were written in the first person singular ‘I’ (*independent* self-knowledge), whereas the other half read paragraphs that focused on the relational self and were written in the first person plural ‘We’ (*inter-dependent* self-knowledge). **Results:** Results showed that older adults who were trained with ‘We’ passages were more successful in remembering objects and their location compared to the group of participants who were trained with ‘I’ passages. **Conclusion:** These findings are discussed in terms of the role that social factors may have in favouring memory functions in aging and delineate a new cognitive clinical protocol based on an inter-dependent self-knowledge approach.

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Introduction

One of the most frequent memory complaints that older adults report to clinicians is their increased tendency to forget where they put things. This subjective complaint is strongly supported by many studies which have confirmed that this type of memory error called ‘source misattribution’ increases with age [1, 2]. Two broad explanations, briefly reviewed here, have been advanced to account for older adults’ difficulty in remembering location information. The first one is linked to older adults’ greater retrieval deficits. In fact, numerous findings show that age differences in source memory result from differential utilization of cues and decision criteria used at test [3]. Indeed, source memory situations typically include many different potential cues (colour, location, etc.) and it may be that older adults fail to select the most effective contextual cue when later recalling source information.

A second assumption is that the various aspects (e.g. the object and its spatial details) of complex memories are presumably bound together as a consequence of working memory (WM) functions that operate at acquisition (e.g. rehearsing, noting, reactivating). Chalfonte and Johnson [4] first suggested that impaired memory for multiple features could contribute to decrements in older adults’ ability to make source attributions. It is thus possible that older adults have more difficulty in conjoining features together at encoding (e.g. object and its location) and therefore fail to remember source information. In addi-

tion, Mitchell et al. [5] developed a WM combination task that required participants to remember object information, location information, or the combination of object and location information. Results indicated a specific binding deficit when older adults were asked to remember combinations compared to memory for single features. The hypothesis is that WM processes may become less efficient as we age and, therefore, source monitoring functions (that depend on these processes for binding features together) are consequently affected.

Similarly, Naveh-Benjamin [6] advanced an *associative-deficit hypothesis* of aging that focuses on the distinction between memory for single features and memory for associations between features. In particular, it was hypothesized that older adults' poorer episodic memory is in large part due to their reduced efficiency in creating and retrieving bindings between features of an event. Moreover, the extent to which a given memory task requires the creation or use of such bindings seems to be a significant determinant of older people's memory performance. Furthermore, changes in frontal-hippocampal neuromodulation typically observed in older adults also support this claim [7, 8].

In sum, there are numerous behavioural studies and an increasing number of neuroimaging studies that have shown how older adults have more difficulty in binding things together and have underlined the corresponding importance of this function in everyday memory tasks.

Recently, a series of promising studies has brought attention to the role of social factors on WM functions [9]. This may represent an interesting avenue for developing new ways of improving older adults' memory. A study by Park et al. [10], for example, focused on the influence of social and asocial reinforcement in a visuospatial working memory task. A group of schizophrenic patients and controls were asked to remember where a target dot appeared (in 1 of 8 different locations) around a central dot. The authors found that when participants were presented with a human reinforcement after each trial (e.g. 'excellent', 'good job', 'well done'), they performed better compared to when they were reinforced by a computer. More interestingly, Kühnen and Oyserman [11] found better performance in a binding task when younger adults were primed with an inter-dependent self-knowledge passage compared to an in-dependent self-knowledge condition. That is, when younger participants were primed with a passage that focused on the individual self ('I'), they recalled a lower number of object and location combinations compared to a group of participants who were primed with a passage that focused on the relational self ('we').

The aim of this study was thus to adopt a social factor intervention to investigate whether it can be used to promote WM functions in older adults. To this end, we used Mitchell and coworkers' WM combination task based on the ability to bind objects and their locations and consequently is focused on the everyday ability to remember objects in their locations. Firstly, this task has been widely used across different populations [5, 12] and provides a reliable measure of binding ability due to the fact that participants are also presented with re-paired objects and locations and are requested to judge whether these combinations are old or new.

Secondly, in the light of the aforementioned literature on binding deficits in aging, it is important to investigate whether, generally speaking, working memory functions in aging are sensitive to social factors, and in our specific case, to a shift in the use of self-knowledge. The basic assumption is that an inter-dependent self-knowledge intervention may change the cognitive style that older adults use during a working memory task. Specifically, inter-dependent self-knowledge may favour attention to specific social context and to context, in general. For example, it has been found that individuals who developed relational self-construals tended to devote more attention to relational stimuli [13]. To our knowledge this is the first time that the influence of inter-dependent self-knowledge intervention on WM in older adults has been tested. The use of this type of knowledge may help them encode relational information and promote binding in WM.

In summary, the aim of this study was to investigate the influence of social factors on WM of older adults. In particular, we used an object-location binding task as a main WM task in order to clarify how their memory is affected by in-dependent vs. inter-dependent self-knowledge conditions and to verify whether a brief inter-dependent self-knowledge intervention may be a potential way of reducing their difficulties.

Material and Methods

Participants

Forty-eight healthy older adults (mean age = 68.0 years, SD = 2.51 years, range = 65–73) were recruited in the Chieti area as participants. They were excluded if they gave self-reports of uncorrected vision or hearing difficulties, a history of psychiatric or neurological disorder, a history of drug or alcohol abuse, a medical history of cognitive deficits (problems with memory, attention, etc.), any serious head injuries or periods of unconsciousness, or if they were taking a prescribed drug with psychoactive properties. Participants' characteristics are reported in table 1.

Table 1. Participant characteristics by self-knowledge group and pre-intervention data

Self-knowledge characteristic	In-dependent		Inter-dependent	
	mean	SD	mean	SD
Age	66.0	2.7	70.0	2.3
Gender, M/F	12/12		12/12	
Education	14.0	3.1	12.0	4.1
MMSE	27.6	1.1	28.1	1.4
Forward digit	7.7	1.9	7.5	2.5
Backward digit	5.1	1.3	5.5	1.9
Vocabulary	19.7	2.7	20.0	2.6
Verbal fluency	11.2	2.3	10.8	2.1
Paired associates	0.62	1.9	0.57	1.7

MMSE: maximum score = 30; Forward Digit Span: maximum score = 8; Backward Digit Span: maximum score = 8; Verbal Fluency: mean number of named words from the norms for 61–70 year-olds = 10.9.

Their mean MMSE [14] score was 27.5 (SD = 1.26), range = 25–30. They had a mean level of formal education of 13.0 years (SD = 3.60). Before participating in the experimental session, they were tested with the forward and backward version of the digit span from the Mondini et al.'s [15] neuropsychological battery. Their mean score in the forward version was 7.6 (SD = 2.18) and 5.3 (SD = 1.59) in the backward version. They also completed a subtest of a standardized vocabulary test [16] (mean = 19.8, SD = 2.60; maximum score = 26).

Given that participants were randomly assigned to two groups of 24 older adults each, we performed paired comparisons to control their years of education, MMSE score, span and vocabulary score did not differ across these two subgroups. In addition, to evaluate the participants' general cognitive and binding abilities, they were also asked to perform a verbal fluency test [15] and a paired-associate task before and after the intervention. In the verbal fluency test participants were required to name as many words as possible beginning with a specified letter (c or p) in a 60-s interval. In the word paired-associate task, instead, participants were required to learn the association between 40 paired words (20 before and 20 after the intervention). In particular, we used a set of controlled word pairs developed by Cavallini et al. [17]. Each pair was presented on a computer monitor in the centre of the screen and participants were instructed to study the all pairs for up to 20 min. Learning was self-paced. At test, participants were presented with single items and asked to write down the missing paired word (for a detailed description of words selection and procedure see the work by Cavallini et al. [17]).

Materials and Procedure

As a main binding task, we used a shortened version of Mitchell et al.'s [5] WM binding task. This task required participants to remember either only object information, only location information, or the combination of object and location information. Participants were always given a 'yes-no' recognition memory task.

Participants received a total of 6 blocks of trials of 12 (2 object, 2 location, and 2 combination). Each block contained 4 trials.

A typical trial started with a cue word on the screen indicating what participants were to remember on that trial (e.g. object, location, or both). Then a sequence of three grids was presented (the overall duration was 3 s) each containing a different object in a different location. After 8 s, a recognition test was given for the single object, location, or both. When participants were asked to remember only object information, an old or new object was presented in the centre cell of the blank test grid, whereas when they were asked to remember the location, a black dot was presented in either an old or new location. Finally, when they were asked to remember object and location information together, either an old object was presented in its correct old position or an old object was presented in a cell that was filled by a different object in the same trial (that is, the studied object was re-paired with an old different location). The number of false alarms to these re-paired conditions yields a binding function measure. The ability to say 'no' to a new object re-paired with an old location implicates remembering how these features were paired during study and can subsequently be considered as an index of efficient binding functions. Before starting the experimental session, participants were presented with ten practice trials in order to familiarize with the test conditions (object, location and combination). The whole session lasted about 20 min.

Intervention

A training session lasted about 40 min for each group. To foster in-dependent vs. inter-dependent self-knowledge in participants, we used a paradigm developed by Gardner et al. [18]. Specifically, participants were given a booklet and read a series of brief paragraphs (e.g. about a trip to a city). They were given a pencil and their task was to circle the 19 personal pronouns contained in each of them before engaging in the WM combination task.

For half of the participants the pronouns were singular representing the individual self (e.g. I, me, mine), while for the other half they were plural representing the relational self (e.g. we, our, us). Each group read a total of 8 paragraphs and circled a total of 152 pronouns (in Italian version). Reading time was self-paced. On average, participants completed each paragraph in about 5 min. Before the intervention phase, the experimenter presented participants with some practice sentences in order to be sure that participants understood the task and remember all the pronouns. If participants made an error or missed a pronoun, they were asked to reread the sentence and look for the correct answer. This was done to promote their attentional focus on the individual/relational self. An example of paragraphs is given below:

'I often go into the city. My desire to arrive quickly increases as soon as I see the skyscrapers emerge. I dedicate myself to explore every angle without letting anything escaping me. My voice fills the air and the ways. I look everywhere, I look at the windows and wherever I go I see my reflection in the hundreds of windows. In the evening I wander a little, the time in the city is about to end. When I must go, I do so knowing that I will come back soon. The city is mine.'

To briefly summarize the whole study timeline, participants first performed a series of cognitive tasks to evaluate their general cognitive and binding ability. Subsequently, they were assigned to an intervention group. Following the intervention, they performed the combination task, the paired-associate task and the verbal flu-

Fig. 1. Mean proportion of hits-false alarms and standard errors of the mean by condition and type of self-knowledge intervention (in-dependent vs. inter-dependent).

ency task. The combination task always immediately followed the intervention phase because we were mainly interested in studying how our self-knowledge manipulation would affect WM binding abilities on this task. The paired-associate task and the verbal fluency presentation order were, instead, counterbalanced.

Data and Statistical Analysis

We first report the data on the main WM combination task. Figure 1 shows the mean proportion of hits and false alarms (together with the standard error of the mean) for each group of older adults. For this task, we adopted a 3×2 mixed design with condition (object, location, combination) as a within-subject variable and type of self-knowledge (in-dependent vs. inter-dependent) as a between-subject variable. The dependent variables were hit-false alarms.

As done in previous studies [5, 12], we focused on accuracy scores expressed as Hits-False Alarm. Due to the adoption of a short version of the binding task, we had fewer observations than Mitchell et al.'s [5], which rendered the analyses and interpretation of reaction times (RT) data less feasible. Here, we report the lure-target difference scores for combination and single feature trials calculated as each participant's median latency on lure minus that participant's median latency on target trials [5]. The single feature score represents the mean of the object and location conditions. The mean RT difference score between single feature and combination trials was -66.8 ($SD = 212.9$) in the in-dependent self-knowledge group, whereas it was -43.2 ($SD = 166.3$) in the inter-dependent group. This comparison was not significant.

We also report data on verbal fluency and paired-associates task. Given that these two tasks were performed before and after the intervention, we were able to study whether our intervention

influenced cognitive abilities in general or was, instead, confined to processing of relational information only. We did not detect any gender differences in any of these tasks.

Results

Combination Task

A 3 (condition: object, location, combination) by 2 (type of self-knowledge: in-dependent vs. inter-dependent) contrast on HITs-FAs accuracy scores showed no effect of type of self-knowledge $F(1,46) = 2.84$, $p = 0.10$, $\eta^2 = 0.60$, $MSE = 0.079$, as the overall performance was 0.55 after in-dependent reading and 0.66 after inter-dependent reading. There was a significant effect of condition, $F(2,92) = 36.93$, $p < 0.001$, $MSE = 0.063$ as participants showed a similar performance for single features, 0.78 for object and 0.77 for location respectively, but greater difficulties for combination, 0.27 .

Most importantly, the interaction was significant, $F(2,92) = 3.39$, $p < 0.05$, $\eta^2 = 0.12$. Planned comparisons showed that there was no difference on single features after reading an in- or inter-dependent passage, $F(1,46) = 1.55$, $p = 0.22$, $MSE = 0.032$, for the object condition; and $F(1,46) = 1.83$, $p = 0.19$, $MSE = 0.067$, for the location condition, whereas the difference was significant on combinations, $F(1,46) = 4.53$, $p < 0.05$, $MSE = 0.106$, $\eta^2 = 0.15$.

Verbal Fluency

The number of correct responses in the verbal fluency task was analysed with a repeated measure 2×2 mixed ANOVA with Type of self-knowledge (in-dependent vs. inter-dependent) as a between variable and Test (pre-test vs. post-test) as a within variable. We did not find a main effect of Test, $F(1,46) = 1.77$, $p = 0.19$, $MSE = 1.98$. The effect of Type of self-knowledge was not significant, $F < 1$. Finally, the two-way Test by Type of self-knowledge interaction was not significant, $F < 1$.

Word-Paired Associated Task

The number of mean correct paired words was analysed with a repeated measure 2×2 mixed ANOVA with Type of self-knowledge (in-dependent vs. inter-dependent) as a between variable and Test (pre-test vs. post-test) as a within variable. We found a main effect of Test, $F(1,46) = 4.20$, $p = 0.05$, $MSE = 0.02$, as participants performed better in the post-test as compared to the pre-test session. The effect of Type of self-knowledge was not significant, $F < 1$. Most importantly, the two-way Test by Type of self-knowledge interaction was significant,

$F(1,46) = 23.47, p < 0.001$. This finding was due to the fact that performance in the inter-dependent group significantly improved from pre-test (0.57) to post-test (0.65, Test LSD, $p < 0.001$) and their performance at post-test was better than the control group's performance (0.59, Test LSD, $p < 0.05$).

Discussion

In the present study, we began examining the potential benefits of a social-based intervention on older adults' WM abilities when invited to use a specific set of social strategies. We found that binding function in older adults can be improved, at least temporarily, by inviting participants to make use of inter-dependent self-knowledge. Previous studies on the relational self [13, 18] found, in fact, that individuals with a highly relational self-view were more likely to have more efficient cognitive processes regarding relational information and to encode, organize and retrieve information about others better than individuals with an in-dependent self-view. The assumption is thus, that when older adults adopt an other-directed cognitive style (inter-dependent self-knowledge), they tend to pay more attention to relational stimuli and increase their memory ability of binding objects and locations together.

This study adds new evidence to the potential role of a social factor intervention in promoting WM functions. A series of recent studies [10, 11], in fact, highlighted how socio-affective factors may influence the use of WM functions showing that the social-affective explanation may be a useful approach in order to better frame and clarify how self-reflection works. More specifically, feature binding in WM has always been cited as a crucial reflective function in source memory and more generally, in long-term memory. Although the effects obtained in this study need to be interpreted with caution as effect sizes were not large and we only have post-intervention data of the WM combination task, we believe that gaining a better understanding of how socio-affective factors promote binding, and WM processes in general, is thus ultimately important for developing new clinical treatments for reducing source misattributions.

We also found that our intervention did not affect general cognitive abilities as shown by the verbal fluency task, while it promotes relational processing. In fact, participants' paired associates' performance only increased in the inter-dependent group. However, we cannot definitely determine whether this increase was due to the differ-

ent mental set fostered by the inter-dependent passages or to the fact that participants received the WM combination task before the paired-associates. The fact that we obtained better performance on the WM combination task and the paired associates task seems to indicate that inter-dependent self-knowledge may promote relational processing across different domains, but, above all, that it may be used to increase levels of awareness of contextual information in older adults.

Future Directions

Literature on social cognition [9] suggests that women are more likely to develop a relational self-view than men due to the fact that they are more socially prone to relational information. Although this study did not detect any gender differences, we believe that our findings can also be linked to potential investigations on the role of gender effects and aging in WM functions.

In this study we did not test whether there were changes in emotion and mood after the self-knowledge intervention. As suggested by Gardner et al. [18], it is highly likely that inter-dependent self-knowledge may shift the general importance of the self in relation to others and promote the expansion of the self as possible reflection of universal needs. Consequently, participants may experience a 'shared cognition' condition and report a greater amount of positive emotions. We are currently conducting other studies in our lab to better understand the link between inter-dependent self-knowledge and positive emotions in aging.

Finally, another future issue may concern investigating neural activity when older adults are asked to use independent and inter-dependent self-knowledge within a social cognitive neuroscience approach [9]. For example, it has been shown that inviting participants to a self-reflection about their hopes and aspirations (promotion focus) rather than on their duties and obligations (prevention focus), thus encouraging participants to pay attention to the self, generated greater activity in the dorsomedial prefrontal cortex and posterior cingulate/precuneus [19]. Our hypothesis is that inter-dependent self-knowledge conditions may recruit different brain regions such as the amygdala and/or temporal lobes compared to those recruited for in-dependent self-view and that the different component processes of working memory may benefit from the different pattern of activation that a relational based encoding may bring. Exploration of potential differential disruption of brain areas should therefore be helpful in providing further information on WM functions in aging.

Conclusion

We conclude that our pilot study represents a first step in preparing social-based protocols that can be used to reduce older adults' memory problems. Our work offers scientific data for cognitive rehabilitation specialists and may also be highly relevant for furthering the development of theory based rehabilitation. Developing new ways that may reduce or even prevent their memory difficulty in older adults is crucial especially for everyday life. Consequently, we focused on the basic ability of remembering objects in their locations and demonstrated that a social intervention based on reading 'we' passages is able

to improve their memory. This study encourages further development in line with this type of intervention, preferably with a focus on long-term benefits.

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Disclosure Statement

The authors report no conflicts of interest.

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