



Acting is the Key: New Directions for the Stimulation of Prospective Memory in Mild Cognitive Impairment.

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Background

Remembering to perform intended activities (e.g. taking medication or attending an appointment) is a fundamental requirement for independent living. Such prospective memory (PM) is especially disrupted in Alzheimer's disease (AD), presenting a severe threat to the individual's health and social relationships, and increasing the burden of care (e.g. Duchek, et al., 2006). PM deficits may appear early in the neurodegenerative process, namely at the stage of Mild Cognitive Impairment (MCI), which usually represents an initial phase of AD (de Mendonça, et al., 2004).

While much recent interest has focused on evaluating the usefulness of external memory aids (e.g. electronic organizers) for patients with memory deficits, these are of limited use for many PM tasks in which an intention must be retrieved when a particular external event occurs (e.g. give a message to Helen when you see her) and for which it might be impossible to predict the moment of occurrence.

Most studies assessing mnemonic rehabilitation strategies in cognitive impairment have tended to focus on retrospective memory. These suggest that many of the encoding manipulations that typically enhance learning in young and healthy older adults (e.g. visual imagery, semantic organisation) are of minimal benefit to AD patients (see Grandmaison and Simard, 2003 for a review). However, there is some indication that these patients can display a recall advantage when encoding is accompanied by enactment (e.g. Karlsson, et al., 1989). Furthermore, fMRI studies have revealed discrepant activation for the verbal encoding of actions to be enacted was identified in brain regions known to be involved in motor preparation for movements (e.g. Eschen, et al. 2007).



Given that enactment effects on retrospective memory can be preserved in the early stages of AD, this encoding method represents a potentially important and widely applicable technique for enhancing PM performance in this patient group. In keeping with this analysis, we have recently investigated whether enactment at encoding could improve PM performance and whether the benefits of enactment for prospective remembering were dependent on the relationship between the retrieval cue and its associated action in young and healthy older adults (e.g. Pereira, 2012).

Methods

Participants

One hundred and twenty-eight participants were recruited. 64 young adults aged 18-39 years ($M = 20.41$, $SD = 3.553$) and 64 educationally matched older adults aged 58-90 years ($M = 71.17$, $SD = 7.204$) were tested. Participants with a self-reported history of psychiatric, neurological or alcohol problems, or probable dementia on the bases of the Mini-Mental State Examination (i.e. a score of 24 or less; Folstein, Folstein, & McHugh, 1975), were excluded.

Design

A 2 X 2 X 2 design was used, with Method of Encoding (verbal vs. verbal + enactment), Cue-Action Relatedness (related vs. unrelated), and Age Group (younger vs. older) as between-subject factors. The effect of these variables on performance accuracy on the PM task was examined. Performance accuracy and reaction times to non-cue items on the ongoing task were also assessed.



Materials

A simple computer-based activity in which participants had to sort different words into two different categories (natural vs manmade) was prepared for the practice and main phase. For the PM cue-action pairings two lists of 6 noun-verb pairs were compiled: 6 related (FSG < 0.1; Nelson, McEvoy, & Schreiber, 1998) and 6 unrelated noun-verb pairs. The word pairs had normative medium values of familiarity (range = 3,71 - 4,59 on a scale of 1 to 7) and memorability (range = 3,71 to 3,34 on a scale of 1 to 7); Molander and Arar (1998).

Procedure

The experimental session involved a practice phase for the ongoing task, followed by instructions for the PM task, a filled delay period and the main ongoing task containing the PM cues. For the PM task, participants were asked to encode, a set of cue-action word pairs. A PM test embedded in a simple ongoing computer-based activity, similar to the one given in the practice phase, was then performed, where participants were asked to press a specific computer key upon seeing any of the cue-words. Following this action, the participants had to say the corresponding action-word aloud and continue their computer activity.

Results

All data were analysed using a 2 X 2 X 2 ANOVA, with Cue-Action Relatedness (related, unrelated), Method of Encoding (verbal, enactment), and Age Group (young, older) as between-subject factors.



Prospective memory performance

The mean proportion of cues that elicited a correct response at the appropriate moment in each Method of Encoding x Cue-Action Relatedness x Age Group condition was calculated, and there was a reliable main effect of Cue-Action Relatedness; $F(1,68) = 19.41, p < .001, \eta^2=.13$. There was a better memory performance for cue-action word pairs in which the cue was semantically associated with the action word ($M = .85, SD = .22$) than for cue-action pairs in which the cue was not semantically associated with the action ($M = .69, SD = .22$). There was also a reliable main effect of Method of Encoding, $F(1,68) = 8.89, p < .01, \eta^2=.07$, such that PM performance was better when enactment was used at encoding ($M = .82, SD = .20$) than when the encoding was only verbal ($M = .71, SD = .26$). A significant effect of age was visible as well, $F(1,68) = 3.93, p = .05, \eta^2=.03$, such that older adults had a poorer performance ($M = .73, SD = .28$) than their younger counterparts ($M = .80, SD = .18$). There were no reliable interactions identified; all $F_s < .62, \eta^2 < .01$.

Reaction Times and Performance Accuracy on the Ongoing Task

There was no influence of Modality of Encoding or Cue-Action Relatedness on either the speed or accuracy of responses on the ongoing task, nor was there any interaction between these two factors; all $F_s < 1.27$, all $\eta^2 < .018$. Nonetheless, there was a notoriously significant effect of Age on speed of response on the ongoing task [$F(1,68) = 14.23, p < .001, \eta^2=.10$] with younger adults being much faster ($M = 1043, SD = 310$) than older ones ($M = 1249, SD = 325$). This effect was however not evident in what regards ongoing task accuracy $F(1,68) = .116, \eta^2=.001$.



Conclusions

Older adults' PM performance (like that of their younger counterparts) benefited from enactment at encoding and from a strong semantic cue-action relation. Furthermore, there were no reliable effects of encoding modality or cue-action relatedness on performance accuracy or speed, despite a generalized slowness associated with age. We argue that a better PM performance was evident when the cue-action pairs were related because this condition might be less demanding than the unrelated in terms of retrieval processes hence providing greater environmental support (cf. Loft & Yeo, 2007). Moreover, the improvement in PM performance when physical enactment was used during encoding might be due to the fact of such encoding providing additional item-specific information about the object-action pair, hence enhancing distinctiveness, and strengthening integration between these two components (cf. Engelkamp & Jahn, 2003). Importantly the advantageous effects of both factors were identified as being not only independent (and consequently cumulative; cf. Engelkamp, 1998) as well as observable even across different age groups.

As PM may be particularly affected at an early stage in the development of Alzheimer's Disease (e.g. MCIs), constituting a great object of concern, distress and even frustration not only for these patients as well as for their carers (Smith et al., 2000), and placing at risk individual's social relationships and maintenance of an independent lifestyle (Huppert & Beardsall, 1993) it is urgent to understand whether such findings can be transposed to the universe of mild cognitive impairment and Alzheimer disease, so as to contribute, in the near future, to the development of a sustenance or even rehabilitation technique for enhancing PM in these patients.



Consequently, we discuss our findings with respect to their potential impact on the developments of strategies to improve PM in people suffering from Alzheimer's disease, and also present extremely recent preliminary fMRI data, collected in our lab under conditions of physical encoding and high semantic relatedness revealing an encouraging pattern of hemodynamic changes not only in regions considered of crucial importance to prospective remembering, as well as in motor brain regions which are usually activated during verbal encoding of actions for later enactment.

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Figure 1. Mean proportion of PM cues eliciting a correct response at the appropriate moment in each Method of Encoding X Cue-Action Relatedness X Age Group condition.

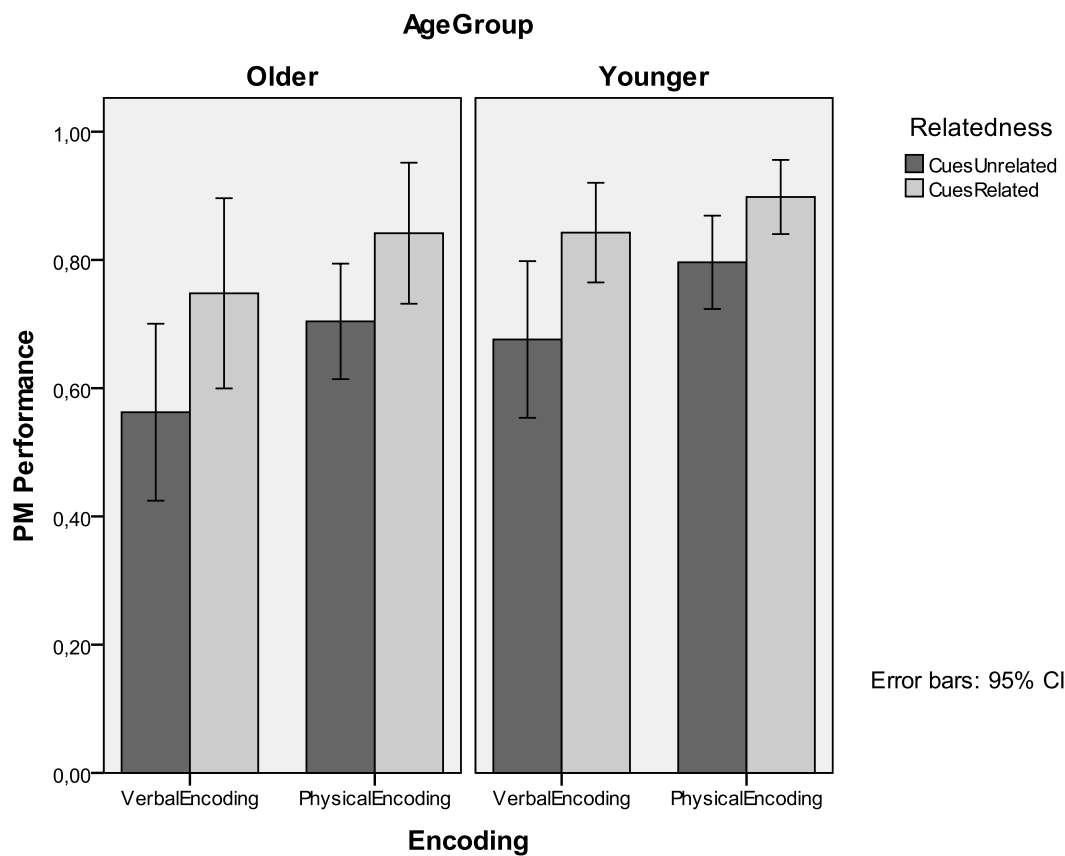


Table 1. Mean (and standard deviation) response time in milliseconds and proportion of correct responses on the ongoing task in each Method of Encoding X Cue-Action Relatedness X Age Group condition.

		Verbal Encoding		Enactment at encoding	
		Related pairs	Unrelated pairs	Related pairs	Unrelated pairs
Older Adults	Mean response time	1290 (357)	1171 (227)	1258 (422)	1277 (300)
	Mean proportion of correct responses	.94 (.09)	.86 (.18)	.90 (.13)	.91 (.15)
Younger Adults	Mean response time	930 (210)	1091 (272)	1076 (448)	1073 (252)
	Mean proportion of correct responses	.93 (.11)	.87 (.13)	.92 (.13)	.92 (.12)