

Validation of selective attention and memory measures as early markers for Alzheimer's disease

CS Tse *, LCW Lam, DA Balota, GTY Leung, KT Hau, JF Chang

KEY MESSAGES

1. The measures of prospective memory (ie the ability to remember what one has to do when a specific event occurs in the future) and selective attention (ie the ability to maintain the task goal over time and resolve the conflict between incongruent information) can discriminate between healthy older adults and those who are in the earliest stage of Alzheimer's disease.
2. Prospective memory and selective attention performance declined as a function of Alzheimer's disease severity, after taking into account age and number of years of education.
3. The discriminative power of prospective memory and selective attention measures for early-stage

Alzheimer's disease is comparable with that of other psychometric measures. These cognitive abilities should be incorporated into standard Alzheimer's disease assessment.

Hong Kong Med J 2016;22(Suppl 2):S37-9

HHSRF project number: 08090041

¹ CS Tse, ² LCW Lam, ³ DA Balota, ² GTY Leung, ¹ KT Hau, ¹ JF Chang

¹ Department of Educational Psychology, The Chinese University of Hong Kong

² Department of Psychiatry, The Chinese University of Hong Kong

³ Department of Psychology and Neurology, Washington University in St. Louis, USA

* Principal applicant and corresponding author: cstse@cuhk.edu.hk

Introduction

It is important to diagnose people with Alzheimer's disease at the earliest possible stage and discriminate these individuals from healthy older adults. This study aimed to develop prospective memory and selective attention measures to enable detection of individuals with the earliest stage of Alzheimer's disease. Three groups of community-dwelling older adults were recruited: healthy older adults (mean age, 75.06 years), older adults in the earliest stage of Alzheimer's disease but not yet clinically diagnosed (mean age, 78.66 years), and older adults clinically diagnosed with Alzheimer's disease (mean age, 80.20 years). Informed consent was obtained from each individual. Participants were screened for colour-blindness, depression, untreated hypertension, reversible dementia, and other disorders that could potentially produce cognitive impairment. Prospective memory and selective attention tasks were conducted using a laptop computer at place of residence or regional social centre.

Prospective memory

Many cognitive tasks tap older adults' memory abilities but most focus almost exclusively on their retrospective memory, eg studying a list of unrelated words and then recalling them. In contrast, prospective memory, which refers to the ability to remember what one has to do in the future,¹ has received much less attention, despite its connection with activities of daily living. In a prospective memory task, older adults were instructed to spontaneously

perform an intended action when a specific event occurs, while engaging in a concurrent attention-demanding task. In each trial, they were asked to respond to a highlighted arrow by pressing the left or right key. The top and bottom bars varied in colours (red, blue, yellow, or green) across trials (Figs 1a and 1b). In one-fifth of trials (24 out of 120 trials), the top and bottom bars were the same colour, and the participants were told to press an alternative key instead of judging the arrow direction. They were reminded to keep this instruction in mind because they would not be told again. That is, throughout the task older adults were not reminded with the prospective memory instruction. At the end, older adults were asked to recall what they had been asked to do during the task. Only those participants who were able to recall the prospective memory instruction were included in the following analyses. This retrospective memory report ensured that older adults' failure to respond on the prospective memory trial was due to their inability to initiate the intended action at the right moment, rather than having forgotten the prospective memory instruction. The task took about 12-15 minutes to complete. As the task does not involve verbal materials, it is suitable for Hong Kong older adults whose education level is generally low. This laboratory task may simulate daily-life situations, eg remembering to take a medicine before sleep or watching the news programme on TV. Older adults with Alzheimer's disease often demonstrate prospective memory failure in their activities of daily living, which poses a great challenge for their caregivers. Hence,

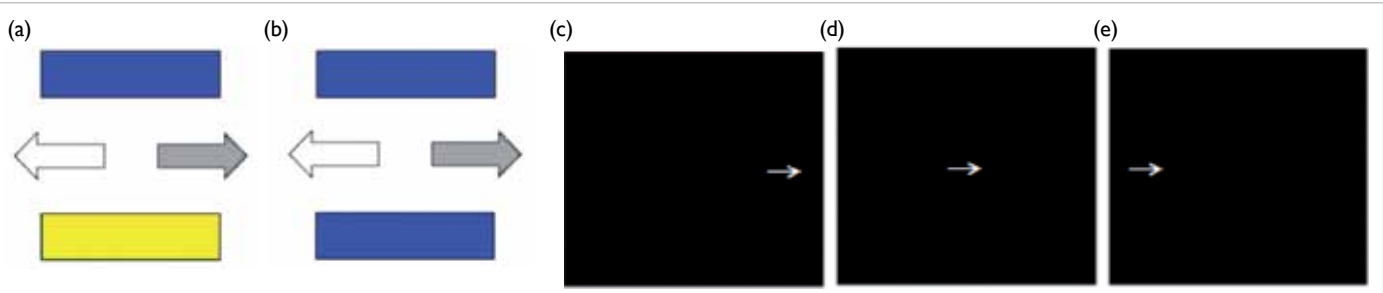


FIG 1. Displays of the prospective memory and selective attention task: (a) typical trial of the prospective memory task, (b) prospective memory trial of the prospective memory task, (c) congruent trial of the selective attention task, (d) neutral trial of the selective attention task, and (e) incongruent trial of the selective attention task

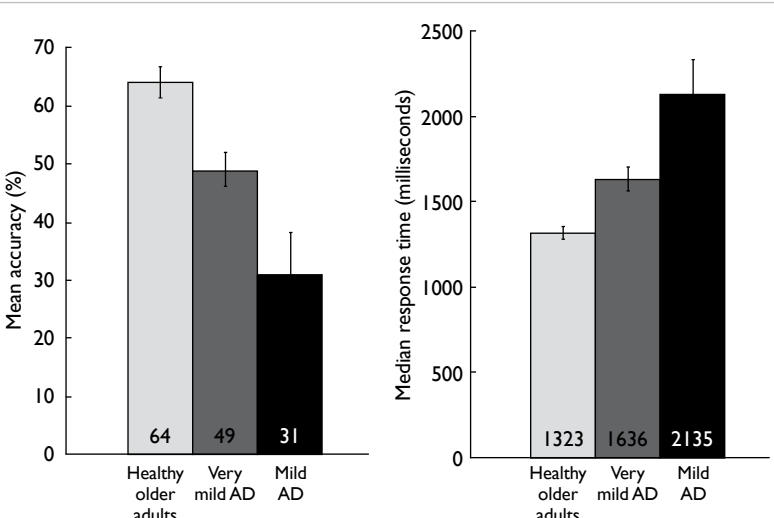


FIG 2. Accuracy and response time in the prospective memory trials as a function of Alzheimer's disease (AD) severity in the prospective memory task

prospective memory performance of older adults may have some implications for their ability to maintain independence in everyday life. Although the current task may not be directly related to older adults' prospective memory in activities of daily living,² it is more objective and relies less on older adults' self-reported data. Older adults' accuracy (and response time) in responding to the prospective memory trials is expected to decrease (and be slower) as a function of Alzheimer's disease severity.¹

After taking into account the differences in age and education level across groups, the accuracy in the prospective memory trials decreased as a function of Alzheimer's disease severity, indicating that older adults with more severe Alzheimer's disease were less able to spontaneously press the alternative key in the prospective memory trials (ie when the top and bottom colour bars were in the same colour). The response time data were congruent with the accuracy data, with older adults with more severe Alzheimer's disease responding more slowly in the prospective memory trials (Fig 2). Hence, prospective memory performance was sensitive to

Alzheimer's disease at the earliest detectable stages. This suggests that those with early-stage (very mild) Alzheimer's disease were less able to track the target events and spontaneously trigger the intended action than healthy older adults. This is consistent with our hypotheses and previous findings.¹

Selective attention

Although memory loss has been considered the first clinical manifestation of Alzheimer's disease, recent evidence also shows a decrease in attentional control as a function of Alzheimer's disease severity.³ Selective attention was studied via a simple task, in which older adults were told that an arrow pointing to either left or right would appear on the left half, right half, or centre of the screen. They were instructed to ignore the arrow location and judge the arrow direction by pressing either left or right key that corresponded to the arrow direction (Figs 1c to 1e). In congruent trials, the arrow direction (eg pointing right) corresponded to the arrow location (eg at the right). In incongruent trials, the arrow direction (eg pointing right) was opposite to the arrow location (eg on the left). In neutral trials, the arrow appeared in the centre of the screen. The three types of trial were randomly intermixed within the task. A deficit in attentional control could lead to an impaired performance in this task, especially when the arrow location was incongruent with its direction. Specifically, to properly respond to an incongruent trial, one must maintain the task goal (responding to arrow direction, but not arrow location) and resolve the conflict by inhibiting task-irrelevant location information and accessing task-relevant direction information. In contrast, there was no conflict between direction and location information in congruent trials. Previous studies showed that older adults in the earliest stage of Alzheimer's disease made far more errors in incongruent trials (relative to congruent trials) than healthy older adults, suggesting that Alzheimer's disease could influence one's attentional control abilities.⁴ The task took about 10-12 minutes to complete. Because the task does not involve verbal materials, it is suitable

for Hong Kong older adults whose education level is generally low. We predicted that older adults' errors in incongruent trials (relative to congruent trials) would increase as a function of their Alzheimer's disease severity.

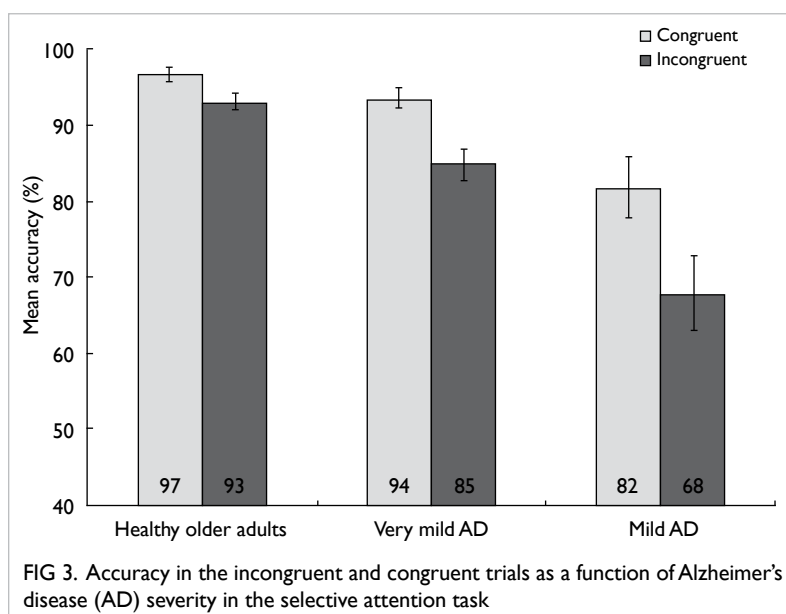
After taking the differences in age and education level across groups into account, the accuracy in both congruent and incongruent trials decreased as a function of Alzheimer's disease severity. Nonetheless, the drop in performance in incongruent trials (93% → 85% → 68%) was sharper than that in congruent trials (97% → 94% → 82%) [Fig 3], indicating that older adults with more severe Alzheimer's disease were less able to maintain the task goal and resolve the conflict between incongruent information. This is consistent with our hypotheses and previous studies.⁴

Predictive utility and reliability of prospective memory and selective attention measures

We also tested whether the prospective memory and selective attention measures could discriminate between healthy older adults and those at the earliest stage of Alzheimer's disease after taking into account their general cognitive functioning, which could be reflected by these older adults' performance in the psychometric assessment. After controlling for the variance explained by each of the psychometric measures, accuracy and response time in prospective memory trials and errors in the incongruent (vs congruent) trials in the selective attention task still significantly predicted Alzheimer's disease severity (ie healthy old *or* very mild Alzheimer's disease) in most cases, suggesting that the constructs measured by our two tasks did not completely overlap with those measured by standard psychometric measures. To test the reliability of our measures, about one-third of our healthy old and very mild Alzheimer's disease individuals were invited to repeat the task. The reliability of most of the measures in the two tasks was acceptable and quite comparable with most of the psychometric measures.

Conclusion

This study identified measures of prospective memory and selective attention tasks that can discriminate an individual who is at the earliest detectable stage of Alzheimer's disease from healthy older adults in a Hong Kong Chinese population. Most of these measures demonstrated moderate reliability and comparable discriminative power for Alzheimer's disease severity to most standard psychometric measures. The findings are consistent with those reported in previous studies, although the mean education level of our samples was lower than that of previous studies (6 vs 14 years). This



suggests that the prospective memory and selective attention measures could be sensitive to the decline due to early-stage and mild Alzheimer's disease for older adults with a lower education level. Future studies should determine whether our prospective memory and selective attention measures can predict older adults' everyday functioning (such as remember to lock the main door before bedtime) or examine the influence of individual differences (such as education level) on the discriminative power of various cognitive measures.⁵

Acknowledgements

This study was supported by the Health and Health Services Research Fund, Food and Health Bureau, Hong Kong SAR Government (#08090041). We thank Ada Fung for her assistance in gathering the psychometric data, Janet Kwan and Kaver Hui for their assistance in data collection, and all older adults for their participation.

References

- McDaniel MA, Einstein GO. Prospective memory: an overview and synthesis of an emerging field. Sage; 2007.
- Chan RC, Qing Y, Wu Q, Shum D. Prospective memory in healthy Chinese people: the latent structure of the Comprehensive Assessment of Prospective Memory Questionnaire. *Neuropsychol Rehabil* 2010;20:459-70.
- Balota DA, Faust M. Attention in dementia of the Alzheimer's type. In: Boller F, Cappa S, editors. *Handbook of neuropsychology*, 2nd Ed. Elsevier Science; 2001;6:51-80.
- Tse CS, Balota DA, Yap MJ, Duchek JM, McCabe DP. Effects of healthy aging and early stage dementia of the Alzheimer's type on components of response time distributions in three attention tasks. *Neuropsychology* 2010;24:300-15.
- Chang J, Tse CS, Leung GT, et al. Bias in discriminating very mild dementia for older adults with different levels of education in Hong Kong. *Int Psychogeriatr* 2014;26:995-1010.