# Foreign language training via mobile application to improve cognitive functions in patients with mild cognitive impairment: abridged secondary publication

**PCM Wong *, SYC Tsang, Z Deng, M Antoniou**

## KEY MESSAGES

1. Foreign language training in community centres has been reported to improve cognitive functions of older adults with mild cognitive impairment.
2. There is evidence of an overall effectiveness of foreign language training on the Alzheimer's Disease Assessment Scale–cognitive subscale score with a medium effect size.
3. Foreign language training may boost cognitive functions in older adults with below-average cognitive abilities; whether long-term or short-term training is more beneficial requires further studies.

Hong Kong Med J 2023;29(Suppl 1):S22-3
HMRF project number: 05160806

[1,2] **PCM Wong,** [2] **SYC Tsang,** [3] **Z Deng,** [4] **M Antoniou**

[1] *Department of Linguistics and Modern Language Studies, The Chinese University of Hong Kong, Hong Kong SAR, China*
[2] *Brain and Mind Institute, The Chinese University of Hong Kong, Hong Kong SAR, China*
[3] *Department of Applied Psychology, Guangdong University of Finance and Economics, China*
[4] *The MARCS Institute for Brain, Behaviour and Development, Western Sydney University, Australia*

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

## Introduction

Computer-based foreign language (FL) training in a community centre has been reported to promote cognitive health in older adults.[1] The current study aims to compare the effect of FL training on promotion of cognitive functions. We hypothesise that FL training via a mobile application may engage the whole episodic memory brain network and promote positive neurophysiological changes potentially via neuronal modification and repair processes.[2,3] In addition, we hypothesise that cognitive improvement is greater after long-term training than short-term training even if the overall training duration is identical.

## Methods

Native Cantonese speakers with no functional knowledge of English aged 60 to 80 years with mild cognitive impairment who had (1) basic literacy skills and completed at least 6 years of primary school education, (2) no significant psychiatric or neurological deficits or hearing difficulties, and (3) no experience with the Rosetta Stone language learning software were included. Mild cognitive impairment was defined as (1) a score of 0.5 or 1 on the Clinical Dementia Rating scale[4] or (2) a score of 0 on the Clinical Dementia Rating scale and 25% standard deviation below the age-typical mean on the Alzheimer's Disease Assessment Scale–cognitive subscale (ADAS-Cog) or the Category Verbal Fluency Test.

Of 258 persons screened, 158 fulfilled the inclusion criteria. Of them, 15 decided not to enrol and the remaining 143 were randomly assigned to four groups: centre FL, long-term mobile FL, short-term mobile FL, or music listening (control).

The three FL groups learned English using the Rosetta Stone language learning software. The centre FL and long-term mobile FL groups spent 1 hour per day, 5 days per week for 6 months. The short-term mobile FL group spent 2 hours per day, 5 days per week for 3 months. The centre FL group went to elderly centres for training, whereas the mobile FL groups installed a mobile application and were taught to use it by a research assistant. The music listening group spent 2 hours per day, 5 days per week for 3 months for music listening using a mobile phone.

The primary outcome measure was the ADAS-Cog. Secondary outcome measures included the Auditory Reading Span, the Boston Naming Test, the Wechsler Digit Span task (forward and backward), the Attention Network Test, and the Short-Form 12-item Health Survey. An intent-to-treat approach was used for statistical analysis. For each of the outcome measures, a 2 (group) × 2 (time) analysis of variance was conducted.

## Results

Of 143 participants enrolled, 80 completed the study and were assessed at the endpoint. The dropout rate was 44.06%, because community centres were closed

at different times during the COVID-19 pandemic.

There was no significant difference in baseline variables between the centre FL and the long-term mobile FL groups. Main effects of time were found on Auditory Reading Span, Clinical Dementia Rating scale, and Category Verbal Fluency Test. No one type of FL training was more effective than the others.

There was no significant difference in baseline variables between the long-term and short-term mobile FL groups. Significant interactions were found on the Boston Naming Test and Attention Network Test reaction time (neutral). From baseline to endpoint, performance in the Boston Naming Test deteriorated in the long-term mobile FL group and improved in the short-term mobile FL group, whereas reaction time in the Attention Network Test deteriorated in the long-term mobile FL group and improved in the short-term mobile FL group. Main effects of time were found on ADAS-Cog, Auditory Reading Span, Clinical Dementia Rating scale, and Category Verbal Fluency Test.

There was a significant difference in baseline ADAS-Cog score between the short-term mobile FL group and the music listening group. A significant interaction was found on the Attention Network Test. From baseline to endpoint, reaction time of Attention Network Test improved in the short-term mobile FL group and deteriorated in the music listening group. Main effects of time were found on ADAS-Cog, Boston Naming Test, Clinical Dementia Rating scale, Wechsler Digit Span, and Attention Network Test. FL improved cognitive performance more than music listening did but only in Attention Network Test.

To assess simple effects (as opposed to comparative training effects) of FL training, we conducted t-tests on ADAS-Cog of each group. FL training had a significant effect with a medium effect size (Cohen's $d$=0.422). In contrast, music listening did not result in a significant effect with a small effect size (Cohen's $d$=0.229) [Fig].

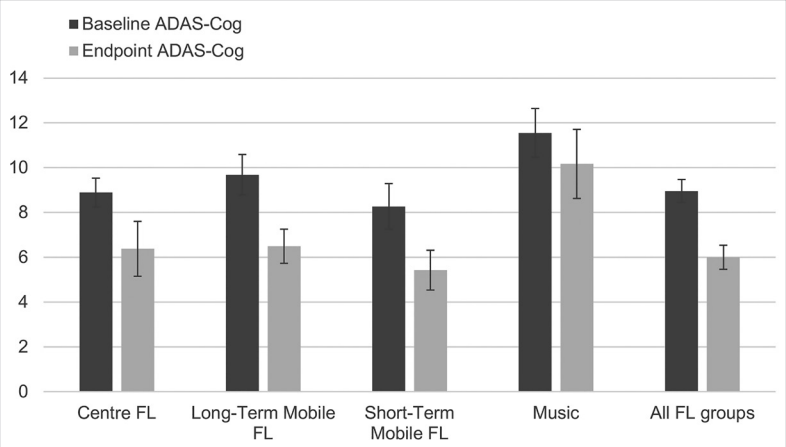


FIG. Baseline and endpoint scores of the Alzheimer's Disease Assessment Scale–cognitive subscale (ADAS-Cog) in foreign language (FL) training groups and music listening (control) group

## Discussion

Because of a large dropout rate, it was not possible to determine whether FL training via mobile application results in cognitive benefits and whether long-term and short-term FL training results in different cognitive benefits. Nevertheless, we found evidence of an overall effectiveness of FL training on ADAS-Cog with a medium effect size. Long-term FL training yielded a larger effect size (Cohen's $d$=0.599) than short-term FL training (Cohen's $d$=0.497), but this difference did not reach statistical significance. Music listening did not improve cognitive abilities.

FL training may be a cognitively stimulating activity that boosts cognitive functions in older adults with below-average cognitive abilities, evidenced by simple training effects (relative to baseline) with a medium effect size. However, whether long-term FL training would produce a larger effect than short-term FL training requires further investigation.

## Funding

This study was supported by the Health and Medical Research Fund, Health Bureau, Hong Kong SAR Government (#05160806). The full report is available from the Health and Medical Research Fund website (https://rfs1.fhb.gov.hk/index.html).

## Acknowledgements

We thank the community centres for assistance in recruitment. We also thank Leyan Xie for assistance in training participants and Dr Hoyee W Hirai for conducting statistical analysis.

### References

1. Wong PC, Ou J, Pang CWY, et al. Language training leads to global cognitive improvement in older adults: a preliminary study. J Speech Lang Hear Res 2019;62:2411-24.
2. Merzenich MM, Nelson RJ, Stryker MP, Cynader MS, Schoppmann A, Zook JM. Somatosensory cortical map changes following digit amputation in adult monkeys. J Comp Neurol 1984;224:591-605.
3. Recanzone GH, Merzenich MM, Jenkins WM, Grajski KA, Dinse HR. Topographic reorganization of the hand representation in cortical area 3b owl monkeys trained in a frequency-discrimination task. J Neurophysiol 1992;67:1031-56.
4. Chu LW, Chiu KC, Hui SL, Yu GK, Tsui WJ, Lee PW. The reliability and validity of the Alzheimer's Disease Assessment Scale Cognitive Subscale (ADAS-Cog) among the elderly Chinese in Hong Kong. Ann Acad Med Singap 2000;29:474-85.