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Original Article

Improving Cognitive Function in Older Adults through Mental Abacus Training: A Single-Arm Pilot Study

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SUMMARY

Background: Mental abacus training is a potential tool for enhancing cognitive function. However, no related research has been conducted on older adults.
Aims: This prospective single-arm pilot study was conducted to evaluate the effectiveness of mental abacus (MA) training on cognitive function in older adults.
Methods: Cognitive function was assessed at baseline and 3 months after training completion by using the Taiwanese Version of the Montreal Cognitive Assessment (MoCA) and Color Trails Test 1 (CTT1) and 2 (CTT2). Participants with a MoCA score of < 26 were subgrouped into the high-risk group, whereas those with a MoCA score of ≥ 26 were subgrouped into the low-risk group.
Results: A total of 80 participants completed MA training. The total MoCA score was 24.6 ± 3.7, CTT1 time was 71.3 ± 46.5 seconds, and CTT2 time was 132.2 ± 85.4 seconds at baseline. After MA training, the MoCA scores (p < .01) and CTT2 time (p < .01) improved comparing with baseline in the overall participants and the high-risk group. In the low-risk group, only CCT2 time improved (p < .01) after MA training.
Discussion: MA training enhanced cognitive function in older adults, especially in the group with low baseline MoCA score. Control without MA training should be included in future studies for confirming the effects of MA training.
Conclusion: MA is a potential culturally adapted cognitive stimulation for older adults in Taiwan.

1. Introduction

People are living longer worldwide, and a longer life presents opportunities as well as challenges, including many chronic diseases such as hearing loss, cataracts, and dementia.[1] Aging is one of the most prominent risk factors for dementia.[2–4] The incidence of Alzheimer disease (AD), the most common cause of dementia, increases by approximately twofold every 10 years after the age of 60 years.[5] Dementia causes considerable burdens for not only patients but also their families and society in general[6,7] and it has become an emerging concern as society ages. Whether the disease course could be modified with currently approved pharmacological treatment, including cholinesterase inhibitors and N-methyl-D-aspartate receptor antagonists, remains under debate.[8–11] Nonpharmacological intervention has the potential to enhance cognitive function and modify the course of dementia.[12] The Cochrane systematic review and meta-analysis indicated that cognitive stimulation programs benefit cognition in people with mild-to-moderate dementia more significantly than does medication.[13] Another meta-analysis demonstrated significant positive effects of cognitive stimulation on mini-mental state examination scores in people with dementia compared with nonactive and active controls.[14] Cultural adaptation of cognitive stimulation is important to ensure participants' engagement.[15] Most of older population in Chiayi city have abacus using experience because the abacus was once widely used in Asian countries including in Taiwan.[16] The familiarity to abacus helps participants to engage in mental abacus training. Mental abacus (MA) involves performing calculations in the mind by using an imaginary abacus. It integrates verbal, visuospatial, and image processing with executive functions.[17] Hatta and Ikeda claimed that long-term MA training can form hemispheric specialization patterns and change approaches to performing cognitive tasks. Abacus-based training has been applied

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to children and demonstrated structural and functional changes in several brain regions.[18–21] Another single-arm pilot study applied the ALOHA abacus arithmetic program in an elderly participants, including 6 healthy controls, 6 patients with amnestic mild cognitive impairment, and 8 patients with AD. The results revealed that the usability, satisfaction, and degree of engagement associated with this program were favorable, as well as cognitive function improvement after intervention.[22] However, in that study, the cognitive stimulation was complicated, and the real effects of mental arithmetic on cognitive function remains uncertain. In the present study, we designed a prospective single-arm pilot study, focusing on cognitive function change after MA training.

2. Materials and methods

We conducted a prospective single-arm pilot study supported by the government of Chiayi City, Taiwan, to examine the effectiveness of MA training on cognitive function improvement in older adults.

2.1. Study population

We recruited participants in an MA training program between March 2018 and June 2018. We included community-dwelling participants aged over 55 years in the Senior Citizens' Active Life Long Learning program in chiayi city, Taiwan. The sample (n = 80) was divided into 2 groups: 1) High-risk group (N = 48) with score < 26 on the montreal cognitive assessment (MoCA); 2) Low-risk group (N = 32) with score ≥ 26 on the MoCA. We excluded people with known diagnosis of neurodegenerative diseases, such as Alzheimer's dementia and Parkinson's disease, or major depressive disorder, that might confound to cognitive impairment, or lead to poor compliance. People who had been taking medications that influence cognitive performance including anticholinergic, antihistamine, GABAergic, and opioid drugs were also excluded. All participants received information regarding the program from the government and voluntarily participated in this study. The study protocol was reviewed and approved by the Institutional Review Board of Taipei Medical University (TMU-JIRB: N201803079). Written informed consent was waived.

2.2. MA training

The MA training involved the use of a 2-hand method, and participants were required to mentally manipulate the abacus in the same manner as they would when using a real abacus. Participants attended an MA training course once every week. Each training course lasted 1.5 hours. The program included a total of 12 courses.

2.3. Cognitive function assessment and demographic variables

Cognitive function was assessed at baseline and 3 months later when training completed by one neurologist and 3 clinical psychologists. The participants were assessed with the Taiwanese Version of the Montreal Cognitive Assessment (MoCA) and Color Trails Test 1 (CCT1) and 2 (CTT2). MoCA is scored out of 30 points, with higher scores reflecting better performance. It examines various domains of cognitive functions including visuospatial/executive function, naming, episodic memory, attention, language, abstraction, and orientation.[29] Color Trails Test 1, the respondent uses a pencil to rapidly connect circles numbered 1–25 in sequence. Color Trails Test 2, the respondent rapidly connects numbered circles in sequence, but alternates between pink and yellow. The length of time to complete each trial is recorded. Normative time to complete CTT1 (mean ± SD): 63.5 ± 24.8 seconds, CTT2 (mean ± SD): 127.6 ± 42.8 seconds, according to a normative study on the Color Trails Test in health middle age and elderly individuals in Taiwan. Participants with a baseline MoCA total score of < 26 were subgrouped into high-risk group, and those with a MoCA score of ≥ 26 were grouped into low-risk group.

Sex, age, and formal education year were collected. After MA training, researchers obtained outcome measure using the same tasks.

2.4. Statistical methods

Continuous variables expressed as means and standard deviations were analyzed using the Student *t* test, whereas categorical variables presented as frequencies and percentages were analyzed using the chi-squared test. The general linear model repeated measure was examined to compare the MoCA scores and CTT1 and CTT2 times between the low-risk and high-risk groups. All statistical analyses were conducted using SAS Version 9.4 (SAS Institute Inc., Cary, NC, USA) considering 2-sided probabilities. Statistical significance was set at $p < .05$.

3. Results

Overall 80 participants were enrolled with mean age of 65.7 ± 7.0 years. Their average formal education years was 12.7 ± 3.2 years. 14 of the 80 participants were men (17.5%). The demographic and clinical characteristics of participants are listed in Table 1. The mean MoCA score was 24.6 ± 3.7; CTT1 was 71.3 ± 46.5, and CTT2 was 132.2 ± 85.4 at baseline. The time required to complete the CTT2 was longer (136.3 ± 56.0 vs. 104.3 ± 33.1, $p < .01$) in the high-risk group. The number of education years was lower (11.9 ± 3.4 vs. 13.9 ± 2.4, $p < .01$) in the high-risk group (Table 1). A total of 4 participants in the high-risk group and 2 participants in the low-risk group refused to take the CTT1; 4 participants in the high-risk group and 1 participant in the low-risk group refused to take the CTT2 (Table 2).

The MoCA score and CTT1 and CTT2 times were compared between baseline and posttraining and between subgroups. The mean baseline MoCA scores and CTT1 and CTT2 times of all participants were 24.6 ± 3.7, 71.3 ± 46.5 seconds, and 132.2 ± 85.4 seconds, respectively. The mean posttraining MoCA score and CTT1 and CTT2 times of all participants were 26.4 ± 3.2, 68.0 ± 51.3 seconds, and 115 ± 72.7 seconds, respectively. The mean baseline MoCA scores in the high- and low-risk groups were 22.0 ± 4.3 and 27.8 ± 1.6 seconds, respectively. The mean baseline CTT1 times in the high- and low-risk

Table 1
Demographic and clinical characteristics of the study groups.

	All participants (N = 80)	High-risk group (N = 48)	Low-risk group (N = 32)	*p* value
Age (y)	65.7 ± 7.00	66.7 ± 7.8	64.1 ± 5.2	.0706
Sex (male)	14 (17.5%)	8 (16.67%)	6 (18.8%)	.8101
Education (y)	12.7 ± 3.2	11.9 ± 3.4	13.9 ± 2.4	.0027*
MoCA score	24.6 ± 3.7	22.0 ± 4.3	27.8 ± 1.6	< .0001*
CTT1 (seconds)	71.3 ± 46.5	78.2 ± 56.4	60.1 ± 23.2	.0619
CTT2 (seconds)	132.2 ± 85.4	136.3 ± 56.0	104.3 ± 33.1	.0086*

Notes: MoCA, Taiwanese Version of the Montreal Cognitive Assessment; CTT1, Color Trails Test 1; CTT2, Color Trails Test 2. High-risk group indicates participants with a MoCA score of < 26. Low-risk group indicates participants with a MoCA score of ≥ 26.
* $p < .05$.

groups were 78.2 ± 56.4 and 60.1 ± 23.2 seconds, respectively. The mean baseline CTT2 times in the high- and low-risk groups were 136.3 ± 56.0 and 104.3 ± 33.1 seconds, respectively. The mean posttraining MoCA scores in the high- and low-risk groups were 25.0 ± 4.0 and 28.0 ± 1.7, respectively. The mean posttraining CTT1 times in the high- and low-risk groups were 72.2 ± 55.2 and 58.8 ± 39.0 seconds, respectively. The mean posttraining CTT2 times in the high- and low-risk groups were 123.6 ± 53.0 and 89.8 ± 22.1 seconds, respectively. MoCA total score significantly improved after MA training in the high-risk group (22.0 ± 4.3 vs. 25.0 ± 4.0, $p < .0001$). CTT2 time also improved after intervention in both groups, meaning less time required to accomplish the tasks (high-risk group: 136.3 ± 56.0 vs. 123.6 ± 53.0, $p < .0001$*; low-risk group: 104.3 ± 33.1 vs. 89.8 ± 22.1, $p < .0001$) (Table 2). A greater improvement in the MoCA total score (3.0 ± 3.4 vs. 0.3 ± 2.0, $p = 0.0140$) was observed in high-risk group than in low-risk group. Improvements in the CTT1 (3.6 ± 23.1 vs. 0.6 ± 42.4, $p = .7702$) and CTT2 (69.0 ± 34.4 vs. 45.7 ± 46.3, $p = .9002$) times were not different between 2 groups (Table 2). A subscale analysis of the change in MoCA score after intervention revealed significant improvement in the attention, language, and delayed recall subscales in the high-risk group (Table 3).

4. Discussion

Our study showed that MA training enhanced cognitive function not only in healthy older adults but also in the participants with mild cognitive impairment. We learn from previous study that frequent participation in cognitive stimulation activities was associated with reduced risk of AD.[23] Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability study revealed that multidomain intervention improved or maintained cognitive function in participants with very mild cognitive impairment.[24] The subscale analysis in our study showed significant improvement in the attention, language, and delayed recall domains among high-risk group, which was consistent with the results of an MA study in children. The authors found that after abacus-based mental calculation, children performed better in digit/letter memory span tasks, which mainly rely on attention and working memory.[21] In addition, a study measuring the effect of reading aloud and arithmetic calculation on older adults with AD in Japan reported that after 6 months of training, the experimental group exhibited significant improvement in communication between staff and participants. The author claimed that the effect was attributable to the immediate feedback of participants during training.[25]

MoCA performance is influenced by education level, age, and sex.[26] Our subgroup analysis revealed no difference between high- (MoCA score < 26) and low-risk groups (MoCA score ≥ 26) regarding age and sex. However, the education years was significantly higher in the low-risk group, which had been adjusted on MoCA scoring in this study.[27] Significantly greater MoCA score improvement was revealed in the high-risk group compared with low-risk group. A possible reason was the ceiling effect on MoCA scores in the low-risk group. Regarding cognitive enhancement through MA training in two subgroups, MoCA and CTT2 improvement were significant in the high-risk group; but only CTT2 improvement was significant in the low-risk group. Both CTT1 and CTT2 measure sustained attention and divided attention. The CTT2 task instructs participants to rapidly connect numbered circles in a sequence, alternating between pink and yellow colors. By contrast, in CTT1, the color need not be considered, which makes it less challenging than CCT2. In our study, the participants performed better in the CTT2 test but not in the CCT1 test after MA training compared with baseline in both groups. We speculated that the CTT1 test in this study might have been too easy to demonstrate beneficial effects. Unlike the results of MoCA scores, no difference in the improvement of CTT1 and CTT2 was observed between subgroups. In summary, improvements in both the MoCA total score and CTT2 time support the potential benefits of

Table 3
MoCA subscale scores at baseline and after training.

	Baseline	Posttraining	*p* value
High-risk group (N = 48)			
Visuospatial/executive	3.9 ± 1.1	4.1 ± 1.2	.077
Naming	2.4 ± 0.9	2.6 ± 0.7	.118
Delayed recall	2.4 ± 1.5	3.7 ± 1.4	< .001*
Attention	4.9 ± 1.2	5.4 ± 0.9	.012*
Language	1.6 ± 0.9	2.2 ± 0.9	.007*
Abstraction	1.1 ± 0.7	1.4 ± 0.6	.115
Orientation	5.4 ± 1.5	5.7 ± 0.8	.164
Low-risk group (N = 32)			
Visuospatial/executive	4.5 ± 0.7	4.6 ± 0.6	.838
Naming	2.9 ± 0.3	2.9 ± 0.3	.711
Delayed recall	4.1 ± 0.9	4.4 ± 0.8	.193
Attention	5.7 ± 0.6	5.9 ± 0.3	.201
Language	2.7 ± 0.6	2.5 ± 0.7	.711
Abstraction	1.6 ± 0.7	1.7 ± 0.5	.324
Orientation	5.9 ± 0.3	5.9 ± 0.3	1.0

Notes: MoCA, Taiwanese Version of the Montreal Cognitive Assessment. High-risk group indicates participants with a MoCA score of < 26. Low-risk group indicates participants with a MoCA score of ≥ 26. * $p < .05$.

Table 2
Cognition assessments at baseline and after training in high-risk and low-risk groups.

	Baseline	Posttraining	*p* value	Difference	*p* value
MoCA score					
All (N = 80)	24.6 ± 3.7	26.4 ± 3.2	< .0001*		
High-risk group (N = 48)	22.0 ± 4.3	25.0 ± 4.0	< .0001*	3.0 ± 3.4	.0140*
Low-risk group (N = 32)	27.8 ± 1.6	28.0 ± 1.7	.4258	0.3 ± 2.00	
CTT1 (seconds)					
All (N = 74)	71.3 ± 46.5	68.0 ± 51.3	.4473		
High-risk group (N = 44#)	78.2 ± 56.4	72.2 ± 55.2	.3105	- 3.6 ± 23.1	.7702
Low-risk group (N = 30#)	60.1 ± 23.2	58.8 ± 39.0	.9388	- 0.6 ± 42.4	
CTT2 (seconds)					
All (N = 75)	132.2 ± 85.4	115 ± 72.7	< .0001*		
High-risk group (N = 44##)	136.3 ± 56.0	123.6 ± 53.0	< .0001*	- 69.0 ± 34.4	.9002
Low-risk group (N = 31##)	104.3 ± 33.1	89.8 ± 22.1	< .0001*	- 45.7 ± 46.3	

Notes: MoCA, Taiwanese Version of the Montreal Cognitive Assessment; CTT1, Color Trails Test 1; CTT2, Color Trails Test 2.
High-risk group indicates participants with a MoCA score of < 26. Low-risk group indicates participants with a MoCA score of ≥ 26.
Adjusted for age and education level, * $p < .05$, # Indicates that 4 participants in the high-risk group and 2 in the low-risk group refused to take the tests.
Indicates that 4 participants in the high-risk group and 1 in the low-risk group refused to take the tests.

MA training in global cognitive function, especially working memory, sustained attention, and divided attention in the high-risk group. The findings indicate that MA training could be a potentially effective intervention for people with mild cognitive impairment. MA training integrates multiple cognitive functions. It is easy to access, requiring no particular facility, and not limited by specific time and place. With advances in technology, computerized cognitive stimulations are increasingly applied. Participants follow the instructions by the computer to do training and evaluation at the same time. Computer measures stimulation dosage and cognitive outcome precisely in real time, although the acceptability is another issue when older participants confront new technology.

4.1. Limitations

This study had a few limitations. First, the lack of a control group with no MA training in this study might have interfered with the interpretation of the results. However, designing trials without any intervention for controls, especially nonpharmacological trials, is a challenge. Recruitment of controls without MA training is further warranted to confirm the effects of MA training. Second, because the seasonal program lasted for 3 months, so post-test was arranged right after training. Though MA training enhanced cognitive performance in older adults, the long term effect will need more studies to confirm. Learning effect could play a role in cognitive improvement with not much known about the extent. However, a period of 3 months in between assessments is still a long time, and we think that a mean improvement of 3 points on the MoCA score could not completely be explained by a learning effect. MoCA examinations at an interval of 3 months should be acceptable. Third, the significantly less improvement in MoCA total score in the low-risk group could be due to the ceiling effect in this group. This tool might not be sufficiently sensitive to detect the magnitude of improvement after MA training in the normal group. Further research is warranted to address cognitive enhancement attributable to MA in participants without cognitive dysfunction by using more sensitive tools. Fourth, the original MA skills of the participants were not evaluated; thus, whether MA skill level at baseline influenced the benefits in cognitive function is unclear.

5. Conclusion

MA training can enhance cognitive performance in older adults, especially in those with cognitive impairment. Controls without MA training should be included for confirming the effects of MA training in the future.

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References

1. World Health Organization. *Ageing and health*. Geneva, Switzerland: World Health Organization; 2018. Available at https://www.who.int/news-room/fact-sheets/detail/ageing-and-health. Accessed April 27, 2020.
2. Carone M, Asgharian M, Jewell NP. Estimating the lifetime risk of dementia in the Canadian elderly population using cross-sectional cohort survival data. *J Am Stat Assoc.* 2014;109:24–35.
3. Matthews F, Brayne C. The incidence of dementia in England and Wales: findings from the five identical sites of the MRC CFA Study. *PLoS Med.* 2005;2:e193.
4. Larson EB, Langa KM. The rising tide of dementia worldwide. *Lancet.* 2008;372:430–432.
5. Baumgart M, Snyder HM, Carrillo MC, et al. Summary of the evidence on modifiable risk factors for cognitive decline and dementia: a population-based perspective. *Alzheimers Dement*. 2015;11:718–726.
6. Nichols E, Szoeke CE, Vollset SE, et al. Global, regional, and national burden of Alzheimer's disease and other dementias, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet Neurol.* 2019;18:88–106.
7. Jia J, Wei C, Chen S, et al. The cost of Alzheimer's disease in China and re-estimation of costs worldwide. *Alzheimers Dement.* 2018;14:483–491.
8. Atri A. Effective pharmacological management of Alzheimer's disease. *Am J Manag Care.* 2011;17:S346–S355.
9. Mielke MM, Leoutsakos JM, Corcoran CD, et al. Effects of Food and Drug Administration-approved medications for Alzheimer's disease on clinical progression. *Alzheimers Dement.* 2012;8:180–187.
10. Rountree SD, Atri A, Lopez OL, et al. Effectiveness of antidementia drugs in delaying Alzheimer's disease progression. *Alzheimers Dement.* 2013; 9:338–345.
11. Livingston G, Sommerlad A, Orgeta V, et al. Dementia prevention, intervention, and care. *Lancet.* 2017;390:2673–2734.
12. Morley JE, Berg-Weger M, Lundy J. Nonpharmacological treatment of cognitive impairment. *J Nutr Health Aging.* 2018;22:632–633.
13. Woods B, Aguirre E, Spector AE, et al. Cognitive stimulation to improve cognitive functioning in people with dementia. *Cochrane Database Syst Rev.* 2012;(2):CD005562.
14. Huntley JD, Gould RL, Liu K, et al. Do cognitive interventions improve general cognition in dementia? A meta-analysis and meta-regression. *BMJ Open.* 2015;5:e005247.
15. Wong GHY, Yek OPL, Zhang AY, et al. Cultural adaptation of cognitive stimulation therapy (CST) for Chinese people with dementia: multicentre pilot study. *Int J Geriatr Psychiatry*. 2018;33:841–848.
16. Li S-Ti. Origin and development of the Chinese abacus. *J ACM*. 1959;6: 102–110.
17. Ku Y, Hong B, Zhou W, et al. Sequential neural processes in abacus mental addition: an EEG and FMRI case study. *PloS One.* 2012;7:e36410.
18. Hatta T, Ikeda K. Hemispheric specialization of abacus experts in mental calculation: evidence from the results of time-sharing tasks. *Neuropsychologia.* 1988;26:877–893.
19. Hanakawa T, Honda M, Okada T, et al. Neural correlates underlying mental calculation in abacus experts: a functional magnetic resonance imaging study. *Neuroimage.* 2003;19:296–307.
20. Chen F, Hu Z, Zhao X, et al. Neural correlates of serial abacus mental calculation in children: a functional MRI study. *Neurosci Lett.* 2006;403: 46–51.
21. Hu Y, Geng F, Tao L, et al. Enhanced white matter tracts integrity in children with abacus training. *Hum Brain Mapp.* 2011;32:10–21.
22. Matías-Guiu JA, Pérez-Martínez D, Matías-Guiu J. A pilot study of a new method of cognitive stimulation using abacus arithmetic in healthy and cognitively impaired elderly subjects. *Neurología.* 2016;31:326–331.
23. Wilson RS, Mendes De Leon CF, Barnes LL, et al. Participation in cognitively stimulating activities and risk of incident Alzheimer disease. *JAMA.* 2002;287:742–748.
24. Ngandu T, Lehtisalo J, Solomon A, et al. A 2 year multidomain intervention of diet, exercise, cognitive training, and vascular risk monitoring versus control to prevent cognitive decline in at-risk elderly people (FINGER): a randomised controlled trial. *Lancet.* 2015;385:2255–2263.
25. Kawashima R, Okita K, Yamazaki R, et al. Reading aloud and arithmetic calculation improve frontal function of people with dementia. *J Gerontol A Biol Sci Med Sci.* 2005;60:380–384.
26. Nasreddine ZS, Phillips NA, Bédirian V, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *J Am Geriatr Soc*. 2005;53:695–699.
27. Borland E, Nägga K, Nilsson PM, et al. The Montreal Cognitive Assessment: Normative data from a large Swedish population-based cohort. *J Alzheimers Dis*. 2017;59:893–901.