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Review

Tai Ji Quan, the brain, and cognition in older adults

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Abstract

The relationship between physical activity (PA) and cognition has received much attention recently. While evidence of improved cognition following PA has consistently been observed, the majority of studies have spotlighted aerobic exercise and the effects of other modes of PA, such as Tai Ji Quan, on cognition have received limited attention. This article provides a brief review of the literature concerning the influence of Tai Ji Quan on cognition in older adults, including those with intact cognition and those with cognitive impairment. In addition, this review proposes potential mechanisms (cardiovascular fitness, motor fitness, movement coordination, social interaction, and meditation statuses as well brain structure and function) evaluated from a neuroimaging perspective that may explain the Tai Ji Quan–cognition relationship. Finally, we present suggestions for future research. In conclusion, Tai Ji Quan, with its multi-faceted characteristics, shows promise as a mode of PA for enhancing cognition, as well as brain health, in older adults. Based on the findings in this review, further exploration of the effects of Tai Ji Quan on cognition in older adults is warranted.

Keywords: Brain plasticity; Dementia; Executive function; Physical activity; Tai Ji Quan

1. Introduction

With increased age, adults frequently experience deterioration in cognitive performance with respect to response speed and accuracy on tasks involving information processing speed, reasoning, memory, spatial orientation, and spatial visualization.[1] The aging process also reduces specific brain area volumes, such as in the caudate nucleus, lateral prefrontal cortex, cerebellar hemispheres, and hippocampus[2] which has been linked to cognitive impairment and age-related neurological pathologies such as dementia and Alzheimer's disease.

While cognitive ailments and brain decay with aging have been generally observed, the rate of deterioration is moderated by individual differences (e.g., education and cardiovascular fitness) as well as by several lifestyle factors (e.g., physical activity (PA), intellectual engagement, social interaction, and nutrition).[3] Among these factors, the effects of PA, particularly cardiovascular fitness, on cognition in older adults has received much attention. A large number of prospective studies have demonstrated that higher levels of participation in PA are positively associated with cognitive function and a lower incidence of cognitive impairment.[4,5] Research into the relationship between cardiovascular fitness and cognition has been strengthened by the development of using neuroimaging techniques. Using cross-sectional and longitudinal designs these experimental studies have revealed that older adults with

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higher cardiovascular fitness levels display better cognitive performance as well as more gray and white matter[6] and larger hippocampal volumes.[7,8]

Although a few recent studies have focused on the influence of resistance exercise modes on cognition,[9–11] the majority of studies regarding PA and cognition emphasize aerobic exercise; thus, the effects of other modes of PA on cognition remain mostly unexplored. Herein, the current review examines the literature focusing on the relationship between Tai Ji Quan (also known as Tai Chi Chuan, Taijiquan, and Taiji), a popular ancient Chinese PA regimen, and cognition in older adults with intact cognition, and on those with cognitive impairment. In addition, based on neuroimaging data we propose potential mechanisms underlying this relationship and suggest several directions for further studies on the effects of Tai Ji Quan on cognition in older adults.

2. Older adults with intact cognition

A few recent studies have examined the relationship between Tai Ji Quan and cognitive performance in terms of attention, memory, and eye–hand coordination. With a cross-sectional design, Man et al.[12] compared the performance of older adults who regularly participated in Tai Ji Quan on attention and memory tests to those with and without regular PA habits. While the researchers observed better performance in the physically active older adults rather than those who were sedentary, the Tai Ji Quan group performed better in sustained and divided attention as well as in everyday memory, encoding memory, and recall memory, compared with those in the regular PA group, which suggests that Tai Ji Quan provides additional beneficial effects on cognition. Another study reported a similar influence of Tai Ji Quan on cognition by examining the age effect. Hall et al.[13] compared cognitive performance on a Rapid Index Finger-Pointing task among young adults, older adults with Tai Ji Quan experience, and older adults who were physically inactive. The results indicated that although older adults displayed worse performance in terms of reaction time, movement time, and response accuracy than younger adults, reflecting age-related cognitive decline, older adults with Tai Ji Quan experience displayed a shorter movement time than their inactive counterparts, suggesting that Tai Ji Quan positively affects eye–hand coordination tasks that involve greater cognitive demand.

The apparent beneficial effects of Tai Ji Quan on cognition that requires higher cognitive processing demonstrated by Hall et al.[13] raises a question about whether Tai Ji Quan would benefit higher-order cognitive functioning, namely executive function. Indeed, meta-analysis has indicated that aerobic exercise not only benefits cognition in general (i.e., speed, spatial, and controlled aspects of cognition) but facilitates executive function to a greater degree,[14] which suggests that the effects of exercise on cognition are disproportional. For example, using a pre–post-experimental design, Matthews and Williams[15] determined that older adults who participated in a Tai Ji Quan intervention three times per week over 10 weeks improved executive function performance on the Trail Making Test B and Clock Drawing test, but not the Trail Making Test A or Digit Symbol test, which are indices of basic information processing tasks. Taylor-Piliae et al.[16] additionally examined long-term Tai Ji Quan intervention (5 times per week for 12 months) to compare cognition alteration in attention control and treatment control groups. Similar to Matthews and Williams,[15] Taylor-Piliae et al.[16] observed that older adults in the Tai Ji Quan group demonstrated better executive function performances with regard to Digits Backward, but not the basic cognitive performance measured by Digits Forward. In contrast, when compared with a 5.5-month motor training program of Tai Ji Quan, fall prevention, and contemporary dance, only adults that participated in the contemporary dance intervention demonstrated better performance in the switch aspect of executive function.[17] Notably, no significant differences were observed in the setting or suppressing attention aspects of executive function, which suggests that Tai Ji Quan might not be sensitive to these aspects of executive function. This disproportionate facilitation of executive function by Tai Ji Quan was discussed in a recent commentary by Etnier and Chang,[18] who argued that the variation in effect on these specific aspects of executive functioning from exercise training warrant further investigation.

In contrast to examining cognitive performance by using the cognitive tasks described above, three studies have examined the effects of Tai Ji Quan intervention on cognition using the Mini Mental State Examination (MMSE) in older adults with intact cognition. However, no effects on the MMSE were found following Tai Ji Quan after 8 weeks,[19] 24 weeks,[20] or 24 months.[21] Although these findings appear contradictory, it should be noted that the MMSE is a popular screening test for cognitive impairment and might be less sensitive in respect of older adults with normal cognition.[22,23]

3. Older adults with cognitive impairment

Beyond emphasizing cognitive function in older adults with intact cognition, a small number of recent studies have focused on the influence of Tai Ji Quan on cognitive functions in older adults with cognitive impairment. Using a pre–post experiential design, Chang et al.[24] indicated that, although post-test MMSE and Digit Symbol scores improved after a Tai Ji Quan program of twice per week for 15 weeks, compared to the pre-test, the differences in cognitive variables did not reach statistical significance. However, when analyzing the dose–response relationship of Tai Ji Quan session attendance (i.e., attending fewer sessions/low-dose group versus regular attendance/high-dose group), the high-dose group had significantly better MMSE and Digit Symbol scores than the low-dose group, which suggests that the beneficial effects of Tai Ji Quan on cognitive performance could be extended to older adults with cognitive impairment if participation reaches an efficacy threshold.

Stronger evidence of the effects of Tai Ji Quan was provided by recent studies that focused on older adults with mild cognitive impairment (MCI).[25,26] MCI is an intermediate stage between normal age-related cognitive decline and dementia[27] and is of particular interest because adults with MCI are at