



Old Dog, New Tricks: Learning Novel Motor Tasks May Enhance Brain Health in Older Adults



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Abstract

Maintaining cognitive vitality remains challenging in our rapidly aging society. It has been well documented that as we age, even simple daily tasks become challenging as it increasingly draws cognitive resources from neural pathways outside of the primary motor cortex. The purpose of this statement is to explore the potential use of novel motor training as a countermeasure to alleviate cognitive declines in older adults.

Keywords: Motor control; Cognitive aging; Mild cognitive impairment

Aging vs Brain Plasticity

On average, humans will develop and retain a steady number of neural connections throughout lifespan. However, as we age our overall number of neurons decreases; therefore, requiring us to share aever-declining resource of neural connections [1]. It has been observed that these connections tend to realign or redistribute as a means of both normal aging and brain pathology. This rewiring of new neural pathway's functions to provide for new learning of common activities of daily living and other important communication and motor skills, and has been observed via positron emission tomography (PET) scans in acute practice of verbal and motor tasks in normal adult brains [2]. In normal adults, excitation in brain regions for new learning is observed in a secondary network consisting of the prefrontal cortex and anterior cingulate cortex as well as other areas specific to the task. This secondary network of neural connections is dubbed the scaffolding areas and is important for the learning of a new motor skill for all ages.

Contemporary View of Compensatory Mechanisms in Cognitive Aging

The Scaffolding Theory of Aging and Cognition (STAC) states that as a compensatory mechanism neural excitability, seen as new brain circuit pathways in the areas outside of the primary network, will act to compensate the decrease in available neurons. This may be due to a decrease in total brain volume, specifically white matter, overall structural integrity as a function of age or pathology, or decreased number of dopaminergic pathways [3]. STAC suggests neural pathway activation changes may be permanent changes that are a result of overused or underused areas of the brain, but the

scaffolding areas of the brain could be trained or reprogrammed to be more efficient. Interventional training may help transfer the execution of simple skills back to the default primary networks, or optimize the scaffolding areas of the brain to function as proficiently as the default. Upon revisiting their theory five years later, Park and colleagues added the inclusion of "life-course factors" such as experience, genetics and environmental influence that may be variables that affect the early onset of the use scaffolding areas to complete simple skills [4].

Although it is recognized that compensatory neural networks assist with the computations performed by the primary or default network, the required use of compensatory networks in older adults has been observed to be less efficient than primary networks used by young adults that do the same task. A few relevant questions remain unanswered concerning this topic-What exactly causes these neural adaptations? Are they entirely detrimental? And what can be done to prevent any cognitive decline that may be associated with these age-related adaptations? Currently, researchers aim to detect if starting interventions at middle age or later adulthood are beneficial to optimize the scaffolding effect on the secondary networks to make them more efficient.

Known Contributing Factors on Cognitive Performance

Emerging evidence has shown that aerobic training and strength training have positive effects on increasing cognitive function and motor performance in older adults [5]. Life-long participation in aerobic training has shown to attenuate the loss of regional brain volume [6]. Conversely, older adults with limited mobility exhibited accelerated accumulation of white matter abnormalities

over a 5-year period [7]. The reduction in white matter integrity has been linked to cognitive instability and motor deficits [8]. The performance of motor coordination has shown to require a higher cognitive demand in older adults where neural excitability has been observed to operate in both hemispheres of the motor cortex [9], and better performance of physical tasks has been linked to excitation within the primary hemisphere for a unilateral task compared to those observed to involve both hemispheres [10].

Novel Gross Motor Training May Enhance Brain Health in Older Adults

Previous studies have measured cognitive and motor function for simple ipsilateral tasks and found that younger subjects outperformed the older subjects by expressing more motor coordination stability, while concurrently activating less brain regions than the older subjects [11]. Interestingly, Berryman et al. [5] observed that in some cases, gross movement motor training yields similar beneficial effects on executive function as aerobic training would confer. To date, very few investigations examined if complex gross motor tasks would promote and enhance performance in cognitive functions in older adults.

Tseng et al. [6] studied a group of older adults aged 50-70 (N=36) undergoing an 8-week intervention consisted of Bilateral Object Manipulation training (BOM) of 3-ball juggling and conventional exercise training [12]. Physical function was evaluated by Range-of-Motion (ROM), Simple and Choice Reaction Times (SRT & CRT), functional reach, and Gait Velocity (GV). Tseng et al. [6] revealed that 8 weeks of BOM training may promote better excitability, reacting time, mobility, and dynamic balance in older adults. Their finding shed light on the clinical implication of a potentially cost-effective home-based therapeutic intervention in preserving daily-living function in older adults. Of note, it appears to be critical that when learning new motor skills to incorporate non-dominant hand [13], and tasks that incorporates multi-limb coordination may offer augmented benefits for older adults [14].

Promoting physical and cognitive health and maintaining functional capacity of daily activities is imperative in our aging society. Future research should 1) Aim to validate the physiologic mechanisms involved in the training adaptations observed in the current research, 2) Confirm the efficacy of novel motor learning in preserving cognitive function in older adults, and finally 3) Explore the potential therapeutic intervention using the BOM model in clinical population such as mild cognitive impairment and early stage dementia.

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