Dance In Mild Cognitive Impairment: A Systematic Review Of Dance Intervention's

Effects On Executive Function, Memory, Learning, and Attention

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Abstract

Several methods of treatment have been attempted to provide care for individuals with mild cognitive impairment (MCI). MCI is a condition defined as having cognitive delay that does not severely interfere with day-to-day activities and is caused by a blockage and buildup of beta-amyloid proteins in the brain. MCI is also regarded as a transitory stage to severe neurodegenerative diseases, such as Alzheimer's disease. Recently, dance intervention as treatment for MCI has become of interest to many researchers. Both physical and musical therapy have been partially effective in treating MCI; dance combines these two practices. Dance intervention can improve executive function, memory, and attention in individuals with MCI, preventing further cognitive impairment. This systematic review synthesizes findings from peer-reviewed journals and clinical trials. After an analysis of these findings, it becomes clear that dance intervention increases the ability of MCI patients to plan, solve problems, make decisions, and manage emotions. This is made possible by an increase in activity in the bilateral fronto-temporal cortex and anterior cingulate cortex. Dance intervention is also helpful to MCI patients with a loss of memory, aiding in the loss of volume from the parahippocampal cortex and less activity in the entorhinal cortex. Dance intervention has beneficial consequences for patients with MCI who have low attention spans or long reaction times. By utilizing dance intervention as treatment for individuals with MCI, physicians can improve patients' executive function, learning and memory, and attention.

Introduction

The U.S. government estimates that about 10-20% of adults ages 65 and older struggle with mild cognitive impairment. More than 90% of these individuals are unaware they have this condition. Mild cognitive impairment (MCI) is a condition defined as having memory loss or cognitive delay that, although possibly noticeable to one's family and friends, does not interfere with everyday function. While language, memory, and judgement can be hindered by MCI, symptoms do not severely affect daily life. In many situations, MCI leads to Alzheimer's disease and eventually dementia; it is a transitory phase.

Both physical therapy and musical therapy have been found to make small improvements in the cognitive function of MCI patients. Dance intervention combines these two therapies, stimulating the brain and body. Research suggests that dance intervention can improve executive function, memory, learning, and attention in individuals with mild cognitive impairment, preventing further cognitive impairment.

Background and Objectives

MCI can occur when clumps of beta-amyloid protein, plaques, build up and disrupt cell function, leading to brain tissue loss (Mormino & Papp, 2018). Neurofibrillary tangles, also known as tau plaques, can also harm cell function. MCI can also occur from strokes when the steady blood flow to the brain is interrupted. Severe concussions may result in MCI due to bruising the brain. While further cognitive impairment is preventable, individuals with MCI are found to have less activity in the prefrontal cortex; additionally, the right hippocampus is slower to encode new information (Johnson et al., 2006). These areas of the brain aid in memory, decision-making, executive functioning, attention, learning, and processing information. Specifically targeted, the bilateral fronto-temporal cortex is affected by cortical thinning, leading to a loss in executive function. MCI marks a reduction of volume in the entorhinal cortex, leading to memory loss. The anterior cingulate cortex changes, reducing the ability for decision-making and executive function. The parahippocampal cortex is marked with noticeable atrophy and reduced volume, leading to a loss of memory.

Dance intervention has been found to have beneficial consequences for the brain and enhance cognitive performance among the elderly due to its neuroplasticity-inducing nature and dual-simulation of the brain and body. Studies suggest that moving to a rhythm or meter allows one to internalize the rhythm and improves temporal predictions, defined as the ability to predict future events based on external surroundings (Chemin et al., 2014). Additionally, audio processing has been found to have greater inter-subject correlation in the superior temporal gyrus (STG) with dance in the presence of music. This means the amount of activity in the STG becomes more similar among individuals dancing (Reason et al., 2016). Just six months of dance intervention can improve cognitive and motor skills in aging individuals (Kattenstroth et al., 2013). Anatomically, dance induces an increase of gray matter in brain imaging, signaling an increase of density and volume of gray matter tissue. Neuron cell bodies are positively affected and brain functions, such as cognition, memory, motor control, and emotion, are strengthened. White matter has also seen a change after dance intervention, signaling repair of damaged tissue. White matter tissue typically increases with age and can drastically increase due to cognitive impairment. Dance intervention saw a change in the volume of white matter, indicating its ability to repair damaged tissue (Karpati et al., 2015). Dance stimulates the brain and body, combining two therapies that have been partially effective in the past: physical and musical therapy. This systematic review analyzes whether dance therapy can have a significant impact on the executive function, memory, learning, and attention of individuals with MCI. It also addresses the probability of dance intervention being used to delay severe neurodegenerative diseases, as well as the gaps in knowledge concerning MCI and dance intervention.

Method

This systematic review synthesizes findings from peer-reviewed journals and clinical trials. The inclusion criteria were: population: people of all ages with MCI; intervention: dance-based interventions; control group: no treatment, usual care, or waiting list group; outcome: improved executive function, learning and memory, and/or attention; study design: published or unpublished randomized controlled trials (RCTs). Keywords included MCI, dance intervention and the brain, dance and MCI, and dance and neurodegenerative diseases. Key sources include neurological studies and randomized controlled trials; 28 studies were reviewed, and 13 total studies were utilized. Some studies were excluded as they did not study the correlation between dance and MCI, dance and the brain, or dance and neurodegenerative diseases and were, therefore, irrelevant to the review. Databases utilized include PubMed and Google Scholar. Exclusion criteria include non-peer-reviewed sources and studies not directly

related to MCI or neurodegenerative disease.

Results

Executive function

Dance intervention increases the ability of MCI patients to plan, solve problems, make decisions, and manage emotions. MCI can drastically affect executive function. This occurs mainly due to the damage of the bilateral fronto-temporal cortex (bi-FTC) and the anterior cingulate cortex (ACC). However, with dance intervention, activity and fluctuations were found to increase in these areas of the brain. The amplitude of low-frequency fluctuations (ALFF, or signals of change in the brain) values were significantly increased, indicating a higher level of spontaneous neuronal activity. It indicates higher metabolic activity and, therefore, higher cognition in the bi-FTC and ACC (Qi et al., 2018). Not only was this change detected anatomically, but behaviorally as well. One study utilized Greek traditional dance as an intervention on a Greek population with MCI. The study reported an increase in verbal fluency and executive function after the intervention. They found, using the Functional Cognitive Assessment Scale (FUCAS) and Trail-making Test (TMT), that patients' executive functioning skills were better after intervention. The study reported a significant decrease in score on the FUCAS [Before training: 42.00 (42.00, 46.00); After training: 44.50 (42.00, 46.00); CI 95%]. This indicates an increase in executive functioning skills (Douka et al., 2019). A similar study using ballroom dancing as an intervention conducted the FUCAS, among other exams, to assess

executive function before and after 10 months of intervention. The intervention group's mean score was 44.74. The control group's mean score was 45.88. Behaviorally, the study reported that cognitive function appeared to worsen for the control group (Lazarou et al., 2017). This indicates that dance intervention is a useful mode of treatment for MCI patients whose executive functioning skills are declining.

Memory and Learning

Dance intervention is also helpful to MCI patients with a loss of memory. Primarily due to the loss of volume in the parahippocampal cortex and less activity in the entorhinal cortex, memory is largely affected by MCI and later stages of neurodegenerative disease. However, Qi et al. (2018) found, in the same study measuring activity in the bi-FTC and ACC, an increase in ALFF fluctuations in this region of the brain, signaling higher metabolic activity in these regions of the brain. At a clinical level, a study using dance intervention measured MCI patients' ability to recall and recognize information using the WMS-R LM exam, a test designed to measure verbal memory using immediate and delayed recall, before and after the intervention. The study reported that the mean increase for the intervention group was 3.4, signaling a memory improvement. They found that while the intervention group's memory strengthened over 6 months, the control group worsened in memory (Zhu et al., 2018). Another study that aimed to understand the difference in cortical gray matter thickness between dancers and non-dancers with MCI tasked the participants with the California Verbal Learning Test; this allowed them to assess the episodic verbal memory of dancers versus non-dancers in individuals with MCI. The

study reported that after a short delay, the control group could recall an average of 6.9 words from a list, while the intervention group could recall an average of 9.6. The study confirmed that dance intervention was beneficial to memory in individuals with MCI. In addition to memory, learning is positively affected by dance intervention. The same study measured the ability of the control group and intervention group to learn after five trials of recalling words. The study reported that the control group's average learning score over five trials was 37.69, while the intervention

group's average score was 46.85 (Porat et al., 2016). These results indicate that dance intervention can be an effective treatment for patients with MCI in strengthening memory and learning.

<u>Attention</u>

MCI greatly affects patients' abilities to remain attentive and alert. The prefrontal cortex is typically disrupted in individuals with MCI, resulting in lower levels of attention (Johnson et al., 2006). Dance intervention has beneficial consequences for patients with MCI who have low attention spans or long reaction times. Douka et al. (2019) reported that dance intervention significantly changed MCI patients' selective attention, sustained attention, stirring of attention, and execution of dual work in visual and auditory attention following dance intervention. The study also reported an increase in alertness. Similarly, the study using ballroom dance intervention. The intervention conducted the Test of Everyday Attention (TEA) before and following intervention.

study confirmed that dance intervention can have positive outcomes for attention in patients with MCI (Lazarou et al., 2017).

Prevention of further impairment

By using dance intervention, patients' cognitive abilities can be improved, preventing severe neurodegenerative disease. One study affirmed that following dance intervention with an elderly Filipino group of individuals with MCI, the intervention group scored higher on the Alzheimer's Disease Assessment Scale - Cognitive (ADAS-Cog). This confirms that dance intervention can delay further impairment for individuals with MCI (Dominguez et al., 2018). In addition, an increase of gray matter tissue is a great indicator of improvement and decreases the likelihood of future neurodegenerative diseases. It is necessary for further research to be conducted on any change of gray matter before and after dance intervention for individuals with MCI. If results match the consistent behavioral results, it can be inferred that dance intervention is an effective treatment for MCI and delays further cognitive impairment.

Future research

Future research is necessary to understand the full capability of dance intervention for MCI patients. In addition to gray-matter imaging, further research should prioritize the effect of dance intervention on verbal fluency/language, motor skills, and perception. Current research focuses on executive functioning, learning, memory, and attention, but little is known about other cognitive functions' relationship with dance intervention. In addition to continuing to study the relationship between dance intervention and MCI, it is beneficial to prioritize research concerning dance intervention and severe neurodegenerative diseases. While dance intervention and MCI have extensive research, dance intervention's effect on cognitive function in individuals with Alzheimer's disease and dementia is far less studied. Since MCI can lead to Alzheimer's and eventually dementia, it is crucial to determine if dance intervention is an effective treatment. A study done in Lagos, Nigeria, on patients with Alzheimer's found increased attention, judgment, decision-making ability, and perception due to dance intervention; however, no improvement in memory was found (Akinyelure, 2022). Research is inconclusive. While dance is effective during stages of MCI, one study deemed that they found little to no difference in neuropsychiatric symptoms in individuals with dementia (Karkou et al., 2023). A relationship between dance intervention and improved cognition in individuals with Alzheimer's disease and dementia is inconclusive, and further research is necessary to understand if dance is a probable treatment.

Conclusion

Mild cognitive impairment is a prevalent condition that affects millions of elderly individuals; it puts individuals at risk for further neurodegenerative disease, such as Alzheimer's. While MCI is rarely fatal, it can alter the brain by weakening vital cognitive functions. By utilizing dance intervention as treatment for individuals with MCI, physicians can improve patients' executive function, learning and memory, and attention. Additionally, further impairment to severe neurodegenerative diseases, such as Alzheimer's, can be delayed. Future research efforts should prioritize the effect of dance intervention on other cognitive functions for patients with MCI, as well as dance intervention's effect on patients with Alzheimer's and other neurodegenerative diseases.

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