Spring 5-18-2019

Creativity and Movement Maintain Synaptic Activity, Improving QOL in Older Adults: A Critical Review

Caitlin Pilette
Lesley University, cpilette@lesley.edu

Creativity and Movement Maintain Synaptic Activity, Improving QOL in Older Adults: A Critical Review

Capstone Thesis

Lesley University

5 May 2019

Caitlin Pilette

Dance/Movement Therapy

Donna C. Owens, PhD, SHRM-SCP

Abstract

People are living longer. Hence, the global population of older adults is increasing. Likewise, the population of individuals living with Alzheimer's disease, other forms of dementia, and general cognitive decline is also growing and is expected to double within the next ten years. This literature review examines the effects of exercise, movement, and creative cognition seeking a positive connection to improvement in an individual's brain function, cognitive abilities, and synaptic plasticity while focusing on their relation to memory recall abilities. It is suggested that exercise and movement increases a chemical within the brain that is involved with memory recall and increased synaptic firing. Additionally, creative cognition utilizes multiple networks within the brain indicating greater opportunities for boosting cognitive abilities. One of these systems is directly involved in the storage and retrieval of episodic memories. Creative thinking has been found to improve the coping, adaptability, and flexibility of older adults' everyday problem-solving skills; thereby, implying it elevates quality of life. Dance/movement therapy combines creative cognition and movement, as well as treats the whole person. Therefore, through neurological, physiological, and psychological lenses, dance/movement therapy is presented as a beneficial and all-encompassing intervention to use with older adults to improve their recall abilities, engage their working memory, maintain synaptic plasticity, and increase quality of life.

Keywords: dance/movement therapy, synaptic plasticity, older adults, quality of life

Creativity and Movement Maintain Synaptic Activity, Improving QOL in Older Adults

Working with older adults for over five years has led to my interest in improving their quality of life (QOL). Older people are an ever-increasing segment of the population (Chancellor et al., 2014); therefore, applied knowledge with this population is of growing importance not only to them, but to those who love and care for them as well. My first experience with this population was teaching dance classes to people with Parkinson's disease. Plus, for the past two years, I have conducted dance/movement therapy (D/MT) groups for older individuals with Alzheimer's disease (AD) and other forms of dementia and cognitive decline at an assisted living facility. There appeared to be a noticeable increase in creative thinking, critical thinking, and the ability to recall memories and vocabulary during our movement and exercise groups. For example, when I asked a 92-year-old female resident with moderate AD to "name something you love to do," her ability to provide an answer was quicker during a creative movement group than when she was not participating in a creative movement group. This piqued my curiosity, and I began to wonder about the connection between creative movement and brain function. I hoped my exploration of the topic would support the use of D/MT to improve the QOL for older adults.

Researchers have shown that exercise does improve brain function and memory. By using a series of tests, Dustman, et al. (1984) demonstrated how aerobic exercise improved neuropsychological functioning of the central nervous system. Vaynman, Ying, & Gomez-Pinilla (2004) used a different experiment to reveal a positive correlation between exercise's ability to increase a particular chemical in the hippocampus and a test subject's increased memory and learning ability. With this knowledge and a new-found interest in neurology and neurobiology, I went on to discover that exercise and movement increased activity within synapses.[1] This information shows how important exercise and movement are to enhanced brain function and led to my desire to create exercises that would improve brain function and the ability to maintain recall for longer periods of time for older adults living with AD, dementia, and cognitive decline. The answer seemed to be in preserving and actually increasing the brain's plasticity.[2] To be more specific, synaptic plasticity is the flexibility of nerve cell junctions to become stronger or weaker in response to increased or decreased use or activity.

Next, I began to contemplate the benefits that thinking creatively could add to this mix. Fisher & Specht (1999) aimed to discover the correlation between aging successfully and creativity's role in an individual's life. They found a common thread reported by the older adult participants was that "characteristics of creativity carry over into other areas of life . . . [becoming] part of the overall process through which they express a sense of self and manage everyday life" (p. 467). The results of their research along with those of the previously mentioned experiments caused me to consider how combining the two, creativity and movement, could improve the cognitive function and QOL in older adults. One way to combine these two areas into one technique would be to use D/MT with this population.

Levy (2005) states:

> Dance therapy, the use of dance/movement as a psychotherapeutic or healing tool, is rooted in the idea that the body and the mind are inseparable . . . Helping individuals . . . regain a sense of wholeness by experiencing the fundamental unity of body, mind, and spirit is the ultimate goal of dance therapy. (p. 1)

---

[1] A synapse is "a junction between two nerve cells, consisting of a minute gap across which impulses pass by diffusion of a neurotransmitter" ("Synapse," n.d.).
[2] Plasticity is described as "the quality of being easily shaped or moulded" ("Plasticity," n.d.).

Additionally, Hamill, Smith and Rohricht (2012) examined the affect circle dance group therapy had on adults with dementia and their caregivers. They reported that two out of seven of the participants with dementia surpassed earlier cognitive state results and five raised their QOL scores (p. 714). However, a gap in the current research that I am interested in exploring in the future is D/MT's effects on synaptic plasticity. This literature review inspects the link exercise/movement and creative/expressive interventions have to improved brain function, memory, and/or QOL. Plus, it explores the connection between D/MT and extending a higher QOL for older adults living with cognitive decline, cognitive impairment, dementia, or AD.

Literature Review

Exploring the Neuroscience of Memory and Cognitive Decline

AD, other forms of dementia, and cognitive decline were better understood by researching articles that discussed both the brains of healthy older adults, as well as those of individuals with neurodegenerative diseases. One thing that is affected in the aging brain is working memory (WM). WM is defined as "the process by which information is coded into memory, actively maintained and subsequently retrieved" (Rypma & D'Esposito, 2000, p. 509). "Working memory (WM) is an essential component for human higher order cognitive activities (Baddeley, 1986; Just and Carpenter, 1992; Nishizaki, 2000)" (Takeuchi et al., 2011, p. 681). Takeuchi et al. (2011) defines WM as:

> the limited capacity storage system involved in the maintenance and manipulation of information over short periods of time (Baddeley, 2003). It is a functionally important system for the facilitation of a wide range of cognitive abilities such as reasoning, learning, and comprehension (Baddeley, 2003). (p. 681)

Rypma and D'Esposito (2000) found that WM "declines with age" (p. 509). The temporary holding space for knowledge in the brain of an older adult becomes increasingly limited and possesses a smaller capacity for storage. Therefore, cognitively declining minds' short-term memories become even shorter.

As reported in Rypma and D'Esposito's (2000) study, "age associated differences in working memory performance may be related to the [prefrontal cortex] changes that occur with age" (p. 509). The prefrontal cortex is most commonly known for being the home of executive functioning skills. It is responsible for tasks such as decision-making, problem solving, and self-control. Individuals who have suffered damage to or display deficits within the prefrontal cortex tend to have difficulty with cognitive abilities. The ventrolateral prefrontal cortex is thought to have roles in motor abilities and decision making executive functioning skills. However, the dorsolateral prefrontal cortex is thought to play a role in the functioning of the WM. "The mid-dorsolateral prefrontal region has been shown to be critical for the monitoring of multiple events in working memory" (Petrides, 2000, p. 44). Additionally, "the discovery of sustained neural discharge in monkey [dorsolateral prefrontal cortex] neurons during the retention and interval of delayed-response . . . tasks suggested that this region is involved in on-line maintenance and manipulation of information (i.e., working memory)" (Mars & Grol, 2007, p. 1801). Mars and Grol also discovered that the "selection-dependent activation of the [dorsolateral prefrontal cortex] (Rowe et al.) . . . explains the delay-related activation reported in delayed-response tasks" (p. 1802).

Rypma and D'Esposito (2000) recruited both young individuals from the University of Pennsylvania and older individuals from the greater metropolitan Philadelphia area that ranged in age from 25 to 68.8 years old. They found that there were "no significant age-related differences in ventrolateral [prefrontal cortex]" (p. 509), the portion of the brain that is responsible for decision making and motor functions. However, this study did find there were "significant age-associated differences" within the dorsolateral prefrontal cortex, but "only during retrieval of high memory" (p. 512) tasks. These results highlighted that the age-related differences within the prefrontal cortex and WM are "limited to retrieval processes" (p. 512). These changes are not due to AD or cognitive decline, but are simply related to the aging of the human brain. Another correlation documented in this study was between the aging brain and its reduced ability to produce "neural activation levels that permit discrimination between responses" (p. 512). This means that the selectiveness of synaptic firing has diminished, since their cognitive responses to any and all stimuli are limited by a decreasing number of neuropathways that they can travel down. This slows down cognitive reaction-time and shows that synaptic plasticity is already dwindling within the aging brain, regardless of the added expedient of AD or other forms of dementia.

Resnick et al. (2003) examined 50 male and 42 female "very healthy" (p. 3295) older adults' brains and found that, over a 5-year span, the brain loses gray and white matter as humans age. It revealed that "frontal and parietal, compared with temporal and occipital, lobar regions showed greater decline" (p. 3295) and are therefore more "vulnerable" (p. 3299) to decline and degradation. In relation to the topic of this inquiry, one of the primary functions of the frontal lobe is cognitive functioning and the parietal lobe processes various types of information (MFMER, n.d.). To fully understand this study, one must understand what gray and white matter are. Gray matter is "the darker tissue of the brain and spinal cord, consisting mainly of nerve cell bodies and branching dendrites" ("Gray matter," n.d.). It is located within several regions of the brain, and for the purposes of this paper, one of its major locations is in areas of the brain that deal with memory (Miller et al., 1980). White matter is "the paler tissue of the brain and spinal cord, consisting of mainly nerve fibres with their myelin sheaths" ("White matter," n.d.). This indicates that white matter is used to carry nerve impulses between neurons, which are synaptic firing sites.

This research done by Resnick et al. (2003) utilized imaging and various statistical analyses to find the "first evidence of substantial longitudinal declines in both gray and white matter brain volumes in older adults ranging in age from 59 to 85 years at baseline" (p. 3298). It indicated that through the loss of gray and white matter with age, the brain is quite literally shrinking because the ventricle-to-brain ratio is increasing over time. A ventricle is "a hollow part or cavity in an organ" ("Ventricle," n.d.). In other words, this empty space becomes greater as the brain shrinks. The subjects of Resnick et al.'s (2003) study were relatively healthy older adults. However, its authors also hypothesized that those "showing the fastest rates of change in mesial temporal and orbital frontal regions," in addition to the decline in frontal and parietal lobes, "are more vulnerable to disease, given our observations of a regional pattern of age-related gray matter tissue loss and the distribution of progression of neuropathology associated with Alzheimer's disease (Braak and Braak, 1997)" (Resnick et al., 2003, p. 3300).

Therefore, it can be deduced that there are multiple things going on with the brain that relate to synaptic firing within the brain of an individual with AD, other forms of dementia, and cognitive impairment. The parts of the brain that are responsible for cognitive functioning and processing abilities are already deteriorating with age, and the part of the brain that is responsible for maintaining and integrating memories—the temporal lobe (MFMER, n.d.)—is degenerating faster than in healthier brains. The WM is fading, the components of synaptic firing are disappearing, and the ability to properly select how synapses are firing is becoming impossible.

Methods of maintaining synaptic plasticity within the highways of the brain that are still available to a person who is cognitively declining need to be explored further.

How Exercise Affects the Nervous System

"The clinical literature has recognized for years that exercise affects overall health and brain function," (Cotman & Berchtold, 2002, p. 300) particularly within the aging population. There is also research that supports that exercise increases and maintains synaptic plasticity. The concept of synaptic and brain plasticity "has been further developed to include structural change in the brain at the cellular, molecular, and system levels, with the convergence of these mechanisms ultimately supporting behavioral plasticity," (p. 295) such as an increase in memory retrieval or the learning of new information. "Research using animal models provides reasonable grounds to expect aerobic exercise to have a positive impact on human cognitive function through a variety of cellular and molecular mechanisms" (Colcombe & Kramer, 2003, p. 125).

Vaynman et al. (2004) discovered a positive correlation between the ability of exercise to increase brain-derived neurotrophic factor (BDNF) in the hippocampus and a subject's increased ability to learn and remember. The hippocampus is an area of the brain "involved in learning and memory formation (Neeper et al, 1997; Vayman et al., 2003)" (p. 2580). "BDNF is a member of the neurotrophin family known to play a prominent role in the survival, growth, and maintenance of neurons," (p. 2580) and it also "modulates synaptic plasticity in the adult brain (Lo, 1995)" (Vaynman et al., 2006, p. 124). This means that this molecule is imperative for learning and memory as well. Therefore, "exercise-induced increases in hippocampal BDNF levels might underlie the ability of exercise to enhance cognitive function" (Vaynman et al., 2004, p. 2580).

In their study, Vaynman et al. (2004) utilized the Morris Water Maze (MWM) to test two groups of randomly selected, male rats, one that exercised daily and another that was sedentary. During the MWM test, researchers documented the time the rats' needed to find a submerged, stationary platform that was unseen due to dyed water. In order to test the rats' memory, they removed the platform and recorded the amount of time the rats spent in the MWM quadrant where the platform had been. In order to isolate the variables, the researchers blocked the action of BDNF by utilizing "a specific immunoadhesin chimera (TrkB-IgG) that mimics the BDNF receptor . . . to selectively bind BDNF molecules" (p. 2581). It was shown that BDNF sub-serves exercise in improving hippocampal-dependent learning if it is not blocked, because when they used TrkB-IgG to block the effects of BDNF, the exercised rats performed no better than the sedentary rats. "This study provides novel direct evidence that the cognitive enhancement seen with exercise is in fact mediated by and dependent upon the action of BDNF," (p. 2586) and in fact, "enhanced the recall ability" (p. 2586) within the exercised rats.

Building on their 2004 study, two years later, Vaynman et al. (2006) "selected a group of molecules involved in synaptic transmission" (p. 125) to examine that were from their initial 2004 procedure with the adult male rats. In this new study, they highlighted that "exercise uses BDNF to selectively modulate the levels" (p. 125) of specific molecules within the hippocampus. Therefore, they thought that through the changing of the molecular levels within the hippocampus, as a result of exercise, that age-related cognitive decline would decrease. Hence, exercise not only increases synaptic plasticity which improves cognitive function, but it also boosts memory and recall abilities. "Blocking BDNF action has been shown to contribute to both synaptic fatigue and decrease of synaptic vesicle proteins (Pozzo-Miller et al., 1999)" (p.

126). So, it would be logical to think that increasing the production of BDNF within the hippocampus through exercise would increase synaptic stamina.

In another study performed by Cotman and Berchtold (2002), they determined that "voluntary exercise can increase levels of brain-derived neurotrophic factor (BDNF) and other growth factors, stimulate neurogenesis, increase resistance to brain insult and improve learning and mental performance" (p. 295). The researchers employed voluntary exercise to avoid confounding variables, such as stress on the participants. Cotman and Berchtold imagined that the "neurotrophic-mediated response to exercise would probably be restricted to motor-sensory systems of the brain" (p. 295), but they found that it also increased levels within the hippocampi of their subjects, 22 male rats and 23 female rats. Within the hippocampus, the changes in these levels due to exercise were found in neurons located within the dentate gyrus. The dentate gyrus is the "first step in the processing of information . . . that ultimately leads to the production of episodic memories" (Amaral, 2007, p. 1). Episodic memories are "a type of long-term memory that involves conscious recollection of previous experiences together with their context" ("Episodic memory," n.d.). These changes in the dentate gyrus were equivalent to those in BDNF. Thus, "suggesting that BDNF is a better candidate for mediating the long-term benefits of exercise on the brain" (Cotman & Berchtold, 2002, p. 295).

Cotman and Berchtold (2002) also found that "peripheral mechanisms" (p. 297) within the brain, such as estrogen or corticosterone, are also imperative. "Steroid hormones such as estrogen influence brain aging, particularly in post-menopausal women" (p. 297). Estrogen replacement has been known to "slow age-related cognitive decline and to delay the onset" (p. 297) of AD. Within this study, they discovered that when in tandem with BDNF produced from exercise, the estrogen replacement provided a greater improvement in cognitive functions within female subjects, thereby, decreasing the chance of AD within women. This means that the increase of BDNF within the brain that exercise provides an individual "could regulate downstream anatomical changes that support brain plasticity" (p. 298-299). "Thus, exercise could provide a simple means to maintain brain function and promote brain plasticity" (p. 295). Furthermore, it is typically found that the changes that happen within the brain due to chronic stress actually decrease brain plasticity. However, the researchers demonstrated that "exercise before a stressful event can counteract this downregulation" (p. 298).

Colcombe and Kramer (2003) believe these neurochemical, cellular, and molecular changes seen in rodents as a result of exercise interventions alludes to the shifts in cognitive abilities among humans (p. 125). Regarding applying this information to older adults, this data implies that an increase in BDNF levels as a response to exercise might enhance memory abilities. Colcombe and Kramer suggest that even a short session of moderate exercise is enough to enhance an individual's memory abilities and could easily be integrated into one's standard method of care or used to create new therapies for treating AD, other forms of dementia, or cognitive decline. "There is already substantial evidence that loss of mesial temporal lobe tissue, particularly in hippocampus . . . is associated with memory impairment and the development of Alzheimer's disease (Convit et al., 1997; Petersen et al., 2000)" (Resnick et al., 2003, p. 3300).

How Exercise Affects Older Adults

Dustman et al. (1984) concluded that older adults involved in their study's 4-month aerobic exercise program showed improved neurological testing results. This intervention used experimental methodologies and consisted of three groups of nine, randomly-assigned older adult males, ranging from age 51 to 70: the aerobic exercise test group, the strength and fitness exercise control group, and an unexercised control group. The researchers hypothesized and demonstrated that aerobic exercise improves neuropsychological function of the central nervous system. "The aerobically trained group demonstrated significant improvement," (p. 37) and it is suggested that the aerobic factor was what was associated with how large the improvement was compared to the other exercise control group. These tests covered: response time, visual organization, memory, and mental flexibility. The data indicated this improvement was due to increased cerebral metabolic activity facilitated by more oxygen getting to the brain as a result of the additional aerobic exercise (p. 40). "The pattern of results, i.e., improved neuropsychological function with no change in sensory threshold following aerobic conditioning, suggests that the effects of aerobic exercise were primarily on central rather than on peripheral mechanisms" (p. 40).

Heyn et al. (2004) presented "empirical support for exercise improving physical fitness, behavior, cognition, communication, and functioning in older people with cognitive impairments" (p. 1694). Through the lens of this meta-analysis it became clear that exercise for older adults was beneficial in many ways. Neurobiologically, exercise "appears to have an association with reduced brain tissue loss in aging humans" (p. 1694). This specific meta-analysis integrated evidence from 30 selected studies, creating a collective sample size of 2,020 older adults, and "calculated the [effect size] of exercise training on physical, behavioral, functional, and cognitive outcome measures" (p. 1702). The results of this analysis postulate that there is "preliminary evidence for the effectiveness of exercise treatments for persons with dementia and related cognitive impairments" (p. 1702).

Colcombe and Kramer (2003) gathered "studies conducted from 1966 to 2001" (p. 126) and compiled information from four theoretical positions: executive control, speed, visuospatial, and controlled processing. The studies collected were divided into two groups, an aerobic group and a group that used a combination of aerobic and strength training. Their first round of analyses revealed that exercise has the greatest effect on executive processing and functioning. They then moved forward with an exploratory analysis of the other areas. Overall, Colcombe and Kramer (2003) discovered that exercise has a "beneficial influence on the cognition of sedentary older adults," (p. 128) and that it increased their cognitive performance in general, "regardless the type of cognitive task, the training method, or participant's characteristics" (p. 128) among the older adults. They also suggested that exercise can "enhance the cognitive vitality of older adults" (p. 128). Both Heyn et al. (2004) and Colcombe and Kramer (2003) propose that future evidence surrounding the exact role that exercise plays in brain function and its relationship to preventing, delaying the onset of, or slowing down the development of dementia is needed.

Despite all of its benefits, Chodzko-Zajko et al. (2009) confirmed that "older populations are generally less physically active" (p. 1512). Deterioration in physiological systems, both structurally and functionally happen when humans age. However, they discussed yet another aspect of how exercise affects the life of an older adult by increasing various domains of QOL. Chodzko-Zajko et al. (2009) found that literature is shifting to also uncover the relationships between exercise and psychosocial control, self-efficacy, perceived competency, improved cognitive function, and overall psychological health and well-being. They also stated that exercise is beneficial to "short-term improvements in memory, attention, and reaction time" and "leads to sustained improvements in cognitive performance, particularly for executive control tasks" (p. 1521).

Creativity within the Brain

"Creativity is a broadly defined construct, but is generally assumed to involve the generation of some product that is both novel and useful" (Beaty et al., 2016, p. 1), is "appropriate (Sternberg, 2005)" (Takeuchi et al., 2011, p. 681), and is "enormously adaptive for individuals and society" (Zaidel, 2014, p. 1). The Oxford Dictionary defines creativity as "the use of imagination or original ideas to create something; inventiveness" ("Creativity," n.d.). Creativity is also demonstrated through originality in problem-solving abilities. The theme found throughout multiple articles regarding creativity and creative cognition is the idea of something being new.

Beaty et al. (2016) found that studies are increasingly beginning to examine the relationship and "dynamic interactions between large-scale brain systems, such as the default and executive control networks, during creative cognition" (p. 2). They have neuroimaging that supports their conviction that divergent thinking is a form of creative thought. Divergent thought within the realm of psychology uses "a variety of premises, especially unfamiliar premises, as bases for inference, and avoiding common limiting assumptions in making deductions" ("Divergent thought," n.d.). "Divergent thinking pertains primarily to information retrieval and the call for a number of varied responses to a certain item" and "has been proposed to be a key aspect of creativity (Guilford, 1967)" (Takeuchi et al., 2011, p. 681).

	Region of the Brain	**Primary Function**
Default Network	"midline and posterior inferior parietal regions"	"spontaneous and self-generated thought"
Executive Control Network	"lateral prefrontal and anterior inferior parietal regions"	"cognitive processes that require externally-directed attention, including working memory"

Figure 1. Functions of the default and executive control networks of the brain. Adapted from "Creative cognition and brain network dynamics," by R.E. Beaty, M. Benedek, P.J. Silvia, and D.L. Schacter, 2016, *Trends in cognitive sciences*, *20*(2), 87-95, p. 2-3cc

Two brain networks have been recognized as “large-scale brain networks that underlie core cognitive and attentional processes” (Beaty et al., 2016, p. 2): the default network and the executive control network, as shown in Figure 1. Beaty et al. found that “creative thought may benefit from the cooperation of default and control network regions,” (p. 4) and that the coupling of these two networks and the regions they activate is present in creative cognition, despite their “antagonistic relationship at rest and during many cognitive tasks” (p. 2). One major function of the default network of the brain is episodic memory retrieval. “Recent research points to an important role of the default network and episodic memory in creative cognition” (p. 5). This also alludes to memory retrieval in general being activated and potentially increased through creative cognition and engagement.

In addition, Zaidel (2014) points out that, neurologically,

> several creativity-related factors have already been identified, specifically brain size in innovative animas (Reader and Laland, 2002; Lefebvre et al., 2004), neurotransmitters (Manzano et al., 2010), intelligence level, (Sternberg and O’Hara, 2000; Reader et al., 2011; Lefebvre et al., 2013), ecological niches (Lefebvre, 2013) and personality attributes (Gardner, 1994a; Miller, 2000). (p. 2)

Zaidel discusses how art is used as a communication and survival tool when the brain is either damaged or degenerating. She provides examples of how “neurological cases of visual artists who had practiced their craft professionally prior to the brain damage can help point the way to neuroanatomical and neurofunctional underpinnings of creativity” (p. 3) because post-brain damage, trauma, and degeneration; these individuals’ creativity does not decrease. Zaidel also states that art-making could possibly be activating different brain regions.

Zaidel (2014) highlights how individuals with AD "continue to produce art well into their condition" (p. 4). Neuroimaging studies unrelated to the measurement of artistic behavior have found a portion of the prefrontal cortex to be important in general creativity. It has been suggested that the frontal lobe is involved in several aspects of the creative process and thinking within a healthy brain (p. 4). Once again, the frontal lobe is involved in tasks such as "memory, concept formulation, and problem solving (Fuster, 2001)" (p. 4). "The art produced by neurological patients reveals that when brain damage is localized or diffused, or when neurodegenerative brain disease is present… artistic depictions of the imagination are still possible" (p. 6)

Takeuchi et al. (2011) examined 63 right-handed, male and female university students and postgraduate students as part of a larger investigation about the relationship between aging, cognitive functioning, and brain imaging. For this portion of their studies, they assessed creativity through the use of a divergent thinking assessment, the S-A creativity test. Their study involved a mix of neuroimaging techniques, MRI, data analysis, and individual-level statistical analyses to test for a "relationship between individual creativity and brain activities" (p. 684). They identified an association between brain activity during a WM task and brain activity within the precuneus brain region, "the key node" of the default-mode network which is active during attention demanding tasks, and creative cognition" (p. 686).

Examining the Correlation between Creativity and Quality of Life

An individual's QOL begins to decrease with the types of changes that stem from AD, other forms of dementia, and cognitive impairments.

> Dementia usually results in loss of cognitive function, which manifests as impairments of short-term memory, deterioration in ability to carry out activities of daily living, and

> change in personality and behavior (Donaghy, 2001). A diagnosis of dementia can have a negative effect on wellbeing; an Alzheimer's Society (2013) survey found that 33% of people lost friends after diagnosis and 39% said they felt lonely. In 2014, less than half of people living with dementia felt part of their community and only 62% felt able to make choices about how they spent their time (Alzheimer's Society 2014). (McGreevy, 2016, p. 20)

Medical treatments for people with early dementia tend to be limited, inadequate, and "their efficacy is marginal" (Chancellor et al., 2014, p. 1). Time for QOL may be shortened. So, "limiting the cultural opportunities of people with early dementia is unjustified" (Ullán et al., 2013, p. 426). "The skills of people with dementia are frequently underestimated, emphasizing their deficits and, consequently, they are faced with tasks of low level intellectual stimulation or sense of achievement" (p. 442). However, it has been found that neurodegenerative diseases take a while to change creative cognition. (p. 442). Therefore, it is vital to their health and well-being that individuals with AD, other forms of dementia, and cognitive impairment be creative.

Fisher and Specht (1999) performed an "exploration of creativity and successful aging" (p. 458). They used subjective analyses and interpretations of data collected from personal, in-home, face-to-face interviews to gain insight into the role of creativity in later life on successful aging. Using a phenomenological approach, they studied 36 older adult artists, who were predominantly white, protestant, married, middle class, retired professionals with some college education (p. 460) that were participants in the Second Annual Senior Art Exhibition.

Fisher and Specht (1999) organized the data according to percentages of similar responses to show various ways creativity contributed to successful aging and how the "characteristics of creativity carry over into other areas of life . . . [becoming] part of the overall process through which they express a sense of self and manage everyday life" (p. 467). They discovered that successful aging "involves an ability to cope with present circumstances by drawing on past experience" (p. 458). They established that adaptability, coping, and flexibility are all important skills to well-being later in life, but also are components of the creative process and creative thinking. By engaging in creative activity, a person hones "problem-solving skills, maintains adaptive competence, deepens an understanding of self, and cultivates purposeful or meaningful involvements" (p. 459). Highlighted in their article is the usefulness of gaining "'practical creativity' (Mariske and Willis, 1998) and 'resourcefulness' (Poon et al., 1992)" (p. 459) through creative activities and how these apply to problem solving in everyday situations and "carry over into other areas of the individual's life" (p. 467).

All participants of Fisher and Specht's (1999) study substantiated that being engaged in the creative process caused them to concentrate on the positive aspects of the process rather than their own undesirable living circumstances (i.e. illness, pain, etc.). The researchers showed that "creative activity involves a mental preparedness to take on challenges, even welcoming them as part of the process of arriving at newer and deeper understandings about oneself and one's work" (p. 467). The creative process and creative thinking allows individuals to maintain a positive outlook, remain active, and foster personal growth. Fisher and Specht (1999) also revealed that creativity asks a person to face problems and view them as "opportunities" (p. 469), "helping individuals stay engaged and feel good about themselves" (p. 470).

Ullán et al. (2013) conducted subjective analyses of observations, assessments, and interviews regarding a contemporary artistic education program for older adults with early dementia to understand its effects on that population. Examining 21 older adults with early dementia, this study included observation of participants, assessment of participants by educators, interviews of five participant focus groups, and interviews of their professional caretakers. Twelve researchers collaborated on this study, but only two were directly involved with the program and analyzed the data. They used summary forms, guidelines for analysis, and frequent responses from participants, their caretakers, and the educators to form relevant categories that could be interrelated and analyzed.

Ullán et al.'s (2013) study identified interrelationships between the topics addressed within each of the four data collection techniques and how they reinforced one another. These techniques consisted of the aforementioned observation of participants, assessment by the educators, focus groups of people with dementia, and a focus group of caretakers. The researchers concluded that "access to art and artistic education [for] people with early dementia" (p. 425) improves their care and maintains their right to take part in and appreciate the arts in the community, plus it contributed to a better self-image and self-efficacy for people with dementia. The study discovered that people gained an interest in learning new things that they "didn't think [they] could learn . . . at this point" (p. 436) and a satisfaction throughout the creative process as well as with their products. Regarding art appreciation, this is conserved in individuals with AD, other forms of dementia, and cognitive impairment. Both Ullán et al. (2013) and Fisher and Specht (1999) found significant correlations between creativity and improved QOL.

Arts-Based Approaches and Expressive Therapies

"Art is produced spontaneously only by humans" (Zaidel, 2014, p. 1). Fisher and Specht (1999) suggest that "creativity may still be a viable outlet for self-expression" (p. 467) for individuals with AD, other forms of dementia, and cognitive impairments. Chancellor et al., (2014) points out that AD primarily affects one's episodic memory, learning, and language, and that these "deficits may alter the content of art, but does not prevent its production" (p. 5). At this time, “a culture of care has emerged that attempts to include and enable people with dementia through creative and arts-based approaches” (McGreevy, 2016, p. 20). This makes sense, because no matter how far the brain has declined, it will still recognize

> art in all of its manifestations (visual art, music, literature, dance, theater, and more) [as] an important feature of human societies because it serves as a cohesive symbolic communicative system conveying cultural norms, history, ideas, emotions, esthetics, and so on. (Zaidel, 2014, p. 2)

“Without treatments to arrest or reverse degenerative dementias, interventions to improve quality of life of patients and their caregivers remain of prime importance” (Chancellor et al., 2014, p. 1). Chancellor et al. (2014) accentuated the idea of art therapy being a successful intervention in dementia due to the fact that individuals within this population “can and do produce art” (p. 2). They analyzed studies that “reported clinically relevant outcomes in treating behavioral, social, cognitive, and/or emotional problems of dementia patients and/or their caregivers” (p. 2-3). Results discussed included studies in which an increase in interest, attention, and self-esteem were the result of art therapy; as well as decreased apathy being observed in the “in-session behavioral improvements” (p. 3) of individuals. Overall, art therapy improved the QOL of individuals with dementia.

Chancellor et al. (2014) also provided a framework for utilizing art therapy with this population. The first step is to engage an individual’s ability to appreciate and produce art. “Art appreciation involves assigning emotional and cognitive significance to artworks” (p. 4) and “while art is often conceptual or meaning laden, it need not be” (p. 5). The next step is to utilize “art as expression” (p. 5). In brain degenerative diseases, non-verbal communication is less affected than verbal skills. However, these individuals tend to have “intense emotional lives” (p.

5) without a way to verbally express it. This is where art-making steps in. The last pillar of the framework is that “artistic engagement can induce ‘flow’” (p. 5).

> Flow refers to a state of intense concentration, satisfaction, and enjoyment that is experienced when one is engaged in an intrinsically rewarding activity. People in flow describe feeling strong, alert, in control, unselfconscious, and at the peak of their abilities. (p. 5)

These are all things that need to be increased in older adults with AD, other forms of dementia, and cognitive impairment. It is believed that this population possesses the neural capacity for flow, however, little is known about flow neurobiologically.

McGreevy (2016) promoted the creative and arts-based approaches of caring for this population. One of the areas examined was music. She discussed how music can provide “meaningful communication . . . without the dependency on words (Craig and Killick 2004)” (p. 21). McGreevy explained how music should be chosen to reflect and relate to an individual’s life. Therefore, in group settings, music can generate an effortlessly “inclusive environment [that] takes the emphasis away from the dementia diagnosis towards sharing an enjoyable, creative, and expressive experience (Stokes 2008)” (p. 22). Furthermore, the importance of movement as expression within dementia care was emphasized. McGreevy (2016) mentioned that this allows individuals to become more involved in their own care. “Hill (2009) explained that while a person’s name usually reinforces identity, the body and movement can also influence identify and individuality” (p. 22). McGreevy stressed that our bodies experience the world through non-verbal lenses, and that is why a movement lens in the expressive therapy realm is important. She concluded that

> communication and self-expression are vital to increase well-being. As dementia progresses, verbal communication is altered and memories become disjointed. But the use of art, music and dance can reignite memories and lead new means of communication, enabling people to become active contributors to their environment with some control over their lives. (p. 23)

Dance/Movement Therapy (D/MT) with Older Adults

"There is often a dominance of biological models of illness and pharmacological treatments of psychopathology in dementia" (Hamill et al., 2012, p. 710). There is a lack of psychological approaches within AD, other forms of dementia, and cognitive decline care.

> The whole spectrum of movement is diminished for the aged. Within our system we have subtle culturally determined reinforcers which encourage negative self-images and attitudes as people grow old . . . Individuals are forced to assume the characteristic physical and mental attitudes of the aged. (Helm & Gill, 1975, p. 1)

With many executive functioning and other abilities declining, "[developing] alternative and effective interventions to work therapeutically" (Hamill et al., 2012, p. 711) with these populations is essential. A dance/movement therapist serves in an essential role of aiding older adults to "rediscover their bodies so that they can use them as instruments for release and joy" (Helm & Gill, 1975, p. 2).

Porat et al. (2016) "investigated the effect dance experience may have on cortical [gray matter] thickness and cognitive performance in elderly participants with and without mild cognitive impairment (MCI)" (p. 508). In this study, they examined "87 participants (39 CN and 48 MCI; 45 males and 42 females; mean age 70 years ranging from 51 to 90 years)" (p. 510) through questionnaires, MRI scans, clinical and neuropsychological evaluations, 3D cortical mapping, independent-sample t tests, and other analyses. Each participant was asked to classify themselves as either dancers or non-dancers, thus creating the two groups of the study. It was found that even when dancers had a "significantly thinner cortex" within the frontal brain regions, they still "performed better in cognitive tasks involving… memory" (p. 508). This implies that individuals exposed to dance may be more likely to maintain gray matter thickness longer, as well as the ability to perform cognitive tasks related to memory and recall. It also insinuates that "dance may result in an "enhancement of cognitive reserve in aging, which may help avert or delay MCI" (p. 508). Additionally, it was only the non-dancer group that presented with typical patterns of gray matter atrophy frequently found in individuals that cognitively decline into AD.

Karkou and Meekums (2017) performed a literature review where they chose 80 out of 102 studies to review independently of each other

> to assess the effects of dance movement therapy on behavioral, social, cognitive and emotional symptoms of people with dementia in comparison to no treatment, standard care or any other treatment, [and] also, to compare different forms of dance movement therapy. (p. 1)

They chose to consider only randomized controlled trials with the D/MT being led by a D/MT practitioner who had received formal training, was a dance movement therapist in training, or was otherwise recognized as a dance movement therapist in their country. "Maintaining relationships [is] at the heart of [the] best practice in dementia care" (p. 4) and "dance movement therapists do . . . treat the person as a whole" (p. 5), addressing their: "cognitive . . . emotional, social, spiritual and physical aspects" (p. 5). They stated that there is a "growing need to offer appropriate services to people with dementia" (p. 5).

Hamill et al. (2012) researched the impact of circle dance group therapy on people with dementia and their caregivers in East London, UK. "People with moderate to advanced dementia . . . who were expressing emotional distress . . . and caregivers who experienced carer burden were identified as suitable for the group" (p. 712) by a senior clinical psychologist and a senior nurse. Eleven people with moderate to severe dementia and seven family caregivers completed a series of test measurements, before and after the 10 weeks of group therapy. The therapists completed progress monitoring sheets following each weekly 45-minute session. Circle dance was chosen due to its being derived from traditional community dances, stressing participation not performance. It is an inclusive, non-verbal way to move together, focusing on body awareness and social connections between people. "Self-reports, therapist observations and weekly monitoring notes indicated benefits as follows: improved mood, concentration and interaction; participants valued meeting new people and looked forward to attending the group sessions" (p. 714). Out of the 11 subjects with dementia, two improved in their cognitive state and five improved in their quality of life scores (p. 714). According to three caregivers, the group helped them acknowledge the dementia diagnosis and process grief and loss, plus helped them re-connect with their loved one and shift their focus from problems to individual personalities and strengths. This study "concluded that people with advanced dementia can engage in and benefit from emotionally salient procedural-based activities" (p. 718) and that "dancing together appeared to enhance the relationship" (p. 718) between individuals with dementia and their caregivers.

Bräuninger (2014) conducted a study in three German-speaking countries that asked "13 colleagues of a major Swiss psychiatric hospital and . . . 10 dance movement therapists" (p. 139) to answer six qualitative questions through the lenses of their personal experience. It was found that “about 90% of the practitioners fully agree that DMT should be offered on an outpatient basis. They are convinced of improvements in QOL, mobility, psychological health, social contacts and in the reduction of isolation” (p. 147). Coaten and Newman-Bluestein (2013) highlighted that dance movement psychotherapy (DMP) “improved memory, alertness, reality orientation, judgment, stability, reduced anxiety, personal insight, acceptance, mobilisation and self-esteem” (p. 679). DMP “[aims] to contribute to a better, more embodied quality of life for people living with dementia and their care partners” (p. 677). Within DMP and D/MT, movement profiles for clients are generated via observation and then placed into treatment plans. It was concluded that “body movement and dance as creative expression, as aesthetic feeling, as meaningful interaction and as richly enlivened aspects of physical engagement can no longer be left out of” (p. 680) dementia care.

Application to Future Interventions

“The over 65 age group is constantly increasing size” (Bräuninger, 2014, p. 138). In fact, the global population of people with AD and other forms of dementia is projected to double in size by 2030 and more than triple in size by 2050 (Chancellor et al., 2014, p. 1). According to Karkou and Meekums (2017), the population of older adults affected is “approximately 35.6 million people worldwide” (p. 2). With the neurobiological and physiological benefits that stem from exercise and movement, dance/movement therapists need to comprehend how to encourage older adults to engage in movement interventions.

Resnick and Spellbring (2000) performed a study to better understand what motivates older adults to exercise. They discovered through open-ended interviews that

> beliefs about exercise and the perceived benefits of exercise activity, personality, past experiences with exercise, goal identification, and unpleasant sensations associated with

> the exercise activity were described as factors that influenced participants' motivation to exercise and adherence to a regular exercise program. (p. 40)

Their non-experimental study combined qualitative and quantitative design to measure things such as intrinsic motivation, self-efficacy, identifying outcome expectancy, and multiple dimensions of health status. Forty percent of the 23 voluntary participants of a retirement community remained for the entire length of the study. Each individual walked for 20 minutes three times per week, because they felt "an inner motivation to exercise, believed they were capable of safely exercising, set appropriate activity goals, and enjoyed the walking activity" (p. 39). The researchers suggest that by educating older adults about the physical and psychological benefits of continuing movement throughout their entire lifespan, they would be more motivated to engage in these types of interventions.

However, not only must there be clarification for why older adults need to keep moving, but why they need to remain thinking creatively and immerse themselves in the creative process from time to time. "The services provided for the elderly usually focus on the most basic physical needs. Most of the therapeutic efforts are directed toward curing specific conditions, and not toward the overall needs of the individual" (Helm & Gill, 1975, p. 3). D/MT treats "the person as a whole" (Karkou & Meekums, 2017, p. 5) and through a creative process. Through the literature examined in this review, it is understood that the creative process is beneficial neurobiologically and increases an individual's QOL. The current "depersonalizing" atmosphere of care for those living with AD, other forms of dementia, and cognitive decline "offers no gratification, and serves only to reinforce the isolation and the separation that is often the cause for the individual being institutionalized" (Helm & Gill, 1975, p. 3).

There is a need for an intervention within AD, other dementias, and cognitive decline care programs that engage an individual both in movement and in the creative process to better enhance memory recall and synaptic plasticity. D/MT appears to be a suitable solution. Hamill et al. (2012) found that within D/MT groups

> the familiar movements and rhythms can help people to re-connect with their own bodies thus accessing memories and facilitating emotional expression. The shared experience can help people to identify as a member of a group with full and unique life histories by finding a 'common language' for their feelings. (p. 718)

"Deterioration is expected in dementia but the need for emotional connection persists" (p. 720). D/MT can offer this emotional connection, as well as the physical and neurological benefits.

Discussion

With age, the human brain's working memory capacity decreases (Rypma & D'Esposito, 2000). The prefrontal cortex is changing (Rypma & D'Esposito, 2000), causing cognitive tasks to become difficult and cognitive functioning to decline. The brain is literally shrinking as the ventricle-to-brain ratio is increasing (Resnick et al., 2003). For individuals with AD, other forms of dementia, and general cognitive decline, their short-term memories are essentially deteriorating. When an individual develops one of these neurodegenerative conditions, the dorsolateral prefrontal cortex is only negatively affected when performing high memory tasks (Rypma & D'Esposito, 2000). Interestingly enough, the difficulty is primarily limited to one's memory retrieval process. It is known that synaptic plasticity decreases with age, and the connections in the brain's circuitry are failing at an increasingly accelerated rate in an individual affected by a neurodegenerative disease.

Studies have revealed that exercise does in fact improve brain function. While exercising, an individual's BDNF increases within the hippocampus (Vaynman et al., 2004). It has been suggested that this correlates with an individual's increase in memory recall and learning abilities (Vaynman et al., 2004). This indicates that movement maintains, and potentially increases, synaptic plasticity within the neural networks. This is due to the fact that an individual's synaptic stamina increases during exercise (Vaynman et al., 2006), and potentially, neurogenesis increases as well (Cotman & Berchtold, 2002). This increase in BDNF within the brain is also present within the dentate gyrus which is involved in the process of storing episodic memories (Cotman & Berchtold, 2002). Regulating these biochemical changes, and thus the anatomic changes they produce, through movement appears to support brain plasticity. Although a majority of these neurochemistry studies have been conducted as part of animal trials, they imply that movement has beneficial applications to human cognitive functioning on both molecular and cellular levels.

Improvements in neuropsychological function within the central nervous system, as well as the reduction in brain tissue loss has been linked to older adults engaging in movement and exercise (Dustman, et al., 1984). It is even thought that living a more active lifestyle in regard to movement and exercise may delay the onset of dementia (Heyn et al., 2004; Colcombe & Kramer, 2003). There is also wide recognition that exercise and movement improve balance, gait, physical strength, and flexibility. Therefore, movement improves the QOL for an older adult both in physical and cognitive abilities.

Creative cognition uses both the default and control networks of the human brain, which are typically antagonistic during strictly cognitive tasks (Beaty et al., 2016). Creative cognition also utilizes the default network of the brain to recall experiences from the episodic memory

(Beaty et al., 2016). This is one of the areas of the brain where researchers have found an increase in BDNF when one exercises (Cotman & Berchtold, 2002). Another area of the brain that is active within creative cognition is the prefrontal cortex (Zaidel, 2014), which is an area of the brain whose subsection, the dorsolateral prefrontal cortex, is active in memory tasks (Rypma & D'Esposito, 2000). The same area of the brain that illuminates during WM tasks illuminates via the default network in creative cognition when using neuroimaging techniques. This indicates that creative cognition has the ability to increase synaptic plasticity and stimulate the same area of the brain needed for WM. Furthermore, it has been shown that creativity is not noticeably affected by a decrease in brain functioning (Zaidel, 2014). In fact, it takes a long time for neurodegenerative diseases to alter creative cognition.

Studies have found that creativity improves overall QOL within the aging population. Older adults agree that creativity carries over into other areas of their life, increasing their coping skills, ability to adapt, flexibility, and creative thinking and problem solving (Fisher & Specht, 1999). This has caused creativity to be viewed as a successful aging factor, making it a significant QOL booster. D/MT is favorable over dance classes, because there is a lack of psychological models being utilized within AD, other forms of dementia, and general cognitive decline care (Hamill et al., 2012). D/MT combines movement and creativity into a therapeutic model. It emphasizes treating the whole person: emotionally, cognitively, physically, socially, spiritually, etc. This is extremely beneficial for a quickly growing population that is receiving little to no psychological attention or care within the medical and healthcare system.

There are additional reasons that D/MT improves the QOL for older adults other than just combining creative cognition and movement. Neurobiologically, it has been found that individuals exposed to dance sustain gray matter thickness (Porat et al, 2016), therefore, maintaining better cognitive functioning related to storing and recalling memories. The areas of the brain responsible for memory abilities are primarily made up of gray matter. Moreover, within the realm of neurodegenerative diseases, non-verbal communication becomes more effective than verbal communication (Chancellor, 2014). The way dance/movement therapists integrate movement is often as a means of expression and a non-verbal way of communicating ideas and emotions. D/MT has also been recognized as a method that improves concentration, interaction, and mood (Hamill et al., 2012).

Blending creative cognition and movement into a single intervention would be beneficial for cognitive functioning, memory abilities, and general QOL in older adults. Neurobiologically and neurochemically, these improvements suggest that this combination would also maintain and improve synaptic plasticity. Doing so within a therapeutic model would decrease the dehumanization happening within the realm of AD, dementia, and cognitive decline care. D/MT may be one of the most beneficial therapeutic models for older adult care, and the reasons behind its being so advantageous could be far more neurologically based than we currently realize.

References

Amaral, D. G., Scharfman, H. E., & Lavenex, P. (2007). The dentate gyrus: Fundamental neuroanatomical organization (dentate gyrus for dummies). *Progress in Brain Research*, *163*, 3-790. http://dx.doi.org/10.1016/S0079-6123(07)63001-5

Beaty, R. E., Benedek, M., Silvia, P. J., & Schacter, D. L. (2016). Creative cognition and brain network dynamics. *Trends in Cognitive Sciences*, *20*(2), 87-95. http://dx.doi.org/10.1016/j.tics.2015.10.004

Bräuninger, I. (2014). Dance movement therapy with the elderly: An international Internet-based survey undertaken with practitioners. *Body, Movement and Dance in Psychotherapy*, *9*(3), 138-153. http://dx.doi.org/10.1080/17432979.2014.914977

Chancellor, B., Duncan, A., & Chatterjee, A. (2014). Art therapy for Alzheimer's disease and other dementias. *Journal of Alzheimer's Disease*, *39*(1), 1-11. http://dx.doi.org/10.3233/JAD-131295

Chodzko-Zajko, W. J., Proctor, D. N., Singh, M. A. F., Minson, C. T., Nigg, C. R., Salem, G. J., & Skinner, J. S. (2009). Exercise and physical activity for older adults. *Medicine & Science in Sports & Exercise*, *41*(7), 1510-1530. http://dx.doi.org/10.1249/MSS.0b013e3181a0c95c

Coaten, R., & Newman-Bluestein, D. (2013). Embodiment and dementia–Dance movement psychotherapists respond. *Dementia*, *12*(6), 677-681. http://doi.org/10.1177/1471301213507033

Colcombe, S., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychological Science*, *14*(2), 125-130. http://dx.doi.org/10.1111/1467-9280.t01-1-01430

Cotman, C. W., & Berchtold, N. C. (2002). Exercise: A behavioral intervention to enhance brain health and plasticity. *Trends in Neurosciences*, *25*(6), 295-301. http://dx.doi.org/10.1016/S0166-2236(02)02143-4

Creativity. (n.d.). In *Oxford Dictionary online*. Retrieved from https://en.oxforddictionaries.com/definition/creativity

Divergent thought. (n.d.). In *Oxford Dictionary online*. Retrieved from https://en.oxforddictionaries.com/definition/divergent

Dustman, R. E., Ruhling, R. O., Russell, E. M., Shearer, D. E., Bonekat, H. W., Shigeoka, J. W., . . . Bradford, D. C. (1984). Aerobic exercise training and improved neuropsychological function of older individuals. *Neurobiology of Aging*, *5*(1), 35-42. http://dx.doi.org/10.1016/0197-4580(84)90083-6

Episodic memory. (n.d.). In *Oxford Dictionary online*. Retrieved from https://en.oxforddictionaries.com/definition/episodic_memory

Fisher, B. J., & Specht, D. K. (1999). Successful aging and creativity in later life. *Journal of Aging Studies*, *13*(4), 457-472. http://dx.doi.org/10.1016/S0890-4065(99)00021-3

Gray matter. (n.d.). In *Oxford Dictionary online*. Retrieved from https://en.oxforddictionaries.com/definition/grey_matter

Hamill, M., Smith, L., & Röhricht, F. (2012). ‘Dancing down memory lane’: Circle dancing as a psychotherapeutic intervention in dementia—A pilot study. *Dementia*, 11(6), 709-724. http://dx.doi.org/10.1177/1471301211420509

Helm, J. B., & Gill, K. L. (1975). An essential resource for the aging: Dance therapy. *Dance Research Journal*, *7*(1), 1-7. http://dx.doi.org/10.1017/S0149767700015886

Heyn, P., Abreu, B. C., & Ottenbacher, K. J. (2004). The effects of exercise training on elderly persons with cognitive impairment and dementia: A meta-analysis. *Archives of Physical Medicine and Rehabilitation*, *85*(10), 1694-1704. https://doi.org/10.1016/j.apmr.2004.03.019

Karkou, V., & Meekums, B. (2017). Dance movement therapy for dementia. *Cochrane Database of Systematic Reviews 2*. http://dx.doi.org/10.1002/14651858.CD011022.pub2

Levy, F. (2005). *Dance movement therapy: A healing art.* Reston, VA: The American Alliance for Health, Physical Education, Recreation, and Dance.

Mars, R. B., & Grol, M. J. (2007). Dorsolateral prefrontal cortex, working memory, and prospective coding for action. *Journal of Neuroscience*, *27*(8), 1801-1802. http://dx.doi.org/10.1523/JNEUROSCI.5344-06.2007

Mayo Foundation for Medical Education and Research [MFMER] (n.d.). Brain lobes. Retrieved from https://www.mayoclinic.org/brain-lobes/img-20008887

McGreevy, J. (2016). Arts-based and creative approaches to dementia care. *Nursing Older People*, *28*(1). doi:10.7748/nop.28.1.20.s20

Miller, A. K. H., Alston, R. L., & Corsellis, J. A. N. (1980). Variation with age in the volumes of grey and white matter in the cerebral hemispheres of man: Measurements with an image analyser. *Neuropathology and Applied Neurobiology*, *6*(2), 119-132. http://dx.doi.org/10.1111/j.1365-2990.1980.tb00283.x

Petrides, M. (2000). The role of the mid-dorsolateral prefrontal cortex in working memory. *Experimental Brain Research*, *133*(1), 44-54. http://dx.doi.org/10.1007/s002210000399

Plasticity. (n.d.). In *Oxford Dictionary online*. Retrieved from https://en.oxforddictionaries.com/definition/plasticity

Porat, S., Goukasian, N., Hwang, K. S., Zanto, T., Do, T., Pierce, J., . . . Apostolova, L. G. (2016). Dance experience and associations with cortical gray matter thickness in the aging population. *Dementia and Geriatric Cognitive Disorders Extra, 6*(3), 508-517. http://dx.doi.org/10.1159/000449130

Resnick, B., & Spellbring, A. M. (2000). Understanding what motivates older adults to exercise. *Journal of Gerontological Nursing*, *26*(3), 34-42. http://dx.doi.org/10.3928/0098-9134-20000301-08

Resnick, S. M., Pham, D. L., Kraut, M. A., Zonderman, A. B., & Davatzikos, C. (2003). Longitudinal magnetic resonance imaging studies of older adults: A shrinking brain. *Journal of Neuroscience*, *23*(8), 3295-3301. http://dx.doi.org/10.1523/JNEUROSCI.23-08-03295.2003

Rypma, B., & D'Esposito, M. (2000). Isolating the neural mechanisms of age-related changes in human working memory. *Nature Neuroscience, 3*(5), 509. https://doi.org/10.1038/74889

Synapse. (n.d.). In *Oxford Dictionary online*. Retrieved from https://en.oxforddictionaries.com/definition/synapse

Takeuchi, H., Taki, Y., Hashizume, H., Sassa, Y., Nagase, T., Nouchi, R., & Kawashima, R. (2011). Failing to deactivate: The association between brain activity during a working memory task and creativity. *Neuroimage*, *55*(2), 681-687. http://dx.doi.org/10.1016/j.neuroimage.2010.11.052

Ullán, A. M., Belver, M. H., Badía, M., Moreno, C., Garrido, E., Gomez-Isla, J., . . . Manzanera, P. (2013). Contributions of an artistic educational program for older people with early dementia: An exploratory qualitative study. *Dementia*, *12*(4), 425-446. http://dx.doi.org/10.1177/1471301211430650

Vaynman, S., Ying, Z., & Gomez-Pinilla, F. (2004). Hippocampal BDNF mediates the efficacy of exercise on synaptic plasticity and cognition. *European Journal of Neuroscience*, *20*(10), 2580-2590. http://dx.doi.org/10.1111/j.1460-9568.2004.03720.x

Vaynman, S. S., Ying, Z., Yin, D., & Gomez-Pinilla, F. (2006). Exercise differentially regulates synaptic proteins associated to the function of BDNF. *Brain Research*, *1070*(1), 124-130. http://dx.doi.org/10.1016/j.brainres.2005.11.062

Ventricle. (n.d.). In *Oxford Dictionary online*. Retrieved from https://en.oxforddictionaries.com/definition/ventricle

White matter. (n.d.). In *Oxford Dictionary online*. Retrieved from https://en.oxforddictionaries.com/definition/white_matter

Zaidel, D. W. (2014). Creativity, brain, and art: Biological and neurological considerations. *Frontiers in Human Neuroscience*, *8,* 389. http://dx.doi.org/10.3389/fnhum.2014.00389

THESIS APPROVAL FORM

Lesley University
Graduate School of Arts & Social Sciences
Expressive Therapies Division
Master of Arts in Clinical Mental Health Counseling: Dance/Movement Therapy, MA

Student's Name: Caitlin Pilette

Type of Project: Thesis

Title: Creativity and Movement Maintain Synaptic Activity, Improving QOL in Older Adults: A Critical Review

Date of Graduation: 18 May 2019
In the judgment of the following signatory this thesis meets the academic standards that have been established for the above degree.

Thesis Advisor: Donna C. Owens, PhD