

The Role of Dance in Cognition: A Narrative Review

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Abstract

There are several aspects of cognition, physiology, and brain structure that are uniquely impacted by dance. These effects occur across the lifespan, from development to aging. This review explores current research efforts in dance neuroscience, with a focus on cognition. Specific topics highlighted in this review include general cognition, memory, predictive processing, and more. Results show that dance can greatly strengthen your brain, ease the symptoms of mental illnesses, and have protective effects against cognitive decline. Evidence-based recommendations to integrate dance into school systems are presented.

Introduction

Physical activity benefits the brain via endorphins, dopamine, and serotonin released during exercise, as well as increased oxygenation and improved cerebral blood flow (Foster Vander Elst et al., 2023); (Fong Yan et al., 2024). Dance is a multifaceted form of physical activity that can be defined as any sort of rhythmic movement, often accompanied by musical and social aspects. Research on the positive effects of dance on cognition and aging compared to research on the effects of other forms of physical exercise is lacking, but recent findings (Foster Vander Elst et al., 2023) and (Faber, 2017) offer strong justification for dance research. This review seeks to summarize the effects of dance on the brain, focusing on cognition and development. Additional aims seek to explore the protective effects of dance, potential avenues for future research, and to propose a set of evidence-based recommendations for implementing dance as an intervention across school systems.

Methods

Using EBSCO, Google Scholar and PubMed, literature was selected that assessed the cognitive impacts of dance, evaluated dance as an intervention, or detailed the mechanisms underlying the effects of dance on the brain. Inclusion criteria were as follows: the study involved dance as the exposure and either cognition or brain structure as the outcome. The following items were a part of the exclusion criteria: poor research design, limited to no data on demographics or methods, not written in/translated to

English, no mention of exposure or outcome, poor operationalization of dance.

Results

Neuroscience of Dance

Predictive Processing

Dancing lets you imagine the beat, which improves temporal predictions about the meter (the ability to predict the timing of beat/patterns in music). Beta band power is related to movement. Specifically, the lower the beta band power, the faster someone responds to stimuli and moves. Decreases in beta band power—meaning the next movement is being planned and predicted—have also been found 200 ms after the beat. This was followed by an increase in power, leading to the onset of the next beat (Fujioka et al., 2015) proving that the brain learned to expect the upcoming beat. That increase was attributed to predictive processing. Predictive processing, which is the brain's way of taking all aspects of the environment into account to predict what external signals it will receive, is a critical survival tool because it allows people to adapt to their surroundings because predictions have already been made according to the environment, and dance strengthens predictive processing (Fujioka et al., 2015). For example, predictive processing is what keeps people from jumping at every noise in an amusement park since the brain can predict that there will be noises in a traditionally crowded place. Additionally, moving to a meter affects neural activity associated with listening to it (Foster Vander Elst et al., 2023) (Chemin et al., 2014), indicating that neural responses to rhythms at frequencies related to the meter were significantly larger after dancing to music with a defined meter/beat.

Groove

The desire to move to music is driven by a combination of reward and motor regions in the brain, and this could be related to the long pleasure cycles experienced when dancing (Foster Vander Elst et al., 2023) (Berridge & Kringelbach, 2015). The pleasure cycle is commonly divided into 3 phases: wanting, a phase of motivation and drive; liking, all of the positive feelings when the brain gets what it wants; and satiety, the satisfaction from a goal being fulfilled. Dance is known to extend the liking phase—which leads to the most positive emotions—causing the pleasure cycle to last longer overall (Foster Vander Elst et al., 2023) (Berridge & Kringelbach, 2015). Most people feel the need to move or even dance to the beat when they hear music. This desire is called groove, and it lights up reward regions of the brain including the nucleus accumbens, the caudate, and the medial orbitofrontal cortex (Matthews et al., 2020). Therefore, even simple movements to music can increase pleasure cycles and utilize the reward system.

Performance

Numerous areas of the brain are involved in performing a dance routine. In their experiment, (Bläsing et al., 2012) found that the performance of a modern jazz dance routine affects neural activity in the alpha and gamma bands. Changes in alpha bands indicate relaxation and passive attention while changes in gamma bands point to focused and fast concentration uses working memory, attentional processing (focusing on certain items and ignoring others), and heightened awareness (Foster Vander Elst et al., 2023) (Wind et al., 2020). Numerous parts of the brain are actively lighting up as one dances. Both in the presence and absence of music, brain activity and functional connectivity increased after the performance compared to pre-performance baseline (Foster Vander Elst et al., 2023) (Wind et al., 2020). Remembering the next movements in a routine requires strong working memory, focusing on the music and beat and ignoring everything else in the environment needs attentional processing, and performing choreography accurately heightens awareness (Dance Theatre of Harlem, 2021). These processes occurring all at once are thought to improve the connections between areas of the brain while strengthening them individually. Furthermore, dancers are guided by stimulus-led bottom-up cortical activity just as much as by cognition-led top-down cortical activity (Foster Vander Elst et al., 2023) (Smith, 2013). The use of bottom-up processing increases awareness of surroundings, and the use of top-down processing indicates constantly pulling from past knowledge.

Observation

Dance training, music training, and exposure to dance all affect neural activity associated with dance observation (strength of perception-action coupling). Dancers have faster processing and recognition of dance, with enhanced visuomotor resonance processes (moving according to external stimuli), and refined action processing (Foster Vander Elst et al., 2023) (Orlandi & Proverbio, 2019). Dance training advances the action observation network (associated with empathy), allowing them to predict and react to rhythm and patterns. By activating mirror neurons, dancers can replicate what someone is doing in front of them in time accurately and easily (Dance Theatre of Harlem, 2021) (Rizzolatti & Arbib, 1998). Humans use similar structures to relate and connect to the people around them and form bonds crucial for survival. These abilities aid the formation and maintenance of social groups. In addition, mirror neurons being used during dance is evidence for the evolutionary idea that dance has enhanced human interpersonal skills and has served as a way for people to communicate in the past (Bonini et al., 2022).

Relevant Imagery

There are many differences in neural activity in dancers and non-dancers during motor imagery (viewing dance without moving). Non-dancers experience more cognitive demand than dancers, and dancers recruit more kinesthetic imagery (the ability to imagine sensations of movement) than

visual imagery (merely seeing images). Dance imagery increases neural plasticity more than non-dance motor imagery (Di Nota et al., 2017). Watching dance is associated with brain growth, change, and adaptation more than observing any other kind of movement. While choreography was imagined, activity initially increased, then decreased, in a network of brain regions, following the usual pattern of learning (Foster Vander Elst et al., 2023). While dance imagery cannot be substituted for actual dance performance, even just watching someone else dance is incredibly beneficial for the brain.

Training

Dance training has lasting impacts on the brain—even when it is not being used in a dance environment (Dance Theatre of Harlem, 2021). For instance, long-term dance training can lead to changes in cortical thickness—the measure of gray matter—and the plasticity of gray matter and white matter—the ability of the brain to adapt (Foster Vander Elst et al., 2023) (Wen et al., 2022). Neuroplasticity plays crucial roles in developing, healing, and protecting the brain. Increased neuroplasticity can delay cognitive decline and other effects of aging; it can also improve the potential and capacity for learning and emotional regulation. For these reasons, dance is considered as one of the most effective forms of interventions in elderly people with disorders related to a lack of neuroplasticity. Getting introduced to dance at a young age has the potential to build cognitive and brain reserve, which is the idea that describes the difference between the amount of brain damage a person suffers and the symptoms they display (Stern et al., 2019).

Perfectionism

Perfectionism is one of the biggest challenges in dance training. Perfectionism sets high standards and a fear of failure; therefore, it both facilitates and inhibits flow because clear goals are not set. Flow is the ability of a person to be so completely invested in an activity that they lose sight of not only their environment but also themselves. This mental state requires intense focus, creative engagement, and a sense of relaxation that's also intense (Arslan & Altan-Atalay, 2023). Researchers experimented on 161 Turkish individuals with some experience in any dance genre to determine the relation between perfectionism and dance (Arslan & Altan-Atalay, 2023). Perfectionism limited the “flow” in individuals due to the inability to set achievable goals and fear of failure. On the other hand, more experienced dancers knew not to expect perfection, achieved “flow” easier, and had generally better states of mind. Dancers, just like other athletes and artists, have to be able to set goals and work towards them with a healthy mindset; oftentimes, they are taught how to do that as they take dance lessons. Eventually, experienced dancers can get over the detrimental effects of perfectionism through dance training.

Dance and Development

Auditory-Motor Synchronization

Aligning movements to auditory rhythms requires accurate beat perception, motor anticipation, and precise motor control. Researchers aimed to see if children could achieve that and if so, what effects it would have on them. For this purpose, 78 children were allowed to dance to specific music without interruptions and were recorded. In the end, the children learned how to anticipate the beat of the music and move accordingly (Kragness et al., 2023), demonstrating how simple and easy it is to learn how to coordinate movements with music. This skill is known as auditory-motor synchronization, which is the same skill that is used while speaking. In children who are just beginning to form words and learn balance and coordination, dance has the potential to provide a significant boost in speaking abilities and motor skills (Kragness et al., 2023).

Positive Affect

In the same experiment referred to in the section above, children expressed intense positive emotion. Positive affect is crucial to the growth and development of young children (Kragness et al., 2023), allowing them to connect socially, improve their mental and physical health, and improve their quality of life overall. Positive affect also facilitates learning and adapting. Dance promotes positive emotions and emotional well-being more consistently than many other forms of physical activity (running, playing sports, etc.) (Kragness et al., 2023).

Isadora Effect

Dance went through a huge transformation over the course of history and is now a critical part of early education. The Isadora Effect—the term coined by a review article—is the idea that dance and movement play an important role in infant brain development (Faber, 2017). The term is used as a metaphor for cognitive development because Isadora was a famous dancer who made dance more emotional and communicated through dance. Dance improves muscle development, increases coordination, smoothens synapses, and improves hemispheric transmission (Faber, 2017). The unique combination of motor skills and artistic creativity strengthens the brain. Dance classes engage peers and emphasize teamwork, promoting external awareness that improves interpersonal skills in children. Creative dance offers ways for young children to learn about themselves and develop intrapersonal intelligence. Creative movement in early childhood is a neutral dance form that teaches children to relate socially without imposing a role (Faber, 2017). Educators are beginning to realize that movement is an effective doorway to develop focus and concentration, memory, and logical problem-solving skills in an academic environment. Dance is non-verbal communication and prepares kids for symbols (Faber, 2017). Although more research is needed to

confirm the Isadora Effect, dance should be included in primary education with a specific curriculum to increase the benefits.

Dance as an Intervention

Intellectual disability

Dance therapy is used to support intellectual, emotional, and motor functions of the body (Mino-Roy et al., 2022). In an experiment aiming to find the effects of music, dance, and drama therapies on people with intellectual disabilities, positive effects were found on gross motor skills, physical fitness, balance, cardiovascular endurance, muscle strength, joint range of motion, body awareness, control over impulsivity, tolerance for frustration, self-confidence, emotion identification, managing emotions, social/communication skills, and memory (Mino-Roy et al., 2022). These experiments show that dance (and other music therapy) can help people with intellectual disabilities thrive.

Psychiatric Disorders

Dance Movement Therapy (DMT) is a psychotherapeutic use of movement to promote emotional, social, cognitive, and physical integration of the individual, for the purpose of improving health and well-being (Millman et al., 2021). In an experiment dedicated to finding if DMT has significant effects on an individual's well-being, many participants experienced reduced negative symptoms. Plasma serotonin and dopamine concentrations increased and decreased, respectively, in the Dance Movement Therapy group while very slightly decreasing and increasing, respectively, in the control group. There were certain positive effects on the quality of life of people with schizophrenia, and people on the autism spectrum managed to reduce their symptoms with dance. Quality of life increased and symptoms decreased for people with somatoform disorder. In conclusion, dance had positive effects on people with a variety of psychiatric and developmental conditions.

Additionally, scientists aimed to find the best form of exercise to treat depression rather than antidepressants and therapy. The tests resulted in the conclusion that dance is the most beneficial mode of exercise intervention for people clinically diagnosed with depression (Noetel et al., 2024). This could be caused by all manner of things including: pleasure experienced during dance, the added social aspect, and more.

Dance and Aging

The following section is organized by specific experiments rather than brain functions to highlight the effects that specific types of dances have on specific aging conditions. The organization is also partly due to the existing literature; since aging studies are usually well-developed and specific, this section highlights individual studies.

Cognitive Function and Flexibility

Dance is often used as an intervention for aging patients because dance can increase hippocampal volume and gray matter and white matter integrity (Hewston et al., 2021). Dance also strengthens the connectivity between both cerebral hemispheres by activating motor and cognitive brain areas (Hewston et al., 2021). Adults 55 years or more were used in an experiment to find the effects of dance as compared to walking and other physical activities. Although benefits of dance were not superior to walking, both dancing and walking reduced Mild Cognitive Impairment (MCI) in older adults. Those with MCI revealed little to no effect in cognitive flexibility scores on the paper and pencil Trail Making Test Part B (TMT-B). There was little to no improvement in immediate memory span with dance across studies; however, recent recall memory showed some improvement in the ability to recall an unrelated list of words or stories with meaning and purpose. The dance group showed a large improvement in expressive language in older adults with MCI. Dance improves global cognitive function but has no effect on complex attention. It has little to no effect on executive function, although there may be an improvement in older adults with mild cognitive function. More info is needed on language, social cognition, and optimal doses. Overall dance has the potential to improve the cognitive health of older adults (Coubard, 2011).

Tango and Dementia Ballroom Dancing and Dementia

In an experiment, researchers worked to determine the impact of tango-therapy in gait speed, functional mobility, balance, falls, ability to perform activities of daily living, and quality of life. Measurements were performed at baseline, and after one and three months of training. Tango-therapy significantly improved gait speed in the Timed Up and Go test, reduced falls in the Katz Index (ability to perform activities of daily living), and increased general coordination in the Quality of life in Alzheimer Disease test (Bracco et al., 2023). Tango-therapy was very successful in reducing dementia's effects in the elderly; therefore, other kinds of dance therapy could potentially be used by aging people to prevent dementia and slow the process of cognitive and functional aging.

Exercise and physical activity are necessary for well-being and can improve cognition (Barna et al., 2023). The aim of another experiment was to find a way to improve the quality of life and cognitive abilities of individuals over 60s. The 10-week ballroom dancing session statistically significantly improved decision-making and reduced stress (Barna et al., 2023). It also greatly improved balance and coordination (Barna et al., 2023). Along with physical strength, dance also improves cognition and has the potential to slow the effects of dementia and aging (Barna et al., 2023). Dance created impressive positive results for the elderly, and should be implemented for a younger population.

Discussion

Implications

All of the research and experiments were conducted from 2010 onwards; the relative newness of the research shows how important and applicable it is to the current society. The lack of funding towards arts programs in public education is a serious issue currently plaguing America. The new research reveals the importance of art programs in brain development (specifically dance) and urgently calls for a solution. The successes of dance as a mode of therapy also set the stage for improvements and developments of new approaches to physical therapy and treatments for mental conditions.

Limitations

Generalizations could not be accurately made from experiments on the Isadora Effect because there has not been enough cooperation between the dance community and neuroscience researchers (Faber, 2017). It is recommended that experiments regarding dance and its impact on early development utilize the same rigor seen in research papers about aging. Alos, nearly all experiments based on the effects of dance therapy were conducted on older adults. The issue prevents scientists from being able to make generalizations regarding all humans. The demographics used in experiments were incredibly specific and not applicable to a large amount of the population. All the tested children were in stable households, had access to technology, and were comfortable enough to dance around their parents. I would benefit this field greatly if people (specifically children) from different socioeconomic backgrounds were also included in research on early childhood development. Specific health conditions were also not tested in certain cases. This could easily be fixed with more research catered towards specific conditions. Additionally, there is certainly more research needed that can be used to find the effects on dance on specific conditions rather than health as a whole.

Recommendations

In the Neuroscience of Dance: A Conceptual Framework, numerous papers found very similar results proving that dance has huge positive impacts on the brain and cognition. The paper on the Isadora Effect was a review article, and the experiments discussed in the paper came to the same conclusions as the ones listed above. Experiments trying to determine if dance is a viable method to help heal certain health conditions are less successful generally; the same was true in Effects of music, dance and drama therapies for people with an intellectual disability: A scoping review. Dance therapy always improves the patients' quality of life and reduces their stress, but the evidence only shows some symptom reduction rather than a complete absence of symptoms. For future experiments, reducing variables and testing specific forms of dance on specific conditions could result in more successful conclusions.

The studies were designed to show clear results in the Neuroscience of Dance: A Conceptual Framework. The research paper—Musical groove shapes children’s free dancing—defined dance in a very specific way/had very strong operationalization. Research papers on dance and aging had the strongest quality of research design/methods out of all these papers. For example, they contained far better time periods: 10 weeks or more. The science world would benefit greatly if more studies (specifically those regarding early development) were structured similar to aging research. For example, the experiments regarding aging were very specific to certain conditions and included several measurements over a long period of time. The demographics in aging research were also more diverse. On the other hand, early childhood research was only open to a very specific demographic and could not produce any generalizations. The experiments conducted on dance and disorder had very strong methods. Lastly, Effects of music, dance and drama therapies for people with an intellectual disability: A scoping review had the largest and most diverse demographic. Wide demographics allow strong generalizations to be made—which is a crucial part of research and experimentation. This is another aspect that should be included in more research.

Conclusion

Based on the literature review, the authors see the following as the path forward in the research on the intersection of dance and cognition:

1. Greater research about the impacts on dance on development
2. More dance programs led by certified dance teachers in public schools starting from primary/elementary school
3. More funding for teachers to learn about how art—including dance—can impact a child
4. Smoother/better communication between dance instructors (and teachers in general) and policy makers
5. More funding towards school art programs in general to increase variety in elective choices
6. Greater access to art/dance education in more rural areas
7. Inclusion of dance therapy in special education programs
8. Inclusion of dance in physical education programs
9. Better collection and reporting of data regarding arts programs

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