

The Neuroscience of Dance

Dancing engages and changes the brain in unique ways.

HIGHLIGHTS from article. Full article follows.

- *...expert dancers display enhanced theta (4-8 Hz) synchronization when watching a dance piece.*
- *... theta brain waves are associated with syncing-up deeper brain areas (such as the hippocampus, basal ganglia, and cerebellum) with the cerebral cortex.*
- *...“The dancers’ brains reacted more quickly to changes in the music. (then musicians) ... reflex before the dancer is even aware of it at a conscious level.*
- *...dancers displayed stronger synchronization at the low theta frequency. **Theta synchronization** is linked to emotion and memory processes which are central to all interpersonal interaction and self-understanding.”*
- *... Our bodies and brains have evolved to dance in synchronized unison. And, dancing on a regular basis seems to change the way we think and interact with one another.*
- *... “In dance, the basic elements of humanity combine in a natural way. It combines creative act, fine-tuned movement and collaboration, much like playing music. The movement involves the whole body, like in sports. . . Studies on producing music and movement show how during cooperation, the brains of two people become attuned to the same frequency. This is apparent in how the low-frequency brain waves of the participants become synchronized.*
- *Brain synchronization enables seamless cooperation, and is necessary for creating both harmonic music and movement. The ability to become attuned to another person’s brain frequency is essential for the function of any empathetic community.”*
- *... human brain choreographs the movement of 600-plus muscles while dancing.*
- *... cerebellum is responsible for keeping time to a beat and maintaining rhythm.*
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- *... researchers speculate that partnered dance has the potential to help those impaired by cerebellar dysfunction on a variety of levels.*

- ...*"Pain, stress and anxiety often go hand in hand with depression. Dance, music and related expressive forms of therapy could help lessen mental fluctuations even before the onset of full depression,"*

Comment: The last sentence makes it seem the author doesn't know that 'dance' is already being used as therapy for conditions listed -- ??

The Neuroscience of Dance

Dancing engages and changes the brain in unique ways.

by Christopher Bergland, The Athlete's Way, May 8, 2018
PSYCHOLOGY TODAY

The *neuroscience of dance* is a relatively new, but rapidly growing, field of research. In recent months, a variety of studies and an article-based dissertation on the neuroscience of dance have been published. These findings help us better understand why we dance and how dancing engages and changes the human brain.

On May 11, **Hanna Poikonen** of the **Cognitive Brain Research Unit at the University of Helsinki** defended her doctoral dissertation, **"Dance on Cortex — ERPs and Phase Synchrony in Dancers and Musicians during a Contemporary Dance Piece."**

[<https://helda.helsinki.fi/handle/10138/234644>] This paper adds fresh insights to the burgeoning "neuroscience of dance" field of study and presents potentially game-changing methods of research that may have clinical applications.

For her dissertation, Poikonen developed novel ways to study various brain functions outside of a laboratory. By using event-related potentials (ERPs) and EEG, she was able to *monitor how professional dancers' brains differ from both the average layperson and well-trained musicians.*

One of the main takeaways from her research is that **expert dancers display enhanced theta (4-8 Hz) synchronization when watching a dance piece.** Previous research has found that **theta brain waves are associated with syncing-up deeper brain areas (such as the hippocampus, basal ganglia, and cerebellum) with the cerebral cortex.**

“Studies of professional dancers and musicians have highlighted the importance of multimodal interaction and motor-related brain regions in cerebral processing of dance and music,” Poikonen said in a statement. “The dancers’ brains reacted more quickly to changes in the music. The change was apparent in the brain as a reflex before the dancer is even aware of it at a conscious level. I also found that dancers displayed stronger synchronization at the low theta frequency. *Theta synchronization* is linked to emotion and memory processes which are central to all interpersonal interaction and self-understanding.”

Notably, in 2006, a groundbreaking study, “**An Electrophysiological Link Between the Cerebellum, Cognition and Emotion: Frontal Theta EEG Activity to Single-Pulse Cerebellar TMS,**” [<https://www.sciencedirect.com/science/article/pii/S1053811906006768?via%3Dihub>] found that transcranial magnetic stimulation over the cerebellar vermis (which connects the left and right hemispheres of the cerebellum) increased theta wave synchronization.

Co-authors Dennis Schutter and Jack van Honk concluded, “*Both animal and human research relate *theta activity* with the septo-hippocampal complex, an important brain structure involved in cognition and emotion. The present electrophysiological study supports the earlier intracranial electrical stimulation findings by demonstrating cerebellar involvement in the modulation of the core frequencies related to cognitive and emotive aspects of human behavior.*”

Dance has been a universal aspect of the human experience for millennia and is part of our collective DNA. Our bodies and brains have evolved to dance in synchronized unison. And, dancing on a regular basis seems to change the way we think and interact with one another.

In a 2017 article, “**A Dancer’s Brain Develops in a Unique Way,**” [<https://www.helsinki.fi/en/news/health/a-dancers-brain-develops-in-a-unique-way>] Poikonen writes:

“In dance, the basic elements of humanity combine in a natural way. It combines creative act, fine-tuned movement and collaboration, much like playing music. The movement involves the whole body, like in sports. . . Studies on producing music and movement show how during cooperation, the brains of

two people become attuned to the same frequency. This is apparent in how the low-frequency brain waves of the participants become synchronized.

Brain synchronization enables seamless cooperation, and is necessary for creating both harmonic music and movement. The ability to become attuned to another person's brain frequency is essential for the function of any empathetic community."

For more on the power of dance to bring people from all different walks of life together see, "**Dance Songs Dissolve Differences That Divide Us**" [<https://www.psychologytoday.com/us/blog/the-athletes-way/201801/dance-songs-dissolve-differences-divide-us>] and "**Neuroscience-Based Madonna: Music Makes the People Come Together.**" [<https://www.psychologytoday.com/us/blog/the-athletes-way/201803/science-based-madonna-music-makes-the-people-come-together>]

Through the neuroscience-of-dance lens, a 2016 article by Peter Lovatt, "**This Is Why We Dance,**" [<https://www.psychologytoday.com/us/blog/the-athletes-way/201805/the-neuroscience-dance#> =] sums up how the human brain choreographs the movement of 600-plus muscles while dancing. Lovatt wrote:

"The motor cortex, located at the rear of the frontal lobe, is involved in the planning, control and execution of voluntary movements. Meanwhile, the basal ganglia, a set of structures deep within the brain, works with the motor cortex to trigger well-coordinated movements. The cerebellum, at the back of the skull, also performs several roles, including integrating information from our senses so that movements are perfectly fluid and precise."

Peter Lovatt, who describes himself as "Dr. Dance," is a world-renowned dance psychologist and director of the [Dance Psychology Lab at the University of Hertfordshire](#).

Lovatt also points out that the cerebellum is responsible for keeping time to a beat and maintaining rhythm. In 2006, a landmark study by Steven Brown, Michael J. Martinez, and Lawrence M. Parsons, "**The Neural Basis of Human Dance,**" recruited amateur [Tango dancers](#) and had them perform specific

dance moves in a PET scan both with and without music. Steven Brown is currently the director of The NeuroArts Lab at McMaster University.

Interestingly, back in 2006, Brown et al. observed that the anterior vermis of the cerebellum supported the entrainment of movement to a musical beat. The researchers concluded:

“The cerebellum would be hypothesized to assist cortical, subcortical and peripheral neural structures in collecting optimal auditory and somatosensory information in order to influence the cortical motor system to better synchronize the execution of movement with the auditory rhythm. Further research is needed to clarify the functions of the foregoing cerebellar regions.”

Along this same line, a 2015 study observed that listening to popular dance music in an fMRI activated the cerebellum, especially the vermis, more intensely in participants who loved to dance than in those who were indifferent to dancing.

How Can Dance-Based Movement Improve People’s Lives?

A recent case study on the neuroscience of dance explored the rehabilitative benefits of partnered dance to improve cerebellum functions in a patient with severe cerebellar ataxia. This paper, **“Effects of Dance-Based Movement Therapy on Balance, Gait, and Psychological Functions in Severe Cerebellar Ataxia: A Case Study,”**

[<https://www.tandfonline.com/doi/abs/10.1080/09593985.2018.1457119>]

was published online March 30, 2018 in the journal *Physiotherapy Theory and Practice*.

For this case study, a 39-year-old male, who was diagnosed with cerebellar atrophy at the age of 24, participated in an 8-week program designed to improve his balance and postural stability through dance-based movement training. The authors sum up their findings: *“The individual demonstrated improvements in independent standing balance, gait characteristics, and functional mobility. In addition, improvements in self-reported depression and quality of life scores were observed after completion of the intervention.”*

Although the results of this study on cerebellar ataxia are limited to a single participant, the researchers speculate that partnered dance has the potential to help those impaired by cerebellar dysfunction on a variety of levels.

Hanna Poikonen is optimistic that someday soon the novel methods she fine-tuned for her "Dance on Cortex" doctoral dissertation will be applied to help develop and gauge the efficacy of expressive forms of therapy, such as dance-based movement.

"Pain, stress and anxiety often go hand in hand with depression. Dance, music and related expressive forms of therapy could help lessen mental fluctuations even before the onset of full depression," Poikonen said. Based on a growing body of empirical evidence, she believes that dance-based movement can be used as part of holistic treatment for conditions such as Parkinson's disease, chronic pain, dementia, autism, and mood disorders.

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