Neuroscientists link musical theater to lower anxiety and higher cognitive states in performers with disabilities

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In a musical theater space at nonprofit organization STEP VA in Fredericksburg, Virginia, a group of performers and their parents passed

around wired white caps that clip around the chin.

The performers inspected the tools, also known as electroencephalography (EEG) caps and asked questions of the researchers who planned to use the caps and other imaging equipment to study their mobile brain activity over the coming months.

Soon, behavioral and neural scientist Julia Basso, assistant professor in the Department of Human Nutrition, Foods, and Exercise in the College of Agriculture and Life Sciences, and Noor Tasnim, a doctoral student in translational biology, medicine, and health, would lead the team in studying how the singing, dancing, and acting of musical theater affect the brain and behavior of performers with disabilities.

Through musicals, STEP VA offers individuals with disabilities—in the case of the group studied, mostly those with autism spectrum disorder—an outlet for creative expression and sensory exploration.

"We had a full discussion about what it was that they were interested in, what outcomes they might be looking to see and think about, and just what their curiosities were," said Basso, who learned to conduct this kind of community-based participatory research as an iTHRIV Scholar. "They explained to us what felt comfortable, what didn't feel comfortable. That was a really nice way to craft the study. We were doing research and serving the needs of the community."

After surveying performers and monitoring their brain activity over the course of STEP VA's four-month musical training program, which culminated in a production of "You're a Good Man, Charlie Brown," Basso's team found that participation in musical theater decreased anxiety among individuals and tapped into states of calmness, focus, concentration, and task switching.

The data helps quantify the mental health benefits of STEP VA's work, said Jan Monroe, the organization's director. Monroe invited Basso's team to learn from performers. "Through our musical theater experience program, we have witnessed substantial growth in self-confidence and friendships among our cast members and their families," Monroe said. "STEP VA seeks all opportunities to validate and share through research what we know to be true."

The team of neuroscientists and artists at Basso's Embodied Brain Lab studies the effects of mind-body movement practices such as dance, yoga, and meditation on how the brain functions. Basso has found that the effects of "multiplex" arts-based practices involving multiple forms of creative expression, such as musical theater, are murky for neuroscientists. Even lesser known is what these multifaceted activities do for the brain and behavior of individuals with disabilities.

"These interventions are so complex in terms of how musical theater performance affects the way we think and feel and also how they impact brain activity," Basso said. "There are holes in the literature, especially with how the moving brain operates, and we're studying this through investigation of dance and other performance art forms."

Encephalography is one of Basso's key tools for studying the brain in motion, and it was a critical tool for measuring brain activity in a practice as dynamic as musical theater. Once STEP VA's performers had gone through their four-month rehearsal process and performance of "You're a Good Man, Charlie Brown," Basso's team rejoined them in the organization's space and recorded their brain activity at a few different stages.

First, the scientists used a technique called hyperscanning to synchronize their recording of the brain activity of all of the performers so they could see how that activity might parallel or vary between individuals.

Then, as performers wore the EEG caps, the team recorded their resting brain activity, followed by the activity that came with reenacting their musical performances.

"We had them sing, we had them dance, we had them engage in that musical theater experience," Basso said. "And we did this all while we were recording their brain activity."

The team also surveyed the performers and their parents at the start and the end of the training program, asking about their mental health and their thoughts on the training experience.

The surveys and brain activity data showed positive effects on both behavior and the brain. On the behavior side, musical theater and the social connection it provided drove a significant decrease in anxiety, especially in forms like separation anxiety and social phobia.

While looking at the brain's inner workings—the changes in delta, theta, alpha, and beta brain oscillations picked up by encephalography—the researchers saw increases in alpha and beta oscillations. Alpha brain oscillations have been associated with a calm, focused state, which helps to explain lowered anxiety among performers, Basso said.

The increase in beta activity makes sense as well, as it's a brain state associated with high concentration and task switching—the kind of brain activity required to go from singing to acting to dancing.

The study also provides the first data to support a hypothesis that Basso put forward about the effects of dance on the brain in 2021, titled "The Synchronicity Hypothesis of Dance." Basso stated that dance could enhance two types of synchrony in the brain. The first is intra-brain synchrony, in which more information flows between regions of the brain, such as those that support sensory, motor, cognitive, or emotional

abilities. The second is inter-brain synchrony, in which the flow of neural activity happens between people.

"When we dance with other individuals, we're syncing up these metrics," Basso said. "We're working together. We're having a socioemotional connection. So this inter-brain synchrony is emerging at the level of the brain, meaning that we're actually synchronizing our brain rhythms."

Basso's team saw greater levels of intra- and inter-brain synchrony among the performers, which they could observe via hyperscanning. For Basso, it's proof that dance and other creative arts-based practices do something deep within the brain—something to dedicate time to teasing apart. She hopes to explore the subject further by studying musical theater's effects over time and studying other arts-based practices among different clinical populations.

After collaborating with STEP VA, Basso also aims to take her team out into the community more often. "How can we serve communities that don't have access to movement-based practices?" she said. "There are people we want to reach in areas like rural Southwest Virginia, but it's hard to bring them to us. So we're trying to get out into communities with partnerships that build trust with their members and see if we can bring our tools and techniques to them."

More information: Julia C. Basso et al, Dance on the Brain: Enhancing Intra- and Inter-Brain Synchrony, *Frontiers in Human Neuroscience* (2021). DOI: 10.3389/fnhum.2020.584312

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