Music moves brain to pay attention, study finds

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Using brain images of people listening to short symphonies by an obscure 18th-century composer, a research team from the Stanford University School of Medicine has gained valuable insight into how the brain sorts out the chaotic world around it.

The research team showed that music engages the areas of the brain involved with paying attention, making predictions and updating the event in memory. Peak brain activity occurred during a short period of silence between musical movements - when seemingly nothing was happening.

Beyond understanding the process of listening to music, their work has far-reaching implications for how human brains sort out events in general. Their findings will be published in the Aug. 2 issue of *Neuron*.

The researchers caught glimpses of the brain in action using functional magnetic resonance imaging, or fMRI, which gives a dynamic image showing which parts of the brain are working during a given activity. The goal of the study was to look at how the brain sorts out events, but the research also revealed that musical techniques used by composers 200 years ago help the brain organize incoming information.

"In a concert setting, for example, different individuals listen to a piece of music with wandering attention, but at the transition point between movements, their attention is arrested," said the paper's senior author Vinod Menon, PhD, associate professor of psychiatry and behavioral

sciences and of neurosciences.

"I'm not sure if the baroque composers would have thought of it in this way, but certainly from a modern neuroscience perspective, our study shows that this is a moment when individual brains respond in a tightly synchronized manner," Menon said.

The team used music to help study the brain's attempt to make sense of the continual flow of information the real world generates, a process called event segmentation. The brain partitions information into meaningful chunks by extracting information about beginnings, endings and the boundaries between events.

"These transitions between musical movements offer an ideal setting to study the dynamically changing landscape of activity in the brain during this segmentation process," said Devarajan Sridharan, a neurosciences graduate student trained in Indian percussion and first author of the article.

No previous study, to the researchers' knowledge, has directly addressed the question of event segmentation in the act of hearing and, specifically, in music. To explore this area, the team chose pieces of music that contained several movements, which are self-contained sections that break a single work into segments. They chose eight symphonies by the English late-baroque period composer William Boyce (1711-79), because his music has a familiar style but is not widely recognized, and it contains several well-defined transitions between relatively short movements.

The study focused on movement transitions - when the music slows down, is punctuated by a brief silence and begins the next movement. These transitions span a few seconds and are obvious to even a non-musician - an aspect critical to their study, which was limited to

participants with no formal music training.

The researchers attempted to mimic the everyday activity of listening to music, while their subjects were lying prone inside the large, noisy chamber of an MRI machine. Ten men and eight women entered the MRI scanner with noise-reducing headphones, with instructions to simply listen passively to the music.

In the analysis of the participants' brain scans, the researchers focused on a 10-second window before and after the transition between movements. They identified two distinct neural networks involved in processing the movement transition, located in two separate areas of the brain. They found what they called a "striking" difference between activity levels in the right and left sides of the brain during the entire transition, with the right side significantly more active.

In this foundational study, the researchers conclude that dynamic changes seen in the fMRI scans reflect the brain's evolving responses to different phases of a symphony. An event change - the movement transition signaled by the termination of one movement, a brief pause, followed by the initiation of a new movement - activates the first network, called the ventral fronto-temporal network. Then a second network, the dorsal fronto-parietal network, turns the spotlight of attention to the change and, upon the next event beginning, updates working memory.

"The study suggests one possible adaptive evolutionary purpose of music," said Jonathan Berger, PhD, professor of music and a musician who is another co-author of the study. Music engages the brain over a period of time, he said, and the process of listening to music could be a way that the brain sharpens its ability to anticipate events and sustain attention.

According to the researchers, their findings expand on previous functional brain imaging studies of anticipation, which is at the heart of the musical experience. Even non-musicians are actively engaged, at least subconsciously, in tracking the ongoing development of a musical piece, and forming predictions about what will come next. Typically in music, when something will come next is known, because of the music's underlying pulse or rhythm, but what will occur next is less known, they said.

Having a mismatch between what listeners expect to hear vs. what they actually hear - for example, if an unrelated chord follows an ongoing harmony - triggers similar ventral regions of the brain. Once activated, that region partitions the deviant chord as a different segment with distinct boundaries.

The results of the study "may put us closer to solving the cocktail party problem - how it is that we are able to follow one conversation in a crowded room of many conversations," said one of the co-authors, Daniel Levitin, PhD, associate professor of psychology and music from McGill University, who has written a popular book called *This Is Your Brain on Music: The Science of a Human Obsession*.

Source: Stanford University Medical Center