

# New study shows different brains have similar responses to music

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Do the brains of different people listening to the same piece of music actually respond in the same way? An imaging study by Stanford University School of Medicine scientists says the answer is yes, which may in part explain why music plays such a big role in our social existence.

The investigators used [functional magnetic resonance imaging](#) to identify a distributed network of several brain structures whose activity levels waxed and waned in a strikingly similar pattern among study participants as they listened to classical music they'd never heard before. The results will be published online April 11 in the *European Journal of Neuroscience*.

"We spend a lot of time listening to music—often in groups, and often in conjunction with synchronized movement and dance," said Vinod Menon, PhD, a professor of psychiatry and behavioral sciences and the study's senior author. "Here, we've shown for the first time that despite our individual differences in musical experiences and preferences, classical music elicits a highly consistent pattern of activity across individuals in several brain structures including those involved in movement planning, memory and attention."

The notion that healthy subjects respond to complex sounds in the same way, Menon said, could provide novel insights into how individuals with language and speech disorders might listen to and track information differently from the rest of us.

The new study is one in a series of collaborations between Menon and co-author Daniel Levitin, PhD, a [psychology professor](#) at McGill University in Montreal, dating back to when Levitin was a visiting scholar at Stanford several years ago.

To make sure it was music, not language, that study participants' brains would be processing, Menon's group used music that had no lyrics. Also excluded was anything participants had heard before, in order to eliminate the confounding effects of having some participants who had heard the musical selection before while others were hearing it for the first time. Using obscure pieces of music also avoided tripping off memories such as where participants were the first time they heard the selection.

The researchers settled on complete classical symphonic musical pieces by 18th-century English composer William Boyce, known to musical cognoscenti as "the English Bach" because his late-baroque compositions in some respects resembled those of the famed German composer. Boyce's works fit well into the canon of Western music but are little

known to modern Americans.

Next, Menon's group recruited 17 right-handed participants (nine men and eight women) between the ages of 19 and 27 with little or no musical training and no previous knowledge of Boyce's works. (Conventional maps of brain anatomy are based on studies of right-handed people. Left-handed people's brains tend to deviate from that map.)

While participants listened to Boyce's music through headphones with their heads maintained in a fixed position inside an fMRI chamber, their brains were imaged for more than nine minutes. During this imaging session, participants also heard two types of "pseudo-musical" stimuli containing one or another attribute of music but lacking in others. In one case, all of the timing information in the music was obliterated, including the rhythm, with an effect akin to a harmonized hissing sound. The other pseudo-musical input involved maintaining the same rhythmic structure as in the Boyce piece but with each tone transformed by a mathematical algorithm to another tone so that the melodic and harmonic aspects were drastically altered.

The team identified a hierarchal network stretching from low-level auditory relay stations in the midbrain to high-level cortical brain structures related to working memory and attention, and beyond that to movement-planning areas in the cortex. These regions track structural elements of a musical stimulus over time periods lasting up to several seconds, with each region processing information according to its own time scale.

Activity levels in several different places in the brain responded similarly from one individual to the next to music, but less so or not at all to pseudo-music. While these brain structures have been implicated individually in musical processing, their identifications had been obtained by probing with artificial laboratory stimuli, not real music.

Nor had their coordination with one another been previously observed.

Notably, subcortical auditory structures in the midbrain and thalamus showed significantly greater synchronization in response to musical stimuli. These structures have been thought to passively relay auditory information to higher brain centers, Menon said. "But if they were just passive relay stations, their responses to both types of pseudo-music would have been just as closely synchronized between individuals as to real music." The study demonstrated, for the first time, that those structures' activity levels respond preferentially to music rather than to pseudo-music, suggesting that higher-level centers in the cortex direct these relay stations to closely heed sounds that are specifically musical in nature.

The fronto-parietal cortex, which anchors high-level cognitive functions including attention and working memory, also manifested intersubject synchronization—but only in response to music and only in the right hemisphere.

Interestingly, the structures involved included the right-brain counterparts of two important structures in the brain's left hemisphere, Broca's and Geschwind's areas, known to be crucial for speech and language interpretation.

"These right-hemisphere brain areas track non-linguistic stimuli such as music in the same way that the left hemisphere tracks linguistic sequences," said Menon.

In any single individual listening to music, each cluster of music-responsive areas appeared to be tracking music on its own time scale. For example, midbrain auditory processing centers worked more or less in real time, while the right-brain analogs of the Broca's and Geschwind's areas appeared to chew on longer stretches of music. These structures

may be necessary for holding musical phrases and passages in mind as part of making sense of a piece of music's long-term structure.

"A novelty of our work is that we identified brain structures that track the temporal evolution of the music over extended periods of time, similar to our everyday experience of music listening," said postdoctoral scholar Daniel Abrams, PhD, the study's first author.

The preferential activation of motor-planning centers in response to music, compared with pseudo-music, suggests that our brains respond naturally to musical stimulation by foreshadowing movements that typically accompany [music](#) listening: clapping, dancing, marching, singing or head-bobbing. The apparently similar activation patterns among normal individuals make it more likely our movements will be socially coordinated.

"Our method can be extended to a number of research domains that involve interpersonal communication. We are particularly interested in language and social communication in autism," [Menon](#) said. "Do children with autism listen to speech the same way as typically developing children? If not, how are they processing information differently? Which brain regions are out of sync?"

Provided by Stanford University Medical Center

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