Hippocampal activity during music listening exposes the memory-boosting power of music

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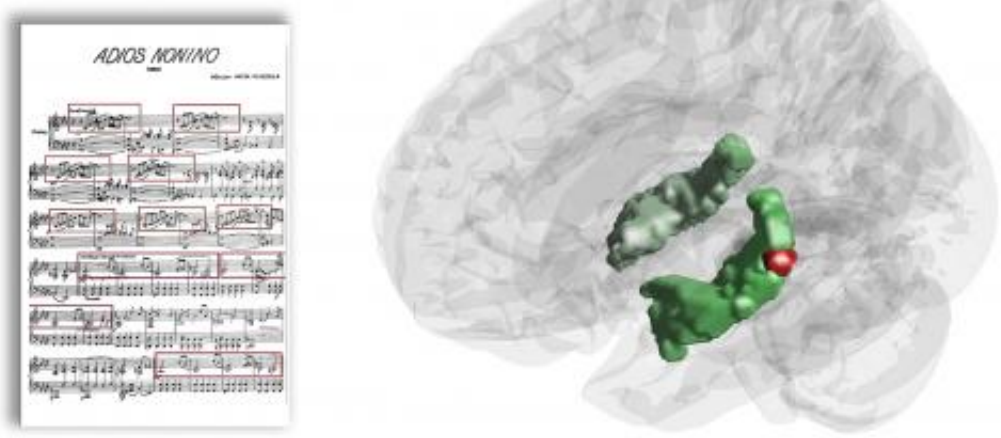

Figure: Activity in an area (in red) within the hippocampus (in green) increased when musical motifs in the piece were repeated.

For the first time the hippocampus—a brain structure crucial for creating long-lasting memories—has been observed to be active in response to recurring musical phrases while listening to music. Thus, the hippocampal involvement in long-term memory may be less specific than previously thought, indicating that short and long-term memory processes may depend on each other after all.

The study was conducted at the University of Jyväskylä and the AMI Center of Aalto University, by a group of researchers led by Academy Professor Petri Toiviainen, the Finnish Centre for Interdisciplinary Music Research (CIMR) at the University of Jyväskylä, and Dr. Elvira Brattico, Aalto University and the University of Helsinki. Results of the study were published in *Cortex*, a journal devoted to the study of the nervous system and behaviour.

"Our study basically shows an increase of activity in the medial temporal lobe areas—best known for being essential for long term memory—when musical motifs in the piece were repeated. This means that the lobe areas are engaged in the short-term recognition of musical phrases," explains Iballa Burunat, the leading author of the study. Dr. Brattico adds: "Importantly, this hadn't been observed before in music neuroscience."

A fundamental highlight of the study is the use of a setting that is more natural than those traditionally employed in neuroscience: the participants' only task was to attentively listen to an Argentinian tango from beginning to end. This kind of music provides well-defined, salient musical motifs that are easy to follow. They can be used to study recognition processes in the brain without having to resort to sound created in a lab. By using this more realistic approach, the researchers were able to identify brain areas involved in motif tracking without having to rely on the participants' ability to self-report, which would have constrained the study of brain processes.

"We think that our novel method allowed us to uncover this phenomenon. In other words, the identified areas may also be related to the formation of a more permanent memory trace of a musical piece, enabled precisely by the very use of a real-life stimulus (the recording of a live performance) in a realistic situation where participants just listen to the music as their brain responses are recorded," Iballa Burunat goes

on to explain. Listening to the music from beginning to end may have imprinted the participants with a long lasting memory of the tune. This might not be expected were the participants exposed to a simpler stimulus in controlled conditions, as is the case in most studies in music and memory.

Although a real-life setting may be sufficient to trigger the involvement of the hippocampus, another explanation could lie in music's capacity to elicit emotions. "We cannot ignore music's emotional power which is thought to be crucial for the mnemonic power of music as to how and what we remember. There is evidence on the robust integration of music, memory and emotion—take for instance autobiographical memories. So it wouldn't be surprising that the emotional content of the music may well have been a factor in triggering these limbic responses," she continues. This makes sense, since the chosen musical piece by Astor Piazzolla was a tribute to his father after his sudden death, and so the main purpose of the piece was to be of a deeply emotional nature". Certainly, the hippocampus—as part of the limbic system—is connected to neural circuitry involved in emotional behavior, and ongoing research suggests that emotional events seem to be more memorable than neutral ones. The authors emphasize that these results should motivate similar approaches to study verbal or visual short term memory by tracking the themes or repetitive structures of a given stimulus. Moreover, the study has implications for neurodegenerative diseases associated with hippocampal atrophy, like Alzheimer's. "Music may positively affect patients if used wisely to stimulate their hippocampi, and thus their memory system," Academy Professor Petri Toiviainen indicates. A better understanding of the link between music and memory could have widespread repercussions, leading to novel interventions to rehabilitate or improve the life quality of patients with neurodegenerative conditions.

More information: Burunat, I., Alluri, V., Toiviainen, P., Numminen, J., & Brattico, E. (2014). "Dynamics of brain activity underlying

working memory for music in a naturalistic condition." *Cortex*. DOI: 10.1016/j.cortex.2014.04.012

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