Mathematical framework explores how the brain keeps a beat

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A new mathematical model demonstrates how neurons in the brain could work together to learn and keep a musical beat. The framework, developed by Amitabha Bose of New Jersey Institute of Technology and Aine Byrne and John Rinzel of New York University, is described in *PLOS Computational Biology*.

Many experimental studies have established which brain areas are active when a person listens to music and discerns a beat. However, the neuronal mechanisms underlying the brain's ability to learn a beat—and then keep it after the music stops—are unknown. Bose and his colleagues set out to explore what these neuronal mechanisms might be.

Using neurobiological principles, the researchers built a mathematical model of a group of neurons that can cooperate to learn a musical beat from a rhythmic stimulus, and keep the beat after the stimulus stops. The model demonstrates how a network of neurons could act as a "neuronal metronome" by accurately estimating time intervals between beats within tens of millisecond accuracy. This metronome relies on rhythmic brain activity patterns known as gamma oscillations to keep track of time.

"We listen to music and within a few measures our body moves to the beat," says Rinzel. "Our model suggests how the brain might learn a rhythm and learn it so fast."

Next, the researchers plan to test their model with real-world psychoacoustic experiments and electroencephalogram (EEG) tests, which reveal activity in a person's brain. These experiments will show how accurately the model might reflect actual neuronal mechanisms involved in learning a beat.

"Our findings provide new insights into how the brain might synthesize prior knowledge to make predictions about upcoming events, specifically in the realm of musical rhythm and keeping time," Bose says. Beyond music, the new model could help improve understanding of conditions in which the ability to accurately estimate time is impaired, such as in Parkinson's disease.

More information: Amitabha Bose et al, A neuromechanistic model

for rhythmic beat generation, *PLOS Computational Biology* (2019). DOI: 10.1371/journal.pcbi.1006450