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Identifying a brain network for musical rhythm: A functional neuroimaging meta-analysis and systematic review

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Introduction: Musical rhythm, a feature of the human experience, is thought to engage a cortico-subcortical network of brain regions.

Methods: We conducted a systematic review and meta-analysis of thirty functional magnetic resonance imaging studies investigating the perception or production of auditory musical rhythms in neurotypical adults. The goals of the meta-analysis were two-fold: first, to identify brain regions important for processing of beat-based musical rhythms (Beat-based) and second, to identify regions modulated by beat-based rhythmic complexity (Complexity). We parsed studies within the Beat-based meta-analysis by the type of baseline condition ("auditory control" or "rest" baseline).

Results: Beat-based rhythms (compared to an auditory control) activated the bilateral putamen and small clusters in the left rolandic operculum and ventral precentral sulcus. A much larger and symmetrical network including the bilateral superior temporal cortices, SMA, and cerebellum appeared for the "rest" baseline subgroup. The Complexity meta-analysis included activations in the bilateral SMA-proper/pre-SMA, cerebellum, inferior parietal regions, and right temporal areas.

Discussion: Our results suggest that musical rhythm engages a largely bilateral cortico-subcortical network of brain regions, with the choice of a baseline condition critical to identifying a brain network attuned to rhythm processing. Despite the lack of specificity of the Beat-based rhythm vs. rest comparison, this contrast captured broad auditory-motor networks, converging with theories for unified frameworks for duration-based and beat-based timing. The Complexity analysis highlighted brain circuitry involved in processing more complex (e.g., syncopated) compared to less complex (e.g., isochronous) musical rhythms. Our findings are discussed in the context of complementary evidence from other methods including clinical lesion data and methods with high temporal sensitivity such as EEG/MEG. This study provides groundwork for understanding 1) how the brain bases of rhythm may overlap with other cognitive domains and 2) clinical-translational applications of rhythm in populations such as those with aphasia or developmental language disorder.

Keywords:

Rhythm, Meta-analysis, fMRI