

# Learning to Listen to the Beat

By Nina Kraus, PhD, and Travis White-Schwoch

Over the past decade, researchers have hinted at a link between hearing, language, and the ability to lock on to the beat of music. For example, individual differences in literacy skills seem to parallel the ability to tap to the beat of a metronome. As we have discussed in previous *Hearing Journal* articles, there are also indications that the rhythm-language link might precede literacy: studies of 20-30 preschoolers showed that children better able to drum to a steady beat performed better on early literacy tasks and had more precise neural processing of speech (<http://bit.ly/HJHearingMatters>).

Research to date, however, has involved relatively small samples of children, largely due to the practical difficulties of conducting large research studies in developing populations. Bonacina and colleagues recently addressed this limitation in a comprehensive study of beat keeping, language development, and auditory processing in a cohort of over 150 children between the ages of 3 and 5 years old (*npj Sci Learn.* 2021;6,1-11).

The study involved three components. First, children had to drum along to a metronome at two paces: one was roughly a steady walking pace, and the other was a quick pace, such as in a lively piece of music. Then, the children completed a large set of paper-and-pencil tests to evaluate their early language, cognitive, and pre-reading skills. Finally, their auditory-neural responses were measured to multiple speech sounds in quiet and noise.

About 40% of the children could lock on to both metronome paces ("Synchronizers"), whereas about 25% could not lock on to either pace ("Non-synchronizers"). The groups were similar in age and nonverbal IQ, and both passed a peripheral hearing screening.

Bonacina and colleagues found the following differences between these two groups:

- There were relatively more females in the Synchronizer group than the Non-synchronizers. This discrepancy was unexpected but is evocative of the higher incidence of learning problems among males.
- Synchronizers had more precocious early language cognitive skills than non-synchronizers. In particular, Synchronizers had higher auditory short-term memory, rapid naming, and phonological awareness. All of these are critical skills for literacy. In fact, there is even some evidence that weakness



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in only one of those three skills is sufficient to cause difficulties when children start learning to read.

- Synchronizers outperformed non-synchronizers on a rhythm perception test, but the two groups had similar melody perception. This suggests that there is something specific about rhythm, rather than musical abilities in general, that underlies these group differences.
- Synchronizers had more accurate and reliable neural coding of speech than non-synchronizers. These differences manifested when measuring how closely individuals' neural responses mirrored the temporal features of the stimulus, and when considering how stably they encoded speech features across multiple stimulus presentations.
- Synchronizers' superior neural speech encoding generalized across multiple stimuli and listening conditions (speech in quiet and speech in noise).

Next, Bonacina and colleagues looked at the remaining 35% of the children who could only drum reliably at one of the metronome paces. They fell precisely in between the Synchronizers and Non-synchronizers on all of the tests and measures, from short-term memory to neural responses to speech. This suggests there is a systematic relationship between early beat-keeping abilities and developing cognitive, language, and neural functions.

Overall, the results of this study resoundingly support earlier evidence that emergent rhythmic abilities are tethered to early literacy and auditory-brain function. Still, this study has some limitations. While results are consistent with the hypothesis that auditory, sensorimotor, and cognitive brain systems function in tight synchrony with each other, the evidence is only correlational. This makes it difficult to disentangle the directionality of these results: Does rhythm directly support auditory system development or vice versa? Longitudinal studies that carefully track how these skills develop and interlink over time can help untangle these questions.

Nevertheless, the work of Bonacina and colleagues has theoretical and practical implications. For example, it shows



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that a brief drumming task reveals remarkable insights about early cognitive and auditory brain functions. It is far easier (and, for most kids, more fun) to take a drumming test than to undergo paper-and-pencil testing. Perhaps such a beat synchronization task could provide early screening to identify

children who might benefit from more rigorous cognitive or language evaluations. Finally, the results of this study suggest that a musical intervention heavily emphasizing rhythm might benefit children at risk for delays in listening, language, and/or literacy development. [\[7\]](#)