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Auto-correlation and entrainment in the synchronous reproduction of musical pulse: Developments in childhood

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Abstract

In 1999, Van Noorden and Moelants postulated a resonance around 2 Hz in the human perceptual system to explain the range of tempi in which one can perceive a pulse or beat in music. In this paper, the question how this resonance develops in childhood is addressed: Is the resonance already present in young children? Is it at the same tempo range and is it weaker or stronger than in adults? To answer these questions an experiment was performed on how well children between the ages of 3 and 11 years (N=421), can synchronise their tapping to the beat of common children’s songs with a tempo of 80 to 160 beats per minute. To make sure that even the youngest children could understand the task an avatar tapping along with the pulse of the music was projected during part of each song. To prevent that the children would feel alone in front of the experimenters, which can be a problem for the youngest ones, they did the tapping in groups of 4. The seating had two conditions: seeing their peers and not seeing their peers.

Children aged 3 and 4 can only tap in a narrow range around 2 Hz. They can adapt their tapping tempo to musical tempi faster but not to musical tempi slower than their spontaneous tempo. This behaviour can be modelled as a kicked rotator. Their phase synchronisation is very weak. Between the ages of 4 and 7 children expand the range in which they can synchronise, from a little faster, but primarily towards much slower tempi. This supports a resonance model for pulse perception and production in which the characteristic frequency, near 2 Hz, remains the same, but in which the damping of the resonance increases with age, even up to critical damping. Also, the phase of tapping changes with the tempo according to a resonance model.

Seeing their peers helped the children of 4 to 6 years old to perform better on the tapping task, children of 8 to 9 performed worse, especially the boys. Boys also start a bit later with the improvement of the tapping variance than the girls do.

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Besides the synchronisation of their tapping to the music the children keep also track of the tapping of the other children in their group. They sometimes entrain better to each other than they synchronise to the music. The auto-correlation of their inter-tap intervals at delay 1 changes from positive to negative between 4 and 7 years of age.

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