Using Unimanual and Bimanual Tapping to Explore Synchronisation with Musical Rhythmic Layers

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Background

Tapping to a rhythm commonly occurs when listening to music, and the tapping paradigm has frequently been used to study sensorimotor synchronisation. However, even though bimanual tasks have been extensively studied in various branches of psychology and bimanual synchronisation is central to playing many musical instruments, bimanual tapping to music has been the subject of only a limited number of studies.

Aims

We present two experiments where two modes of finger tapping (unimanual and alternate bimanual) are employed to explore how participants synchronise to the different rhythmic layers of a set of musical patterns and metronomic cues. Experiment 1 was designed to study how people perform at different rates and find out if the tapping modality has an effect on the performance. In experiment 2 we aimed at finding out if the tapping modality and the morphology of rhythmic patterns have an effect on the perception of the internal beat (i.e. the pulse) of musical rhythms played at the same tempo.

Method

Exp. 1: In order to find reliable synchronisation rates for each tapping mode, participants were asked to tap 1:1 to an isochronous click track played at 16 different rates, from very slow (33 BPM; IOI ≈ 1792 ms) to very fast (715 BPM; IOI ≈ 84 ms). Exp. 2: Participants were asked to tap at their preferred rate to a set of musical patterns consisting of 4 instruments (bass drum, snare drum, hi-hat, bass) assigned to 4 rhythmic subdivisions (whole note, half note, quarter note, eighth note). All the possible combinations between instruments and subdivisions were presented, resulting in 24 musical stimuli for each tapping mode, all played at 120 BPM in 4/4 time. Participants performed the tasks by tapping on a low-latency touch pad.

Results

Experiment 1 showed that the best performances for both tapping modes were found between 83 and 150 bpm, where more than 95% of taps were considered successful and absolute mean asynchronies were below 50 ms. At fast tempi (366-715 BPM), alternate bimanual tapping mode yielded tapping sequences with significantly lower coefficient of variation of asynchronies ($p = .002$) and with a higher percentage of successful taps ($p < .001$). Experiment 2 showed that the mean inter-tap interval (ITI) of the tapping sequences in bimanual mode was significantly lower ($p = .014$), thus suggesting that tapping in bimanual mode induced synchronisations with faster rhythmic subdivisions of musical patterns playing at the same tempo. A correlation between a distance measure between the rhythmic patterns and the variability of preferred synchronisation layer showed that participants tapped more consistently with patterns similar to popular rhythms ($p = .023$ for unimanual; $p = .006$ for bimanual).

Conclusions

Results suggest that patterns closer to highly-codified rhythms are likely to induce the same synchronisation rate more often. The analysis of the mean ITI shows that tapping modality has a significant effect on internal beat perception, as participants preferred to synchronise to smaller rhythmic subdivisions when tapping bimanually. This, together with the results of the first task, indicates that the bimanual mode affords more stable and spontaneous synchronisation with finer-grained rhythmic layers.

Keywords: sensorimotor synchronisation, tapping, unimanual, bimanual, rhythmic layers.