

Perceived Metrical Accent in Musical Rhythms

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Abstract¹

How do monolingual English speaking musicians and non-musicians simply tap along to a variety of simple rhythms? How consistently do they tap and what factors seem to influence tapping behavior? Performance variability, tapping rate, and the way that people synchronize their tapping with the rhythms were examined.

Introduction

This study builds on two earlier studies, one by Parncutt (1994) and the other by McAuley and Semple (1999). In Parncutt's study, six stimulus rhythms were presented at varying tempos and listeners were asked to tap along with the perceived underlying pulse. It was found that 1) listeners tend to tap along to rhythms at comfortable rates, choosing tap periods of around 700 ms, and 2) at faster presentation tempi, taps coincided with events preceding longer spans of silence. McAuley and Semple's study re-examined Parncutt's rhythms and addressed the effect of tempo and musical experience on perceived beat period. They found 1) perceived absolute beat periods are longer for slower presentation tempi, 2) perceived relative beat periods are at lower metrical levels for slower presentation tempi and 3) musicians prefer to tap with faster rates than non-musicians. In this study, five rhythms of the previous studies (excluding a simple pulse rhythm) along with seven new rhythms were investigated.

Method

Twenty college age subjects were recruited in Bloomington, Indiana in the US. A subject classified as a musician if they had over 5 years of musical training.

Apparatus

MIDI files were generated with drum sequencing software (Virtual Drummer for Macintosh). The files were imported into a multi-track recording program (ProTools Free for Macintosh). Subjects listened to the stimuli on a set of headphones (Philips SBC HP820) as they tapped along on a miniature MIDI piano keyboard (Midiman Oxygen 8). Subject's taps were recorded on separate tracks of each stimulus file. Subjects heard their responses as a percussive sound distinct from the stimuli.

Stimuli

The rhythms are notated in the top portions of Figure 1 where a “[” denotes an event or pulse and a “-” denotes a non-event or rest. All rhythmic events were the same percussive sound at the same intensity. A test was comprised of all rhythms presented multiple times; each rhythm was heard beginning from all possible starting positions. Rhythms with two events were heard twice, rhythms with three events were heard three times and rhythms with 4 events were heard four times (per test). Participants tapped through two pseudo-random ordered tests. All stimuli lasted 20 seconds. Tempo was not varied. All rhythms were presented near 150 events per minute; all two-event rhythms had a period of .77 seconds, all three-event rhythms had a period of 1.18 seconds and all four-event rhythms had a period of 1.54 seconds. It is important to note the rhythms are not all based on the same underlying metrical structure.

Procedure

Listeners were instructed to tap along to each pattern with its underlying pulse and to begin tapping whenever they were ready. A couple of practice rhythms were first presented to familiarize the subject with the equipment and task. Testing began when the experimenter was confident the listener understood the task. Break intervals between stimuli lasted around 20 seconds. Participation typically took about 50 minutes.

Results

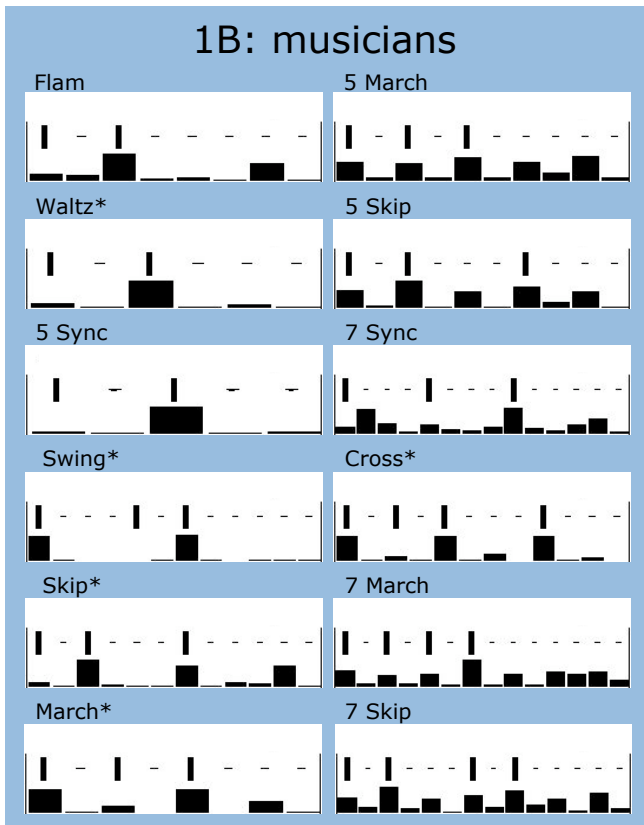
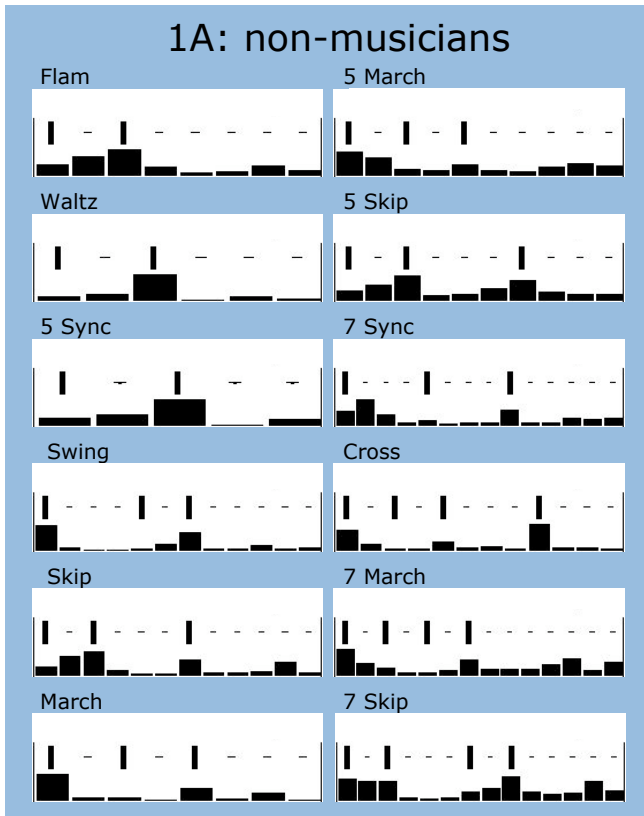
Musicians vs Non-musicians

Subjects' phase-relation taps were pooled into bins corresponding to the events (pulses) or non-events (rests) of the rhythms as notated in Figures 1. Figure 1a shows results for non-musicians over all presentations of all rhythms while Figure 1b pools results for all listeners classified as musicians. Both figures 1a and 1b are pooled over initiation conditions.

Double Cycle Tapping (DCT)

Often subjects tapped to rhythms in ways corresponding to more than one cycle. Double-cycle tapping (DCT) is the number of times a subject tapped in two cycles divided by the number of presentations. Figure 2 illustrates double-cycle tapping patterns for a few rhythms where DCT scores

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Figures 1a and 1b: rhythms with an asterisk were the ones used by Parncutt, and McAuley and Semple.

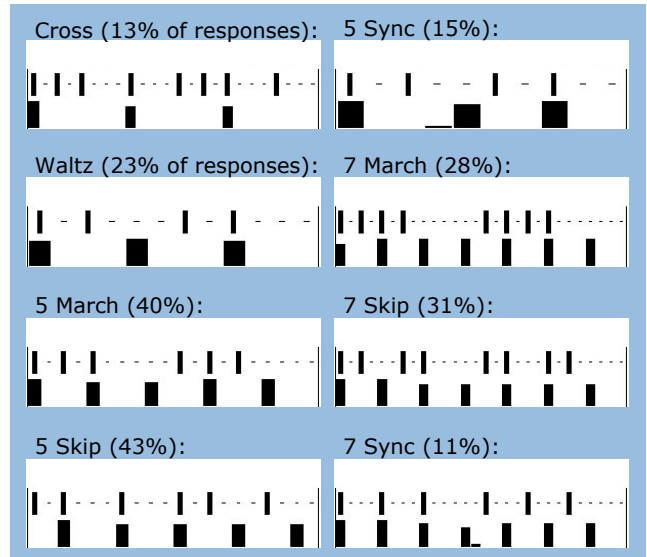


Figure 2: typical examples of double-cycle tapping (DCT)

(in parentheses) are averaged over all subjects. Figure 3 plots DCT scores averaged across rhythms for each subject on the vertical axis. It is interesting to note that musicians were more likely to respond with double-cycle tapping than non-musicians. Also, musicians generally chose the same tapping patterns for rhythms more consistently.

Consistency Scores (CS)

Consistency score (CS), a measure of how consistently a subject chose the same tapping pattern when presented with the same rhythm, is the number of occurrences of the most frequent tapping response for a rhythm divided by the number of presentations, averaged over all rhythms and initiation conditions. CS is plotted for each subject on the horizontal axis of Figure 3.

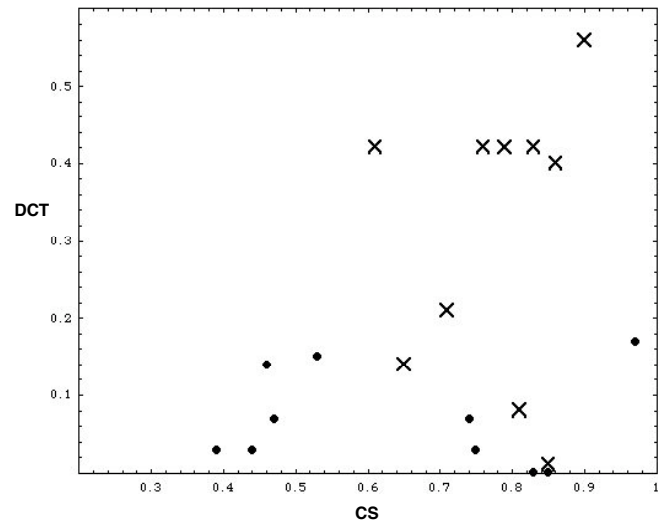


Figure 3: Consistency scores and overall double cycle tapping for musicians (x) versus non-musicians (.)

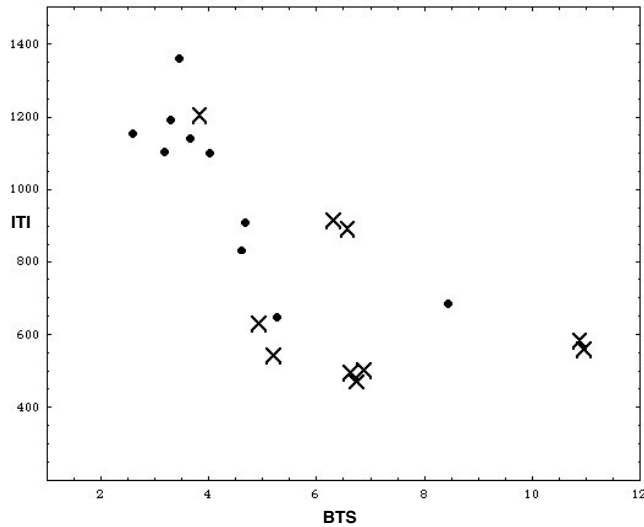


Figure 4: musicians (x) took longer to start tapping and preferred to tap at faster rates than non-musicians (.)

Beats To Start (BTS)

Beats to start (BTS) is a measure of how long it took a subject to begin tapping relative to their tapping rate. Figure 4 plots average BTS for subjects on the vertical axis.

Inter-Tap-Interval (ITI)

The mean period of tapping for each subject (ITI) is shown in Figure 4 on the horizontal axis.

Influence of Initiation

Subjects heard all rhythms beginning from all possible starting positions twice in order to examine how a rhythm's initiation influences performance. Figure 5 illustrates the two most salient examples averaged over all subjects. In the Cross and March initiation conditions, where listeners heard the rhythm begin with the intra-group event (marked with asterisk), listeners were more likely to tap with that intra-group event and corresponding rests than they were when the rhythm was initiated from other events. There is not a large influence, but it is there.

Further Point of Interest

Tapping in response to the 7-Sync rhythm is especially interesting in that one cannot comfortably tap with a steady pulse which falls on both the first and last event of the group. Subjects basically had to choose one event to align with while not aligning to the other (if they wanted to tap at a period faster than 1.2 seconds - the period of the rhythm). The most typical response was to align tapping with the last event of the group and to tap slightly late for the first event. This suggests the last event of the group (the event preceding the longest period of silence) is a stronger attractor.

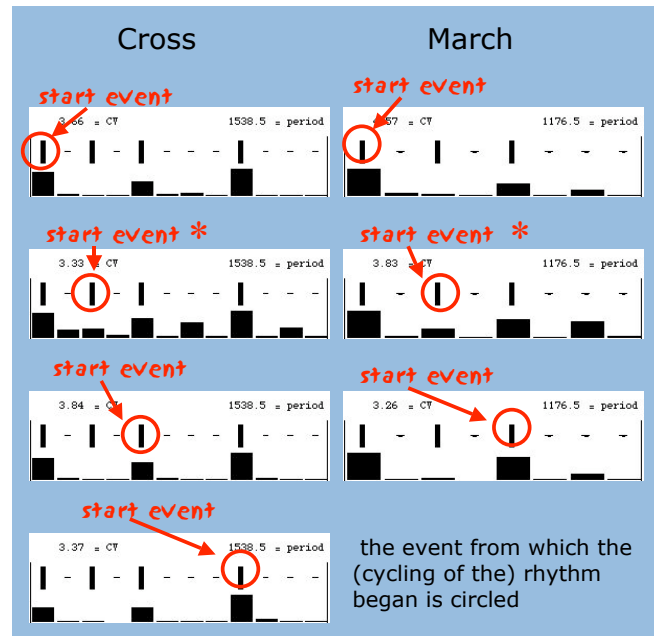


Figure 5: influence of event of initiation

Conclusions

Results are consistent with earlier findings. People prefer to synchronize their tapping with isolated events and with events preceding longer spans of silence. Musicians are more consistent in their tapping rates and with synchronizing behaviors. Musicians took longer to begin tapping. Musicians tended to tap at faster rates and were more likely to tap in 2 cycle patterns. Initiation event has influence on tapping choices under certain circumstances.

Thanks & References

Thanks go to Robert Port for useful insights and discussion during this study.

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