

SHORT-TERM MEMORY FOR TEMPO OF METRONOMIC SEQUENCES

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ABSTRACT

Background. Our previous studies addressed the problem of short-term memory for tempo of metronomic sequences and demonstrated, how the memory decays as a function of duration of a retention interval and tempo zone.

Aims. The present research is devoted to (1) memory interferences between a base tempo and an additional temporal sequence and (2) the effect of a tempo zone on short-term memory for tempo of metronomic sequences.

Method. In Experiment 1 participants heard a short metronomic sequences with IOI of 500, 600, and 700 ms (base tempo). Subsequently, a short metronomic sequence in an additional tempo was presented. After the retention interval the participants were asked to recall the base tempo with finger tapping. The additional tempo was either equal to the base tempo or faster/slower than the base tempo (there were four different temporal ratios between the base tempo and the additional tempo). The similar paradigm was employed in the Experiment 2, in contrast base tempi with IOI 300, 400, 500, 600, and 700 ms were used.

Results. The error of memory recall was the smallest in the intermediate tempo with IOI 600 ms. The additional temporal sequences impaired memory recall, but their effect differed with particular base tempi. In all base tempi it was found that the additional tempo, which was twice as fast as the base tempo, caused deceleration of a memorized tempo, while the tempo, which was twice as slow as the base tempo had the opposite effect.

Conclusions. The interference between additional and base tempo caused a contrast effect: fast additional tempo led to deceleration of memorized tempo and vice versa. The effect of tempo zone can be understood in terms of the “interval of indifference” with the most precise performance in the zone of intermediate tempi.

1. INTRODUCTION

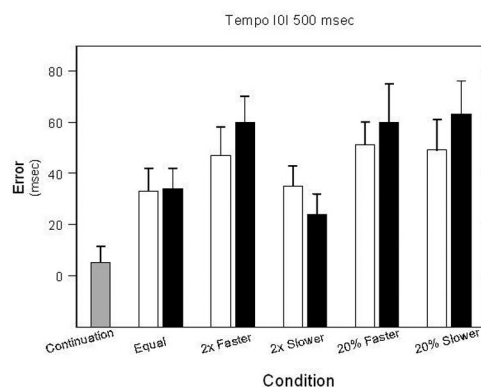
Our previous research (Franěk and Fabiánová, 2002) addressed the problem of short-term memory for tempo of metronomic sequences and demonstrated, how the tempo memory decays as a function of duration of a retention interval and tempo zone. Present experiments examined memory interferences between a base tempo and an interpolated additional tempo. Similarly to experiments in pitch short-term-memory conducted by Deutsch (1973) it was predicted that interpolated tempi might deteriorate precision of memory recall.

2. METHOD

Eight participants, musical amateurs, took part in **Experiment 1**. They heard a short metronomic sequence with an inter-onset interval (IOI) of 500, 600, and 700 ms (base tempo). Fifteen metronomic beats were presented. Participants were asked to synchronize their finger tapping with the metronome. After a pause of 1 sec, ten metronomic beats of interpolated tempo were presented. Participants were instructed to listen the tempo. After a retention interval, which lasted 1 or 5 sec, the participants were asked to recall the base tempo with finger tapping. Twenty taps were recorded. The beginning and the end of the retention interval were marked by a light, which appeared on the computer screen. There were five conditions of tempo interpolation. In Condition 1 the interpolated tempo had the same rate as the base one. In Condition 2/Condition 3 the interpolated tempo was twice as fast/slow as the base tempo. In Condition 4/Condition 5 the interpolated tempo was slightly (by 20%) faster/slower than the base tempo. The stimuli were presented in random order.

There was also an additional control condition, “continuation”, where participants heard ten beats of a metronomic sequence and then they immediately started to tap in the same tempo. Ten taps were recorded. The metronomic sequences had IOIs of 500, 600, and 700 msec.

In **Experiment 2** the same paradigm was employed. However, only Condition 1, Condition 2, and Condition 3 were used. In contrast to Experiment 1, fast and intermediate base tempi with IOIs of 300, 400, 500, 600 and 700 ms were utilized.



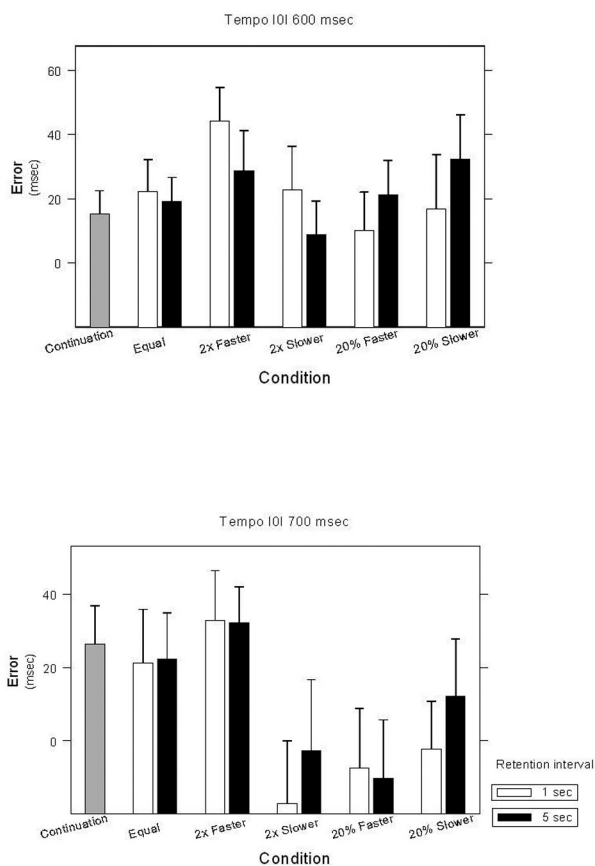


Figure 1: Errors of memory decay of retrieved tempo as a function of condition and duration of a retention interval in Experiment 1. Empty columns correspond to the retention interval of 1 sec, black columns correspond to the retention interval of 5 sec.

3. RESULTS

3.1. Experiment 1

Memory decay was expressed in the form of absolute error of a retrieved tempo with respect to the rate of a base tempo. The error was computed as the deviation between the retrieved tempo (the mean duration of the ITIs, the inter-tapping intervals) and the base tempo of the corresponding IOIs.

The data are showed in Figure 1. The error of memory recall was the smallest in the intermediate tempo with IOI 600 ms.

A repeated measures ANOVA revealed significant effects of condition of temporal interpolation [$F(4,28)=7.17$; $p<.000$], rate of a base tempo [$F(2,14)=31.33$; $p<.01$], and interaction between condition and tempo [$F(8,56)=3.48$; $p<.000$]. There was no significant effect of duration of a retention interval.

Compared to the control condition “continuation”, interpolated temporal sequences impaired memory recall. The effect of condition of tempo interpolation in particular tempi differed. Only in Conditions 2 and 3, the effects were identical in all base tempi - the interpolated tempo, which was twice as fast as the base tempo, caused deceleration of retrieved tempo, while the interpolated tempo, which was twice as slow as the base tempo had an opposite effect.

3.2. Experiment 2

The experiment is still in the progress. Preliminary results showed that the interpolated tempo, which was twice as fast as the base tempo, had similar effect as in Experiment 1 - it caused deceleration of retrieved tempo

4. DISCUSSION

The interference between base and interpolated tempi resulted in the error of memory recall of the base tempo. While the effect of interpolated tempi, which were by 20% faster/slower than base tempi was not consistent, interpolated tempi, which were twice as fast/slow as base tempi had the clear contrast effect: interpolated tempo, which was twice as fast as base tempo led to a slight deceleration of retrieved base tempo, while interpolated tempo, which was twice as slow as base tempo had the opposite effect.

The data showed that also the base tempo (tempo zone) had a significant effect on the precision of memory recall. The effect of tempo zone can be understood in terms of the *interval of indifference* (Vos & Ellermmann, 1989) with the most precise performance in the zone of intermediate tempi. According to the concept of the interval of indifference, short temporal intervals (= fast tempi) are overestimated, whereas long ones (= slow tempi) are underestimated. However, there is a temporal area around the indifference interval, in which subjects neither under- nor overestimate the duration of temporal intervals. The interval of indifference is located roughly in the range between interval duration of 500 and 1000 ms. Our data showed that the error of memory recall was the smallest in the intermediate tempo with IOI 600 ms.

5. REFERENCES

1. Deutsch, D. (1973). Interference in memory between tones adjacent in musical scale. *Journal of Experimental Psychology*, 100, 228-231.
2. Franěk, M., & Fabiánova, H. (2002). Short-term memory for tempi of metronomic sequences: the effects of base tempo and retention interval. *Journal of Music Perception and Cognition* (in press).
3. Vos, P. G., & Ellermmann, H. H. (1989). Precision and accuracy in the reproduction of simple tone sequences. *Journal of Experimental Psychology: Human Perception and Performance*, 15, 357-379.