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# Abstracts

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# The Effect of a Rhythmic Pulse on the Heart Rate: A Validation of the Rhythmical “Entrainment” and “Synchronization” Hypothesis

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## Background

The heartrate (HR) is an important psychophysiological parameter which can be used as an indicator of emotional reactions to music. Especially the tempo of a musical pulse seems to significantly influence the HR. Two different phenomena have been discussed in previous studies: 1. The adaption of the HR to the frequency of the stimulus (so-called “entrainment”). 2. The phase synchronization between the onset of the stimulus and the R-waves of the ECG (so-called “synchronization” (von Holst, 1936)).

Concerning the “entrainment” effect, Saperston (1993) reported successful manipulations of the HR -- however, only when the frequency of the stimulus was coupled to the actual HR of a listener in real-time. In contrast, discontinuous and random changes in tempo did not influence HR (Van Dyck et al., 2017).

To the best of our knowledge, up until now the “synchronization” effect of tempo changes of the trigger pulse on the HR has not been investigated.

## Aims

We investigated whether “entrainment” and “synchronization” effects on a rhythmic pulse can be observed under the condition of tempo changes coupled to the actual HR in real-time.

The following hypotheses were tested: 1. By multiplying the average mean of the HR with a coefficient  $x > 1$  and using this numeric value for the real-time tempo change of the stimulus (rhythmic pulse), the average HR would significantly increase (“entrainment”). 2. By presenting an isochronous rhythmic pulse in a similar tempo to the actual averaged HR, the phases of the R-waves in the ECG would be linked to the onset of the stimulus (“synchronization”).

## Method

The hypotheses were tested in a repeated measures design using a real-time feedback loop based on a researcher-developed MATLAB script. The stimulus frequency was continuously adapted in relation to the moving average HR. Data analysis was based on circular and Bayesian statistics.

Participants (N = 23) were music students at the Hanover University of Music, Drama and Media.

## Conclusions

In testing the “entrainment” hypothesis, the Bayesian repeated measures ANOVA (software JASP V. 0.8.2.3) revealed an overall Bayes-Factor of  $BF(10) = 0.417$  ( $BF(01) = 2.4$ ), meaning that there was no support for the alternative hypothesis and weak evidence for the null hypothesis. In testing the “synchronization” hypothesis, the individual analysis with circular statistics showed no consistent tendencies of synchronization across all subjects.

## Discussion

No assumed effects were found for either of the hypotheses, which is in line with the assumptions by Koelsch and Jäncke (2015). The positive finding of Saperston (1993) could also not be replicated. May be the tempo of a rhythmic pulse alone does not cause “entrainment” or “synchronization” effects, but additional parameters such as emotional involvement might lead to an increased HR.

## References (selection)

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