

Influence of a rhythmic context on the foreperiod effect: Behavioral and eye-tracking evidence for rhythmic facilitation but not for entrainment



RAFAEL ROMÁN-CABALLERO¹ ELISA MARTÍN-ARÉVALO¹ LAUREL TRAINOR² JUAN LUPIÁÑEZ¹

MIND, BRAIN, AND BEHAVIOR RESEARCH CENTER (CIMCYC) DEPARTMENT OF EXPERIMENTAL PSYCHOLOGY, UNIVERSITY OF GRANADA

² MCMASTER INSTITUTE FOR MUSIC AND THE MIND DEPARTMENT OF PSYCHOLOGY, NEUROSCIENCE, AND BEHAVIOUR, MCMASTER UNIVERSITY ROTMAN RESEARCH INSTITUTE, BAYCREST HOSPITAL, TORONTO, CANADA

- We observed robust behavioral and eye-tracking effects of foreperiod and rhythm.
- However, rhythm facilitation was not specific for in-phase targets.

BACKGROUND

- Attention fluctuates over time. At longer time scales, it waxes and wanes throughout the day. When exercised in a sustained way, performance typically decreases (i.e., vigilance decrement).
- Theories such as *Dynamic Attending Theory* (DAT; Jones, 1976) extend this idea to short periods of time (on the order of seconds) and propose that attention acts as an oscillatory system that alternates between moments of enhanced perceptual sensitivity and moments of attentional disengagement, at an intrinsic rate between 1–4 Hz.
- DAT proposes that the oscillatory pattern of attention can be entrained by exogenous stimulation to the benefit of perceptual discrimination and response preparation for stimuli in phase with the rhythm.
- On the other hand, DAT proposes that the attentional oscillation is self-sustained, that is, the oscillator decays back to its intrinsic period when the external rhythm disappears. However, a recent study (Trapp et al., 2020) suggests that the benefits of a rhythmic background can remain for some minutes after it discontinues.
- Moreover, when there is the certainty that the target will appear after an interval (i.e., foreperiod) the passage of time itself can be used to support attention. As the probability that an event will occur given that it has not yet occurred increases over time, reaction time (RT) decreases as the foreperiod becomes longer.

RESULTS

- Robust behavioral and eye-tracking foreperiod effects were found, with faster responses and larger pupil size for longer target IOIs.
- The presence of a rhythm before the target produced overall faster responses and a larger pupil size with more flexible dynamics (i.e., a steeper decrease of the diameter at the beginning of the sequence of standard tones along with an increase before the target onset).
- However, these modulations were observed regardless of whether the target was in phase or out of phase (i.e., no evidence of an oscillatory pattern).



AIMS & HYPOTHESES

- To investigate the modulating effect of a rhythmic context on the foreperiod effect in behavioral outcomes (RTs and accuracy) and eye-tracker measures (pupil size).
- A. A classic foreperiod effect is expected in RT and accuracy.
- B. The presence of a rhythmic context before the target will enhance the perceptual sensitivity and the preparation at moments in phase with the rhythm.
- C. Regarding eye-tracker measures, a decrease of the pupil size at the beginning of the sequence of standard tones (context) is expected, along with an increase before the target onset, that will be more marked in the rhythmic block.

METHOD

• Forty university students received 15€ for participating.

Pitch discrimination task

A sequence of standard tones with either a fixed IOI of 500 ms or a random value between 250 and 750 ms is followed by a comparison tone that is either in phase with the rhythm (500, 1000, 1500, or 2000 ms) or out of phase (250, 750, 1250, 1750, and 2250 ms). Participants judged if the comparison tone was higher or lower in pitch than the standards.



DISCUSSION & OPEN QUESTIONS

• As in our study, some other studies have failed to find an effect of entrainment in pitch discrimination tasks (Bauer et al., 2015; Lin et al., 2020). These two previous studies and ours followed designs that allow the appearance of a foreperiod effect.

Could the foreperiod effect mask any influence of the rhythmic context in out-of-phase targets?

• In contrast with Bauer et al. and Lin et al., we found an overall effect of rhythm, specifically, facilitation for all target IOIs. Whereas in both studies the context before the target had the same length for all the conditions (rhythmic vs. random, in-phase vs. out-of-phase), in our study rhythmic and arrhythmic contexts had the same average length but differed in variability.

Could the rhythm produce two types of benefits, one regarding the precise moment of the appearance of the target (*phase-specific benefit*), and also supporting the estimation of the duration of the non-demanding period to strategically devote more attention to the potential target onset (*overall benefit*)?

• For the examination of the impact of rhythm over the foreperiod effect, our task, as well as the task in Lin et al., had long periods of silence (up to several seconds) intermixed with periods of rhythm. Other designs with a continuous stream of tones showed an effect of rhythm (Chang et al., 2019).

Could the addition of long periods of silence disrupt rhythmic entrainment and the use of the rhythm for predicting in-phase targets?

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