

## Unique Effect of Entrainment on Perception? Context-Specific Temporal Prediction Mechanisms in Multiple Aspects of Perception

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Temporal prediction and preparation are essential for adaptive behavior, and can be generated based on various temporal regularities, including rhythms and interval memory. In rhythmic streams temporal predictions are thought to uniquely rely on phase-aligning neural oscillations to the external rhythm. However, in motor tasks, previous studies found similar behavioral benefits and neural phase alignment patterns for rhythm- and interval-based temporal predictions, questioning the unique role of entrainment in these phenomena. Yet, if rhythmic entrainment acts at low-level sensory circuits, its unique effect might only be revealed under high perceptual load. Here we address this using a challenging perceptual discrimination task, in which visual target timing is either non-predictable, is on-beat with a preceding rhythm (~1.11 Hz), or matches a previously presented interval (900 ms). Examining the differential effect of temporal expectation on multiple levels of perception, we collect both objective classification accuracy and subjective visibility reports, a fundamental distinction in consciousness research that has been overlooked in the temporal attention literature. In line with previous findings, both interval- and rhythm-based temporal expectations improve performance compared to the irregular stream, but to a similar degree, which is inconsistent with the idea that rhythmic entrainment provides a unique perceptual benefit beyond temporal prediction. In EEG, we critically found similar increases in occipital delta phase alignment in the rhythm and interval conditions. This was not found in central channels, demonstrating the independence of sensory from high-level phase alignment. Taken together, these results show that phase alignment can occur in the absence of oscillatory entrainment and call into question whether rhythmic entrainment provides perceptual benefits beyond what would be expected by temporal prediction alone.

Keywords: temporal attention, rhythmic entrainment, interval, EEG, visual discrimination