Effects of Luminous Modulation on Brain Function During the Stroop Task

Patricia Van Roon, Jennifer A. Veitch, Arnold Wilkins, Brad Lehman, Greg J. Burns, E. Erhan Dikel, and Amedeo D'Angiulli

Abstract

Introduction
A flickering light source resolves into a continuous perception (critical flicker frequency, CFF) at ~60-100 Hz but at higher frequencies has neural effects that are not consciously reportable. We do not know the frequency of the upper limit of detection, but electroretinogram data show responses as high as 200 Hz. Visual performance and eye movement disruptions are associated with 100-120 Hz flicker in comparison to ~40 kHz flicker, but there are few studies within a narrower frequency range.

Objectives
This investigation fills some of the gaps in our knowledge of the effects of flicker at frequencies higher than CFF but < 40 kHz. We tested whether brain activity, cognitive performance, and eye movement would differ for 100 Hz flicker in comparison to both 0 and 500 Hz.

Methods
In an experiment with repeated-measures design, we compared the effects of 0, 100, or 500 Hz, 100% modulation, square-wave flicker on a Stroop task and on sentence reading, eye movements, and brain activity (ERPs and dipole source analysis) in healthy, right-handed young adults. This paper reports results for dipole source analysis of 68-channel EEG recordings during Stroop task performance. Separate analyses were conducted for trials with responses to the stimulus colour and those with responses to the stimulus word meaning. Two dipoles were localized for three intervals: 60-100 ms post-stimulus, 170-210 ms, and 300-340 ms, as well as for the overall period -200 to 1000 ms.

Results
The dipole localizations changed across the intervals, with different sequences for the colour and word trial types. Analysis of the dipole moments showed greater brain activation at the left hemisphere during colour trials, and greater activation at the right hemisphere during word trials. Brain activation was greater for higher flicker frequencies and more difficult tasks (incongruent Stroop trials), suggesting that being exposed to higher frequencies increases information processing load.

Conclusion
Luminous modulation above the CFF affects brain activity despite not being consciously reportable as flicker. EEG-based techniques show potential for elucidating temporal patterns of brain activation in response to these stimuli.

Note: Abstract for submission to Brain 2014 (http://www.brain2014.com/ingles/index.php).
Limit: 2500 characters including spaces.
Deadline: February 7, 2014