

## Harmonic components of SSVEPs simultaneously generate both broad bilateral and focal contralateral responses

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### Abstract

When an observer views a rapidly flickered stimulus (8-30 Hz), the resulting steady-state visual evoked potential (SSVEP) includes Fourier components at the flicker frequency (1f) and at twice the flicker frequency (2f), as well as higher harmonics. We recorded SSVEP responses from 64 scalp electrodes using lateralized stimuli (circular gratings presented to the left and/or right visual hemifields). We found a surprising topographic difference between 1f and higher harmonic responses in the posterior regions of the scalp. Whereas 2f (and higher harmonic) responses were localized to contralateral scalp locations, 1f responses were broadly bilateral. These localized versus broadly distributed responses were not tied to any specific flicker frequencies. Rather, scalp distribution varied in accordance with 1f versus higher harmonic responses. For example, 2f responses to a 12.5-Hz stimulus flicker and 1f responses to 25-Hz stimulus flicker both produced SSVEPs at 25 Hz, but 2f responses were localized to the contralateral hemisphere whereas 1f responses were bilateral. Because we obtained localized 2f responses and broadly distributed 1f responses simultaneously, their topographic differences could not be due to artifacts such as eye movements. Based on the fact that 2f responses are robust across a variety of stimuli and are more strongly modulated by top-down influences such as voluntary attention, we speculate that higher harmonic responses reflect processes that are tuned by feedback interactions. In contrast, 1f responses might reflect broad bottom-up activation of visual cortical areas.

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