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ABSTRACT

Recognition by Flickering Components: The Effect of Temporal Modulation on Image Recognition

by

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A primary goal of vision is to identify objects rapidly and efficiently. Successful object and scene recognition results from the integration of both feed-forward and feedback processes that correspond a two-dimensional retinal image to a representation of its content stored in memory (Bar, 2003). One general organizing principle may be that the visual system analyzes images and scenes according to their spatial components in a coarse- (low spatial frequency) to-fine (high spatial frequency) sequence (Bullier, 2001; Hegde, 2008). An individual's sensitivity to these spatial components is described by contrast sensitivity function (CSF), which indicates the minimum contrast required for the detection of patterns of various sizes. A consistent finding is that, when temporally modulated at a moderate rate, sensitivity to lower spatial frequency gratings is heightened relative to its static counterpart (Robson, 1966; Abramov et al., 2012). This suggests that temporal modulation may enhance image detectability, especially so for those coarsest spatial components—the lower spatial frequencies—that seem to be most important for detection and categorization of objects and scenes. We presented participants with an array of grayscale images depicting objects and scenes under 3 spatial (3cpd-filtered, 4cpd-filtered,

and unfiltered full-spectrum) and 3 temporal (static, 6Hz counterphase flicker, and 250ms presentation) conditions, at 4 levels of near-threshold contrast. Responses were open-ended identifications. Temporal modulation was hypothesized to improve recognition in all spatial conditions, while short-duration presentation was predicted to result in performance comparable to the full-duration static condition. Males were hypothesized to perform better than females based on previously reported (Abramov, et al., 2012) sensitivity differences. Results partially supported our hypotheses: temporal modulation at 6Hz had recognition enhancement effects only for the lowest spatial frequency-cutoff—3 cpd. We describe a distinction among the neurological underpinnings of the CSF into two separate mechanisms responsible for the lower and upper halves of the CSF.

Keywords: Object recognition, Contrast Sensitivity Function, Spatial Frequency, Visual Psychophysics, Temporal Modulation, Sinusoidal Grating