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The role of temporal integration windows in visual perception

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Abstract

The brain receives a constant, analogue flow of stimulation from each of the senses. One of the main goals of perceptual systems is to segregate this steady influx into meaningful spatio-temporal units such as objects and events. Perception of objects, motion or events requires information to be integrated over a period of time. Such temporal integration windows (TIW) are thought to operate across multiple timescales (Gibbon et al., 1997; Poeppel, 1999). For example, studies of perceived duration and of simultaneity have consistently found a time limit of around 40 ms as the minimum integration window. In other words, only when a stimulus is presented for more than 40 ms does it seem to have a duration longer than a single instant, and two stimuli presented less than 40 ms apart from each other seem to be simultaneous. Longer TIWs of around 100-150 ms have been found in various paradigms such as backward masking (for review, see Enns & Di Lollo, 2000). In terms of subjective perception, stimuli presented in sequence within such a time period are integrated into a single percept. In addition, a number of other studies have reported TIWs of around 200-300 ms for tasks such as apparent motion, the attentional blink, and inhibition of return (Posner & Cohen, 1984; Raymond, Shapiro, & Arnell, 1992). Beyond this time period, two stimuli tend not to interact at all with each other perceptually. Thus, our subjective perceptual experience of two or more stimuli depends critically on the temporal spacing between them according to multiple TIWs. Finally, it has been suggested that relatively long temporal windows of 2-3 s can be found across different sensory modalities and tasks, corresponding to our subjective impression of “now” (Poeppel, 1999).

Previous studies of TIWs raise the question of how these different TIWs interact with each other in creating our subjective experience of a spatiotemporally stable and continuous world. In a series of studies, we have examined how temporal integration is influenced by the fact that people typically make several saccadic eye movements per second. These ballistic eye movements are the main strategy for looking around scenes in everyday life, yet saccades introduce a dramatic discontinuity in visual stimulation and laboratory studies have demonstrated systematic alterations in both spatial and temporal perception around the time of saccades (Morrone et al., 2005; Yarrow et al., 2001). Here, we present new results showing that for the relatively short TIWs of around 100 ms, saccades seem to reset the TIWs. Apparent motion, in contrast, is relatively unaffected by saccades, suggesting that the medium-level TIWs of around 200-300 ms continue to operate across eye movements (Fracasso et al., 2010; Melcher & Fracasso, 2012). Likewise, we have found that temporal windows of around 2 s can be found under free-viewing conditions when people watch movies, with little or no interference by saccades on this long TIW. Overall, these findings suggest...
that relatively long TIWs underlie our subjective experience of a spatiotemporally continuous and stable visual world.

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References