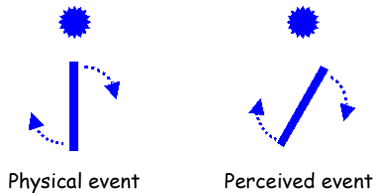


Attentional binding and the root of visual illusions

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Background

The need to identify a specific feature of an object at an exact instant in time is an element of vital perceptual tasks. A hotly debated example is the flash-lag effect (FLE): A moving object appears to lead a briefly flashed object, even when the two are aligned.



Psychophysical experiments have found a flash-lag-like effect involving the relationship between an abrupt stimulus and more general continuously changing stimuli (such as "motion" in color, luminance and spatial frequency spaces), as well as between stimuli belonging to different sensory modalities (a crossmodal flash-lag effect).

The present proposal

Empirical support indicates that processing streams in the visual pathways are segregated, so that the perceptual attributes of an object, from local features to abstract properties, have to be bound together into a coherent representation by means of a coordinated activity taking place across widespread neuronal populations.

Starting with the detection of the flash, a shift (or spread) of attention from the *stationary object* to the *moving object* has to occur in order to bind them together into a unitary package, allowing the completion of the perceptual judgment. The time spent in shifting attention between different objects (or in spreading over different parts of a single object) would lead to a percept whose components consist of a changing stimulus further ahead along its pathway in feature space.

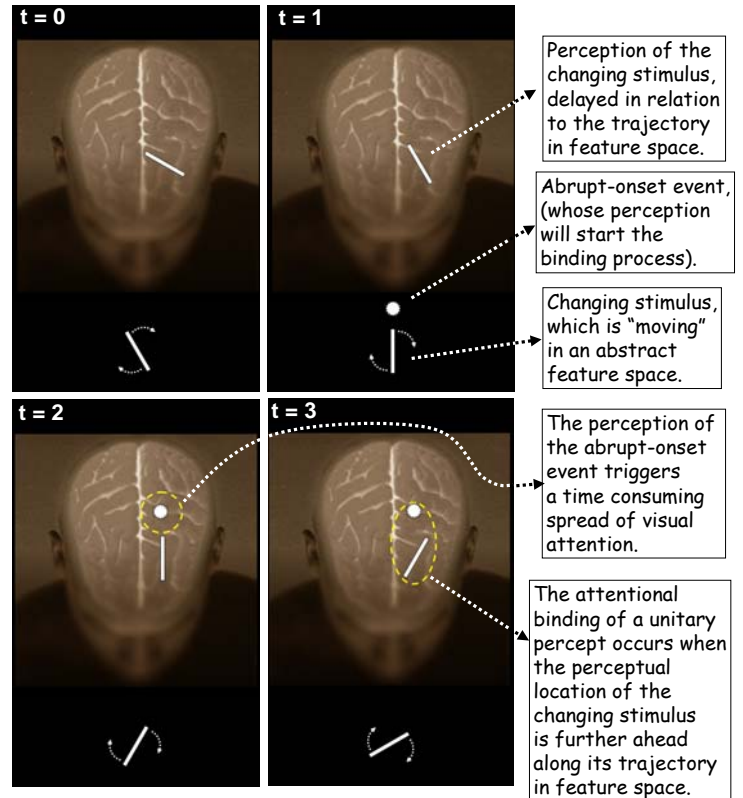
Supporting evidence from related work

"Therefore, we conclude that the shift-related parietal and dorsal frontal activations observed in the present study can be attributed to the control of object-based, and not space-based, attentional control" (Serences *et al.*, *Cerebral Cortex*, 2004).

"We investigated how attention shifts from one object to another by recording neuronal activity in the primary visual cortex. The reallocation of attention was associated with a rapid and strong enhancement of responses to the newly attended curve, followed, after 60 ms, by a weaker suppression of responses to the curve from which attention was removed" (Khayat *et al.*, *The Journal of Neuroscience*, 2006).

"[T]he perceived color lags behind perception of the vertical bar[. W]e show that perceptual asynchrony is a natural consequence of redirecting attention from a "defining" attribute to a "report" attribute" (Enns & Oriet, *Journal of Vision* [Abstract], 2004).

"In a color-motion pairing task [...] attentional cues modulate and in some cases eliminate the feature asynchrony, arguing against differential latencies" (Holcombe & Cavanagh, *Journal of Vision* [Abstract], 2006).



Main conclusions

1. In summary, the recipe is quite simple: given that a reference, abrupt-onset, stimulus is perceived, attention is recruited to bind it to a changing stimulus, whose current status must be recorded; since this attentional binding takes some amount of time, the changing variable will be pinned down at an advanced location within its feature space.
2. Therefore, the model offers a unified framework in which general manifestations of the FLE can be accommodated, being able to assimilate other visual illusions as well.
3. Still more general is the fact that the present attentional account conveys the potential emergence of the FLE in a sensory modality other than the visual system, or even across different modalities.
4. Psychophysical parameters (e.g. luminance, eccentricity, etc.) also shape the dynamics of the spatial and temporal processing, being an integral part of the overall phenomenon.
5. The *attentional binding* account of spatiotemporal illusions (such as the FLE) is compatible with current neurophysiological data, computational simulations and also cognitive models of conscious perception (for instance, the *Global Workspace Theory*).