**Flash-lag Illusion**

Camden Alexander McKenna

**Brief (Magnifying Glass) Description:** An illusion related to motion in which a stimulus appears to lag another when it does not.

**Instructions:** Watch the red square move across the screen. When it reaches the midpoint of the black screen, you will notice a green square appear below the red square. Note where the green square seems to appear relative to the horizontal position of the red square.

**Effect:** Most observers report that the green square appears to “lag” the red square, i.e. the green square appears slightly to the left of the red square’s horizontal position. However, the green square is actually presented directly underneath the red square, but we fail to perceive it as such.

**Illusion Credit**: An effect of this kind was noted by D.M. MacKay (1958) but current research on the flash-lag illusion follows a revival of interest stemming from studies by Romi Nijhawan (1994).

**Keywords/Categories**: Visual, Motion, Time, Order, Post-Diction

****

**Gif Credit: Laurent Perrinet**

In the flash-lag effect a non-moving object is quickly flashed directly underneath a moving object, which leads us to perceive the non-moving object as “lagging” the moving object, even though the two objects actually occupy the same horizontal position at the time of the flash. In the example above, for instance, a red square moves across a screen. At the midpoint of the red square’s journey from one side to the other, a green square is quickly presented (flashed) just below. Despite the fact that the two stimuli are presented at the same coordinates along the x axis, the stationary square is perceived as behind the moving square. The perceived lag of the flashed stationary object becomes greater when the speed of the moving object is increased and vice versa (Nijhawan 1994).

A mysterious wrinkle, however, is that the effect is *not* present if the moving object stops moving at the time the stationary object is presented, with the two objects occupying the same horizontal position (Hubbard 2014; Kanai et al. 2004). We can see this in the animation below:



The illusion thus appears to suggest that the *later* movement of the stimulus affects how the two stimuli are perceived *earlier*, when they appear together. More provocatively stated, it is as though the *future* is influencing our *present* perception, against the normal direction of causation! Of course, the latter scenario is highly implausible. As a result, numerous theories have attempted to explain the phenomenon in more natural ways.

Though no consensus exists, one prominent interpretation puts the flash-lag effect in a category of temporally exotic phenomena known as postdictive effects (see e.g. Eagleman and Sejnowski 2000) and less commonly known as “backwards perceptual phenomena” (Shimojo 2014). Postdictive effects can be defined as perceptual phenomena that appear to involve later sensory input affecting earlier percepts, though only within a timeframe of around 100-200 milliseconds (Shimojo 2014). These effects include a large and growing family of similar illusions, each of which disrupt the ordinary temporality of perceived events in some way or another. Other examples, besides the flash-lag effect, include the cutaneous rabbit illusion, apparent motion, the color phi effect, and more.

According to the postdictive interpretation of the flash-lag effect, it is only the continued movement of the stimulus *after* the midpoint that results in the perception of a discrepancy between the positions of the two stimuli when they are in fact both atthe midpoint of the screen. Eagleman and Sejnowski’s postdictive interpretation of the flash-lag effect suggests that our perception of the locations of the two objects is constructed out of a process of averaging positions over time, with the relevant sampling taking place immediately after the presentation of the stationary object. This averaging would then lead to the moving object perceived as slightly ahead of the stationary object, with an increasing lag depending on the distance travelled by the moving object within the sampling period (Eagleman and Sejnowski 2000).

Some have resisted the postdictive interpretation of the flash-lag effect. If this camp is correct, the illusion is less counterintuitive than it appears. Hubbard (2019) outlines some of the views of this kind that can be found in the psychology literature, beginning with the first postulated theory on the matter. This is the view that perceivers *extrapolate* based on presently perceived motion leading to the moving object perceived as ahead of its actual position, while the stationary object is accurately perceived (Nijhawan 1994, 2008).

Another non-postdictive view contends that the illusion results from a discrepancy in the visual processing of information between moving and stationary objects, such that information about moving objects is processed more quickly (Purushothaman et al. 1998). Consequently, we should expect that we will have perceived the moving object at a later point in its trajectory by the time we are able to perceive the presentation of the stationary object. This view is known as the “differential-latency hypothesis.” Patell and Bedell (2000) have argued that Eagleman and Sejnowski’s (2000) study is fully consistent with such a hypothesis, though Eagleman and Sejnowki disagree.

One further non-postdictive account is that the flash-lag effect is modulated by attention. According to this view, our attention moves from the moving object to the stationary object when it is flashed, and by the time we are able to attend again to the moving object, it has already moved past the stationary object (Baldo and Klein 1995; cf. Baldo and Klein 2010).

As can be surmised from the lack of consensus regarding the appropriate interpretation of the flash-lag effect, this illusion requires further study before researchers can be confident about the mechanisms involved.



**References:**

Baldo, M. V. C., & Klein, S. A. (1995). Extrapolation or attention shift? *Nature, 378*, 565–566.

Baldo, M. V. C., & Klein, S. A. (2010). Paying attention to the flash-lag effect. In R. Nijhawan & B. Khurana (Eds.), *Space and time in perception and action* (pp. 396–407). Cambridge, UK: Cambridge University Press.

Eagleman, D.M. and T.J. Sejnowski. 2000. Motion integration and postdiction in visual awareness. *Science* 287: 2036-2038.

Hubbard, T.L. 2014. The flash-lag effect and related mislocalizations: findings, properties, and theories. *Psychological Bulletin* 140: 308-338.

Hubbard, T.L. 2018. The flash-lag effect. In T.L. Hubbard (ed.), *Spatial biases in perception and cognition*. 139-155. Cambridge, UK: Cambridge University Press.

Hubbard, T.L. 2019. Spatiotemporal Illusions Involving Perceived Motion. In V. Arstila, A. Bardon, S.E. Power, A. Vatakis (eds.), *The Illusions of Time: Philosophical and Psychological Essays on Timing and Time Perception*. 289-314.

Kanai, R., B.R. Sheth, and S. Shimojo. 2004. Stopping the motion and sleuthing the flash-lag effect: spatial uncertainty is the key to perceptual mislocalization. *Vision Research* 44: 2605-2619.

Mackay, D.M. 1958. *Perceptual stability of a stroboscopically lit visual field containing self-luminous objects.* Nature 181 (4607): 507-508.

Nijhawan, R. 1994. Motion extrapolation in catching. *Nature* 370: 256-257.

Patel, S.S., H. Ogmen, H.E. Bedell, and V. Sampath. 2000. *Science* 290 (5494): 1051.

Purushothaman, G., Patel, S. S., Bedell, H. E., & Öğmen, H. (1998). Moving

ahead through differential visual latency. *Nature, 396*, 424.

Shimojo, S. 2014. Posdiction: its implications on visual awareness, hindsight, and sense of agency. *Frontiers in Psychology* 5: 196.