be perceptually adjusted until simultaneity is perceived (Stetson et al. 2006). Although this recalibration is normally adaptive, note a strange consequence: Imagine we repeatedly inject a tiny delay (e.g., 100 msec) between a subject's key-press and a subsequent flash for a dozen trials, and then we suddenly remove the delay. Because the perceptual systems have recalibrated to compensate for the delay, the subject now perceives that the flash occurred before the key-press: an illusory reversal of action and sensation (Cunningham et al. 2001a; Stetson et al. 2006). Note that this recalibration is no mere party trick – it is critical to solving the problem of causality, which requires, at bottom, temporal order judgments. The only way causality can be accurately determined in a multisensory brain is to keep the temporal delay of signals calibrated in the face of different sensory pathways operating at different speeds. This example serves to buttress Nijhawan's general argument that compensation for delays can take place at very early, perceptual levels.

Transient signals per se do not disrupt the flash-lag effect

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Abstract: Nijhawan's theory rests on the assumption that transient signals compete with predictive signals to generate the visual percept. We describe experiments that show that this assumption is incorrect. Our results are consistent with an alternative theory that proposes that vision is instead *postdictive*, in that the perception of an event is influenced by occurrences after the event.

Nijhawan has presented a predictive theory of visual motion perception. He notes that because of the delays inherent in visual processing, the visual system cannot detect events at the instant at which they occur. He argues that the visual system compensates by using the information it has to predict the current state of the world. In other words, he suggests that we do not see reality, but rather, the visual system's best guess at reality is based on slightly out-of-date information. To support this theory, Nijhawan relies heavily on a particular visual illusion – the flash-lag effect. Here, we briefly describe experiments that Nijhawan's account cannot handle. Although Nijhawan's predictive theory can readily account for the standard flash-lag paradigm, the flash-terminated version poses a problem. In this version of the paradigm, the moving object disappears at the time of the flash. As Nijhawan notes in the target article, "At the outset, spatial extrapolation should continue beyond the time of unpredictable disappearance of the object. Yet these displays produce no flash-lag effect" (sect. 5.2.2, para. 1). To explain why the flash-lag effect does not occur under these circumstances, Nijhawan makes an additional assumption. He proposes that the transient signal produced by the disappearance of the moving object generates a neural representation (perhaps thalamic) that competes with and eventually overwhelms the predictive representation (perhaps cortical) that would normally cause the flash-lag effect. We will refer to this as the transient signal assumption.

The support for this assumption comes from Maus and Nijhawan (2006, reviewed in section 5.2.2 of the target article). That study did not employ a flash-lag design. Instead, Maus and Nijhawan demonstrated that when a moving object disappears gradually by moving behind a variable neutral density filter, it remains visible past its standard luminance threshold. This finding could be caused by hysteresis (Palmer 1999). In any case, it does not address the issue of whether the presence of a transient signal eliminates the flag-lag effect (i.e., the transient signal assumption).

To test this assumption, we used a reversed-contrast version of the flash-lag paradigm in which the background was gray and the moving object changed from black to white at the moment of the flash. The resultant transient signal must be at least as large as in the flash-terminated version (probably larger, since the neurons in the thalamus are sensitive to contrast polarity; Hubel & Wiesel 1961). If Nijhawan's transient signal assumption is correct, this should abolish the flash-lag effect. Nevertheless, the magnitude of the effect was just as strong with our stimulus as in the standard flash-lag paradigm (i.e., with no transient).

Perhaps Nijhawan's proposed transient signals do not originate in the thalamus and are generated by cells that are not sensitive to contrast polarity (Hubel & Wiesel 1962). Such cells respond as strongly to a white dot as they do to a black dot and so may not generate a transient signal in the reversed-contrast version of the flash-lag effect. If it is assumed that it is these cells that need to generate the relevant transient signals, then this might explain why the flash-lag effect still occurs in our reversed-contrast version of the paradigm. We tested this hypothesis by comparing two versions of the flash-lag paradigm. In one case, the Michelson contrast of the moving object was reduced from 0.30 to 0.04 at the moment of the flash. In the other case, it was reduced from 0.04 to 0; that is, it disappeared. The first condition should produce a larger transient than the second, yet we found the flash-lag effect to be of normal strength in the first case but entirely absent in the second. It appears that, contrary to the transient signal assumption, the flash-lag effect is not disrupted by transients but only by the actual disappearance of the moving object.

Why, then, does the flash-lag effect vanish in the flash-terminated condition? Nijhawan proposes his transient signal assumption as the reason, but our data fail to support that account. Our data are more compatible with the *postdictive* theory of Eagleman and Sejnowski (2007). In brief, this theory postulates that the apparent position of the moving object at the time of the flash is influenced by the motion of the object after the flash. In other words, consistent with our observations, the flash-lag effect should occur in any situation in which the moving object does not disappear, irrespective of any transient signals that might be generated at the time of the flash. This theory can readily account for all our data without invoking any additional mechanisms.

Mental and sensorimotor extrapolation fare better than motion extrapolation in the offset condition

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Abstract: Evidence for motion extrapolation at motion offset is scarce. In contrast, there is abundant evidence that subjects mentally extrapolate the future trajectory of weak motion signals at motion offset. Further, pointing movements overshoot at motion offset. We believe that mental and sensorimotor extrapolation is sufficient to solve the problem of perceptual latencies. Both present the advantage of being much more flexible than motion extrapolation.

Nijhawan claims that the offset of a smoothly moving object masks the extrapolated trajectory of the moving object. Therefore, the flash-lag effect is suppressed in the flash-terminated