How to see in total darkness and why a curveball curves

Much of what we perceive as visual motion is predicted by other cues, such as object position and even other sensory modalities (e.g., observing one's own kinesthesis). Here, we show, in two studies, that this predictability of motion is exploited by our vision. When people view their own hand motion in total darkness, most perceive visual motion. This subjective observation was objectively confirmed with eye tracking of smooth pursuit eye movements, where those who reported more vivid motion sensations exhibited smoother visual pursuit of their own hand. Individuals with synesthesia experienced considerably stronger visual sensations from kinesthesis, suggesting that multisensory connectivity may be a key determinant of this phenomenon. Overall, we show that kinesthesis can be solely sufficient to generate visual sensations.

In natural environments, object motion is strongly correlated with changes in object position. Yet, there is no unifying theoretical framework that can account for both motion and position perception and their interactions (many vision scientists, myself included, often study motion with stimuli are fixed in space). We developed an object-tracking model that accounts for a number of well-known and seemingly independent visual illusions, including motion-induced position shifts, slow speed biases and the curveball illusion. Moreover, the model also predicts novel motion and position illusions; predictions that were experimentally confirmed. In sum, we provide a unifying object tracking framework that reconceptualizes how the human visual system integrates noisy position and motion signals.