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The Existence of Second-Order Reversed Phi: A Prediction from a Theory of Motion Perception

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In a reversed-phi motion stimulus (Antsis, 1970), the black-white contrast of successive frames is reversed, and the direction of apparent motion may, under some conditions, appear to be reversed. Three classes of novel second-order reversed-phi stimuli (contrast, spatial frequency and flicker modulation) that are invisible to first-order motion analysis were constructed. In these stimuli, the salient stimulus features move in the forward (feature displacement) direction but the second-order motion energy model predicts motion in the reversed direction. In peripheral vision, for all stimulus types and all temporal frequencies, all subjects saw only the reversed-phi direction of motion. In central vision, subjects perceived reversed-phi at temporal frequencies above about 4 Hz and movement in the forward direction at lower temporal frequencies. As all of these stimuli are invisible to a first-order motion computation, these results indicate that the second-order reversed-phi stimuli activate two subsequent competing motion mechanisms: Both involve an initial stage of texture grabbing (spatiotemporal filtering followed by fullwave rectification). The second-order motion system then applies motion energy analysis (or equivalently, an elaborated Reichardt model) directly to this signal and arrives at the reversed-phi direction. The third-order system marks the location of features that differ from the background and computes motion in the forward direction from this dynamic map. The second-order motion energy system dominates in peripheral vision and in central vision at higher temporal frequencies because it has better spatial and temporal resolution than the third-order system. But, in central vision, the third-order system's report of resolvable movement of something salient dominates the second-order system's report of texture-contrast movement.