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Proving the Independence of First- Second-order Motion System

((George Sperling, Zhong-Lin Lu))* *University of California at Irvine, CA 92697. University of Southern California, Los Angeles, CA 90089.

(1) *Independent Motion Adaptation.*[1] Corresponding points in the left and right eyes can be simultaneously adapted to oppositely-directed motion of first-order stimuli or of second-order stimuli, and there is no cross adaptation between first- and second-order stimuli. (2) *Phase Independence for Same Movement Directions*[2] (a) When superimposed equal-strength first- and second-order stimuli of the same temporal and spatial frequencies move in the same direction, the measured strength of motion is independent of the relative phase of the two stimuli. Phase independence for an assortment of same-direction stimuli *requires* independent motion computations. (b) The probability of correct motion detection in the combined stimulus follows probability summation (the same at all phases). Together, (a) and (b) indicate that first-order and second-order motions are first computed in independent channels and then the outputs are combined. (3) *Drastically Different Saturation Properties.*[3] First-order motion-direction thresholds (for luminance sinewaves) are unaffected by small pedestals but, at pedestal contrasts above 1 to 2%, motion thresholds increase proportionally to pedestal amplitude (a Weber law). On the other hand, second-order motion-direction thresholds (for texture-contrast sinewaves) are independent of pedestal amplitude (no gain control whatever!) throughout the accessible pedestal amplitude range (from 0% to 40%). However, when *baseline* carrier contrast increases (with constant pedestal amplitude), second-order motion thresholds increase, showing that gain-control in second-order motion is determined not by the modulator (as in first-order motion) but by the carrier. The drastically different gain-control properties of the two motion systems imply different neural substraits. **Conclusion.** Single-motion-system theories can account for isolated phenomena; encompassing the spectrum of phenomena enumerated above requires dual-system theories.

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