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Update on the Three-Motion-Systems Theory *George Sperling*, Zhong-Lin Lu*
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Lu & Sperling[1] proposed that human visual motion perception is served by three separate motion systems: A first-order system that responds lo moving luminance patterns; a second-order system that responds to moving modulations of *feature types* — stimuli in which the expected luminance is the same everywhere but an area of higher contrast or of flicker moves; and a third-order system that computes the motion of *marked* locations in a "salience map," that is, a neural representation of visual space in which the locations of important visual features ("figure") are marked and "ground" is unmarked.There have been at least six reports of apparent contradictions to this theory and we consider here as many as space permits.

(1) Strohmeyer et al[2] find that adding a stationary sine (a pedestal) to a moving sine of the same spatial frequency produces large variations of threshold for the moving sine depending on the initial phase of the two stimuli. This is a gross violation of the Lu & Sperling1 claim of pedestal immunity (no effect on motion threshold of stationary pedestals) for a Reichardt detector. *Resolution:*. For sampled motion stimuli of n cycles duration, m samples per cycle, pedestal immunity requires m=4 and exactly nm+l samples. Strohmeyer et al used n=l and m=13, not 4. Nevertheless, a Reichardt detector accounts for their data quite well. And, for similar stimuli, we verified that when m=4 and 5 samples are used, pedestal immunity obtains.

(2) Smith & Ledgeway[3] allege that imposing a moving texture-contrast modulation on a static instead of a dynamic carrier (both second-order stimuli) artifactually produces a first-order motion stimulus, and so our results based on such stimuli are erroneous. This hinges on their measured temporal frequency tuning functions for second-order motion stimuli. Static carriers mimic first-order motion tuning, dynamic carriers produce lower temporal frequency cutoffs. *Resolution:* We tested the accused static-carrier second-order motion stimuli with first-order motion probes. Visible beats, a sensitive test of first-or&r contamination, were not observed. Theoretically and experimentally, there was no indication of artifacts. However, adding a dynamic second-order carrier to an ordinary first-order motion stimulus produced the same (lower) Cutoffs as in dynamic second-or&r stimuli. The alleged artifact was merely high-frequency masking by dynamic noise. (3) Analogous arguments deflect the other critiques. Conclusion. The current status of the three systems theory is "healthy."[4]

1. Lu, Z.-L & Sperling. G. (1995). *Vision Research*, 35, 2697-2722.
2. Suomeyer III. Zemany, L., C. F., Chaparro. A. & Kronauer, R. E. (1997). *ARVO*, #1031.
3. Smith, A, T. & Ledgeway, T. (1997). *Vision Research*, 37, 45-62.
4. Supported by AFOSR Life Sciences, Visual Information Processing Program.