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McKee, Suzanne

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The visual system can use local speed information to determine whether one surface or two transparent surfaces are visible. The local speed signals are very noisy, so a large difference in speed is necessary to produce surface segregation. Once the segregation has occurred, the visual system then integrates the local speed signals associated with each surface to improve the precision of the speed information. To study this phenomenon, speed discrimination was measured for a display composed of random dots all moving in one direction, but at two different speeds. When the speeds were sufficiently different to create the percept of two transparent planes, speed discrimination was as precise for either of the two speeds as when each was viewed alone. The local motion vectors specifying the two speeds had to be present simultaneously to produce segregation (and good speed discrimination). If all dots alternated rapidly between the two speeds in *synchrony*, no segregation was observed. On the other hand, *asynchronous* alternation, in which different subsets of dots changed speed in every frame, produced excellent segregation.

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RESEARCH OBJECTIVES

Our research program is using random dot cinematograms to study how human observers extract information about speed, and how they use this information to segregate surfaces and determine their depth. Dr. Scott Watamaniuk and Andrew Duchon had found that observers average local speed vectors to estimate the global speed of a display formed of random dots, all moving in the same direction at speeds ranging from 2 - 8 deg/sec. Dr. Mary Bravo found this result very puzzling, because relative speed is commonly thought to segregate the optic flow field into different depth planes (motion parallax). How could the brain use speed as a powerful segregation cue, if the speed signals were averaged? Previous studies of motion transparency used displays in which dots moved in many directions and speeds simulating a rotating shape or surface; observers in these studies inspected the display to judge whether it produced a sensation of depth and/or transparency. In their study, Dr. Bravo and Dr. Watamaniuk used a display composed of random dots all moving in one direction, but at two different speeds. They used a quantitative psychophysical measure, the precision of speed discrimination, to demonstrate that the transparent surfaces were neurally independent (segregated). When the speeds were sufficiently different to create the percept of two transparent planes, they found that speed discrimination was as precise for either of the two speeds as when each was viewed alone. The local motion vectors specifying the two speeds had to be present simultaneously to produce segregation (and good speed discrimination). If all dots alternated rapidly between the two speeds in *synchrony*, no segregation was observed. On the other hand, *asynchronous* alternation, in which different subsets of dots changed speed in every frame, produced excellent segregation. This asynchronous condition also produced a new illusion. When a dot, moving along a fixed trajectory, changed from one speed to the other, it "twinkled" and disappeared as though it had jumped from one perceptual plane to the other; physically, it was still moving along the same trajectory, only at a different speed. This "twinkling" was not seen in the synchronous condition, although for a given dot moving along a fixed trajectory, the alternation between speeds was identical to the asynchronous condition.

Soon, Dr. Julie Harris, Dr. Norberto Grzywacz, Dr. Scott Watamaniuk and I will use three-dimensional displays to examine the interplay between speed information and disparity information. We will measure how precisely human observers encode speed for targets moving along oblique trajectories in depth. We will also examine how well they can discriminate the speed and axis of rotation for displays that simulate surfaces rotating in three-dimensions. Under the supervision of Dr. Grzywacz, Doug Taylor is presently programming these displays with the assistance of Dr. Watamaniuk and Dr. Harris.

PROFESSIONAL STAFF

Dr. Suzanne P. McKee, Principal Investigator
Dr. Norberto M. Grzywacz, Scientist
Dr. Scott N.J. Watamaniuk, Postdoctoral Fellow/Research Assistant
Douglas G. Taylor, Programmer/Engineer

PUBLICATIONS:

<u>Papers</u>

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