DETECTABILITY OF GLOBAL FORM IN GLASS PATTERNS AND RANDOM DOT MOTION STIMULI DEPENDS ONLY ON SIGNAL-TO-NOISE RATIO

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Global form and complex visual motion may be processed by separate brain mechanisms. We are using Glass patterns (Glass, 1969), dynamic Glass patterns, and random dot motion stimuli to study this issue. Static Glass patterns (SGPs; see example stimuli below) consist of many pairs of signal dots (with the same spatial separation) whose orientations are varied systematically across the stimulus to generate global structure, e.g. rotation. Dynamic Glass patterns (DGP) are Glass patterns in which each video frame consists of a fresh pattern with the same statistics. Dynamic random dot motion stimuli, or optic flow patterns (OPFs), are like dynamic Glass patterns except that there is a temporal delay between the presentations of the two dots in each signal dot pair. These types of stimuli are ideally suited for studying the integration of local motion and form cues by higher brain mechanisms, because the global structure of the stimuli (rotation, expansion, translation) can be manipulated without changing the local cues (dot pairs).

Much research has shown that discrimination of optic flow patterns depends on signal-to-noise ratio (e.g. Morrone et. al, 1995). However, recent research by Dakin et. al (2000) suggests that the discrimination of average orientation in a static texture stimulus depends on the number of signal elements in the stimulus. We wanted to see if number of signal elements (i.e. dot pairs) is important in detection of Glass patterns and optic flow patterns, and if there is a difference between static and dynamic patterns in this regard.

Methods:
Stimuli:
- Static Glass patterns (stat), dynamic Glass patterns (dyn), or optic flow patterns (opt). All stimuli had 1.0 sec duration.
- Rotation (rot) and translation (trn) patterns of white dots on a mid-gray background. Each dot’s area was 0.167 deg².
- Stimulus form was defined by systematic variation of signal dot pair orientation across the stimulus.
- Spatial separation between paired dots was varied from 0.065 - 0.52 deg.
- Temporal separation = 0 (stat, dyn), 20 msec (opt(fast)), or 60 msec (opt(slow)).
- Density of static and dynamic/optic flow stimuli was matched via method of adjustment. Subject EA adjusted the density of a static random dot pattern to match the perceived density of a simultaneously shown dynamic random dot pattern, for each dynamic density value used.

Task:
- 2 interval, 2 alternative forced choice detection. Subjects discriminated an interval containing a SGP, DGP, or OPF from a second interval containing the same numbers of paired and unpaired dots, but with the orientations of the paired dots randomized. We varied the proportion of total dots that were paired - the coherence - to determine noise threshold for detection, and take sensitivity as the inverse of coherence at threshold.
- Stimulus type (rotation, translation; static, dynamic, optic flow), spatial and temporal separation of signal dots, and dot density were varied between blocks of trials.
- 1 subjects were naïve (EP) and 2 were non-naive MF, EA).

Example Stimuli:

Static Glass Patterns:
See right.

Dynamic Glass Patterns:
Independent static Glass patterns shown sequentially at 100 Hz.

Optic Flow Patterns:
Same as dynamic Glass patterns except with a temporal as well as a spatial separation between paired signal dots.

Results: Noise Sensitivities for Detection:

Conclusion:
There is no effect of dot density on noise sensitivity for detection for any of the patterns (rotation and translation) or types of stimuli (static dynamic, and optic flow) that we tested. Therefore, detection of these stimuli depends on signal-to-noise ratio only, and not on the number of signal dot pairs.

References:

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