A COMPARISON OF HUMAN AND IDEAL PERFORMANCE FOR THE DETECTION OF VISUAL PATTERN

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ABSTRACT

Human performance was compared with ideal performance for the detection of visual patterns in the presence and absence of dynamic visual noise in four experiments.

1) Contrast thresholds for Gaussian enveloped sinusoidal gratings were measured as a function of spatial extent in the presence and absence of noise. To a first approximation, spatial summation in noise, for a given spatial frequency, can be described by the cross-correlation of the stimulus with a template matched to the pattern "seen best" for that frequency, a grating about a cycle wide. These results are contrasted with spatial summation for the same patterns in the absence of noise, where a simple cross-correlation model does not work.

2) Contrast thresholds were measured for spatially narrowly windowed 2 and 6 c/deg gratings presented alone and superimposed. If one allows for differences in relative sensitivity, detection performance is determined by contrast energy.

3) Four lines of converging evidence were provided which suggest that phase information becomes increasingly relevant to detection as the noise level is raised and when the spatial and temporal frequencies (drift rate) are lowered.

4) The signals to be detected were visual noise. Contrast thresholds for noise signals grow with the fourth root of bandwidth both in noise and in the absence of noise for bandwidths greater than 1 or 2 octaves for the human observers and the ideal observer. The efficiency for detection in noise was uniformly high (30-69%) for bandwidths from 2 to 6 octaves. The implication is that for noise signals, the strategy is "ideal like", i.e. the bandwidth monitored by the observer appears to match the signal bandwidth to at least 6 octaves.

In summary, efficiency can be quite high in noise for deterministic signals which may match "receptive field" profiles. Efficiency is also quite high for stochastic or noise signals superimposed on a noise background. This indicates highly flexible detection strategies resembling on the one hand cross-correlation and on the other "energy detection". In contrast to detection in noise, detection strategy against a uniform field seems to be relatively inflexible.

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