When four, six, eight, or sixteen hearts beat as one: Effects of perceptual organization on search for temporal frequency outliers

Todd S. Horowitz, Ashley M. Sherman, Erica Kreindel, & Jeremy M. Wolfe

Suppose a radiologist is searching for rhythmic abnormalities in images of a beating heart. The heart is a complex spatiotemporal object. Different points move in different phases and, potentially, different frequencies. Is it easier to find an anomaly as part of a coherent structure or as one of several independently oscillating points?

Observers searched for targets differing from distractors in temporal frequency. Stimuli were 4, 6, 8, or 16 dots oscillating in alternating phase. Four experiments examined a range of target frequencies, both lower (0.125 Hz, 0.25 Hz, 0.5 Hz) and higher (2.0 Hz, 4.0 Hz) than the distractor frequency (1 Hz). In the baseline, *grid,* condition, dots were randomly positioned on 4 x 4 grids. In the *spline* condition, dots connected by splines to form a single, pulsating object – a deformable circle. The *radial* condition omitted the splines but preserved the deformable circular configuration.

Mean reaction times (RTs) depended on target-distractor similarity. RT x set size slopes declined as target frequency rose. Thus, in the grid condition, search for 0.25 Hz targets among 1 Hz distractors produced inefficient slopes >25 ms/item, while search for 4.0 Hz targets among 1 Hz distractors produced slopes in the "pop-out" range, ~0 ms/item.

Critically, slopes were modulated by perceptual organization. In the spline condition, search for low frequency targets became more efficient, and search for high frequency targets became less efficient. Radial condition performance lay between the grid and spline conditions, but closer to the grid condition, suggesting that linking the dots by a single contour was more important than organizing them into a circle.

As a practical matter, these results suggest that the ability to visualize relative object motion in several ways might be valuable to clinicians looking for rhythmic anomalies.

295 words