Title: Visual sensitivity to achromatic gradients with different luminance profiles

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Gradients (smooth spatial variations in luminance and/or chromaticity) are all around us as shading or other illumination phenomena. They provide cues to light-source positions, object shape and the spatial layout of scenes. However, not much is known about how the visual system processes gradients. We measured detection and discrimination thresholds for horizontal achromatic gradients.

The gradient stimuli had a fixed size (4˚). Its horizontal luminance profile was either linear or sinusoidal and was generated such that its mean luminance was constant and equiluminous with the surround (56 cd/m^2). Only its contrast varied from trial to trial. We used a temporal 2-AFC with a QUEST procedure to determine contrast thresholds for four observers in detection and discrimination experiments.

In the detection experiment, the background was either uniform (UB) or non-uniform (NUB; mosaic-squares of different luminance). Detection thresholds for gradients against UB and those for a step stimulus of a control study (against UB or NUB) were all identical. However, detection thresholds for gradients against NUB were on average 4 times higher, indicating that NUB effectively disrupts the edge cue at the boundaries of the gradients. Thresholds for sinusoidal gradients were significantly lower than for linear gradients.

In the discrimination experiment, two conditions were tested using only NUB; observers indicated which interval contained a gradient that was stronger (or weaker) than a reference gradient of fixed contrast. Observers performed better in the stronger condition by an average factor of 2. For this condition, thresholds for sinusoidal compared to linear gradients were lower by a factor of 2.

The differences in thresholds found between sinusoidal and linear gradients suggest that the visual system uses the information within the gradient for detecting or discriminating it. The asymmetry found between discrimination conditions implies that increments and decrements might be processed differently.