Identifying static versus kinetic stimuli at threshold and suprathreshold eccentricities

In equating the static and kinetic tasks in Experiment 2, the stimuli may have also inadvertently become equated, i.e. that detection might not have matter whether it was static or kinetic. If the stimuli were inadvertently equated, then the results of Experiment 2 would not represent a comparison of static and kinetic perimetry tasks, but rather that solely of contrast detection. Therefore, we conducted an additional experiment to determine if observers could identify whether or not the stimulus was static or kinetic. We determined whether or not the same subjects from Experiment 2 were able to correctly identify the stimulus as being static or moving. Performance in this task was measured at three eccentric locations: at threshold eccentricity, at a suprathreshold eccentric location, and at a location in between. A prediction is that as the stimulus is presented closer to the threshold eccentric location the proportion of times correctly identified as static or kinetic would decrease.

Observers, Stimulus and Procedure

The same observers (n=6) and apparatus (iMac 27” monitor) as in Experiment 2 were used for Experiment 3. This time, a single-interval three-alternative forced choice (3AFC) procedure was used to determine if the observer could tell whether the stimulus was static, moving inward or moving outward. Stimuli were the same as those used in Experiment 2 (0.23 degrees in diameter, at fixed contrast for each observer as per Figures 7 and 8, presented upon a white-gray background of constant luminance, 10 cd.m⁻²), as was the fixation mark.

Observers were instructed to maintain fixation on the central fixation mark. After 3 seconds, the trials began: a stimulus appeared at the test location for 200 ms, followed by a beep, after which the observer had to indicate with a keyboard press whether the stimulus was static, moving inward or
moving outward (Supplementary Figure 1). Each block of trials consisted of 10 presentations of each stimulus condition (static, inward or outward moving), shown in random order. Each observer repeated each block three times, and the proportion of times the stimulus characteristic was identified correctly was recorded. The stimuli were presented at three possible locations nasally: 23° away from the fovea (at the approximate eccentricity threshold), 20° (3 degrees closer to fovea) and 17° (6 degrees closer to fovea, i.e. a suprathreshold location).

The proportion correct was averaged across each subject. A proportion of 0.33 was considered chance performance for the 3AFC procedure. The proportions for each condition were compared using a logit transform, followed by a one-way ANOVA, carried out using GraphPad Prism Version 6 (La Jolla, California, USA), with a $p<0.05$ considered significant (Warton & Hui, 2011). A logit transform was used instead of arcsine, as it maps proportions between 0 and 1 better, since the sine function’s periodicity alters the relationship between the transformed and the untransformed proportions. One limitation of the logit transform is that it transforms proportions of 0 and 1 to undefined values ($-\infty$ and $+\infty$, respectively). We applied a small $\varepsilon$ correction factor to such proportions, as per the recommendations of Warton & Hui (2011).

Results and Discussion

Average proportions of correct identification for each stimulus presentation location showed that performance was well above chance level (0.33) across all participants (one-sample t-test average $p$-value = 0.0023) (Supplementary Figure 2). Incorrect responses were random, i.e. no tendency for any response to occur more than another for each condition. Notably, identification of outward moving stimuli was worse than static and inward moving stimuli at all test eccentricities, but this did not reach statistical significance ($p>0.05$). Two-way ANOVA showed a significant effect of eccentricity upon proportions of correct identification ($F(2,162)=24.35$, $p<0.0001$). Proportions of correct identification were significantly higher at the 6 degree closer to the fovea condition...
compared to at eccentricity threshold for static ($p=0.0005$), inward moving ($p=0.0009$) and outward moving ($p<0.0001$) stimuli. There were also significant differences between 3 and 6 degree conditions when using inward moving ($p=0.0099$) and outward moving ($p=0.0250$) stimuli.

Although there was a tendency for a slightly worse performance with the outward moving stimulus, there was no significant effect of stimulus characteristic ($F(2,162)=1.622$, $p=0.2008$).

We hypothesize that the relatively poorer performance with outward moving stimuli may be due to the reduction in certainty, as it moves from a region of seeing to a region of non-seeing, particularly at the eccentricity threshold presentation location. Although the performance for each subject was still well above chance level, this may also explain why there may be a slight bias for a more “nasal” eccentricity threshold found when using a kinetic outward moving target in the nasal meridian in Experiment 2. In comparison, an inward moving stimulus moves closer to an area of seeing and greater sensitivity. Similarly, a static stimulus has the same energy distributed within a single area. Hence, their proportions correct were higher than that of an outward moving stimulus.

Nonetheless, the results of Experiment 3 suggest that the static and kinetic stimuli are perceived subjectively differently, and that the brief stimulus presentation of 200 ms has not equated the stimuli. Temporal integration has been shown to occur up to approximately 100 ms, though this is also dependent upon parameters such as stimulus velocity and background luminance (Barlow, 1958; Snowden & Braddick, 1991). It has also been shown that the direction of motion could be discerned for brief stimuli (~250 ms) travelling distances as short as 1 degree (Westheimer & Wehrhahn, 1994). Thus, whilst the psychophysical procedure has been equated in Experiment 2, the stimuli are still perceived sufficiently differently to compare static and kinetic tasks.
Phu et al 2016 Concordance of static and kinetic perimetry

References:


