Can saccades be selected by separate foci of attention in the two hemispheres?

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INTRODUCTION

It is widely held that the targets of saccades are typically selected by a winner-take-all mechanism in which neural activity in some brain map (perhaps the superior colliculus or frontal eye fields) converges on one location having maximal activity and inhibiting other sites.

In humans, there is some evidence that attention can be split between two locations; this splitting may be more evident between locations in the right and left hemifields than between two locations in the same hemifield (Sereno & Kosslyn, 1991; Awh & Pashler, 2000; Mueller et al., 2003; McMains & Somers, 2004).

We asked whether saccadic reaction times showed evidence of separate foci of attention. To do this, we chose three pairs of stimuli, in each of which a change would be especially evident if one had been attending to the stimulus at the time of the change (that is, one could not use an instantaneous “snapshot” to assess which of the pair had changed). This was either because the change was intrinsically in the temporal domain (Experiments 1 & 2) or because the stimuli were moving and were obscured by temporal noise, although the change was spatial (Experiment 3).

METHODS

In the three experiments, subjects were instructed to make a saccade to the patch that changed, as soon as the change was noticed. Correct trials were signaled by an auditory tone. Incorrect trials were discarded from subsequent analysis.

Eye movements were recorded using an infrared video system (ISCAN, 240 Hz); saccades were detected on-line based on eye velocity. 192 trials were recorded in each experimental condition.

In the Horizontal trials two identical stimulus patches were displayed 4 degrees below a fixation point for 1000 to 1000 ms, after which one of the patches changed to the second stimulus for the remainder of the trial.

Experiment 1: the patches were 5-deg rotating colored gratings, which changed from smooth rotation to rotation in 16 equal-angle steps.

Experiment 2: the patches were 4-deg fields of dots moving randomly, in which the lifetime of each dot changed from 50 msec to 500 msec.

Experiment 3: the patches were 1-deg rotating vanes divided in segments (6 or 8), in which the number of segments changed (from 6 to 8 or from 8 to 6). The patches were embedded in a field of randomly moving dots.

RESULTS

Saccade latencies were shorter when attended locations were in opposite hemifields than when they were in the same hemifield.

CONCLUSIONS

1. On average, saccade latencies were >100 ms longer when the attended objects were placed in the same visual hemifield than when they were in different hemifields.

2. The 100 msec latency difference is comparable to the time to shift attention from one spot to another (as assessed, for example, by the Illusory Line Motion). It is tempting to infer that in our Vertical stimulus arrangement, spatial attention needs to shift, but in our Horizontal task it may not need to.

3. If attention cannot be split within one hemifield, one might expect some latencies in the Vertical trials to be short, if attention happened to be on the stimulus that changed, and others long, if attention needed to shift to the other stimulus. However, the lack of a bimodal distribution to the Vertical trials argues against this interpretation, although the temporal randomness of the stimuli might have obscured the details of the latency distribution.

4. We conjecture that this oculomotor task may assess attentional allocation in the superior colliculi (or FEF), which may enjoy greater hemispheric independence than is the case for perceptual attention, which may be mediated by brain structures that are more tightly linked across the hemispheres, giving rise to our subjective impression of the unity of attention.

REFERENCES


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References: