How Does Object Structure Influence Saccade Targeting within An Object?

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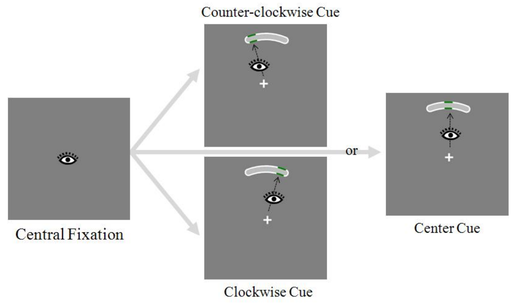
Introduction

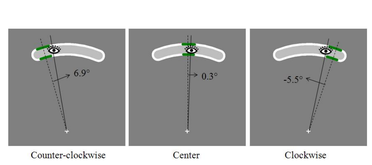
How is attention distributed within a spatially extended object? Some evidence suggests, with multiple seconds of viewing, attention comes to be peaked at the center of an object, even when the end of this object is cued (Alvarez & Scholl, 2005; Doran et al., 2009). In addition, eye movements to objects often land at the center of the object (the center of gravity effect, e.g., Denisova, et al., 2006; Kowler & Blaser, 1995; Melcher & Kowler, 1995; Vishwanath & Kowler, 2003), consistent with the idea that covert attention (prior to the saccade) comes to be concentrated at the center of the object. In the latter case, however, center of gravity effects have been observed for goal-directed saccades at relatively long latencies, thus, they might not reflect the automatic spread of attention through an object (Hollingworth et al., in press). In the present study, we examined the extent to which rapidly-generated saccades to a part of an object are biased toward the center of the object.

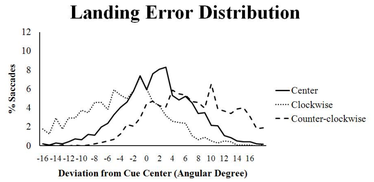
Methods

As observers maintained the central fixation, a spatially extended object appeared at a random position on an imaginary circle. One section of the object was cued (center, clockwise end, or counter-clockwise end) by green contour. The center of the end cue was +/-17° from the object center. The observers were instructed to execute a saccade to the cued region of the object as quickly and accurately as possible. The landing position of the primary saccade was recorded. A landing position bias toward the center of the object was expected.



Experiment 1: Spatially Extended Object





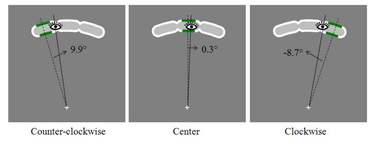
The landing positions of saccades to end cues were significantly biased toward the center of the object.

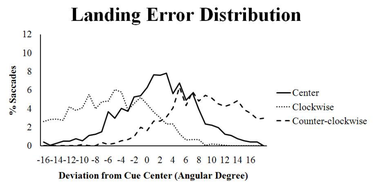
Experiment 2: Part Boundary Cues

In Experiment 2, we examined how part boundary cues that segment a single object into multiple parts influence the center bias observed in Experiment 1.

If part boundaries constrain the spread of attention within the object, then the spread toward the center of the object may be limited, reducing the size of the center bias observed in Experiment 1.

However, if part boundaries generate greater competitions to select the cued segment (e.g., by creating additional discrete peaks of activation corresponding to object parts), then the center bias may be increased.

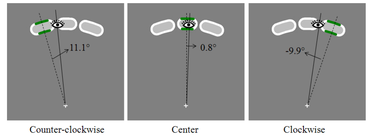


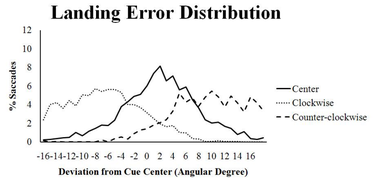


The magnitude of the center bias significantly increased relative to Experiment 1.

Experiment 3: Separate Objects

As a stronger manipulation of object structure, part separation was completed, resulting in three discrete objects.





A numerically larger center bias was observed in Experiment 3 than in Experiment 2; however, this difference did not reach statistical significance.

Discussions

Saccade landing position is biased toward the center of an object or group of objects, even for saccades that are generated rapidly to a localized cue.

The center bias grows larger as a spatially extended object is segmented into multiple parts. These results suggest that changes in object structure produce greater competitions while selecting a part of an individual object.

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