The representation of the saccade target object depends on visual stability

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The representation of the saccade target object depends on visual stability

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During everyday scene viewing, the human visual system faces many challenges. The most frequent disruption of the visual input occurs during saccadic eye movements. Every time we execute a saccade, the perceptual input is disrupted by both saccadic suppression and shifts of objects’ retinal locations. Despite these
frequent changes, the visual system is quite efficient at representing a stable visual world (i.e., establishing visual stability). We have previously proposed that transsaccadic integration depends on an object-mediated updating (OMU) process (Tas, Moore, & Hollingworth, 2012). According to this view, the representation of the saccade target object depends on visual stability. Specifically, if stability is established, the postsaccadic object is perceived as the continuation of the presaccadic object. In this case, the properties of the presaccadic object are overwritten by the postsaccadic properties. In contrast, when visual stability is disrupted, the pre- and postsaccadic objects are represented as separate objects. Therefore, the properties of the presaccadic object are protected from overwriting.

In the present study, we tested this assumption directly. Specifically, we asked whether visual stability modulates the availability of the presaccadic object’s features for report.

**PRESENT STUDY**

In all experiments, a coloured saccade target was presented either at the left or right side of fixation (Figure 1A). Participants were instructed to execute a saccade to the target object. Visual stability was manipulated with the intrasaccadic target blanking method (Deubel, Schneider, & Bridgeman, 1996). Specifically, on half of the trials (blank condition), visual stability was disrupted by deleting the saccade target for 250 ms after the initiation of the saccade. On the remaining trials (no-blank condition), the saccade target stayed on the screen throughout the trial. In addition to the visual stability manipulation, on some trials the colour of the saccade target was also changed to a new value.

To ensure that visual stability was only influenced by the object’s spatiotemporal properties (i.e., blanking), we ran pilot experiments to determine the largest magnitude of colour change which would not disrupt visual stability. In separate experiments, the colour of the postsaccadic object was changed 30°, 45°, or 75° (Experiments 1, 2, and 3, respectively), either clockwise or counterclockwise in colour space. After completion of the saccade, participants were presented with a colour wheel and asked to report the colour of either the pre- or postsaccadic object by selecting the appropriate colour from the colour wheel.

If the properties of the presaccadic object are overwritten by the postsaccadic properties when visual stability is established, as suggested by the OMU account, participants should have difficulty accessing the presaccadic object’s colour in the no-blank condition. Specifically, participants should be more likely to incorrectly report the postsaccadic colour when asked to report presaccadic colour. However, there should be separate representations for pre- and postsaccadic objects when visual stability is disrupted. Therefore, we expected to find accurate colour reports for both pre- and postsaccadic objects in the blank condition.
Figure 1. (A) Sequence of events in no-blank (top) and blank (bottom) trials of Experiment 2 (45° of colour change). (B) Proportion of colour reports as a function of colour value in no-blank (top) and blank (bottom) trials of 30°, 45°, and 75° colour change experiments. To view this figure in colour, please see the online issue of the Journal.

RESULTS

Figure 1B shows the proportion of colour responses as a function of colour values, separately for blank and no-blank conditions of each experiment. We fitted participants’ colour response distributions in the colour change trials with probabilistic mixture models (Bays, Catalao, & Hussain, 2009; Golomb, L’Heureux, & Kanwisher, 2014). To test whether the presaccadic colour was
overwritten by the postsaccadic colour under visual stability, we first calculated
the probabilities of reporting the target colour (Pt), the distractor colour (Pd), or a
random colour (Pr). We ran 2 (stability: no-blank, blank) × 2 (report: presaccadic,
postsaccadic) ANOVAs separately for Pt and Pd measures. In all three
experiments, the main effect of stability, the main effect of report, and the
interaction were significant for both Pt and Pd measures (ps < .001). Pairwise
comparisons showed that the probability of reporting a distractor was higher in
the no-blank than in the blank condition for trials in which participants were asked
to report the presaccadic colour (ps < .04). No significant difference was found for
postsaccadic colour reports.

As converging evidence, we tested whether response distributions were better
fit by a bimodal distribution than a unimodal distribution in the no-blank and
blank conditions. To achieve this, we ran two separate models (unimodal vs.
bimodal), separately for each of the four conditions. Comparisons between the
models’ AIC values showed that, in the no-blank condition, the distribution for
presaccadic reports (green lines in Figure 1B) was better fit by a bimodal
distribution than a unimodal distribution (p < .001). The fits for the remaining
three conditions were better for the unimodal than the bimodal distribution.
Together, these results support our prediction that the presaccadic colour was
overwritten by the postsaccadic colour when visual stability was established
compared to when stability was disrupted. Next, we tested whether the
representation of the reported colour was affected by the distractor colour for
trials where participants successfully reported the presaccadic colour. We ran
separate models for each condition with the mean of the main distributions
as free parameters. For both 45° and 75° of colour changes, reports were
significantly shifted towards the distractor values, regardless of visual stability
(no-blank or blank) and the reported object (pre- or postsaccadic) (ps < .01).

DISCUSSION

The present study tested the role of visual stability in the representation of the
saccade target object. Consistent with the OMU account, we found that, when
visual stability is established, the initial properties of the saccade target object are
overwritten by the properties of the postsaccadic properties. In contrast, when
visual stability is disrupted by spatiotemporal discontinuity, the pre- and
postsaccadic objects are treated as separate objects, and both of their properties
can be retained and successfully reported. We have also found preliminary
evidence that pre- and postsaccadic features may also interact in a more dynamic
way: Colour reports were shifted towards the nonreported value even when
visual stability was disrupted.
Working memory capacity predicts workload capacity

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Working memory (WM) refers to aspects of online cognition, such as monitoring, processing, and maintenance of information. Since Baddeley and Hitch (1974) first published a chapter on WM, many theories have been proposed. One of the most widely supported theories is the controlled attention theory of WM (Engle & Kane, 2004). The theory suggests that individuals with high working memory capacity (WMC) may have better control of attention in integrating information from different domain-specific subsystems.

Around the same time, another capacity measure, workload capacity (WLC), has been developed (Townsend & Ashby, 1978; Wenger & Gibson, 2004). A system’s WLC measures the efficiency of processing as workload (i.e., the number of channels operating) increases. If the processing rate of an individual channel does not change as the number of signals increases, the system is described as unlimited-capacity processing. If the channel processing slows...