Transsaccadic updating: Evidence for overwriting of color information

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Introduction

How is the pre-saccadic information updated with the post-saccadic information after the saccade?

As we make saccadic eye movements, the representation of the saccade target is shifted from our peripheral vision to foveal vision. While some studies have found that we integrate the pre-saccadic and post-saccadic representations,[1] we have recently provided evidence that the pre-saccadic information is overwritten by post-saccadic information, especially when visual stability is established.[2] In our previous study, we used maximum likelihood estimates to test the overwriting hypothesis (i.e., whether participants were more likely to report the post-saccadic color when asked to report the pre-saccadic color) and the feature integration hypothesis (i.e., whether participants reported a color which is between the pre- and the post-saccadic colors). Our results supported the overwriting hypothesis. An alternative way to test integration is to use the cue integration method where performance in the transsaccadic condition is compared against performance in the peripheral and foveal alone conditions.[3] To implement this, we modified our previous design and added two more blocks in which participants only saw the pre-saccadic color or the post-saccadic color.

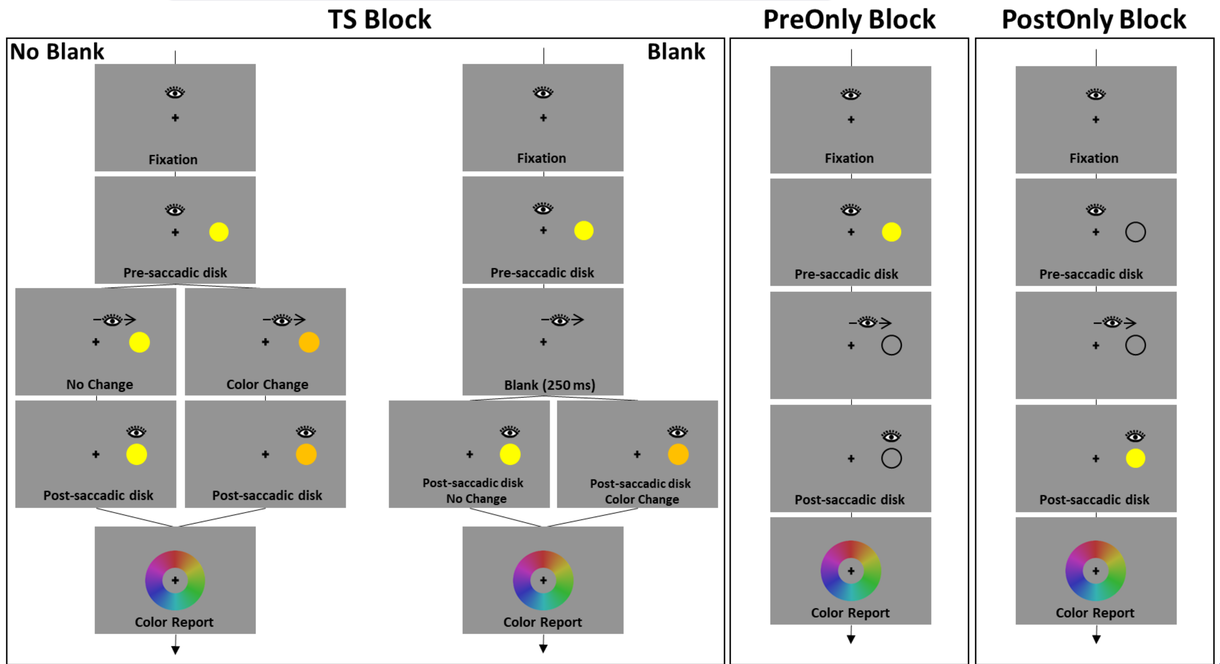
Methods

Task: To report the color of the object on a color wheel (without specifying which state – pre- or post-saccadic)

3 Blocks:
Transsaccadic (TS), PreOnly, PostOnly

TS Block:
- The saccade target remained on the screen throughout the trial.
- The color of the object was changed by 15° on half of the trials.
- Object continuity was manipulated by blanking on half of the trials.

PreOnly & PostOnly Blocks:
- The same colors on the No Change trials from the TS block were used in PreOnly and PostOnly blocks.
- In the PreOnly block, the target was presented only pre-saccadically.
- In the PostOnly block, it was presented post-saccadically.
- The order of these last two blocks was randomized.



Analyses

We used two tests of integration:

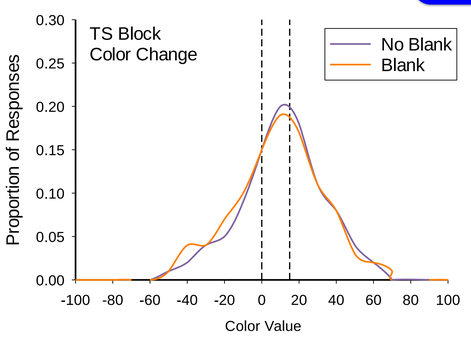
Feature Integration

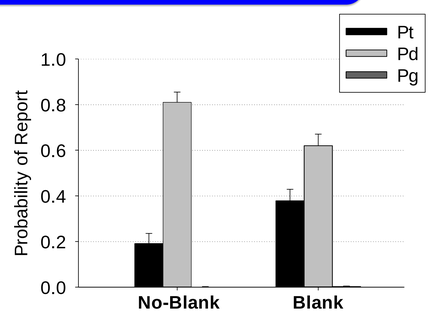
- Color response distributions in the Color Change trials of the TS block were fit with probabilistic mixture models.[4]
- We compared two models:
  1. Single Gaussian model with the mean, SD, and probability of guessing (p_g) were free parameters.
  2. Dual Gaussian model with means fixed at 0° (target value) and 15° (distractor value), but the SD, p_g, and probability of reporting the distractor value (p_d) were free parameters.
- If the pre- and post-saccadic features were **integrated** into a single representation, Single Gaussian model should result in better fits.
- If, pre-saccadic color was **overwritten** by the post-saccadic color, Dual Gaussian model should result in better fits with a substantial proportion of the reports coming from the post-color.

Cue Integration

- Color response distributions in the No Change/No Blank trials of the TS block, PreOnly trials, and PostOnly trials were fit with a probabilistic mixture model.[4]
- We compared the SD of the TS block with the best single performance (PreOnly or PostOnly).[5]
- According to cue integration, if the pre- and post-saccadic colors were integrated, then performance in the TS block should be significantly better than the best of the single blocks.

Feature Integration

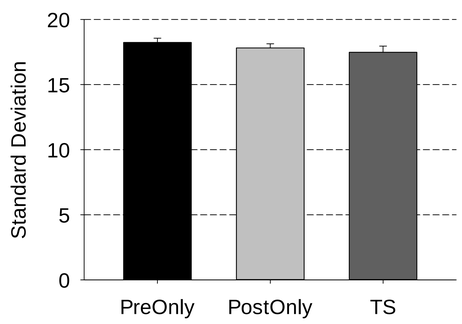




We calculated Bayes Factor (BF) to test which model explains the data better.
- For the No Blank condition, the Dual Gaussian model was superior compared to Single Gaussian model, supporting the overwriting hypothesis.
- The probability analyses revealed that the pre-saccadic color was overwritten by the post-saccadic color on 80% of the trials.

	Single Gaussian (Model 1)					Dual Gaussian (Model 2)					Model Comparison	
Condition	μ	SD	p_g	p_t	BIC	SD	p_d	p_g	p_t	BIC	ΔBIC	BF_{21}
No Blank	12.55	21.97	0.001	1.00	635.74	21.35	0.81	0.001	0.19	630.53	5.21	13.55
Blank	9.28	22.86	0.003	1.00	630.37	21.86	0.62	0.003	0.38	635.71	-5.34	0.07

Cue Integration



We found no evidence of optimal cue integration:

The standard deviations of the best of the PreOnly and PostOnly trials (M = 17.57) and the TS trials (M = 17.48) were not significantly different $t(16) = 0.19$, $p = .847$.

Summary

- The pre- and post-saccadic features are not merged into a single representation – **No feature integration**
- Color reports were not significantly better when the colors were presented transsaccadically, compared to either pre-saccadically or post-saccadically – **No cue integration**
- Color reports were better fit by a Dual Gaussian than a Single Gaussian model for No Blank condition. On majority of trials, pre-saccadic color was overwritten by the post-saccadic color – **Overwriting**

References

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3. Wolf, C. & Schütz, A. C. (2015). Trans-saccadic integration of peripheral and foveal feature information is close to optimal. *Journal of Vision, 15*(16):1.
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