

# New Paradigm: Brenner Color Illusion

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## Contents

<b>1</b>	<b>Experiment Description</b>	<b>2</b>
1.1	Experiment Flow . . . . .	3
1.2	Hypothesis . . . . .	3
<b>2</b>	<b>Pilot 1: Assimilation</b>	<b>4</b>
<b>3</b>	<b>Pilot 2: Green Vertical Grating Stabilized in Each Direction</b>	<b>5</b>
<b>4</b>	<b>Experiment: Green and red gratings alternating direction; half stabilized</b>	<b>7</b>
4.1	Prediction . . . . .	7
4.2	Data . . . . .	7
4.3	Experiment Results . . . . .	7
<b>5</b>	<b>Updates</b>	<b>8</b>

## 1 Experiment Description

This experiment investigates the effect of retinal stabilization on the perception of colors. We plan to test whether color perception can be induced by stabilizing the stimulus in either the horizontal or vertical direction (corresponding to either green/red grating). The green/red gratings cause color assimilation which affects the percept of the grey background to tend toward green or red. By stabilizing the stimulus in one direction, small eye movements no longer cross over the grating which we predict will have less of an assimilation effect. Evidence of this would indicate that temporal modulations play an important role in color perception.

See example of stimulus (Figure 1). When presented with the stimulus, the subjects had to report whether the grey background, the color which varied from trial to trial, appeared more red or more green.

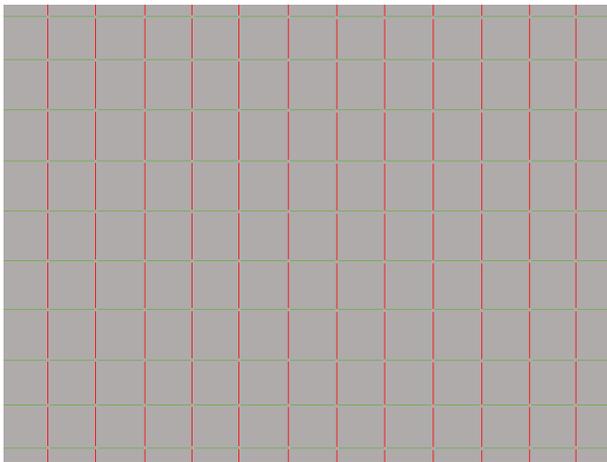


Figure 1: Example of stimulus. Central gray background with green horizontal lines and red vertical lines across. Grating is 1 pixel in width with a spacing of 15 pixels. The overall stimulus size is 200x200 pixels.

During each trial, the stimulus will be stabilized on the retina either horizontally or vertically. Stabilizing the stimulus horizontally will prevent small jitters of the retina across the vertical grating (in the case of the figure above: the red lines). Red assimilation will therefore be absent while green assimilation will occur.

## 1.1 Experiment Flow

- Recalibration every 10 trials
- A fixation of 500s every few trials
- 1 s ramp increased the contrast of the stimulus linearly until fully presented
- 1 s stimulus display, after which the subject indicated whether the central patch was more red or more green
- The color of the central patch changed randomly from trial to trial from a discrete set of colors tending toward red or green
- The horizontal and vertical gratings changed randomly from red to green, where each color simultaneously corresponds to one grating.

## 1.2 Hypothesis

Color induction is primarily caused by temporal modulations in the position of the image on the retina. Temporally varying stimulation of receptors, produced by small eye movements that jitter the retina across the edge, produce an assimilation effect. Without the varying stimulation, this effect no longer occurs.

In red-direction stabilized cases, which prevents jittering across the edge of the green grating but allows jittering across the red grating, would produce a red percept due to color assimilation. Therefore, red-direction stabilization cases would produce more red responses and more green-direction stabilization cases would produce more green responses.

## 2 Pilot 1: Assimilation

A pilot has been run to test whether the assimilation effect occurs. No eye movement data was collected and there was no stabilization in the experiment. In this pilot, we presented only the vertical line which altered from green to red. The subject was instructed to determine whether the grey background tending toward red or green. Six discrete grey values were presented that were closer to green or red values. The predicted results are below:

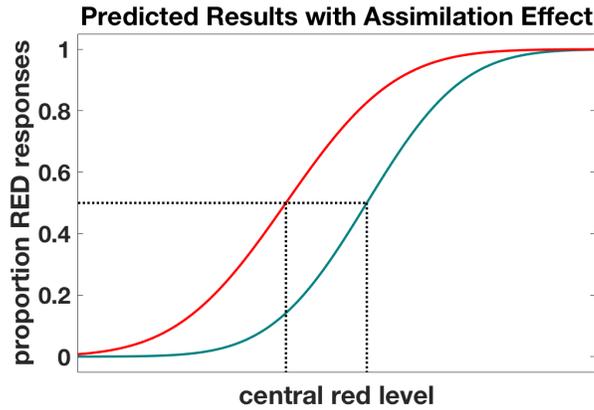


Figure 2: The predicted results showing an assimilation effect. Stabilization in the red-grating direction (trials represented by red line) results in eye jitters only across the red line which would give a redder percept. Stabilization in the green-grating direction (trials represented by green line) allows jitters only across the green line resulting greener percept.

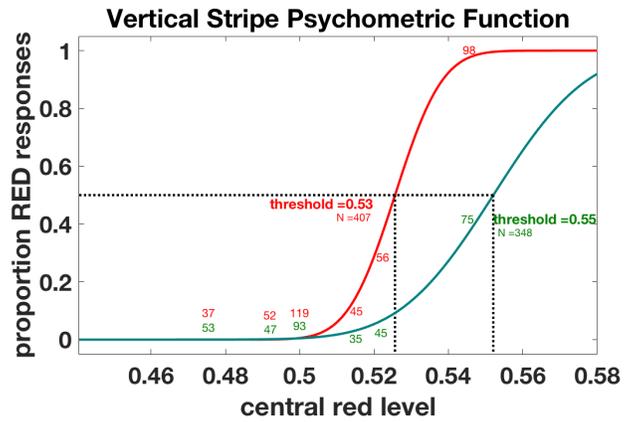
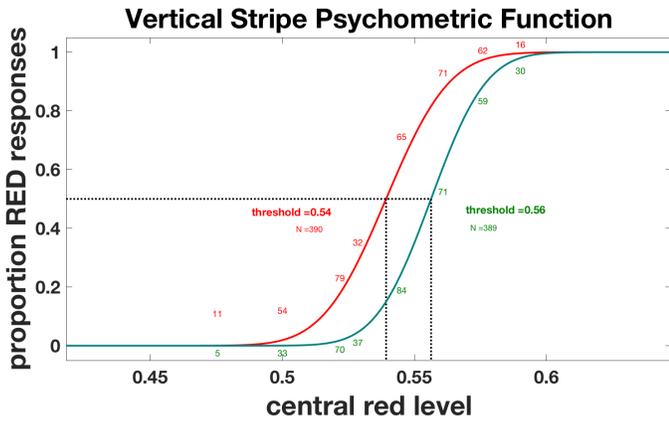


Figure 3: The results for GI (left) and RA (right) show an assimilation effect. The trials where the green grating appears are represented by the green function. The trials where the red grating appears are shown as the red function.

### 3 Pilot 2: Green Vertical Grating Stabilized in Each Direction

Experiment was run with only green vertical grating to eliminate any other factors posed by the red grating. No significant results were found yet.

Number of Trials	GI
Total Trials	1631
Invalid	109
Saccade	309
Microsaccade	851
Drift	362

Reminder of Expected Results: We expect that the horizontal stabilization (brown line) will have a higher threshold than the vertical stabilization (green line). Note: Black line (baseline condition) should correspond to the green line because eye movements across the green grating occur.

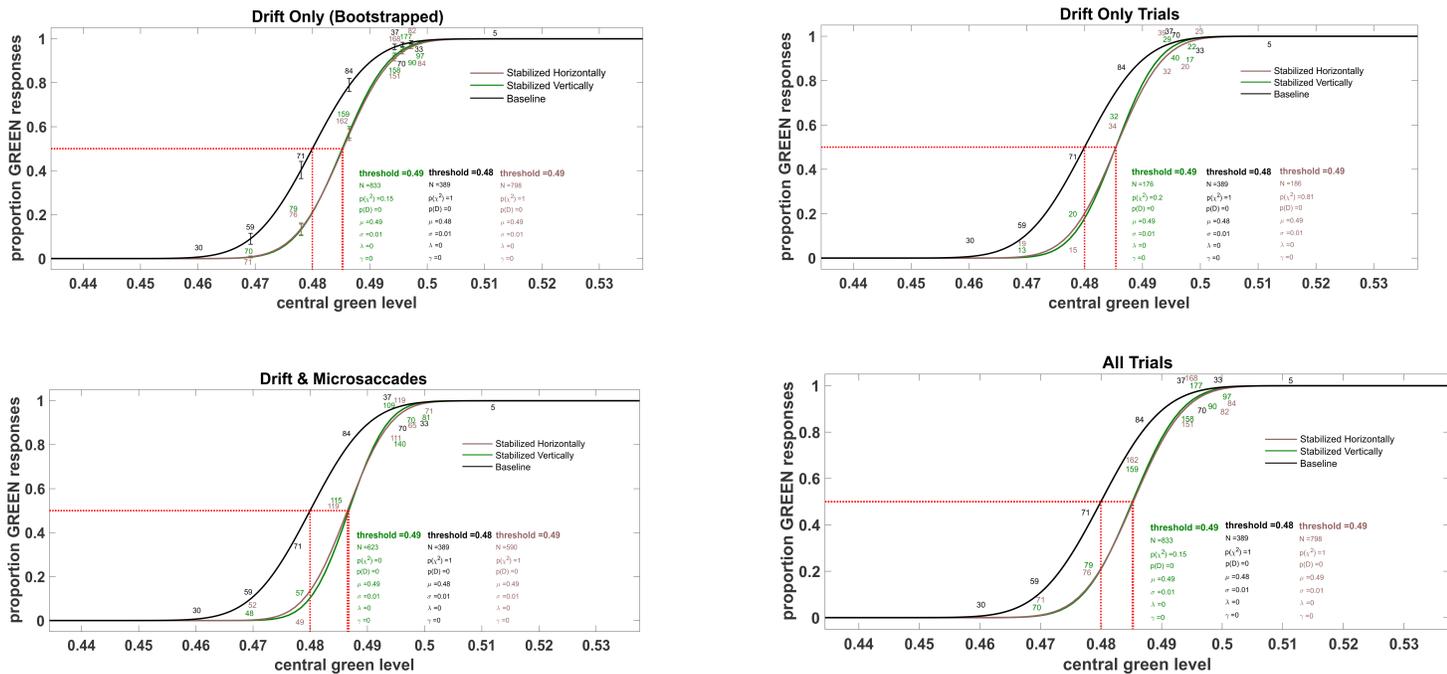


Figure 4: Results of subject GI tested on horizontal vs. vertical stabilized green grating only. The black line represents the baseline condition that was collected for the green gratings with no stabilization. The brown line represents the condition that is stabilized horizontally. The green line represents the condition that is stabilized vertically (that we predict to be a greener percept i.e. lower threshold). Note that the values for the baseline (assimilation testing) were a different range.

## Bootstrapped means and standard errors

	<u>mean1</u>	<u>error1</u>	<u>mean2</u>	<u>error2</u>	<u>mean3</u>	<u>error3</u>
<b>0.3943</b>	0	0	0	0	0	0
<b>0.3954</b>	0	0	0	0	0	0
<b>0.4692</b>	0.007	0.004	0.008	0.004	0.09	0.025
<b>0.4780</b>	0.131	0.026	0.135	0.027	0.403	0.039
<b>0.4864</b>	0.574	0.027	0.564	0.027	0.79	0.03
<b>0.4943</b>	0.923	0.012	0.912	0.013	0.963	0.013
<b>0.4957</b>	0.95	0.009	0.941	0.01	0.974	0.01
<b>0.4972</b>	0.97	0.007	0.963	0.008	0.984	0.007
<b>0.4986</b>	0.982	0.005	0.977	0.006	0.989	0.005

Table: mean1 and error1 refer to green line (the vertically stabilized). mean2 and error2 are of brown line (horizontally stabilized). mean3 and error3 are of black line (baseline).

**Extra note:** subject stated that all colors seem green and that the task is very difficult.

## 4 Experiment: Green and red gratings alternating direction; half stabilized

In the experiment, both vertical and horizontal lines were presented and the stimulus was stabilized in one direction (corresponding to either the red or green grating). The subject was instructed to determine whether the grey background tends toward red or green. Six discrete grey values were presented that were closer to green or red values. Expected results are below:

### 4.1 Prediction

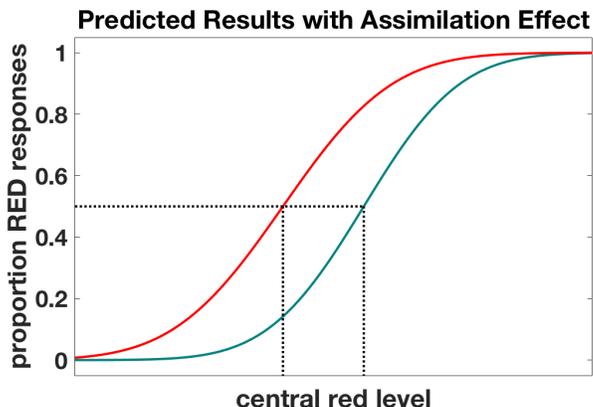


Figure 5: The predicted results showing a difference between red-direction stabilized and green-direction stabilized trials. Stabilization in the red-grating direction would give a redder percept. Stabilization in the green-grating direction results in a greener percept.

### 4.2 Data

The experiment has been run on subject GI and RA who has been tested for the assimilation effect prior to data collection.

Number of Trials	GI	RA
Total Trials	680	399
Invalid	68	31
Saccade	91	200
Microsaccade	438	154
Drift	83	14

### 4.3 Experiment Results

The data show no effect so far. The trials where the stimulus is stabilized in the green direction is represented by the green function. The trials where the stimulus is stabilized in the red direction is represented by the red function

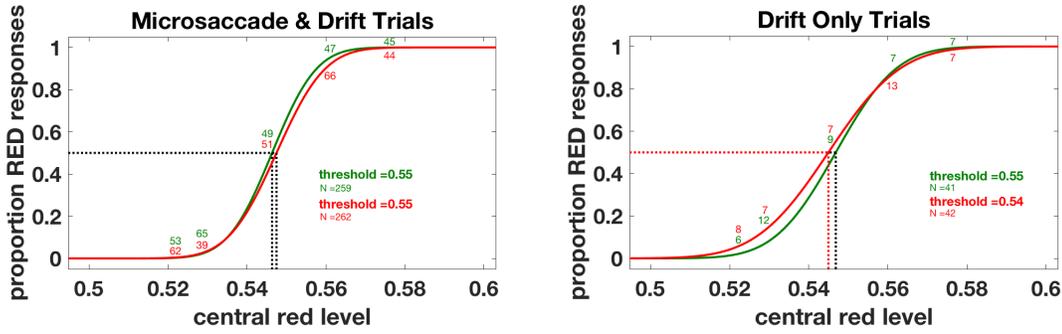


Figure 6: Results of subject GI tested for difference between stabilization in red and green direction.

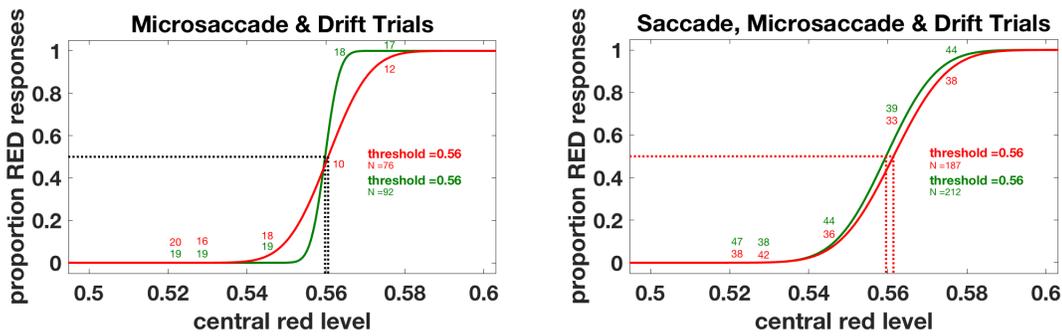


Figure 7: Results of subject RA tested for difference between stabilization in red and green direction.

## 5 Updates

- Including a new range of values (shifted toward redder values)
- Might test horizontal assimilation as well