The Relationship between Saccadic Suppression and Perceptual Stability

Supporting Information

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Supplementary Results

Experiment 1

As a test of significance, we used the bootstrapping methods of the Psignifit toolbox [1,2]to test the null hypothesis that the cumulative Gaussian fitted to the %PHE (Perceived Horizontal Elongation) in the horizontal and vertical line conditions could be generated by the same underlying distribution. All participants showed a significant difference in point of subjective circularity depending on the orientation of the inducing bar both before and after completion of experiment two ($p<0.001$ for each participant). Four participants displayed the classic shape contrast effect while one participant showed a consistently opposite, attractive effect (Figure S1). As we were interested in whether the illusion remains despite saccadic omission we only measured the relative difference in illusion between the fixation and eye movement conditions and the sign of the illusion here does not concern us.

All participants except the individual who had an attractive illusion showed a reduction in the size of the illusion after the substantial practice gained during the intervening eye movement trials.

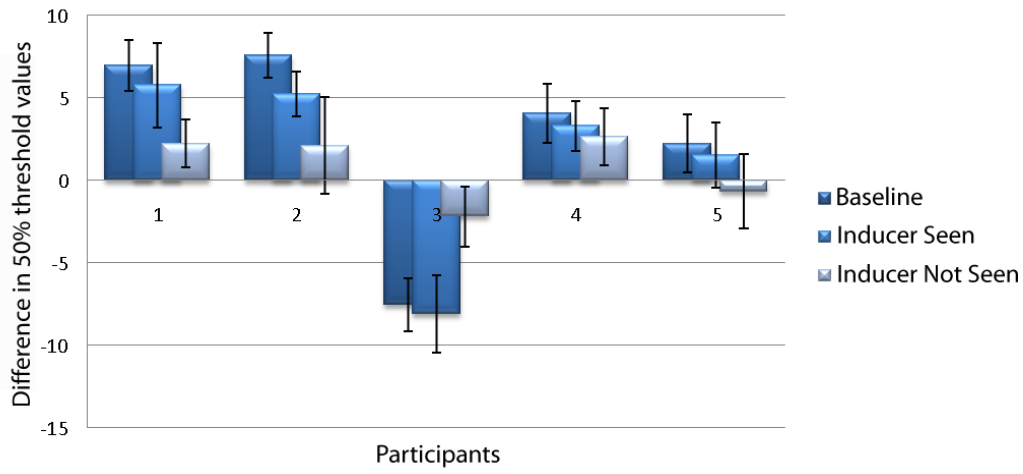

Figure S1; Strength of the shape contrast illusion. Individual participants illusion strength at baseline (dark bars), when the inducer is seen during an eye movement (mid bars) and not seen during an eye movement (light bars). Error bars represent 95% confidence intervals.

Experiment 2

Omission

To estimate the effectiveness of saccadic omission, we compared the number of inducers reported as unseen in two time windows. The first contained the bars presented between 200 to 80 ms before the saccade; this is expected to be outside the saccadic omission window[3] . The second window contained the bars presented within the omission window (75 ms before until saccade onset). On average each participant reported less than 10% of the inducers as unseen when they were presented in the first window while almost 50% were reported as unseen in the omission window (Figure S2).

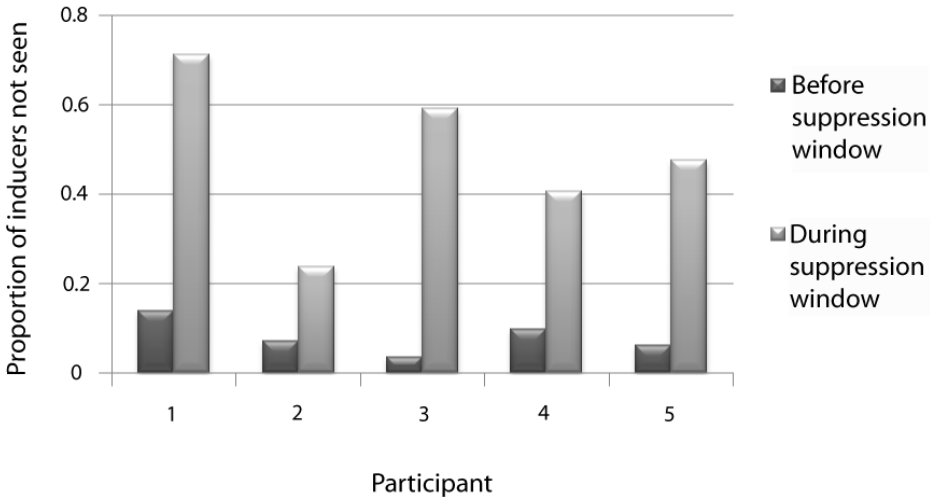

Figure S2; Stimulus miss rate during eye movements. Individual participants miss rate for inducer presented before the saccadic suppression window (dark bars) and within the suppression window (light bars). All subjects show clear evidence of saccadic omission in the relevant time window.

Illusion

The shape illusion in the unseen condition was individually significant in three out of five subjects. An example of the cumulative Gaussian fits to one naïve participant's data in each condition of experiment two can be seen in Figure S3, demonstrating the size of the illusion when no inducing line was presented and when the inducer was omitted or visible. Figure S4 shows, for the same participant, the time of onset of the inducing line relative to saccade onset when the line stimulus was reported as omitted or visible. It is notable that omission occurs most readily when the stimulus was presented as close as possible to saccade onset. This is consistent with previous studies showing that peri-saccadic suppressive effects increase from 75ms before and are maximal at saccade onset [3]. Individually, participant two rarely reported the line stimulus as 'not seen' (Figure S2). As a consequence it was exceedingly difficult to gather enough trials in the 'not-seen' condition to estimate the strength of the illusion. This is reflected in this subject's large confidence intervals (figure S1). Subject 5 had an illusion that was small at fixation and non-significant during eye movements, irrespective of whether the line was seen or unseen, hence this subject's results have no direct bearing on the hypothesis we tested. These individual differences notwithstanding, we found that at the group level the effect was significant.

We performed a t-test comparing the two points of subjective equality depending on the orientation of the inducer. The inducer orientation had a significant effect both for seen (t_4=4.2519, P<0.05) and saccadically omitted (t_4=2.8125, P<0.05) oriented lines.

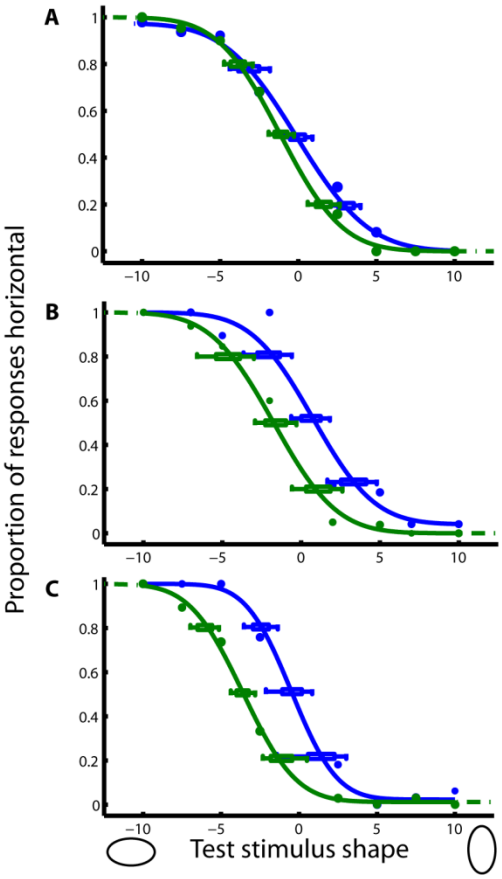

Figure S3; Gaussian fits to Experiment Two data for one naive participant; Blue = Vertical Inducer, Green = horizontal inducer. Test stimulus shape is represented in units of percentage of elongation of the 3 degree of visual angle diameter of a test circle (the circle is represented by 0 on the X axis). A shows the data when the inducing lines were assigned an orientation but their contrast was set to zero (i.e they were not displayed- this graph serves as a visual indicator of the typical noise in our behavioral measurements). B; the inducer was present but reported as unseen. C; the inducer was present and reported as seen.

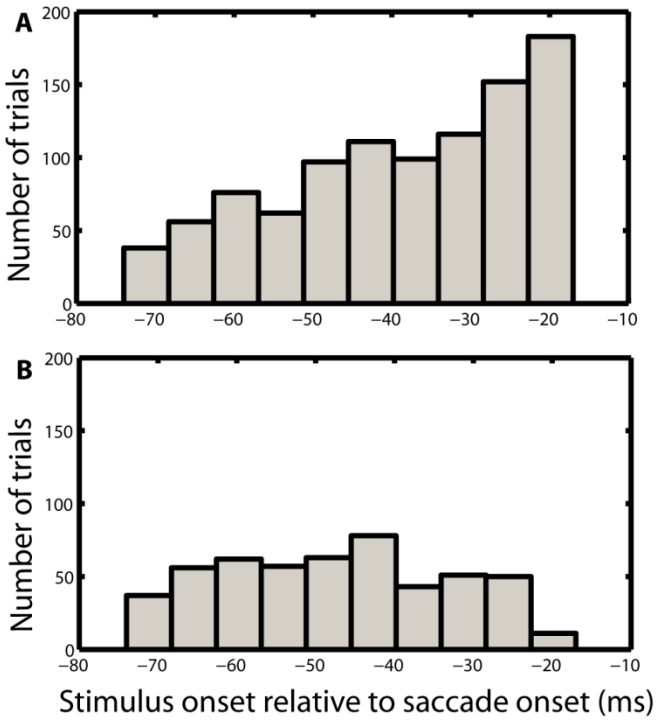

Figure S4; Time of onset of the inducing line relative to saccade onset at time 0. Data is from naïve participant shown in figure S3 above. A; Inducer reported as unseen. B; Inducer reported as seen.

Given that it is possible that subjects erroneously reported lines as 'unseen', we analyzed how many such mistakes an observer would have to make to generate an illusion of the observed size. Data from experiment 2 were re-sampled to simulate the effect of responding 'unseen' in a trial that was actually seen. Trials were chosen at random from those correctly identified as containing an inducer to replace trials where the inducer was correctly identified as not presented. The percentage of trials replaced in this way was determined by each participant's own miss rate from trials where the inducer appeared well before the eye movement and was therefore expected to be visible (Figure S2). As an even more stringent test we also simulated an insertion rate of 25% for all participants as a comparison. This re-sampling procedure was repeated 1000 times at each insertion rate and the mean size of the illusion was recorded. The data shown in Figure S5 suggest that even when trials containing correctly detected inducers are misreported as 'unseen' much more than 25% of all trials would need to be under reported in this way to generate an illusion of the size found during saccadic omission. At a 25% insertion rate only one participant matched the strength of illusion found during saccadic omission.

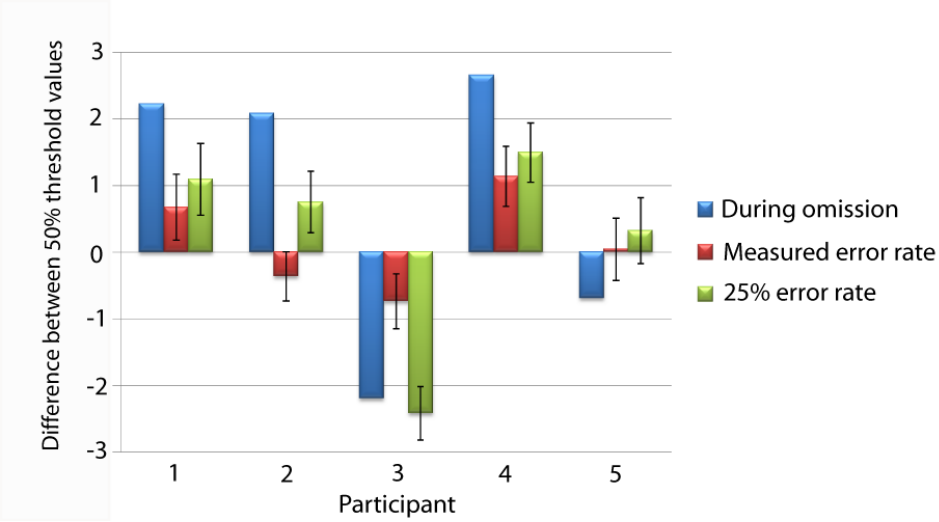

Figure S5; Strength of the illusion assuming mistaken reporting. Individual participants observed illusion strength during omission (dark bars), estimated illusion strength at the measured error rate during an eye movement (mid bars) and estimated illusion strength at a 25% error rate (light bars). Error bars represent 95% confidence intervals.

Reference List

1. Wichmann, F.A., and Hill, N.J. (2001). The psychometric function: II. Bootstrap-based confidence intervals and sampling. Percept Psychophys *8,* 1314-29.

2. Wichmann, F.A., and Hill, N.J. (2001). The psychometric function: I. Fitting, sampling, and goodness of fit. Percept Psychophys *8,* 1293-313.

3. Diamond, M.R., Ross, J., and Morrone, M.C. (2000). Extraretinal control of saccadic suppression. J Neurosci *9,* 3449-55.