The Effects of Priming on Object Localization in the Visual Field

Edmund Lam
Gunn High School

INTRODUCTION

Visual Perception is a field of research studying the way vision is processed and perceived in human brains. When the brain focuses on certain parts of a person's vision— their visual field, some information is inevitably lost or changed in order to preserve others in full quality. For example, receptor cells in human retinae have a larger concentration around the fovea, or the focal point, rather than the periphery, providing more detailed information to the brain in that area (Wässle & Heinz 1989).

This experiment was conducted to investigate the effects of priming on object localization. Priming is a technique whereby exposure to one stimulus influences a response to a subsequent stimulus, and has been shown to cause an unconscious bias towards certain stimuli due to the influence of past stimuli (Tulving, Endel, & Schacter 1990). The use of priming has already been shown to affect various different aspects of visual perception, from motion perception (Wohlschläger 2000) to higher level emotional perception (Li 2008). After a past study concluded that errors in object localization are in fact unique to each subject yet consistent to the location of the object in the visual field, the natural next step is to see whether such a systematic predictable error could be remedied. This experiment focuses on the use of a technique called priming in order to observe its effects on object localization.

RESEARCH METHODOLOGIES

Subjects were volunteer students from Gunn High School and are chosen by convenience sample. Subjects remained anonymous throughout the test, and the only information collected from subjects were the age and gender of the subject.

Subjects were to be seated in front of a 2560 x 1440 Resolution computer display with a 27" diagonal such that their eyes were approximately 40-50 centimeters away from the center of the screen. Subjects were be asked to sit straight and attempt to keep their head still in order to minimize the effect of unwanted variables.

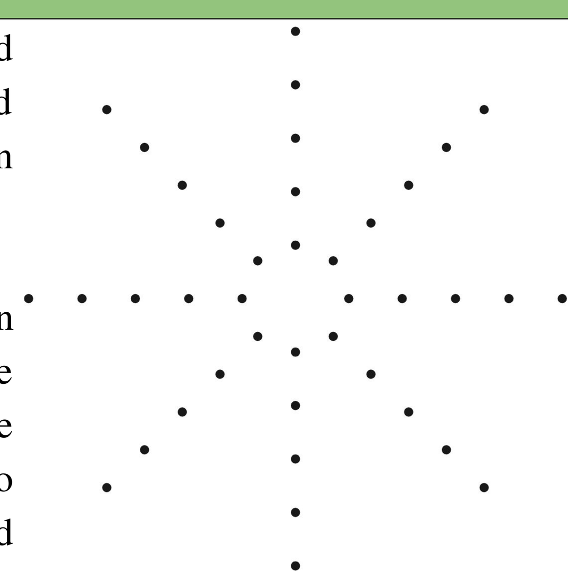

Figure 1. Visual representation of all possible locations of points used in the experiment.

Random points on the screen were generated radially, with 8 possible directions for the points to appear in and 5 different distances for each direction, as shown in Figure 1. Each point was to be shown 3 times, but in a randomized order. In each trial, a gabor patch was flashed as a priming stimulus, and afterwards one of the random points was flashed to the user. After the flashing of the point, subjects were allowed to move the mouse from the center of the screen and click on the position they believed the point appeared. This allowed us to generate the warped gabor patch using the minimum error for each point over the 3 different trials to minimize the effect of randomness. Subjects were not told how the random points were generated, and believed they could appear anywhere on screen.

Gabor patches are spatial frequencies or sinusoidal waves in two dimensions, where darker and lighter colors represent the height of the sine wave at a point in the image. The contrast of the image is masked using a gaussian curve, which just makes the gabor patch fade out towards the sides of the image, as illustrated in Figure 2. The reason we used a gabor patch is because the receptive fields of simple cells in our visual cortex are in the shape of a gabor patch (Field, Tolhurst), and as such seeing one helps induce brain activity.

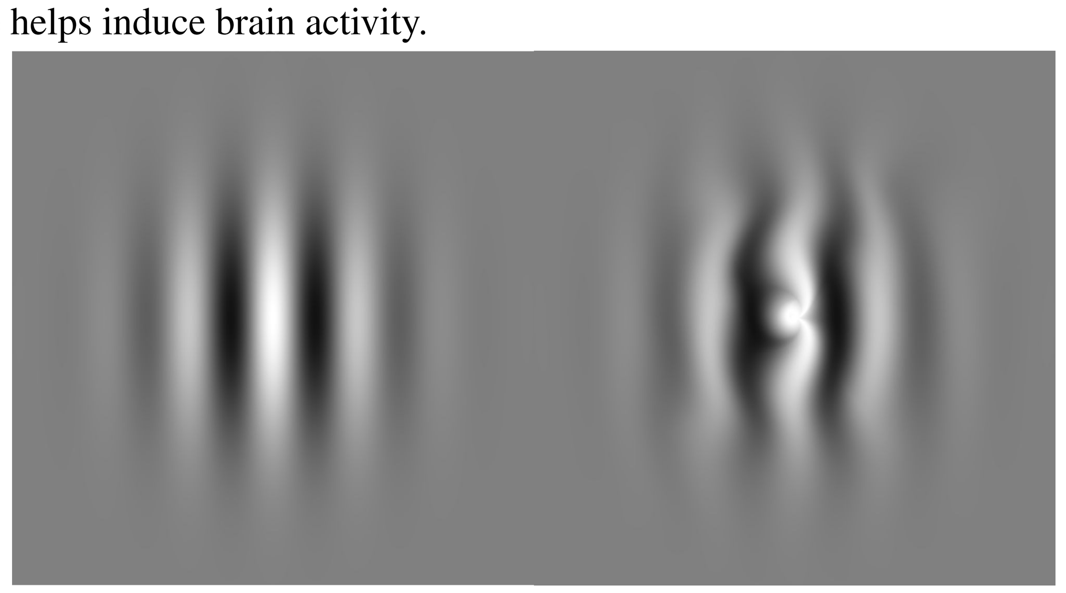

Figure 2. An example of an un-warped gabor patch on the left coupled by a warped gabor patch on the right.

For the first set of trials, the gabor patch were unwarped in order to get data on the initial localization skills before the second test. After the first trials were done, a second warped gabor patch was generated using an algorithm which morphs areas of the gabor patch according to the error at those areas. The trials then repeats but with this warped gabor patch shown instead, allowing for more data to be collected with the inclusion of the priming. Finally, the two test sets will be compared to see if a pattern or significant change in ability was observed.

DATA AND FINDINGS

Although the change in accuracy from the normal gabor patch to the warped gabor patch shows no consistent pattern, the results show a clear effect on accuracy. We run a 1 sample T test for means, with the null hypothesis being that the positive difference in error is 0, and the alternative is that it is not zero. With an alpha level of 0.05, every single subject passes this T test, proving that there is in fact a significant difference caused by the priming with the warped gabor patch.

Differences in accuracy vary from individual to individual in a seemingly unpredictable way. This implies that although we have strong evidence proving a significant effect on visual perception, more work must be done to research what exactly this effect is and how it differs between each person.

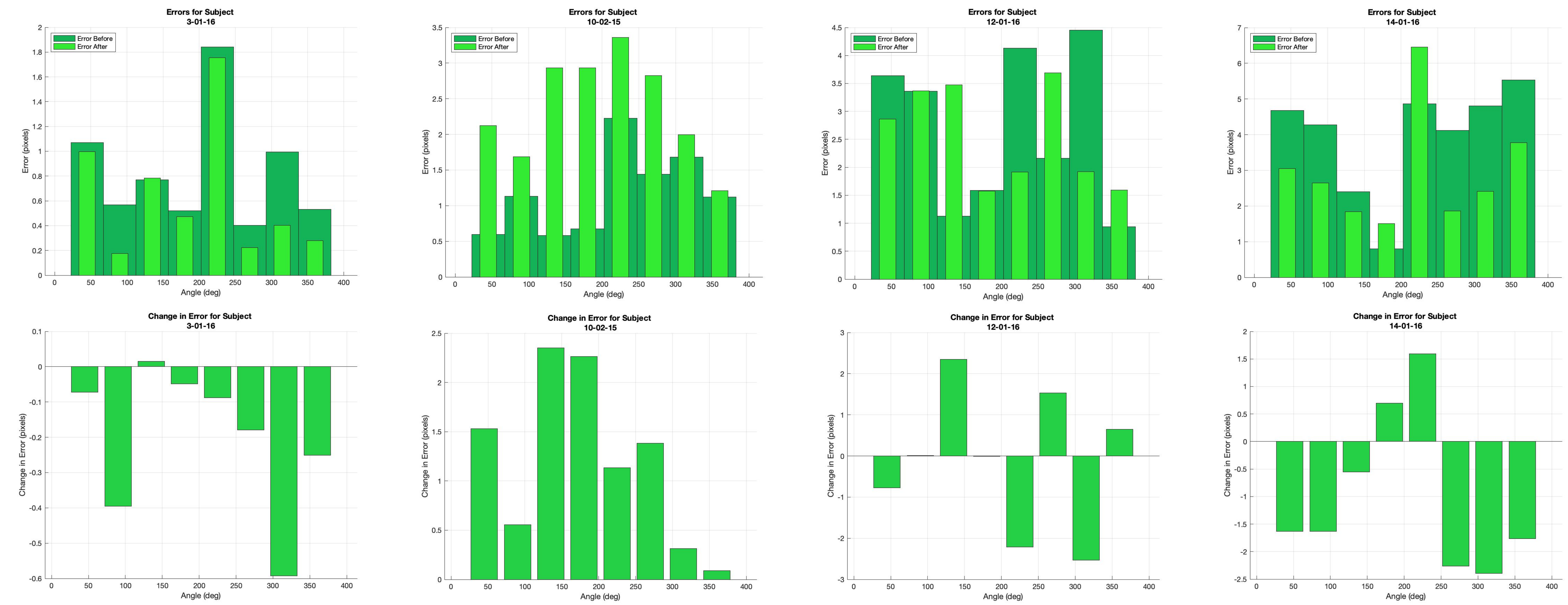

Figure 3. Graphs displaying error data and changes in error for selected subjects for both before the warped gabor patch priming and after.

CONCLUSIONS AND ANALYSIS

The results of the experiment support the original hypothesis, showing a significant effect on the accuracy of object localization through the use of priming. An exceptionally significant example of this phenomenon is in test subjects 3-01-16 and 10-02-15. Test subject 3 shows a consistently negative change in error, or a consistent improvement with the warped gabor patch, regardless of the angle of the point. However, test subject 10 exhibits the completely opposite behavior, with the a consistently positive change in error, or a worsened performance regardless of angle. The majority of other subjects displayed a mixed assortment of positive and negative changes.

It is important to mention that subjects were not tested with a control in mind, which could have been used to better test the significance of the changes, as there is currently no clear pattern. However, as a pilot study, the experiment has done well in providing a baseline for future experiments in priming.

If the data had shown no difference, the graph of error change would hold mostly values near zero. However, the data shows clear positive and negative changes, proving priming does in fact have an effect on visual object localization, despite in unpredictable ways. Coupled with existing data on unique visual maps in terms of differences in object localization in terms of position in the visual field, we can conclude that the change in object localization caused by priming may well be dependent on location of the point located.

This study was very much a pilot in the uses of priming and object localization, and as a pilot study, it provides valuable data showing that priming may in fact have an effect on object localization. However, the study has many areas in which it could be improved, namely, inclusion of a control, as well as further research into different masks to induce priming.

By making use of priming, which has already been shown to have repeatable controlled effect on human visual perception, it may be possible to improve object localization in subjects as well in a replicable and predictable manner. Although this study has successfully proven that priming does in fact have an impact on object localization, this effect has yet to become predictable or consistent among test subjects, and will definitely require further investigation.

IMPLICATIONS AND NEXT STEPS

As a pilot study, this experiment can definitely be expanded upon with measuring changes in object localization based on position as well as angle, and the introduction of controls or other methods to measure significance more accurately. One of the largest limitations of this experiment is definitely the number of subjects as well as the limited length of the test. As such, an important next step is to better measure the significance of the effect of priming, especially on samples with or without pre existing visual conditions, over a more diverse sample group, and provide a longer test to subjects to collect more accurate data.

If visual spatial acuity can be improved through the use of priming, this could be applied to improve judgements on localizing objects in real time could lead to future research on whether this could have permanent benefits through visual training, be integrated through real-time calculation to improve visual perception, and be an introduction into a plethora of possible tools for visual perception manipulation.

Further research will need to be done regarding how significant the measured effect is on object localization, as well as the optimal priming stimulus to use in order to create the most consistent effect on accuracy.

ACKNOWLEDGEMENTS / REFERENCES

Special thanks to Angela Merchant for guiding me and making this project possible. Thanks to all the subjects for providing their time to participate in the experiment.

Wässle, Heinz, et al. "Cortical magnification factor and the ganglion cell density of the primate retina." Nature 341.6243 (1989): 643.

Field, David J., and David J. Tolhurst. "The structure and symmetry of simple-cell receptive-field profiles in the cat's visual cortex." Proceedings of the Royal society of London. Series B. Biological sciences 228.1253 (1986): 379-400.

Wohlschläger, Andreas. "Visual motion priming by invisible actions." Vision research 40.8 (2000): 925-930.

Tulving, Endel, and Daniel L. Schacter. "Priming and human memory systems." Science 247.4940 (1990): 301-306.

Li, Wen, et al. "Neural and behavioral evidence for affective priming from unconsciously perceived emotional facial expressions and the influence of trait anxiety." Journal of Cognitive Neuroscience 20.1 (2008): 95-107.