Resting Focus May Affect Perception of Stereogram Illusions

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Introduction

Conventional eye exams are performed in optimal environments when the patient is seated, and they overlook many factors that influence visual perception in dynamic environments. For example, when a person "stares off into space," as they may when looking up at a blue sky, the eyes involuntarily converge at a point of resting focus (RF) (i.e. they do NOT point in two parallel lines of sight; the eyes cross a little or a lot). This point varies from person to person and distance between this point and the observer can affect the way people judge depth when something suddenly comes into an otherwise empty visual field. This has consequences for drivers and airplane pilots who can spend hours looking out across wide, unchanging visual scenes before having to react to an object that suddenly enters the visual field (Owens, 1984). These poorly understood and possibly life-threatening effects beg for further research but measuring RF requires time and access to a sophisticated device that can present light stimuli to each eye, individually.

The aim here is to determine if the ability to see a three-dimensional random-dot stereogram illusion as "popping in" (appearing behind the plane of the figure) or "popping out" (appearing in front of the plane of the figure) (Figure 1) can be used to predict the point of dark focus as measured by a more sophisticated technique. If these measures correlate, random-dot stereograms may serve as quick screening tools in the assessment of resting focus.

Methods

Seventeen undergraduates who passed stereoacuity screening viewed a series of five random-dot stereograms displayed on a flat 17" computer screen at 40cm in an illuminated room. While viewing stereograms, participants were told to "un-focus their eyes" or "look through" the center of the display. Participants often cannot describe how or where their eyes come to rest while performing this task and if the RF point is far beyond the plane of the display, they will not be able to perceive the illusion which requires a resting focus point to be within approximately 20 cm of the display. In this study, each stereogram "hid" a simple shape (circle, square, star, heart, diamond) and participants were asked to report the shape and if they "popped in" and appeared behind the plane of the screen or "popped out" and appeared in front of the screen.

After the stereogram testing, the point of RF was measured by having participants wear polarized glasses and view a 30cm horizontal array of computer-controlled yellow LEDs at a distance of 100cm in a dark room. The yellow LEDs were covered with polarization filters and visible to only the left eye. At one point above and below the array of yellow LEDs were two constantly illuminated green LED's that were covered with filters orthogonal to those used for the yellow LEDs and visible to only the right eye. As the yellow LEDs were illuminated, the participant used a hand-held button box to make forced choice decisions as to whether the yellow light was to the right or left of the green LEDs. The computer used the responses to calculate the location of the yellow LED that the participant believed was closest to the green LEDs and this location could be used to calculate the participant's point of RF. If the participant believed that the yellow and green LEDs were aligned when, in fact, the yellow LED was to the right of the green LEDs, the participant's RF point was beyond the array (>100cm), if this location was to the left of the green LED's, the participant's RF was closer than the array (<100cm).

Figure(s)

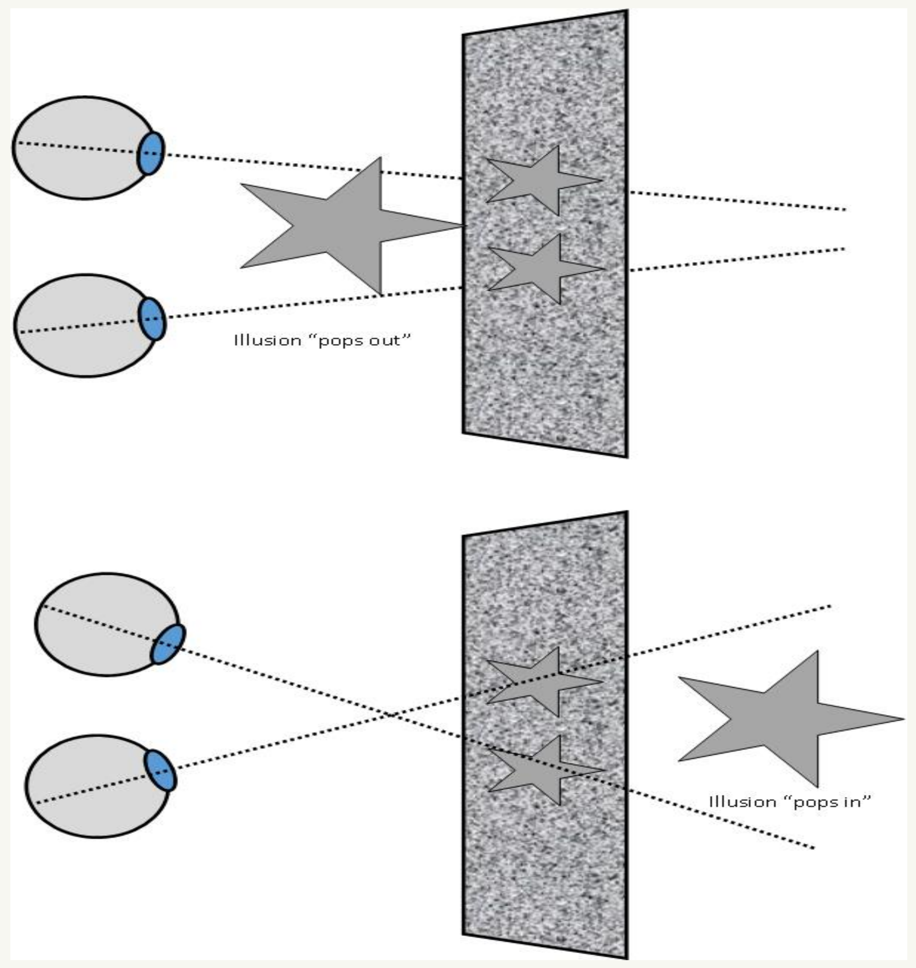

Figure1: Illustration of different ways of perceiving stereograms

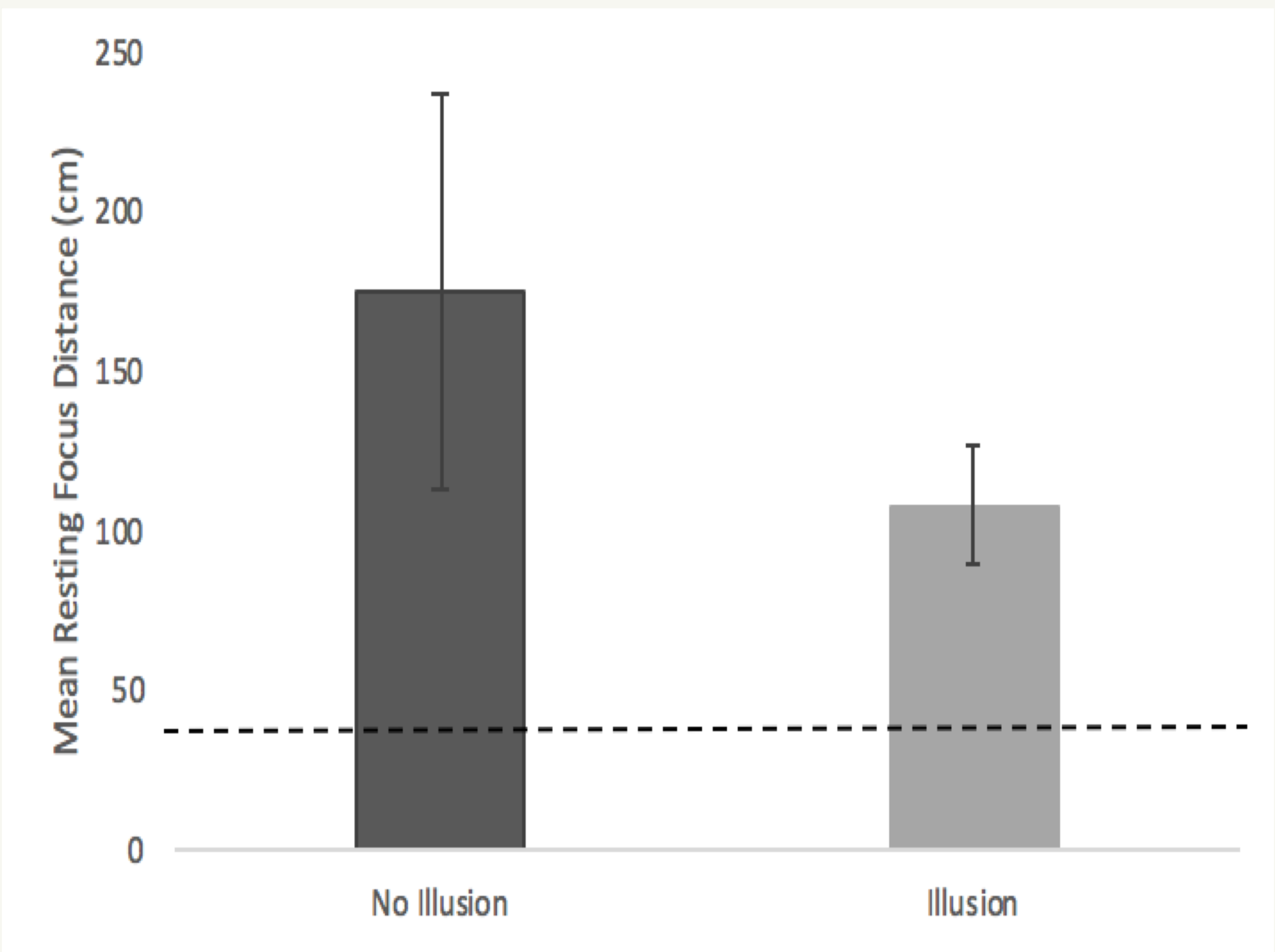

Figure 2: Bar graph of mean resting focus distances. *Note.* Dotted line represents 40am viewing distance.

Results & Discussion

Seven participants could not see the stereogram illusion and had a mean RF distance of 175.54cm +/- 61.89 SEM. The ten who could see the stereogram illusions had a mean RF of 107.99cm +/- 18.31 SEM (Figure 2). These are not statistically significant differences but of the seven who could not perceive the random dot stereograms, two had the largest RF distances measured (399 and 427cm). If these were their RF points while viewing the stereogram displays, they would have not been able to perceive the illusion.

Discussion: Resting focus is an understudied phenomenon that biases depth perception, but it is difficult to objectively assess and alerting clinicians to its importance will require the development of simple screening and assessment tools. An individual's RF may influence the ability to perceive random-dot stereograms but, if it does, it will be only one of several factors. This study did not control for the effects of practice and illumination which are known to influence one's ability to perceive these illusions. There is also no easy way to evaluate how well a participant can consciously control their point of focus and override the involuntary.

Recommendations:

Display the stereogram at a distance closer to the median resting focus distance. The distance of 40cm was closer than resting focus distance of almost all participants.

Resources

Frisby, J. P., & Clatworthy, J. L. (1975). Learning to See Complex Random Dot Stereograms. *Perception,4*(2), 173-178. https://doi.org/10.1068/p040173

Owens, D. (1984). The Resting State of the Eyes: Our ability to see under adverse conditions depends on the involuntary focus and convergence of our eyes at rest. *American Scientist*, 72(4), 378-387. Retrieved from http://www.jstor.org/stable/27852762

Acknowledgements

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