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Resting Focus May Affect Perception of Stereogram Illusions

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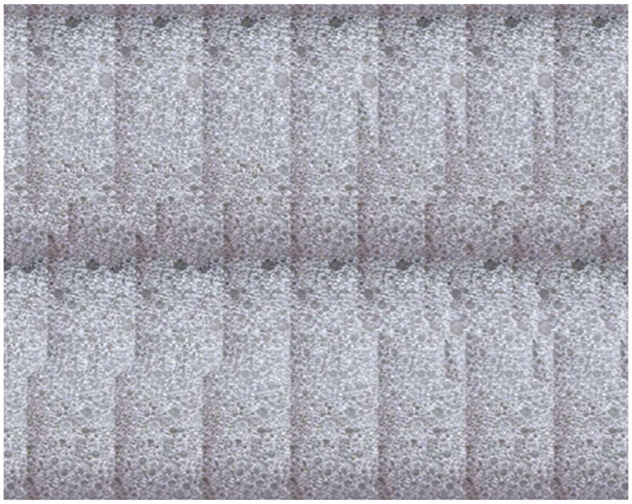
Abstract

When staring out into space, with no particular fixation target, the eyes still converge at a point somewhere between the individual and "optical infinity". This point of convergence is referred to as one's "resting focus" (RF). This resting focus distance seems to be idiosyncratic to each individual and cannot be determined by pre-established measurements of vision (Owens, 1984). This RF may influence an individual's ability to perceive random-dot stereograms, optical illusions that require the viewer to "relax" their eyes in order for the eyes to converge at a point in space not located on the plane of the image. We hypothesized that an individual's RF would predict the nature of the stereogram illusion, whether the three-dimensional image appeared to be "popping out" or "popping in".

Conventional eye exams are performed in optimal environments (sufficient lighting, stark contrast between background and foreground- black letters appear on a white background, minimal external distractions, patient is generally focused, patient is seated). Tand therefore they these exams overlook many factors that influence visual perception in dynamic environments (Owens, 1984). For example, when a person "stares off into space," as they may when looking up at a clear 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 ranging from a little to a lot). This point varies from person to person. The 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, a laser optometer, that can present light stimuli to each eye, individually.



Random-dot stereograms are optical illusions of depth created by the layering of at least two images with varying disparity. Each eye locks in on one image and the level of disparity between the two messages from the two eyes is perceived by the brain as depth. This is the stereogram illusion. The aim of this project is to determine if the ability to see a three-dimensional random-dot stereogram illusion as “popping in” (away from the viewer) or “popping out” (towards the viewer) can be used to predict the point of resting focus as measured by a more sophisticated technique. Resting focus being the involuntary convergence of the eyes to a specific distance in adverse viewing conditions. If these measures correlate, random-dot stereograms may serve as quick screening tools in the measuring of resting focus.

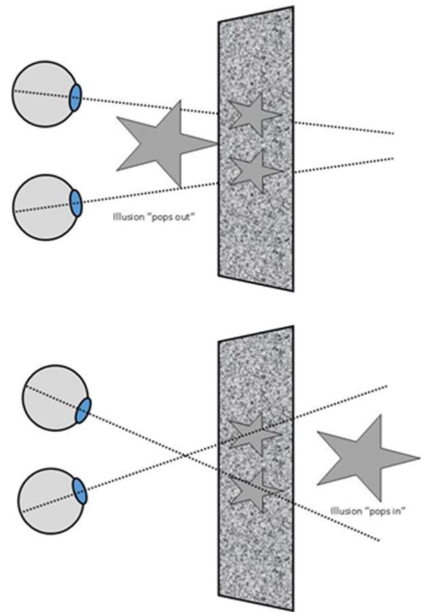


Figure 1. Random-dot Stereogram of a star

Method

Participants

Seventeen undergraduate students at Millersville University who passed stereo-acuity screening (standard Titmus Fly Stereo Test).

Materials and Procedure

Participants viewed a series of simple random-dot stereograms displayed on a flat 17” computer screen at 40cm in an illuminated room. While viewing stereograms, participants were told to “look through” the center of the display. Participants often cannot describe how or where their eyes come to rest while performing this task (Frisby and Clatworthy, 1975), 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, easily identifiable shape (circle, square, star, heart, diamond) and participants were asked to report the shape and if they “popped in” or “popped out”.

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 perpendicular 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 remote 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. 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).

Results

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. 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 and is difficult to objectively assess. 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. A new study targeting participants who have never attempted random-dot stereograms is underway.

References

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