5-14-1986

Stereoacuity in various fields of gaze

Ricky F. Groetsch
Pacific University

Michael S. Lackman
Pacific University

Mark T. Steckler
Pacific University

Stereoacuity in various fields of gaze

Abstract
Stereoacuity in various fields of gaze

Degree Type
Thesis

Degree Name
Master of Science in Vision Science

Committee Chair
Harold M. Haynes

Subject Categories
Optometry

Stereoacuity in Various Fields of Gaze

Ricky F. Groetsch
Michael S. Lackman
Mark T. Steckler

Advisors:
Harold M. Haynes O.D.
Alan W. Reichow O.D.

Pacific University College of Optometry
Forest Grove, OR

May 14, 1986

Stereoacuity in Various Fields of Gaze

Harold M. Haynes O.D. Harold M. Haynes O.D.

Alan W. Reichow O.D. Alan W. Reichow O.D.

Michael S. Lackman Michael S. Lackman

Ricky F. Groetsch Ricky F. Groetsch

Mark T. Steckler Mark T. Steckler

Introduction

This experiment was designed to address factors associated with stereoacuity in various fields and positions of gaze. It is customary for patients having their distance stereoacuity tested to have measurements taken only in the primary position, that is, with the head held erect and the eyes aimed straight ahead. Many visual tasks requiring good stereoacuity do not take place in the subject's primary position. A review of the literature revealed no previous investigations of stereoacuity outside of the primary position. The purpose of this experiment was to determine if there was a measurable difference in stereoacuity between the primary position and any of the other eight cardinal points.

There are different ways for a person to foveate an object. He may either shift his eyes, turn his head or use a combination of head and eye movement. If the eyes are shifted toward a target there is an effective reduction in the interpupillary distance. There would be no such reduction in interpupillary distance if the entire head was turned to fixate a target. Our hypothesis was that this reduction in interpupillary distance would lead to a decrease in a person's stereoacuity.

Problem

This experiment was designed to determine whether shifting the eyes or head to a peripheral cardinal point causes a reduction in stereoacuity, and if so, whether that reduction is due to a decrease in effective interpupillary distance or a change in head posture.

Design

Twenty Pacific University students were to be selected to participate in the study. Potential subjects were to be found by searching existing optometric records and placing into a subject pool the name of any currently matriculated student meeting the following criteria:

1. unaided acuity of 20/20 or better, OD, OS, OU[1]
2. not currently using corrective lenses for near or far[2]
3. subjective to best visual acuity of not more than 1.00 diopters of hyperopia
4. subjective to best visual acuity of not more than 0.50 diopters of myopia
5. subjective to best visual acuity of not more than 0.50 diopters of astigmatism
6. subjective to best visual acuity of not more than 0.50 diopters of anisometropia[3,4,5]
7. no grossly observable limitations in ocular pursuits or saccades
8. stereoacuity of at least 20 arc seconds as measured by the Randot stereotest[6,7]
9. ages 18 to 40 years inclusive[8]
10. eye dominance recorded; either right or left dominance accepted

People in the subject pool were to be contacted randomly by phone and asked to participate in the study. Those agreeing to participate would have undergone a visual screening to ensure that they met the above criteria. The first twenty people agreeing to the screening procedure and meeting the criteria were to be selected as research subjects. None of the research subjects would have received any remuneration for their participation.

In performing the experiment, it was necessary to find an instrument capable of measuring distance stereoacuity through a continuous range. An electronic Howard-Dolman (H-D) device would have met this criterion and also would have provided the needed sensitivity of measurement. Subjects would have operated the H-D with remote-control units. A digital readout was to have to been incorporated into the H-D to increase measurement accuracy and internal consistency. Additional equipment was to have included an adjustable stool, an adjustable chin rest, ceiling and wall mounting brackets for the H-D's, a ceiling suspended plumb bob for accurate reproduction of eye position, and a velcro headband to stabilize the head position.

The H-D devices were to be arranged so that the central instrument was at the subject's primary position while two other identical devices were placed ten degrees above and below the central instrument (relative to the subject). The subject was to be seated in a height adjustable chair with his chin in an adjustable chinrest. The chair and chinrest were to have been placed twenty feet from the H-D. Using a remote-control switch, the subject was to have moved an adjustable rod on the device until he/she perceived that it was aligned with a stationary rod. Ten measurements were to be taken in this position, five with the movable peg initially in front of the stationary peg, and five with the movable peg behind the stationary peg. Successive readings were to alternate between the two starting points. The digital readout of each measurement would have been recorded on the subject's recording form. This procedure was to have been repeated for each of the eight cardinal points. In order to accomplish a thirty degree lateral eye turn, the subject's chair would have been turned thirty degrees and the subject would then have been directed to shift only his eyes back to the H-D. Compliance was to be facilitated by the use of a velcrow headband that would have effectively prevented the subject from turning his head. Measurements involving a head turn would have been accomplished by turning the subject's chair thirty degrees and then directing the subject to turn his head to fixate the device.

In analyzing the data, each subject's baseline stereoacuity was to be measured in the primary position. Stereoacuity was then to have been measured in each of the remaining cardinal points under the two test conditions (head turn and eye turn). Measurement sequences were to have been randomized for all subjects . Mean range values for each cardinal point and test condition were to have been computed, and each mean would have been compared to the baseline mean for a significant difference using an alpha level of .05. Mean values were then to have been compared using a within-subjects design.

Results

No data has been collected to this date due to problems in constructing the remote-controlled H-D. The initial builder of the device was unable to correct flaws in the unit's motor drive. We were not informed of this until it was too late to collect and analyze data. We have since contacted an electrical engineer who has drawn up a new set of plans for a remote-controlled H-D. Those plans and the engineer's name and phone number have been turned over to the project advisor.

Though no data was collected, areas of concern have been found and will need to be addressed. Difficulties in construction of the H-D devices may lead to an attempt to utilize only one such device. We recommend that this be avoided. One device would multiply greatly the time required to take measurements. This would lead to subject fatigue. Constant repositioning might induce measurement error and might also affect the electronic calibration. Another suggestion may be made in reference to the method of testing. The adjustable peg should be moved by the subject through the perceived alignment position until it is noted that the peg is in front of or behind the stationary peg (method of limits). Efforts were made to account for all possible variables in setting up the design of the experiment. Though minor modifications may be called for, it is hoped that due consideration will be given before deviating from the existing framework. Future researchers are advised to address an article written by W. L. Larson (November 1985, Am J Optom Physiol Optics) which questions the reliability of the H-D as a test for stereoacuity.

In all practical consideration, future researchers should consider a pilot study in order to uncover unforseen complexities of this experiment.

References

1. Levy NS, Glick EB. Stereoscopic perception and Snellen visual acuity. Am J Ophthalmol, 1974; 78: 722-4
2. Fry GA, Kent PR. The effects of base-in and base-out prisms on stereoacuity. Am J Optom Arch Am Acad Optom, 1944; 21: 492-507
3. Larson WL, Lachance Andre. Stereoscopic acuity with induced refractive errors. Am J Optom Physiol Opt, 1983; 60(6): 509-13
4. Ong J, Burley WS. Effect of induced anisometropia on depth perception. Am J Optom Arch Am Acad Optom, 1972; 49: 333-5
5. Peters HB. The influence of anisometropia on stereosensitivity. Am J Optom Arch Am Acad Optom, 1969; 46: 120-3
6. Ogle KN. Note on stereoscopic acuity and observation distance. J Opt Soc Am, 1958; 48(11): 794-8
7. Schor CM, Flom MC. The relative value of stereopsis as a function of viewing distance. Am J Opt Arch Am Acad Opt, 1969; 46(11): 805-9
8. Jani SN. The age factor in stereopsis screening. Am J Optom Arch Am Acad Optom, 1966; 43: 653-7

Additional Sources

Amigo G. Variation of stereoscopic acuity with observation distance. J Opt Soc Am, 1959; 49(6): 639

Cormack RH. Stereoscopic depth perception at far viewing distances. Perception and Psychophysics, 1984; 35(5): 423

Eames TH. The relationship of the central visual field to the speed of visual perception. Am J Ophthalmol, 1957; 43: 279-80

Everson, RW. Visual acuity in relation to eye position. Am J Optom Arch Am Acad Optom, 1962; 39(11) 603-09

Goldstein JH, Clahane AC, Sanfilippo S. The role of periphery in binocular vision. Am J Ophth, 1966; 62(4): 702-06

Jonkers GH, Kylstra PH. Brightness contrast and color contrast in stereoscopic visual acuity. Ophthalmologica, 1963; 145: 139-43

Krekling S. Stereoscopic threshold within the stereoscopic range in central vision. Am J Optom Physiol Opt, 1974; 51: 626-34

Leibowitz A. Stereoacuity for various levels of illumination. Am J Psychol,1955: 68: 266-73

Lit A, Dwyer WO, Morandi AJ. Effect of background wavelength on stereoscopic acuity at scotopic and photopic illumination levels. Am J Optom Arch Am Acad Optom, 1968; 45(3): 195-203

Luria SM. Stereoscopic and resolution acuity with various fields of view. Science, 1969; 164: 452-53

Luria SM, Kinney JAS. Stereoscopic acuity under water. Am J Psychol, 1968; 81(3): 359-66

Luria SM. Duction, stereoacuity and field of view. Am J Opt Physiol Opt, 1971; 48(9): 728-35

Mueller CG, Lloyd VV. Stereoacuity for various levels of illumination. Nat Acad Sci, 1948; 34: 223-27

Nielsen KR, Poggio T. Vertical image registration in stereopsis. Vision Research, 1984; 24(10): 1133-40

Ogle KN, Weil MP. Stereoscopic vision and the duration of the stimulus. AMA Arch Opth, 1958; 59(1): 4-17

Ogle KN, Groch J. Stereopsis and unequal luminosities of the images of the two eyes. AMA Arch Ophth, 1956; 56(6): 878-95

Ogle KN. Stereopscopic acuity and the role of convergence. J Opt Soc Am, 1956; 46(4): 269-73

Patterson R. Stereopsis during continuous head motion. Vision Research, 1984; 24(12): 2001-003

Pennington J. The effect of wavelength on stereoacuity. Am J Opt Physiol Opt, 1970; 47(4): 288-94

Richards W. Correlation between stereo ability and recovery of structure from motion. Am J Optom, 1985; 62(2): 111

Rosner J. The validity of the frisby stereotest as a measure of precise stereoacuity. J Am Optometric Assoc, 1984; 55(7): 505

Simmerman JS. Absolute threshold of stereopsis using the frisby stereotest. J Am Optometric Assoc, 1984; 25(5): 50

Somers, WW. Estimation of the stereoscopic threshold utilizing perceived depth. Ophthalmic and Physiol Opt, 1984; 4(3): 245

Stigmar G. The effect of blurred visual stimuli on vernier and stereoacuity. Acta Ophthalmol (Kbl), 1971; 49: 364-79

Weinman J. Eye dominance and stereopsis. Perception, 1982; 11(2): 207

Westheimer G, McKee SP. Stereoscopic acuity with defocused and spatially filtered retinal images. J Opt Soc Am, 1980; 70: 772-80