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EGOCENTRIC VISUAL LOCALIZATION IN NORMALS AND PARTIALLY BLIND DURING A CHANGE IN DIRECTION OF GRAVITOINERTIAL FORCE*

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SUMMARY PAGE

THE PROBLEM

The purpose of this experiment was to compare the interactions of visual and nonvisual information during the perception of the visual horizontal in twelve normal and seven partially blind observers during exposure to centripetal force. Both the normal and the partially blind observers had normal vestibular functions. The observers set a collimated, luminous line to the horizon in darkness while they sat in a cockpit 20 feet from the center of rotation. Settings were made with the device stationary and during rotation at three velocities.

FINDINGS

The results show negligible differences between the normals and the partially blind for all conditions. Both groups showed minimal errors during the static series both before and after rotation and during rotation the settings were very close to the resultant horizontal. It was concluded that interaction between visual and nonvisual information is possible with extremely limited central vision.

INTRODUCTION

A number of studies of the space perception of the blind and partially blind have been reported in the literature (1,5,8,9). The data on vestibular functions of the blind, however, are extremely limited (10) although other sensory capacities of the blind have been studied extensively. Some of these studies support the notion that visual experience is of importance in later perceptual (1,5) and motor (1) functioning. But no data have been found which were concerned with the interaction of nonvisual and visual information in partially sighted persons. The purpose of the present investigation was to compare the effects of stimulation by centripetal force on the perception of the visual horizontal in partially sighted and normal individuals.

PROCEDURE

OBSERVERS

The partially blind observers were four women and three men from the Florida State School for the Deaf and the Blind. All of them had normal vestibular function as shown by an ataxia test (4) and a threshold caloric test (6), but they had serious visual deficiencies. Only three had vision in both eyes with 20/100 or less in the better eye while four had vision in but one eye (20/100 or less). Two of the seven could not be tested on standard vision charts, but they could perceive large vertical and horizontal structures in the visual field. The normal observers were six men and six women who had normal vestibular function by the same tests and normal visual acuity in each eye.

APPARATUS

The data were collected in the Pensacola Slow Rotation Room Facility (2). The device always rotated counterclockwise while the observer sat with his head 20 feet from the center of rotation in a seat which supported a head and body mold which held him snuggly in position. A chest plate was clamped over his chest to maintain him in a fixed but comfortable position. A collimator was mounted directly in front of the observer who viewed a dim, luminous line of light which subtended an angle of approximately 5.5° at his eye. This visual target could be rotated in the subject's frontal plane by either the subject or the experimenter. A communication system was available between the observer and the experimenter, and a buzzer was also used as a signal to set the luminous line to the horizon.

METHOD

All observations were monocular and made in darkness with the unused eye covered with an eye patch. For every experimental trial, the experimenter offset the luminous line and then turned it on. The observers' task was merely to set it to the horizon. They were instructed to imagine a distant horizon and to set the line parallel to it as one would the wings of an airplane. Each setting was recorded to the nearest one-half degree by an experimenter. Ten settings were made for each condition. Each series of settings began with the cab stationary while the observer made ten settings in the covered cab to determine his perception of the visual horizontal under static conditions. The device was then set in motion and settings were made at velocities which produced changes in the direction of the gravitoinertial horizontal of 10°, 20°, and 30° at the observer's head. After these settings were completed, a final series was made with the centrifuge stationary. The cab was rotated at each velocity for at least one minute before any settings were made, and the final static series was delayed for one minute after rotation stopped. The first series of settings was made with the observer facing forward, and a second series was made facing backward. All of the settings to the visual horizontal during rotation were computed as deviations from the egocentrically localized visual horizontal determined during the initial, static series. The data with the observer facing forward were combined with those facing backward for purposes of analysis (Table I).

RESULTS

PRE- AND POST-ROTATION STATIC OBSERVATIONS

For the normal observers, the settings to the visual horizontal while the cab was stationary (Table I) confirm the results of several other studies (2,3,7). The maximum constant error from the gravitational horizontal was only 1.6°. Furthermore, the differences between the two eyes showed no consistent trends and were of no more than one degree, which is of no practical significance in this experimental situation (2,7). The partially blind observers exhibited the same results. They set the luminous line to the horizon with very small errors, but comparisons between the two eyes are not warranted because four of them had vision in but one eye. The data in Table I are, therefore, a restricted sample for each eye in the case of the partially blind. Conventional statistical comparisons between the two groups are not appropriate since the underlying assumptions for statistical inference are not met. Nevertheless, it is noteworthy that the differences are less than a degree in each case. These small differences are further supported when the data for the right and left eyes are combined for the normals and the partially blind with two functional eyes, and the observers with but one eye are represented in the group by the data from their one functional eye (Table I).

OBSERVATIONS DURING ROTATION

When rotation began while the observer faced forward, he observed the horizontal, luminous line rotate clockwise. To set it to the horizon, he merely rotated it counterclockwise, the deviation from the horizontal being a measure of the oculogravic illusion (3) for each setting. When the observer faced backward, the setting was, of course, in the opposite sense, and therefore the settings during rotation have no sign (Table I). In every setting, however, each observer set the line in the direction indicated; i.e., all nineteen observers demonstrated the perception of the oculogravic illusion. For the normals, it is apparent that this change in setting corresponded closely with the change

Table I

Perception of Visual Horizontal in Twelve Normal and Seven Partially Blind Observers During Rotation*

Deviation from Gravitoinertial Upright (and horizontal)	Prerotation Static 0°		Observations During Rotation 10°		20°		30°		Postrotation Static 0°	
Eye	R	L	R	L	R	L	R	L	R	L
Normals										
Mean	-1.1	-0.7	9.2	9.4	21.6	21.5	31.3	32.8	-1.6	-0.6
S. D.	1.2	0.9	1.9	1.9	4.6	3.8	5.6	4.9	1.5	0.9
"Blind"										
Mean	-1.1	-0.8	10.3	8.9	22.8	19.5	33.5	29.9	-0.9	-1.0
S. D.	0.7	1.9	2.8	0.7	3.2	3.5	2.6	5.8	1.8	2.1

Combined Data	0°	10°	20°	30°	0°
Normals					
Mean	-0.9	9.3	21.6	32.1	-1.1
S.D.	0.9	1.8	4.4	5.0	1.2
"Blind"					
Mean	-0.9	9.7	20.4	30.2	-0.8
S.D.	1.7	2.3	4.2	5.5	1.5

* The combined data and the direction of the gravitoinertial horizontal are expressed in degrees deviation from the gravitational horizontal. The data from the partially blind were computed from a restricted sample in each case (see text). Minus indicates a counterclockwise setting.

in the direction of the gravitoinertial horizontal in accordance with other similar studies (2,3). It is also clear that there are no important differences between the two eyes. Similarly, the partially blind observers set the luminous line in accordance with the direction of the gravitoinertial horizontal and therefore can be said to have perceived the oculogravic illusion. This generalization is supported by both the monocular data and the combined data as indicated above. It is evident (Table I) that the differences between the normal and partially sighted observers are minimal. Statistical comparisons were not attempted because the conditions of observation for the partially blind observers were not equivalent to those for the normals. It is obvious, however, that the differences between the results from the normal individuals and from these partially sighted observers under these conditions of observation were extremely small both during rotation and while the centrifuge was stationary. The data clearly support the notion that partially blind observers with severe visual deficiencies, but with normal vestibular function, perceive the visual horizontal much like observers with normal central vision.

DISCUSSION

The results of this experiment make it plain that only minimal visual acuity is required to set a luminous line to the horizontal with an accuracy equal to that demonstrated by persons with normal vision. Nevertheless, it must be emphasized that all of the partially blind observers did use visual information to some extent in getting about, and, of course, they were able to see the luminous line although not necessarily with central vision. Two of them encountered much difficulty in seeing the line adequately. Each observer was questioned regarding his use of vision in spatial orientation in everyday life, and all replied in the affirmative to each of the following questions: 1) Can you see the floor as flat? 2) Can you see vertical and horizontal lines in a lighted room? 3) Can you see telephone poles as vertical? 4) Can you see buildings as vertical and roof tops as horizontal? These affirmative replies make their good performance much less surprising. In other words, these individuals regularly received information regarding the visual horizontal and vertical in their daily experiences and therefore had developed the necessary visual framework to make "normal" responses in this experimental situation. It is worth noting, however, that accurate settings can be made by observers with extremely limited visual capacity. One observer whose vision was rated as no better than "light perception" had a constant error of 0.0° in the prerotation static series and +0.1° in the postrotation series, while another who was able to read no letters on the test chart even within 10 feet showed a constant error of only -2.1° in each case. Both of these observers clearly perceived the oculogravic illusion. The results of this study support the notion that interaction between visual and nonvisual sensory mechanisms is possible with very minimal visual information available to the observer. Certainly normal central vision is not required. The data also suggest that the oculogravic illusion may be expected to be perceived by normal individuals under conditions of severely reduced visual functioning.

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13. ABSTRACT

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