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16. Abstract

The placement of a point in the median vertical plane under the influence of a moving optical environment was tested in 12 subjects. It was found that the median plane was displaced in the same direction as the movement of the visual environment when the environment was moved at speeds ranging from 9 $\pm$ 1 radians/minute to 45 $\pm$ 1 radians/minute. It was established that unidirectional movements of the total optical environment always caused a spatial disorientation with respect to external visual reference points.

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EFFECT OF A MOVING OPTICAL ENVIRONMENT ON THE SUBJECTIVE MEDIAN

I. Introduction.

The point in the visual space which is judged subjectively to lie straight ahead in the median plane has been studied under various conditions in the past.[5] Armin von Tschermak conducted some of the earliest intensive investigations of the conditions causing the displacement of the subjective straight ahead from the objective straight ahead.[7] More recently the "sensory tonic motor theory" has been proposed to explain the displacement of the subjective median plane.[3]

According to Ewald Hering, who did the first studies of the setting of a point in the median plane, this point may be established with small errors when an individual is sitting in a normal upright position.[4] The purpose of the present study was to determine if movement of the optical environment influences the setting of the straight ahead.

The ability to orient oneself to optical reference points external to oneself, especially the ground and horizon during flight, is often necessary. Most accidents attributed to disorientation have occurred when visual references were obscured in either hazardous weather or at night and disorientation is often experienced among pilots who fly through clouds or in formation.[6]

Though the emphasis in the past has been placed on the effects of vestibular and proprioceptive stimulation on disorientation, recently the potency of optical stimulation on orientation has been given greater attention.[1-2]

II. Methods.

A rotating cylindrical drum was used for the purpose of eliciting disorientation. The top and the bottom of the drum were conical in shape to eliminate all stationary stimuli which may be viewed by the subjects inside of the drum. The bottom of the drum had an opening 36″ in diameter and was suspended so that the bottom was 28″ from the floor. The drum was 4′ in diameter and 5′5″ high. The inside of the drum had alternating 1.5″ black and white vertical stripes.

The subjects were seated in the drum and their heads were held in a fixed position by a headband which was secured to a metal bar above the subject; thus, their heads were held so that the point which was objectively straight ahead could be established.

A ½″ by 6′ vertical rod was moved by the experimenter in a semicircular path in front of the subject and the subject was required verbally to direct the experimenter so that the rod appeared exactly in the subject's median plane. The rod was guided in a predetermined path by a semicircular metal ring at the base of the rod. Each time the rod was placed in the position of "straight ahead" as instructed by the subject this placement was recorded by the experimenter and the rod was moved out of the subject's field of view. The side from which the rod entered the subject's visual space was alternated with each trial.

In order to determine the constant error[4] or average distance of displacement from the objective straight ahead, the subject placed the rod three times for each test condition. Each test was performed at one preselected drum speed. Errors in a counterclockwise direction were assigned negative values and errors in a clockwise direction were assigned positive values.

Twelve visually normal college students were used as test subjects. After being given the instruction that they were to direct the experimenter to move the rod to a "straight ahead" position, they entered the optokinetic drum. For each subject a control measurement was obtained in which the subject placed the rod in a straight ahead position when the drum was standing still. Thereafter each subject then placed the rod while the drum was moving at speeds ranging from 9 ± 1 to 45 ± 1 radians/minute.

III. Results.

In all tests the subjects displaced the subjective median in the same direction in which the optical environment was moving. All subjects were influenced by higher speeds of optical stimulation and set the subjectively determined median at a greater distance from the objective median than they did at the slower speeds (see Table 1). Even at the slowest speed used, the subjects placed the rod a significantly greater distance from the objective median than they did in the control tests in which the optical environment was stationary ($t=8.2454$ $P<.05$).

IV. Discussion.

It is clear from these findings that a person may be influenced by his optical environment so that objects are displaced with respect to an objective reference to the egocenter. These experiments provide quantitation of the observation that the optical environment plays an important role in orientation in space. For this reason it is strongly advised that the subjective optical space should never be equated with the objective space when the visual environment is in motion, though under normal stationary conditions the subjective and objective space practically coincide.

TABLE 1.—Placements of the Subjective Median Plane under Conditions of Various Speeds of Rotational Optical Stimulation

Placement of median (+ = clockwise − = Counterclockwise) N = 12

speed (clockwise) radians/minute	constant error (degrees)	Deviation
0 (control)	−0.08	3.77
9±1	+6.53*	9.43
18±1	+8.59	8.46
27±1	+10.22	11.74
36±1	+11.00	9.40
45±1	+11.90	11.65

* Significantly greater than control ($t = 8.2454$ $p<.05$).

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