Time judgment as a function of angular velocity

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The present experiment was undertaken in an attempt to determine possible effects of angular velocity upon time judgment. Thirty-six college sophomores were used as Ss. Angular velocity was induced by means of a motor-driven rotating chair. An analysis of variance and t test indicated bodily rotation during time reproductions had a significant ($p < .05$) effect upon 27- and 37-sec time reproductions. The results implied that speed of rotation is directly proportional to the magnitude and occurrence of positive time-judgment error.

The amount of experimental material concerning the effects of bodily rotation is phenomenal. However, the majority of the articles deal with physiological reactions to the stress of rotation, and few, if any, are concerned with objective sensory judgments. Wendt (1951) described the effects of rotation as unique sensory experiences. Hirst, Pickford, & Wyburn (1964) described the effects of rotation in terms of eye-muscle reactions, vascular effects, and head pains. With the exception of studies done by Graybiel, Kerr, & Bartley (1948) concerning angular accelerations, little has been done to determine the relationship between time perception and body movement.

The present experiment is an attempt to determine the possible effects of what Bartley (1958, p. 325) and Johnson & Taylor (1965, p. 26) termed "angular velocity" upon time judgment using the method of reproduction. The experimental hypothesis contends that the speed of bodily rotation will be directly related to the amount of negative error. If one is to assume that bodily rotation increases the number of observable changes, such a hypothesis will be found to be consistent with the findings of Fraisse (1963), that stimuli which increased the number of observable changes increased the apparent duration. Bartley (1958) states similar findings in which he refers to rates of body processes as determinants of sensory perception of activity.

The subject of time judgment of filled or active time intervals, compared to unfilled or inactive intervals, has been researched by Loehlin (1959) and by Hirst, Pickford, & Wyburn (1964). Hirst et al (1964) have tried to clarify this relationship be denouncing time and external movements as direct sensory experiences and by referring to such effects as perceptual experiences derived from the integration of a mass of sensory data. However, in experiments done by Loehlin (1959) and Triplett (1931), no differences were found in accuracy and reliability of reproductions between empty or filled intervals with time intervals of less than 8 sec. It is therefore consistent with the experimental hypothesis and reasonable to deduce from the majority of published research that the rotation of Ss during reproductions will increase the number of observable changes, resulting in negative time-judgment error.

SUBJECTS

The Ss consisted of 36 male college sophomores.

APPARATUS

The apparatus consisted of a blindfold, stopwatch, clicker, and an office swivel chair fitted with a small variable-speed motor effectuating chair rotation. The chair was equipped with a headrest, waist strap, footrest, and leg straps.

PROCEDURE

Nine Ss were assigned randomly to each of two experimental and two control groups. All Ss were individually blindfolded and seated in the rotational chair with waist and legs strapped in a normal sitting position. Ss were instructed to listen, without counting, to a time constant (TC) that they would later have to reproduce. Three Ss in each group received 17-sec TCs, three received 27-sec TCs, and three received 37-sec TCs. E initiated and terminated the TCs with the snap of a clicker. After a 2-min delay, E again initiated the beginning of a time interval, which each S had been instructed to terminate by saying the word "stop," in an effort to reproduce the previously administered TC.

In Experimental Group 1 the chair was rotated counterclockwise at 15 rpm during reproduction attempts. A similar procedure was used for Experimental Group 2, with the exception of the speed of rotation which was increased to 30 rpm. In an attempt to keep noise level constant in control groups, the experimental group procedure was duplicated with the motor uncoupled from the chair during reproduction attempts, resulting in a noise level of 15 rpm for Control Group 1 and a 30-rpm noise level for Control Group 2.

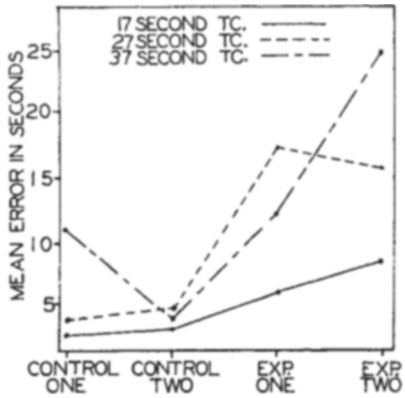

Fig. 1. Error as a function of bodily rotation.

Using a stopwatch, E recorded the length of reproductions to the nearest 10th of a second for each S. In an effort to control any experimental stimuli affecting motivation, all Ss were instructed prior to reproduction attempts that experimental conditions would remain constant for a period of 2 min, regardless of length of replication.

RESULTS

A perusal of Table 1, which exhibits the time estimations of each S and the mean time judgments of the individual groups, indicates a general trend of positive time-judgment error. However, Table 1 also illustrates a marked increase in positive error in the experimental groups which an analysis of variance and a two-tailed t test indicated was significantly ($p < .05$) larger than the positive error achieved by the control groups. Figure 1 illustrates the overestimation relationship between the control and experimental groups and lack of error variation among Ss subjected to 17-sec TCs.

Table 1
Time Judgments

TCs	17 Sec	27 Sec	37 Sec
Rotation			
	17.5	49	57
15 rpm	28	55	54.5
	30	28	39
	$\bar{X}$ = 25.1	$\bar{X}$ = 44	$\bar{X}$ = 50.1
	33.5	37	34
30 rpm	18.5	37	67
	19	53.5	75
	$\bar{X}$ = 23.6	$\bar{X}$ = 42.5	$\bar{X}$ = 59.3
Nonrotation			
15 rpm	21	29.5	38
Noise	13	27	75
Level	21	31	31
	$\bar{X}$ = 18.33	$\bar{X}$ = 29.1	$\bar{X}$ = 48
30 rpm	18	28	40
Noise	17	30	42
Level	20	38	39
	$\bar{X}$ = 18.33	$\bar{X}$ = 32	$\bar{X}$ = 40.3

DISCUSSION

Contrary to the experimental hypothesis, the results of this experiment imply that perceivable body movement results in positive time-judgment error. Such implications are in accordance with the findings of Woodrow (1933), which pose time perception or experiences of duration as dependent properties of sensory experiences.

Since the function of time perception cannot be assigned to a specific body mechanism (Bartley, 1958), a wide variety of controls are pertinent to insure exclusion of extraneous variables capable of affecting such a massive expanse of sensory receptors (Hirst, Pickford, & Wyburn, 1964). Such rigid controls were exercised in the present experiment with the exception of noise level. The noise produced by the rotation motor afforded a slightly higher-pitch noise level when uncoupled from the chair in control group reproductions than it did when coupled to the chair in the experimental group replications. Such a change in noise level has been found to shorten judgment of time intervals when using brief durations (Fraisse, 1963). However, the noise-level differences between control and experimental groups were significantly ($p < .05$) less than that produced between 15 and 30 rotation levels.

It is pertinent to note the method of time judgment used in the present experiment. Arons & London (1969) found that time-interval estimations were influenced by the method employed in the estimates. The results of studies conducted by Hornstein & Rotter (1969) indicate that time intervals are underestimated when the method of reproduction is used. Such results enhance the significance of the positive error exhibited in the experimental groups, but are inconsistent with results obtained from the control group. However, the consistent positive error of the control group may be attributed to a reversal of spontaneous judgment, due to anticipated demands of the perceivable experimental situation (Arons & London, 1969).

Although it is evident from the results of this experiment that bodily rotation induces positive time-judgment error, the magnitude of such error is questionable, due to an insufficient explanation of similar positive error in the control groups. The relationship of time perception to speed of body movement warrants further investigation utilizing longer TCs and a wider range of rotation speeds.

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The effect of stimulus type on formal similarity between stimuli and their primary associations

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The experiment investigated the effect of stimulus type on formal similarity (FS) between stimuli and Ss' primary associations to them. Word (W) and nonsense (NS) stimuli were employed. FS was defined as percentages of letters appearing in the same ordinal positions in associations as in stimuli. Results indicated that FS between NS stimuli and their primaries consistently exceeded chance while that between W stimuli and their primaries exceeded chance in only one of six cases.

Noble (1952) developed an index of meaningfulness, m, which has achieved wide usage among researchers of verbal behavior (m = mean number of continuous associations evoked to a stimulus in a 60-sec interval). But Schulz & Hopkins (1968) noted that Noble and his followers (e.g., Noble & Parker, 1960) paid little attention to the nature of associations, being chiefly concerned with reliable measurement of their numbers. Schulz & Hopkins obtained the primary associations of 96 disyllables previously scaled for m by Noble (1952). They found that a tendency for the primaries to have the same initial letters as their stimuli was inversely related to the m of the stimuli. The present research attempts to test a proposed explanation for this finding.

Noble used two types of stimuli in his research: Words (W) and nonsense (NS). It is proposed that Ss respond to W and NS stimuli on different bases. In their previous experiences with words, Ss have learned the objects, events, or attributes to which they refer. Associations to W stimuli are based on these semantic referents. But Ss have not previously encountered NS stimuli and, therefore, such stimuli cannot refer directly to Ss' prior experiences. Consequently, Ss respond to NS stimuli on a formal basis, i.e., in terms of the similarity of their letters and/or sounds to known words. It is hypothesized that formal similarity (FS) between a W stimulus and Ss' associations to it does not exceed chance, while that between a NS stimulus and Ss' associations to it is significantly greater than chance.

This hypothesis accommodates Schulz & Hopkins's results. They found that stimuli