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The effects of age on perceptual changes using two new perspectives of the Necker cube

GARY L. HOLT
Eastern Illinois University, Charleston, Illinois 61920

and

JOHNNY L. MATSON
Indiana State University, Terre Haute, Indiana 47809

Eleven age groups of 22 each were shown the Necker cube illusion on three separate trials, using a different instructional set for each. Frequency of reversals was determined by the number of times the subject indicated that the "X" on the cube changed perspectives during a 90-sec trial. The results of a 3 by 11 analysis of variance revealed a .01 level of significance between the peak age groups, 25 and 45 years, and the 55-, 65-, 75-, 85-, 95-, 5-, and 10-year-old groups. These data suggest that young and old people were less able to reverse visual perspectives than the middle age groups.

Since the original study by Necker (1832), most perceptual research using the Necker cube examined the illusory quality of perceptual reversals. Results showed that factors such as brain damage (Cohen, 1959), heart rate, cold (Roland, 1970), retinal anoxia (Pickergill & Jeeves, 1964), and hyperventilation (Targowski & Baer, 1966) affected reversal rates, while lumination and the presence of cataracts did not (Heath, Ehrich, & Orbach, 1963). These studies suggest that physiological factors are important in determining the number of perceptual switches recorded. A further assumption is that the aging process may create perceptual changes. Results with the Müller-Lyer, Ponzo, and Titchner circles illusions follow this hypothesis.

In that the Necker cube has not been used to test the effects of age on reversal rate, the present study will examine whether different age groups report a similar or divergent number of reversals on the Necker cube illusion using different instructional sets varying in degree of structure. Also, two additional perspectives of the Necker cube have been identified (Holt & Matson, 1974) and used for this experiment as a measure of perceptual reversability. Varying instructional sets and adding two new perspectives may prove to be a useful development in creating a more sensitive instrument for examining visual perceptual differences.

METHOD

Subjects

Two hundred and forty-two volunteers were obtained from the general population of upper New York State and central Illinois. Of this sample, 11 males and 11 females were chosen from each of the following mean age groups: 5, 10, 15, 25, 35, 45, 55, 65, 75, 85, and 95 years. Equal portions of the sample were collected from both sections of the country. Many of the 85- and 95-year-olds lived in nursing homes.

Apparatus

A Kodak 800 Carousel slide projector was used to present the stimulus and a battery-powered digital counter aided in recording. A hand-operated stopwatch was incorporated to time duration of stimulus exposure.

Procedure

The experiment was divided into three separate 90-sec trials; each was composed of different instructional sets. The first two sets of instructions prompted spontaneous, or random, reversals in which the subjects could change the "X" in any order. Instructions on Trial 3 specifically directed the subject where to see the "X" on the cube.

Frequency of reversals consisted of the number of times the subject pressed the detonator on the counter during each trial. The slide was projected on a wall 1.5 m in front of the subject, who was on the experimenter's right. Instructions were read to the subject and reread if he so desired. When further explanation was necessary, prearranged examples were used. A maximum time limit of 5 min for explanation was set. If at any stage of a trial the instructions could not be understood or carried out, the experiment was terminated for that subject. The following are specific instructions for the three trials:

Trial 1: The subject was told to perceive the cube as a three-dimensional transparent glass object with a black "X" painted on it. He was then asked to describe where the X was seen on the cube. If the person could not perceive the X in at least two positions, the frame of reference was changed and the experimenter outlined two of the perspectives until the subject saw the X in those positions. When the subject understood the instructions, he was asked to press a detonator every time the X changed perspectives in relation to the cube. The subject was given 90 sec to switch the X as many times as possible. He was asked to change perspectives of the X as fast as possible.

Trial 2: The subject was told to explain where the X was seen on the cube. If he did not see it in four different positions, the subject was shown where the perspectives could be perceived. He was then given the following instructions: "I want you to try to see the 'X' on the cube in four different ways. See the 'X' in the lower left-hand corner on the top of the box [see Figure 1a]. The second way to see the 'X' is in the bottom middle of the box. Now see the 'X' a third way: in the center front, middle of the box [see Figure 1b]. The fourth way is to see the 'X' in the lower back left-hand corner of the front of the box." The subject was then asked to switch the X as rapidly as he could by moving it from position to position as fast as he could for the entire 90-sec trial. All four perspectives of the X were to be used.

Trial 3: The subject was asked to point out and explain the different perspectives of the X to the experimenter. Each subject

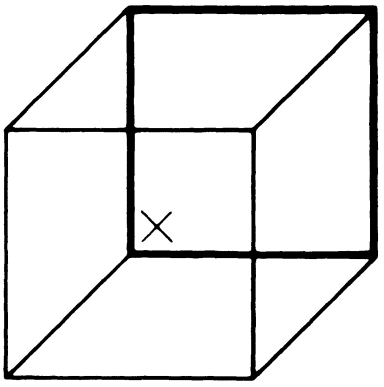

Figure 1a. The Necker cube with wide lines on the front side of the cube. When viewed in this perspective, the "X" is seen in the lower left-hand corner on the top of the box and at the bottom middle of the box. Wider lines are included only to assist the reader in identifying the visual perspectives and were not a part of the original stimulus.

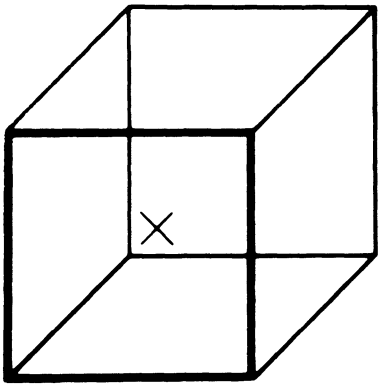

Figure 1b. The Necker cube with wide lines on the front side of the cube. When viewed in this perspective, the "X" is seen in the front middle of the box and at the lower back left-hand corner of the box. Wider lines are included only to assist the reader in identifying the visual perspectives and were not a part of the original stimulus.

was then asked if he understood the verbal descriptions of the four different positions. If the subject said no, he was retrained. If he said yes, the trial was begun.

The subject was given each of the above perspectives verbally, one by one, and was asked to switch the X into the requested position as quickly as he could. When he located the named perspective, he was to immediately press the detonator. Another perspective of the X was then given. The four different positions were chosen from a prearranged random list during the 90-sec time limit.

RESULTS

Figure 2 shows the number of reversals for each age group on every trial. Interactions of the three trials of the experiment were measured over age by a 3 by 11 Trials by Age Group analysis of variance. Data showed significance at the .01 level with respect to performance by age groups and trials.

A Duncan's multiple-range test showed further that 5-year-olds scored significantly lower than 10-year-olds, while 65-, 75-, 85-, and 95-year-olds scored significantly lower than all other groups, excluding 5-year-olds, on every trial. The 35-year-old mean age group achieved the highest scores in all instances. The 45 and 25 mean age groups scored second and third highest, respectively, but significantly lower than the peak age group on Trials 1 and 2.

Higher scores and larger differences between scores for each age group are present in Trials 1 and 2 of the experiment. Conversely, Trial 3 response rates are smaller for all groups, with little difference between the scores of peak groups 15, 25, 35, and 45, and between the scores of the lowest scoring groups 5, 65, 75, 85, and 95. However, data on Trial 3 did show significant differences between 5- and 10-, 10- and 15-, 45- and 55-, and 55- and 65-year-olds.

DISCUSSION

Much of the life-span research in perception has shown that the response patterns of young and very old subjects are similar when observing visual-perceptual stimuli, a finding consistent with results reported here (Comalli, Note 1; Leibowitz & Judisch, 1967; Wapner & Werner, 1975; Wapner, Werner, & Comalli, 1960). The significantly fewer reversals obtained between Trial 3 and the other two instructional sets over age groups suggest that these varying instructions may also be of value for measuring visual perceptual flexibility. Of particular significance was the small number of reversals reported during Trial 3, in that the subjects had time to assimilate the method of perceiving the various perspectives of the X but consistently reported the lowest number of reversals.

The ability to reverse the visual perspectives of the Necker cube is thought to be an indicator of visualization, the ability to organize and process materials and the ability to shift from one way of thinking to another within the context of familiar intellectual operations (Baltes & Schaie, 1974). Age differences

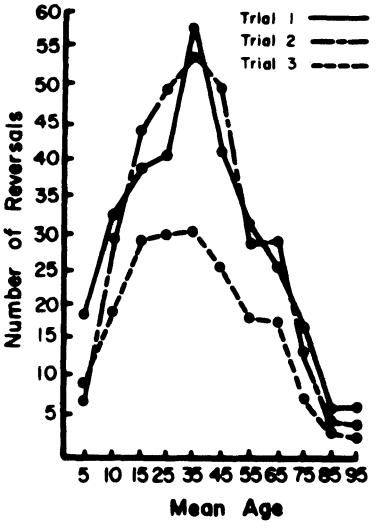

Figure 2. Number of reversals as a function of mean age for the three different trials.

Table 1
Summary of Analysis of Variance on Necker Cube Reversals

Source	df	SS	MS	F
Total	725	562,419		
Trials	2	19,409	9,705	18.8*
Age Groups	10	172,522	17,252	33.4*
Age Groups by Trials	20	12,252	613	1.1
Errors	693	358,236	516	

*$p < .01$

were not apparently due to visual acuity, since all subjects who were unable to clearly see the lines of the illusion were dropped from the experiment. Therefore, the poorer performance of the old and young might be due to organizing and intellectually processing visual-perceptual stimuli. This variable may also account for the marked decrements of responding on Trial 3 which required a more active reorganization of the perspectives. Factors producing differences in the ability to perceptually organize the Necker cube may vary from age group to age group. For 5- and 10-year-olds, maturation may be the variable enabling them to perform well on cognitive-perceptual tasks such as coordinating spatial perspectives (Broadinsky, Jackson, & Overton, 1972; Overton, Wagner, & Dolinsky, 1971; Shantz & Watson, 1971), while with the aged a lack of environmental stimulation may be the important causative agent (Hoyer, Labouvie, & Baltes, 1973).

The data presented here support previous developmental studies on visual-perceptual phenomena. This is of particular singificance here because a new stimulus has been tried with a significance sample size. It is suggested that further research using visual perceptual illusions, including the Necker cube with the four different perspectives (Holt & Matson, 1974), may aid the study of developmental differences over age. An examination of causative agents should be enhanced by applying methods such as the one described here.

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