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The Effects of Age, I.Q. and Achievement on Children's Ability to Reverse the Necker Cube

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THE EFFECTS OF AGE, I.Q. AND ACHIEVEMENT ON CHILDREN'S ABILITY TO REVERSE THE NECKER CUBE

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THE EFFECTS OF AGE, I.Q. AND

ACHIEVEMENT ON CHILDREN'S

ABILITY TO REVERSE THE NECKER CUBE

Developmental psychology originated from and remained the domain of child studies for fifty years. Then research with the aged was initiated. In the last two decades additional studies incorporating the middle age groups has been conducted with the result of connecting young, middle, and old-age into a continuum. Prior to this trend two separate entities of childhood and old-age developmental psychology had existed. As a comprehensive life-span psychology developed (Schaie, 1970; Neugarten, 1971) it was inevitable that experimentalist and their procedures would flood this area with sophisticated techniques. In this manner the stigma attached to poorly conceived research with children was resolved. As a result, a much needed base for distinguishing differences between age groups was established.

Present research has placed an increased emphasis not only on age-related changes but on factors such as I.Q. and achievement as possible determinants of behavior. This article will examine these three agents with the hope of determining their relationship to visual perceptual switching in the Necker Cube.

Age Changes in Perception

One of the most highly researched areas in life-span development was and is changes of ambiguous perceptual illusions over age. These phenomenon are two-dimensional optical-geometrical-figures drawn in dark lines on a contrasting background. Many times these figures confuse the viewer because what is perceived may be different from the physical information given by the eye. Therefore, it seems that the image may be modified by other information. This information, whatever it is, has created results differing over chronological age with respect to performance and magnitude of illusion in visual perceptual phenomenon.

Wapner and Werner (1956, 1957) dealt with ontogenetic changes in perception with subjects between 6 and 20 years of age. Using the Müller-Lyer and Titchner Circles Illusions the following results were obtained.

See Figure 1 and 2

(a) The Müller-Lyer showed a decrease in susceptibility between 6 and 15, followed by an increase through 19 years of age. (b) The Titchner Circles increased in susceptibility from 6 through 19 years of age. It was proposed that these results were due to changes in part-whole relationships character-

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See Graph 1 and 2

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istic of each illusion. The Müller-Lyer results were felt to be related to embeddedness of parts within the whole (assimilation) which had greatest effects with the youngest children. The Titchner Circles, conversely, was proposed to require a relationship between defined parts (contrast) and as such had its greatest effects at the older age levels. Later, using the same methodology, Wapner, Werner, and Comalli (1960) extended these findings over the entire life-span. One hundred male subjects between the ages of 20 and 80 were divided into seven groups with 10 people in each of the age-intervals, 20-24, 25-29, 30-34, 35-39; and 20 subjects in each of three age groups 40-44, 45-49, and 65-80. In the first half of the experiment, subjects were presented with the Müller-Lyer illusion on four trials. The left side or angles-in part of the illusion was set as the control while the angles-out or right half of the illusion was varied in length from trial to trial. The initial setting found the experimental variable, or angles-out, from the line as smaller than the control, or angles-in, toward the line. The angles-out line was then altered on each presentation from a larger length in one trial to a smaller length in the next. Conversely, the angles-in line was held constant for all trials. Subjects were asked to make the lines equal in length by turning a knob on a rack and gear device. No prior hint as to the correlation in length between the two lines was given. Results showed a relatively consistent degree of susceptibility between 20 and 39 years of age, while from 39-80 an increase in illusory effect was found with the most striking results occurring in the 40-44 age group.

The second half of the experiment utilized the Titchner Circles, an illusion consisting of an inner circle surrounded by a concentric ring of circles. The standard, always on the left, was composed of an inner circle, 16.5 mm. in diameter, and 5 surrounding circles each with a diameter of 25 mm. in steps of .75 mm. The variable circles were surrounded by 8 circles each, 9 mm. in diameter. Subjects were presented with a chart on which were drawn 17 stimulus pairs containing the control on the left and the independent variable on the right. At the top of the chart the inner circle of the variable was at its smallest (9 mm. in diameter). The inner circle increased in size toward the bottom so that the variable of the pair lowest on the chart had the biggest inner circle, 21.00 mm. in diameter. Subjects judged each of the 17 pairs of circles to see if the center circle of the experimental group was larger, equal to, or smaller than the center circle of the control figure. Two trials were given; in one, subjects went from the top down, and in the other subjects went from the bottom up. Results were presented in terms of differences between inner circles, where a larger score represented greater susceptibility to the illusion. Constant scoring occurred between ages 20 to 44 with decreases at the last two age levels, 45-49 and 65-80.

Combined results of the Wapner and Werner (1956, 1957) and Wapner, Werner, Comalli studies with the age range (6-80) showed the following: Müller-Lyer illusionary effects are greatest at the earlier age levels, decreasing with age during young and middle adulthood, then increasing again in old age. This contrasts Titchner Circles findings in that a steady increase in illusory effects occurred from 6 through 44, followed by a decrease at the two oldest age groups, 45-49 and 65-80 with a magnitude approaching that found at the earliest age levels.

In another study pertaining to age changes in perceptual illusions, Hanley and Zerbolio (1965) measured the effects of five illusions, Müller-Lyer, Ponzo, Horizontal-Vertical, Modified Ponzo, and Inverted-Horizontal. Subjects ranged in age from nursery school children to college students

Figure 3

and were randomly selected from Michigan State University and nursery and elementary schools in the immediate area. Following preliminary warm-up exercises subjects judged illusions in the following order: Modified Ponzo, Inverted-Horizontal, Müller-Lyer, Ponzo, and Horizontal-Vertical. Each illusion was displayed in turn on a 5" x 8" white card with contrasting black and blue lines for identification purposes. Pictures were encased in a 6" x 9" clear plastic frame atop a table on the opposite side of which, some 2-4 feet away, sat the subject in an upright position. He was forbidden to tilt his head or use fingers to measure the lines. A shaded 100-watt lamp slightly to one side between the display and the subject removed glare and reflection from the surface of the frame. Each subject pointed to the line that appeared longer. Responses were recorded by marking a data sheet at the appropriate level with a plus when the subject chose the variable as longer and a zero when he picked the standard as longer. A different sheet was used for each illusion, age group, and sex. Results found increases to third grade then a decline in magnitude of illusion similar to those of Wapner and Werner (1956, 1957). Similarly the modified Ponzo showed gradual but steady declines from first to fifth grade and a sharp decline from fifth graders to college students. Conversely, the Ponzo illusion

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See Graph 3

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showed rapid increases in illusion from nursery school to third grade then the scores remained constant through college age. Similarity to the Inverted-Horizontal is shown by increases in illusory effect reported from fourth grade to college students inclusively, while the Horizontal-Vertical increased from third grade to college students.

See Graph 4

Leibowitz and Judisch (1967), in further research with the Ponzo illusion, used a method similar to Hanley and Zerbolio's (1965) in that

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See Figure 4

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the stimulus was presented on cards in front of a seated subject. This study, however, used twenty-one stimuli of 4" in length, located near the open end of the array. A variable stimulus near the apex of the array differed in the lengths from 2½" to 5" with 1/8" increments per card. The variable line was 2½" and the standard line was 10 5/8" from the apex. Subjects were presented with one card at a time using a randomized order. The sample which ranged in age from 3.5 to 88 years was obtained from six different institutions. Results support those of Hanley and Zerbolio (1965). Illusory effect was essentially nonexistent for the youngest subject, then rapid increases occurred in magnitude with greater age until 13 years, after which consistent scoring was found up to age 50. For the oldest subjects tested, a marked decrease in magnitude of illusion resulted.

See Graph 5

It has been shown that illusory effect over age differs with respect to the illusion measured. This was demonstrated by findings in which the Müller-Lyer and Modified Ponzo declined in illusory effect with increasing age, while the Ponzo, Inverted-Horizontal, and Horizontal-Vertical showed increases in illusion from younger to older ages. It is noted, however, that while different illusions display various trends with respect to illusory effect over age, a consistency existed with respect to studies reported on the same illusion. Commonality is also shown with all developmental studies reported. Illusory effects differ over the life-span in either a progression-regression-progression, or regression-progression-regression pattern with middle age ranges scoring similarly to one another but differently from old and very young subjects who score alike. It is hypothesized that these results may be a base for future research with optical perceptual illusions in that consistent trends over age may show a relationship to developmental processes.

As noted, age is an influential determinant of visual-perceptual phenomena. Further discussion will focus on the relationship of achievement to perception.

The Effects of Achievement on Visual Perception

As demonstrated, much research has investigated age effects of perceptual illusions. In observing this phenomenon it seems that other variables may exist which influence change. One variable that could be important is general achievement.

Wright (1969) incorporated this variable with I.Q. and perceptual tests as a comparison of how well students achieve in the classroom. Third and fourth grade experienced teachers in a midwest city school system judged children in their respective classes. Those considered moderate to severe conduct problems were measured for academic achievement on items taken from the Behavior Problem Checklist. Third grade boys referred through this process comprised the final sample which was administered the following tests: (1) the Bannatyne Visuo-Spatial Memory Test; (2) the Graham-Kendall

Memory for Design Test; (3) the Wepman Auditory Discrimination Test; (4) the revised Illinois Test of Psycholinguistic Abilities; (5) the WISC Vocabulary subtest; (6) the California Short Form Test of Mental Maturity; and (7) the Iowa Test of Basic Skills. Results showed that the present sample performed significantly poorer on measures of auditory discrimination, visuo-motor memory, visual sequential memory, grammatic closure, auditory reception, verbal expression, delayed recall, reading, and spelling. Comparisons made between this group and classmates not chosen was based on teachers' ratings. Results showed experimental subjects to be more easily flustered and to have significantly lower performance on group tests of achievement and intelligence than the general populace of third graders. It is implied that adaptive behavior is interwoven with perceptual and cognitive development, all of which are affected by environmental factors.

Little (1970), studying normal third grade children, found a relationship of perceptual-motor proficiency to intelligence and academic achievement. Forty-seven girls and forty-four boys were given the Purdue Perceptual-Motor Survey, the Lorge-Thorndike Intelligence Tests, and the Iowa Tests of Basic Skills. Significant positive relationships were found among all variables tested.

Raven and Strubling (1968) have made practical application of the importance of visual perceptual skills. This was accomplished by using 238 second grade students from nine separate classrooms representing all races, nationalities, and socio-economic groups. Each class was randomly assigned to one of three groups. In the first treatment period Group I was presented with the Perception of Spatial Relationships unit of the Marianna Frostig Developmental Test of Visual Perception, while Group II was presented with the Frostig unit of Visual-Motor Coordination, and Group III, the control, was given outlined pictures to color. The coloring task was not considered a developer of perceptual skills, but this task might have contained an element of undirected perceptual activity.

The first treatment period lasted for fifteen school days. All groups within a classroom were taught by the same homeroom teacher. Upon completion of the Frostig treatment, the Science Curriculum Improvement Study Science Unit was undertaken for twelve days. Then, the S.C.I.S. achievement test and two subtests of the Frostig program were administered. Results indicated that transfer of specific content taught by the Perception of Spatial Relationships unit enhanced learning on the science material as did the more general Visual-Motor Coordination Unit.

It is believed that smooth accomplishment of the sighted person's visual-motor coordination depends on space perception. He must be able to move his body appendages up and down, to the right and left, and away from and toward his torso. Visual-motor coordination further requires the individual to focus on the relative position and motion between his body parts and objects. The Frostig materials may be interpreted as preliminary exercises of these abilities. This conclusion is supported by the results of the second planned comparison which showed no appreciable differences between the two Frostig groups on the science achievement test.

Raven and Strubling (1968) feel that development of elementary school science curriculums could be enhanced by further research analyzing more efficient modes of transferring perceptual skills needed to facilitate learning in similar tasks.

These studies indicate that a positive correlation may exist between achievement and ability to perform on perceptual exercises. Implications of results in the present study may be valuable in supporting this hypothesis.

The next topic to be discussed is a variable quite often mentioned in conjunction with achievement (Little, 1970). This variable, I.Q. will be examined with respect to its effects on optical perceptual skills.

The Relationships Between I.Q. Scores and Optical-Perceptual Illusions

As stated, age and achievement have been related to visual perceptual changes (Raven and Strubling, 1968; Little, 1970). It has also been suggested that I.Q. may effect outcomes on visual perceptual tasks. In illusion research it has been found of value to separate optical perceptual forms into two categories, those in which intelligence effects perceptual change and those in which it does not (Pollack, 1963, 1964; Flavell, 1963). It was found that optical-geometrical illusions tested over the life-span could be grouped according to decreases (Type I) or increases (Type II) in magnitude of illusion with greater age. Through critical examination it was noted that many Type II illusions involve a successive comparison of figural parts rather than a simultaneous examination. Furthermore, results demonstrate a high correlation between I.Q. scores and increased magnitude of illusion (Pollack, 1966). Similarly, Piaget found (Pollack, 1964) that phenomena perceived by decentration or successive viewing of configurational parts must involve their comparison through time (short-term memory) which for him is a form of intellectual behavior. Conversely, since Type I illusions appear to be determined largely by stimulus variables and the state of the receptor system, they are not viewed as being dependent on intellectual capacity (Flavell, 1963; Pollack, 1963, 1964).

Examinations of the available evidence tends to support the above assertions. For example, it has been shown that retardates are as susceptible to the Müller-Lyer (Type I) illusion as the normal populous of the same chronological age (Spitz, and Lipman, 1938; Jenkins and West, 1959). Furthermore Pollack (1963), also using the Müller-Lyer, found no correlation between I.Q. and magnitude of illusion with 50 normal children.

A key study by Pollack (1964) using children ranging in age from eight to eleven seems to add further support to this hypothesis. The Müller-Lyer (Type I) was converted to a Type II perceptual phenomenon by altering the temporal order of presentation of one of its two components. That is, the forked lines, or arrowheads, of the open component were presented first (arrowheads pointing toward each other); then an interval of 500 msec. occurred followed by presentation of the straight line in a position directly between the forks as opposed to presenting both components simultaneously. Along with the Müller-Lyer straight line, a comparison straight line was also shown because it produces by far the larger proportion of illusory magnitude (Pollack, and Chaplin, 1964). A greater accuracy at finding direction of illusory reversals existed during stimulus presentation as age increased.

The Necker Cube is a Type II illusion different from many others, because it is a two-dimensional drawing of a three-dimensional object. Concept formation is required for spatial comprehension, while cognitive

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See Figure 5a and 5b

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flexibility is needed for performance and the varying of instructional sets (Welford, 1958; Holt and Matson, 1974). Furthermore, the addition of an "x" on the cube adds two additional perspectives and makes the instrument a more sensitive tool for measuring visual perceptual switching.

The illusion was developed by L. A. Necker (1832) and most attention has been directed to the relationship of perceptual reversals, how they occur and what affects their rate. One of the leading theories attempting to explain why is proposed by Orbach, Ehrich, and Heath (1963). They state that switching of the cube may be due to equal size of both squares creating an orientation conflict concerning which square should be the front and which should be the back. They proposed satiation as an explanation of how this conflict is resolved. The central figure mediating one orientation is assumed to reach threshold during the viewing of the cube, at which point a reversal is reported. Central events mediating the new perception then satiate in the same way, while the previous satiation process begins to decay, and the first perception becomes dominant again.

In examining reversals as a measure of performance, a major concern is what affects switching of perspectives. Studies conducted are divided into two categories, those which pertain to physiological factors (not incorporating intelligence), and those incorporating the suggestibility level of a subject (showing high relationships to I.Q.). The former category has shown that reversal rates increase with incidents of brain damage (Cohen, 1959), drugs (Eysenck, Holland, and Trouton, 1957), heart rate, cold (Roland, 1970), and retinal anoxia (Pickergill and Jeeves, 1964) while fewer reversals occurred when electric shock (Baer, 1964; Riaichelli, Rockwell, and Clark, 1955) and hyperventilation (Targowski and Bare, 1966) were introduced. Furthermore, it was found that lumination and presence of cataracts (Heath, Ehrich, and Orbach, 1963) had no effect.

Orbach, Ehrich, and Heath (1963) discovered that reversal rates of the Necker Cube increased directly as a function of unsystematic figure-on, figure-off presentation. Later Orbach, Zucker, and Olson (1966) extended this study by alteration of the stimulus. This was accomplished by holding figure-off duration constant while varying length of figure-on duration for the first half of the experiment, then reversing stimulus duration roles with figure-off duration varying and figure-on time being constant. Both studies showed that growth of satiation to a perspective of the Necker Cube was enhanced by length and number of stimulus presentations. It is hypothesized that satiation thresholds are reached during figure-on time which increases switching of perspectives, whereas, during figure-off duration a decay of satiation occurs.

As mentioned, another explanation of reversals is suggestibility. Since three instructional sets are used in this experiment, it is of importance to note effects this variable might have on results. McGee (1963) found that positive verbal suggestion increases illusory effects of the Ames Trapezoidal illusion. This was accomplished by giving immediate feedback to the experimental group while the control group, who remained uninformed, continued to see the same number of reversals. Franks and Lindahl (1963) reported similar results. In their paper control subjects were told to let the cube change naturally while the experimental group was instructed to hold a perspective of the Necker Cube as long as possible. Findings showed that the hold condition was effective in creating a lower number of observable reversals than the control group.

Wolf, Ford, Cogan, and Cogan (1967) also addressed themselves to the problem of the possible effect suggestion might have on reversal rates of the Necker Cube. They randomly divided 30 subjects into three groups of equal size designated, H-H, H-L, and C. Group H-H was told that people of higher intelligence tend to see more reversals than people of lower intelligence, while Group H-B was told that people of higher intelligence tend to see fewer reversals than people of lower intelligence, and Group C was read a set of neutral instructions. Subjects were then taken individually to another room and seated at a desk on which the test figure lay. Experimenter 1 read the instructions to the subject, experimenter 2 tallied the number of responses, and experimenter 3 recorded the time. Results indicate that suggestion to decrease reversal rates created significantly fewer reversals, but that suggestion to increase reversal rate had no effect. It is concluded that the suggestion given to Group H-I appears to have been substantial enough to motivate subjects to try and decrease the number of reversals.

Holt and Matson (1974) have concluded a more recent study measuring effects of instructional sets on reversal rates of the Necker Cube over age. A random sample of 242 subjects from Central Illinois and Upper New York State was selected. Subjects were divided into mean age groups of 5, 10, 15, 25, 35, 45, 55, 65, 75, 85, and 95 with 11 males and 11 females in each group. Data obtained was of interest because: (1) No significant regional differences were found in scoring at any age level. (2) Results over age closely fit the shape of a normal probability curve. (3) Reversals were a measure not only of magnitude of illusion, but also of a conscious effort to change perspectives of the Necker Cube (a form of visuo-motor performance). (4) Three instructional sets with greater rigidity in each, from the first trial to the last, created slower reversal speeds. Results obtained seem to indicate that instructions and a change in mental state may effect perceptual switching. Examining data over age shows that increments were most significant from 5 to 10 and greatest decrements occurred between 55 and 75.

See Graph 6

This study examined causes of change in reversal rates with the Necker Cube. The two cells with greatest increments (5 and 10 mean age groups) in the Holt and Matson study were expanded by comparing 7, 8, 9, 10, and 11 year olds. It was felt that this method might give a more explicit definition of where the greatest increments occur in development. It is believed that findings might aid in establishing a base for examining other variables, possibly important as effectors of optical-perceptual illusions.

I.Q., achievement, and age are examined in this study. The first two have not been used as criterion for Necker Cube performance, nor have they been measured simultaneously, although each has been used in other studies pertaining to optical-perceptual change. By testing the same subjects on these three variables more valid relationships might be demonstrated. The Necker Cube is considered a Type II illusion which incorporates intelligence as an effector of illusory magnitude (Pollack, 1963, 1964; Flavell, 1963). Therefore, the correlation between I.Q. and Necker Cube reversals could prove to strengthen this hypothesis.

In that achievement is a goal oriented concept, determining a relationship between high achievement and high number of reported reversals seems to suggest motivational factors at work. It is felt that the need to achieve may be externally induced (other directed) by verbal and non-verbal cues from the teacher. Factors such as reported I.Q. results and the personality of the student could be important for inducing bias in the instructor which could affect his perceptions of how the student "should" perform (Wolf, Ford, Cogan, and Cogan, 1967).

The author concludes that achievement, I.Q. and age may be determinants of performance on the Necker Cube illusion. This might be demonstrated by a relationship between high I.Q., achievement and number of reversals within a given age range. Findings coupled with further research will determine if intellectual factors such as flexibility and comprehension are significant in perception and as such may be important in the learning process. If so, strategies may be implemented on various tasks aimed at developing perceptual skills. However, regardless of the explanation that accounts for perceptual changes with age, the phenomenon itself is worth describing because it reveals aspects of the world seen by the child and how it is transformed into the world adults perceive (Hanley and Zerbolio, 1965).

Method

Subjects

The experiment consisted of mean age groups 7, 8, 9, 10, and 11 with 10 subjects per age level. Students were chosen randomly from the general populace of the Eastern Illinois University Lab School. Children with visual problems were not used.

Experimenters

Ten experimenters were trained to administer the test. Observations were made after a three week practice period to judge the testers efficiency at administering instructions. It was stressed that a major concern was deciding if subjects were seeing the number of reversals reported. The following points were emphasized: 1. Number of eye blinks and orientation of the body nearer to and farther from the stimulus seemed to be related to reversal rates (Holt and Matson, 1974). 2. The subjects concentration on the stimulus needed to be maintained for reversals to occur. 3. Scores were not reported to the subjects therefore, no feedback was available to infer what a "high" and a "low" score should be.

Apparatus

The stimulus consisted of an 8" x 10" card made of white cardboard. Lines were made with india ink. Dimensions of the cube were 4" (per) on a side.

A hand operated stop watch was used to time the duration of stimulus exposure.

Scores from the California Short Form Test for Mental Maturity were used as the measure for I.Q. while teachers' ratings based on a scale of 1 to 5 were used for achievement.

Procedure

Testing was conducted between 9 and 12 in the morning. Subjects were staggered so that people from each cell could be tested at different time slots. This was done to minimize warm-up and fatigue effects associated with different parts of the school day.) The experiment was divided into three separate 90-second trials. Each trial consisted of different instructional sets. The first two sets of instructions prompted spontaneous, or random, perceptual reversals in which the subject could change the cube's perspectives in any order. The third trial consisted of instructions from the experimenter directing the subject to different perspectives in which the "x" could be seen on the cube. Frequency of reversals were then tabulated on the number of times the subject lifted his left index finger in each 90-second trial.

For all three trials, the stimulus card was displayed horizontally on a table before the subject. The experimenter was on the subject's immediate left.) Instructions were read to the subject and reread if he so desired. (If further explanation was necessary, prearranged examples were used with a maximum time limit of five minutes.) If at any stage of the various trials the instructions could not be understood, or executed the experiment was terminated for that subject. (If the subject reported more than 154 reversals (10 more switches than any of the 242 subjects used in the Holt and Matson study 1974) then his scores were discarded and another subject was randomly chosen. This was done to insure that results consisted of observed reversals as opposed to false reporting.) The following are specific instructions for the three different trials.

Trial 1: The subject was told to perceive the cube as being a 3-dimensional transparent glass object with a black "x" painted on it. He was then asked to describe where on the cube the "x" could be seen. If he could not perceive it in at least two positions, the frame of reference was changed by having the experimenter outline the "x" on the cube so that it could be seen by the subject in two different perspectives. If the subject understood the instructions, he was asked to lift his left index finger every time the "x" changed perspectives in relation to the cube. The subject was given 90 seconds to try and change the "x" on the cube.

Trial 2: The subject was first asked to explain where on the cube he saw the "x". If he did not see it in four different positions the subject was instructed as to where those perspectives were. When the subject understood this, he was given the following instructions: "See the "x" on the cube? I want you to try to see the "x" in relation to the cube in the following four ways. See the "x" in the lower left hand corner of the top of the box (see figure 5a). The second way to see the "x" is in the bottom middle of the box (see figure 5a). Now see the "x" a third way, in the center front middle of the box (see figure 5b). The fourth way is to see the "x" in the lower back, left-hand corner of the front of the box (see figure 5b)." He was then asked to switch the "x" while moving it around in all positions.

See Figure 5a and 5b

Trial 3: The subject was given each of the above perspectives verbally, one by one, and then asked to indicate when he saw the "x" on the cube from that perspective. When he could identify all four perspectives from the experimenter's description, trial three was started. The subject was asked to immediately lift his left index finger to show the reversal. When a described perspective could be perceived the subject was given another position in which to see the "x". The trial lasted 90 seconds.

Although the measurement procedure will be identical in all cases, past research with small children indicates that it may sometimes be necessary to exercise ingenuity in the pretest period for proper cooperation. This usually will involve making friends with the child before testing or permitting a balking child to return later (Hanley and Zerbolio, 1965; Holt and Matson, 1974).

Results

A 3X10 ANOVA examined three instructional sets for all subjects. Treatment consisted of high and low I.Q. groups for each of five ages.

Results showed significant interaction between treatments only. The Duncan's Multiple-Range Test was then run to determine the presence of significant differences between groups. Data revealed that with all ages except 11 year olds, the low I.Q. group saw fewer reversals than the high

I.Q. group. A breakdown of these scores found significant differences from

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See Graph 7 and Table 1

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high to low I.Q. groups; high I.Q. subjects saw larger numbers of reversals in 7, 8, and 10 year olds, while 9 year olds with high I.Q. saw more reversal at a nonsignificant level than the low I.Q. subjects of their age.

However, converse results occurred with the 11 year old high I.Q. group. They saw fewer reversals than the 11 year old low I.Q. group as well as high and low I.Q. groups in the 9 and 10 year old range and the high I.Q. groups in the 7 and 8 year old range. It is felt that this score could be due to small sample size (5 in each group). This hypothesis would seem to be supported by the consistency of results in all other cells. For example, with low I.Q., reversal rate increased with age except for two nonsignificant dips with the 8 and 10 year old mean groups performance. Similarly, high I.Q. treatments showed steady increments except for a nonsignificant dip in reversal rates by 9 year olds and the before mentioned decrease with respect to 11 year olds. This trend is demonstrated further when scores of high and

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See Graph 8

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low I.Q. treatments for each age are combined. Steady increments in performance occur from 7 through 10 years of age. However, the high I.Q. treatment of the 11 year old age groups decreased mean reversal rates to a performance level greater than 7 and 8 year old groups but less than ages 9 and 10.

Achievement ratings for each subject were measured against the total number of Necker Cube Reversals for all three trials. Three Pearson Product

Moment Correlations were run; one test correlated scores for all subjects, one correlated scores for high I.Q. subjects, and one examined low I.Q. subjects. All tests yielded correlation between .1 and .2.

Discussion

Findings of this study seem to support Pollack's (1963, 1964) and Flavell's (1963) contention that intelligence is an effector of magnitude of illusion with Some of Type II optical-perceptual stimuli. As noted previously, four of five high I.Q. age groups performed better than their low I.Q. counterparts. Also, results indicated that a significant difference between treatments existed in three of these age groups.

Results also support previous research with other illusions which contend that age may be an important determinant of performance in perceptual illusions. It is emphasized that the method of this study was the same as Holt and Matson (1974) who found large increments in reversal rates with the Necker Cube between mean age groups 5 and 10. It is noted that 7, 8, 9, 10, and 11 year olds in the present study found similar results.

No relationship between switching and achievement ratings were found. Conversely, achievement test scores reported by Little (1970), and Raven and Strubling (1968) found significant relationships to perceptual tasks. While at first glance these findings may seem ambiguous, the author feels an important difference may exist. Results of previous studies measured scores on achievement tests while this study measured achievement ratings in which the teacher judged the degree of motivation or goal oriented behavior exhibited by the subject. It is felt that implications of the present results should be considered on the grounds that these scores are not measuring the same variable. The author believes that lack of correlation demonstrates the poor predictability of success which teacher's perceptions have on student achievement. Also, implication of these findings may point to the subjective nature of many practices used to evaluate students in the classroom. It is noted that research examining achievement ratings may make teachers more aware of the vulnerability inherent in evaluative procedures used in the school.

Prior research showed (Holt and Matson, 1974) the greatest number of reversals on trial one while in the present study, trial three had the most perceptual switching. It is felt that several factors may be involved in differing results. One consideration may be practice effects. Therefore, while trial three requires the greatest amount of flexibility of the three instructional sets, trial one may need the greatest adaptability because the stimulus is novel; whereas in trials two and three it is not. Also, prior experiences unique to each individual may affect performance. For example, working with verbal and written instructions, either independently or semi-independently, could be crucial for evaluating performance. Therefore, security may be offered by the structured setting of trial three in that personality factors demonstrated by emphasis of the individual's teaching method or the degree of extroversion or introversion of the child could be important. Either or both might cause increments seen in results on trial three. But whatever the causative agents, three points deserve consideration. (1) The problem is a complex one. (2) The phenomenon of differing results over levels was made comparing 44 subjects to 50 subjects. (3) Further research needs to be conducted before this subject can be fully understood.

In summary, this study supports the contention that age and I.Q. are linked to performance with the Necker Cube. Because other studies on perceptual tasks have found similar results, it may be possible to infer that developmental and cognitive factors are important in determining results of visual perceptual paradigms. Conversely, achievement scores had no relationship to Necker Cube reversals in this study. It is felt that present results may measure the teacher's perceptions of student motivation toward goals, rather than their knowledge of a particular subject as was the case in the Wright (1969) and Little (1970) studies. Furthermore, it was shown that performance between instructional sets differ from this experiment and a similarly conducted life-span study (Holt and Matson, 1974). It is felt that practice effects, environmental conditions, and personality traits may be causative agents.

Results indicate that I.Q. and age may be relevant factors while differences in instructional sets and achievement need to be researched further before practical application of the data can be initiated.

Fig. 1. The Muller-Lyer pattern.

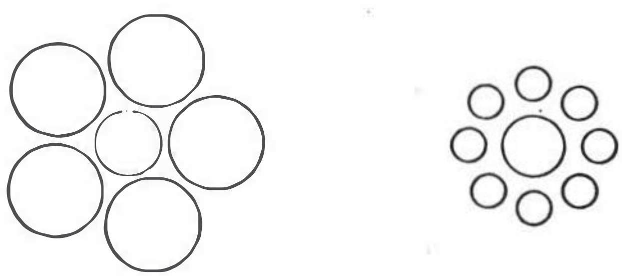
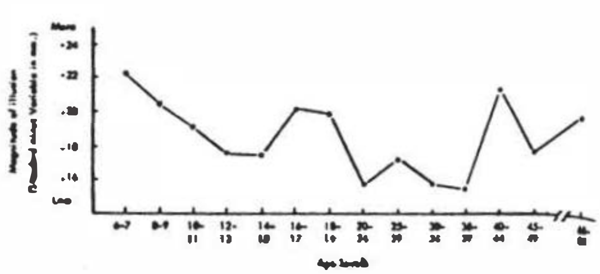
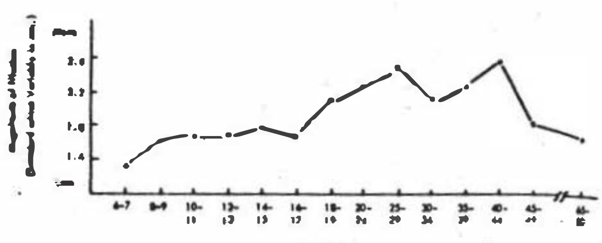


Fig. 2. The Titchener Circles pattern.



Graph 1. Developmental changes in the Muller-Lyer illusion from ages 6 to 80.



Graph 2. Developmental changes in the Titchener Circles illusion from ages 6 to 80.

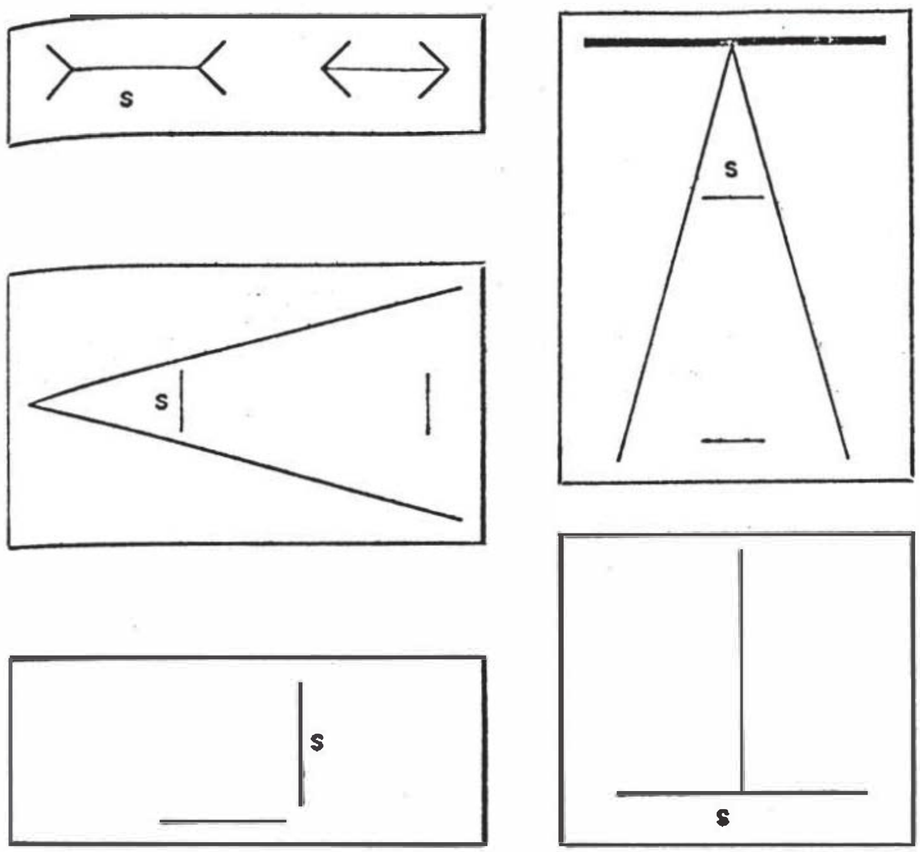
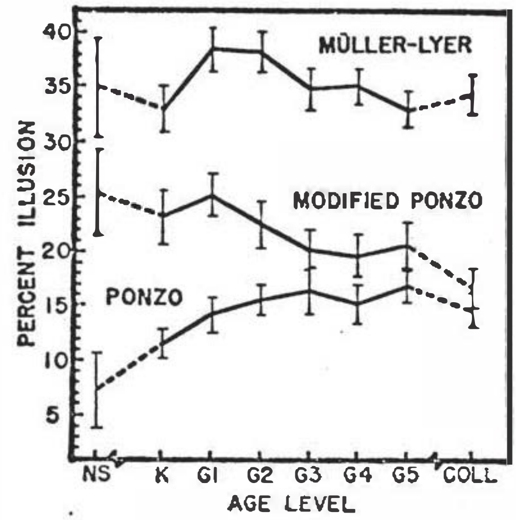
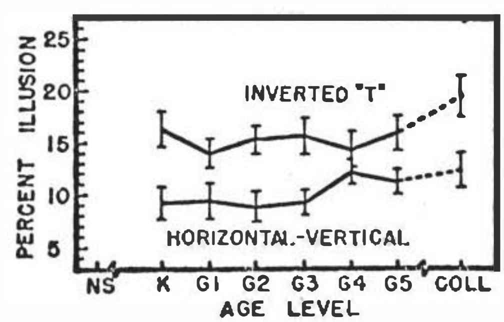


Fig. 3. Left,top to bottom: Muller-Lyer,Ponzo,and Horizontal-Vertical illusions;right,top to bottom: Modified Ponzo and Inverted T illusions. Added s marks the standard in each illusion.



Graph 3. Developmental changes in the Muller-Lyer, Ponzo,and Modified Ponzo.



Graph 4. Developmental changes in the Horizontal-Vertical and Inverted T.

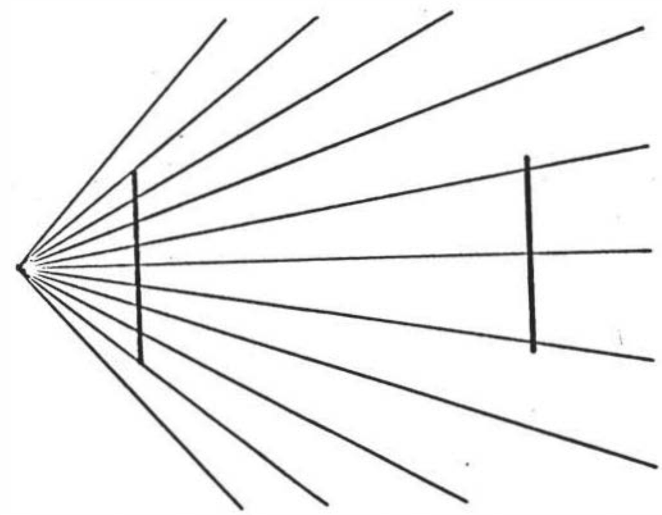
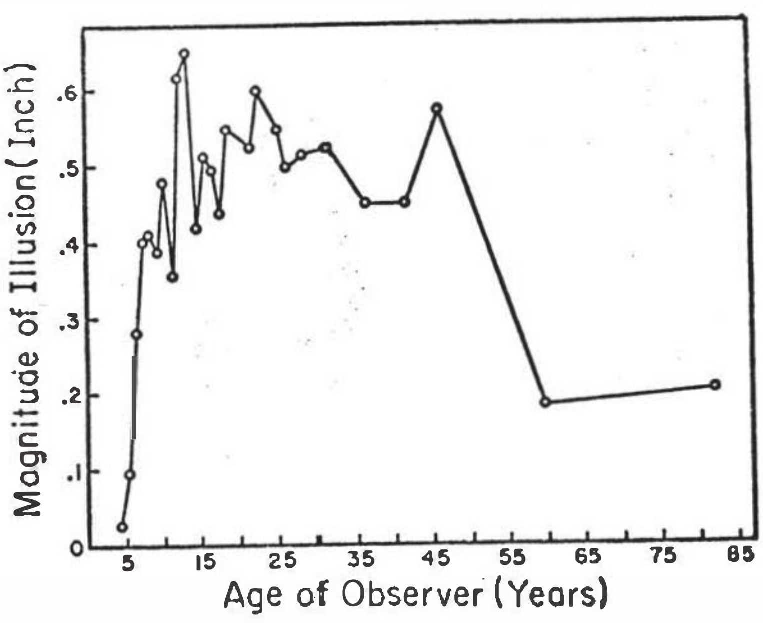


Fig. 4. The Ponzo Illusion. The two vertical lines are of equal length.



Graph 5. The magnitude of the Ponzo Illusion as a function of age. The magnitude is calculated as the underestimation of the length of the 4-inch standard-line, located near the open end of the figure, as computed from the setting of the variable line.

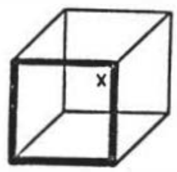


Fig. 5a. The heavy line represents the front of the Necker Cube Illusion.

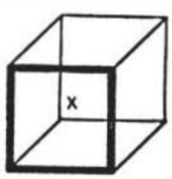


Fig. 5b The heavy line represents the front of the Necker Cube Illusion.

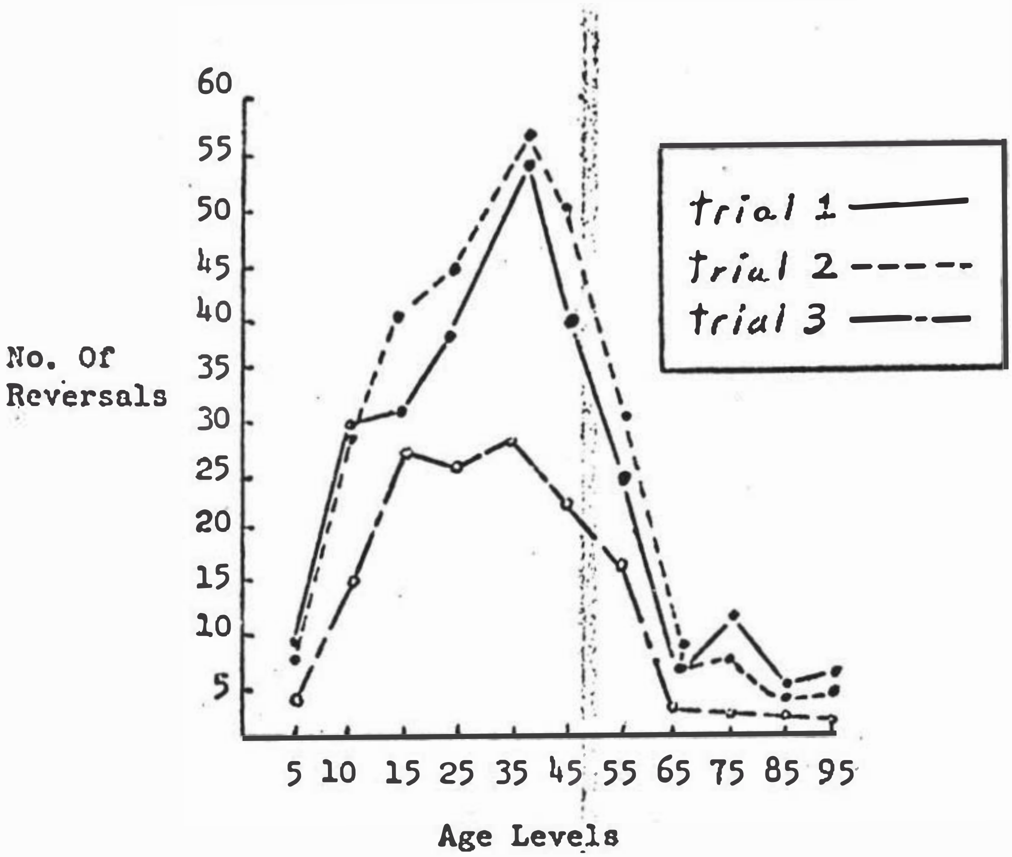
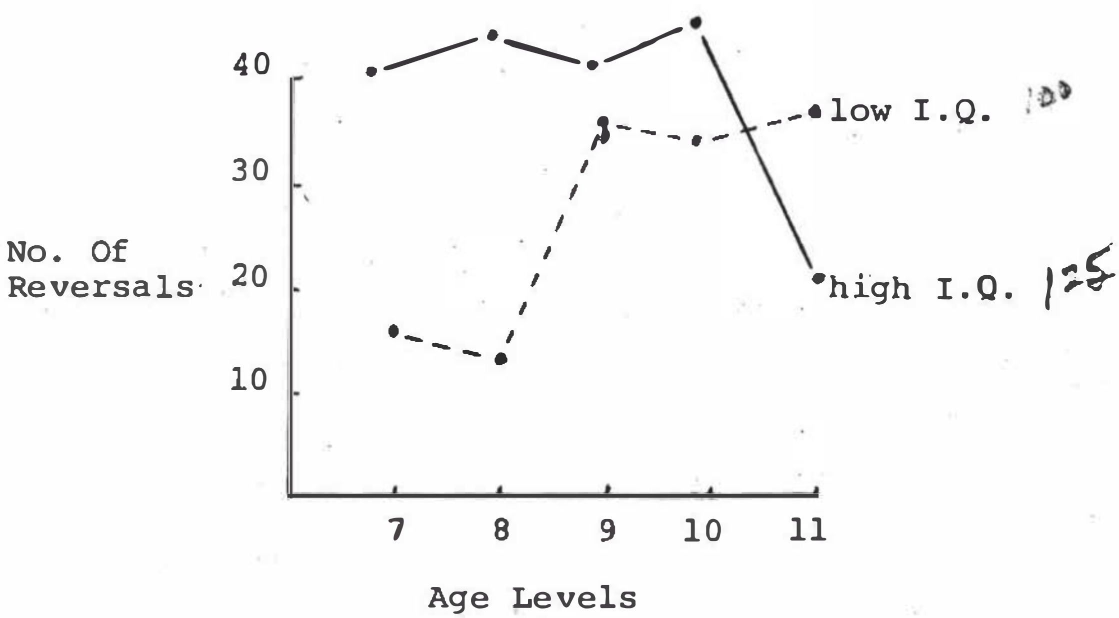


Fig. 6. Number of reversals as a function of age and trial number.



Graph 7. Number of reversals for mean age groups on high and low I.Q.

Graph 8. Number of Necker cube Reversals on Mean Age Groups.

Source	df	SS	MS	F	P
Total	149	9831	-	-	-
Levels	2	149	74.5	1.05	n.s.
Treatments	9	3661	406.8	8.31	.001
Treatments x levels	18	192	10.7	.22	n.s.
Error	120	5829	48.6	-	-

Table 1. Distribution of significant main effects and interactions of Necker Cube reversals with age and three different instructional sets in a 3X10 analysis of variance.

REFERENCES

Baar, D. J. Set and shock-stress effects upon illusion perception. Journal of Psychology, 1964, 467-472

Cohen, B. Rate of apparent change of a Necker Cube as a function of prior stimulation. American Journal of Psychology, 1959, 72, 327-44.

Eysenck, J. J., Holland, H. and Trovton, D. S. Drugs and personality; IV The effects of stimulants and depressant drugs on the rate of fluctuation of a reversible perspective figure. Journal of Science, 1957, 103, 656-665.

Fleichelli, V. R., Rockwell, R. V., and Clark, L. The effects of electro-shock on the rates of reversals of ambiguous perceptual figures. American Journal of Psychology, 1955, 68, 638-644.

Flavell, J. The developmental psychology of Jean Piaget. Princeton: Van Nostrand, 1963.

Franks, C. M. and Lindahl, L. E. Extraversion and rate of fluctuation of the Necker Cube. Perceptual and Motor Skills, 1963, 16, 131-137.

Hanley, C. and Zerbolio, D. J. Developmental changes in five illusions measured by the up-and-down method. Child Development, 1965, 35, 437-452.

Heath, H., Ehrich, D., and Orbach, J. Reversibility of the Necker Cube II: Effects of various activating conditions. Perceptual and Motor Skills, 1963, 17, 539-546.

Holt, G. L. and Matson, J. L. Perceptual Rigidity as a function of age in the Necker Cube. Submitted, Human Development, 1974.

Jenkins, N., and West, N. I. Perception in organic mental defectives; an exploratory study II. The Müller-Lyer illusion. School Bulletin, 1959, 55.

Leibowitz, H. W., and Judisch, J. The relationship between age and the magnitude of the Ponzo Illusion. American Journal of Psychology, 1967, 80, 105-109.

Little, S. J. Investigation of the relationship between perceptual-motor proficiency, intelligence and academic achievement in a population of normal third grade children. International Dissertation Abstracts, 1971, 31, 6441A.

McGee, J. M. The effect of group verbal suggestion of age on the perception of the Ames Trapezoidal Illusion, 1963, 56, 447-453.

Necker, L. A. Observations on some remarkable phenomena seen in Switzerland and an optical phenomenon which occurs on viewing of a crystal or geometric solid. Philadelphia Magazine, Ser. 1, 1832, 3, 329-337

Neugarten, B. L. Introduction to the symposium models and methods for the study of the life cycle. Human Development. 1971, 14, 81-86.

Orbach, J., Ehrich, D., and Heath, H. A. Reversibility of the Necker Cube I: An examination of the concept of satiation of orientation. Perceptual and Motor Skills, 1963, 16, 439-458.

Orbach, J., Zucker, E., Olson, R. Reversibility of the Necker Cube: VII. Reversal rate as function of figure-on and figure-off durations. Perceptual and Motor Skills, 1966, 22, 615-618.

Pickersgill, M. J. and Jeeves, M. A. The origin of the after effect of movement Journal of Experimental Psychology, 1964, 15, 90-103.

Pollack, R. H. Contour detectability thresholds as a function of chronological age. Perceptual and Motor Skills, 1963, 17, 411-417.

Pollack, R. H. Simultaneous and successive presentation of elements of the Müller-Lyer figure and chronological age. Perceptual and Motor Skills, 1964, 19, 300-310.

Pollack, R. H. Temporal range of apparent movement as a function of age and intelligence. Psychonomic Science, 1966, 5(6), 243-244.

Pollack, R. H. and Chaplin, M. R. Perceptual and Motor Skills, 1964, 18, 337-382.

Raven, R., and Strubling, H. The effect of visual perception units on achievement in a science unit; Aptitudinal and sustantive transfer in second grade children, 1968, 5(3).

Roland, B. Relationships between G.S.R., heart rate, and reversibility of the Necker Cube. Perceptual and Motor Skills, 1970, 30(1), 36-38.

Schaie, W.K. A reinterpretation of age-related changes in cognitive structures and functioning; in L.R. Goulet and P.B. Baltes (eds.), Life-Span Developmental Psychology: Research and Theory, New York: Academic Press, 1970.

Spitz, H. H., and Lipman, R. S. Some factors affecting Necker Cube reversal rates, Perceptual and Motor Skills, 1962, 15, 611-625.

Targonski, E. E. and Baer, D. J. Hyperventilation effects on Necker Cube reversals and duration of spiral after effect. Perceptual and Motor Skills, 1966, 23, 783-786.

Wapner, S., and Werner, H. Perceptual Development. Worchester, Massachusetts: Clark University Press, 1957.

Wapner, S., Werner, H. and Comalli, P. E. Perception of part-whole relationships in middle and old age. Journal of Gerontology, 1960, 15, 413-415.

Welford, A. T. Aging and Human Skills. London: Oxford University Press. 1958.

Wright, L. S. Perceptual and cognitive characteristics and their relationships to social factors and academic achievement in third grade conduct problem boys. International Dissertation Abstracts, 1969, 572-A.

Wolf, L. Ford, G., Cogan, R., and Cogan, D. The effect of instructions upon Necker Cube reversals. Psychonomic Science, 1967, 8(10), 339-400