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Age, Sex and Intelligence Differences in Size Constancy

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AGE, SEX AND INTELLIGENCE DIFFERENCES
IN SIZE CONSTANCY

by

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CHAPTER I

STATEMENT OF THE PROBLEM

Does the five, six and seven year old, in estimating sizes of objects show a tendency to "regress to the real object", to borrow a phrase from Thouless,[1] or, is his response based more on the proximal stimuli determining size of images? At what age level does he develop this estimation of objects not exactly as they present themselves to his senses but rather as things known to him through experience? Does a relationship exist between his growing habits of judging perceived sizes and his measured intelligence?

A mass of data has been accumulated covering countless manifestations of the discrepancy that exists between perceptual awareness and the pattern of sensory stimulation. This lack of perfect correspondence between perceptual awareness on the one hand and sensory stimulation caused by physical reality on the other, has been a central problem of perception. One of these measurable manifestations is that referred to as size constancy

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1 R. H. Thouless, "Phenomenal Regression to the Real Object," British Journal of Psychology, 1931, XXII, 1-30.

or phenomenal regression to the real size.

Those who have worked extensively in the field of size constancy have not failed to remark upon the widespread individual differences. Since relatively little has been done with the younger child, this investigation is designed to learn whether or not there is development of size constancy in children, five, six and seven years old; whether there are sex differences in size constancy; and to determine the relationship which might exist between size constancy and intelligence and between size constancy and sex.

The phenomenon of perceptual constancy occurs when the physical stimulus and corresponding psychological reaction are at variance. This problem of constancy forces us to ponder the contradiction it presents when we are faced with the fact that our perceptions correlate so well with their objects under widely varying stimulus conditions, while there is no doubt that our retinal image alone is not a reliable basis for judgments of the object's size, shape or color. The man approaching us on the street does not grow proportionally larger despite the much enlarged retinal projection; the circle observed on the oblique plane retains its circularity after its retinal image has become a very flat ellipse; the shaded white disk remains white, the illuminated black one remains black even though the latter reflects more light.

The phenomenon of size constancy presents itself when the size of the object is judged differently from the size of the physical projection on the retina. The judgments do not adhere to the stimulus-value and a correction for the variations in distance is made. Vigorous experimental studies on the perceptual constancies have familiarized readers of psychological literature with the law of visual angle which states that the area of the retinal image of an object decreases with the square of the distance. This relation, however, between the perceived properties of the visual object and the size of the retinal image is not constant. Boring[2] informs us that "the retinal image of a coin held at ten inches from the eye is four times as large as when held at twenty inches, but for perception there is little if any difference in size." There is a tendency then, for the object's perceived size to remain constant even though it is seen at different distances. On the other hand, in visual perception the size of the retinal image with respect to the distance of the object from the perceiver may be determined by the following equation:

Retinal Image = Size of Object / Distance of Object.[3]

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2 Boring-Langfeld-Weld, <u>Psychology</u>, 1946, 214.

3 Harold Schlosberg, "A Note on Depth Perception, Size Constancy and Related Topics," <u>Psychological Review</u>, 1950, LVII, 316.

Thouless[4] has suggested that the ultimate effect of the process of constancy is usually to make the "phenomenal" object like the real one, that there is "phenomenal regression" to the real object. The tendency to constancy of size could be regarded as an example of a general tendency in perception for phenomenal characters to be intermediate between the characters of the perceived object and modification of the sense organs. For this tendency the term "phenomenal regression" to the 'real' object was suggested.

Brunswik's interpretation as mentioned by Moore,[5] is similar to that of Thouless when in the perception of a non-normally oriented object he asserts that the subject makes a compromise between tendencies to react to each of two poles. One pole is the real size or shape of the object and the other is the retinal image.

For Thouless the regression is <u>from</u> the stimulus color, size or shape, but the actual impression, that is, the apparent or phenomenal color, size or shape is usually intermediate between these two poles. His law of regression states: when a stimulus which by itself would give rise to a certain phenomenal

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4 R. H. Thouless, "Phenomenal Regression to the Real Object," <u>British Journal of Psychology</u>, 1931, XXI, 339-359.

5 W. E. Moore, "Experiments on the Constancy of Shape," <u>British Journal of Psychology</u>, 1938, XXIX, 104-116.

character is presented together with 'perceptual cues' which indicate a 'real' character of the object, the resulting phenomenal character is neither that indicated by the stimulus alone nor that indicated by these perceptual cues, but is a compromise between them.[6] Phenomenal regression in the perception of shapes and sizes, is at least then, in large part determined by the actual presence of cues indicating the real shapes and sizes of the objects observed. When these are partially eliminated the effect is reduced.

Gibson[7] also states that in judging the size of far objects in terms of near objects the estimates are fairly accurate but the accuracy is only possible if there are adequate cues to the distance of the far object. Not even nearly correct judgments of the size will occur if all cues indicating distance are reduced or eliminated from the situation.

Another explanation of constancy of objects in ordinary uncritical perception is that there takes place a correction of our sensations of the size and shape of things due to the fact that we remember the object's true size and shape. However, a specific memory of the object used in testing would be

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6 R. H. Thouless, "Phenomenal Regression to the Real Object," British Journal of Psychology, 1931, XXII, 1-30.

7 James Gibson, The Perception of The Visual World, 1950, 176.

excluded since the sizes and shapes of the figures used in a constancy experiment are not usually known to the subject. Gibson[8] believes there are indications that the above explanation is not a true one since birds discriminate correctly between a large and a small object despite the retinal image continually changing which would indicate that birds memorize the true sizes of all objects seen. The real weakness of this explanation lies in the fact that it does not account for the fact that the errors on the average are always in the same direction, namely between stimulus value and real object.

Andrews[9] believes that the <u>object itself</u> remains constant under varying circumstances and not so much the size, shape or color. "The stimulus correlates of <u>all</u> these features, shape and orientation, its size and distance, its color and illumination, are necessary to make the perceived object look like what it is. The interaction between the members of these pairs of stimulus correlates provides the basis for a consistently identifiable, or constant object in perception."

Locke[10] mentions some factors in size-constancy which might be well to mention. He claims that the mechanism for the

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8 James Gibson, <u>The Perception of the Visual World</u>, 1950, 176.

9 T. G. Andrews, <u>Methods of Psychology</u>, 1948, 182.

10 N. Locke, "Some Factors in Size Constancy," <u>American Journal of Psychology</u>, 1938, LI, 518-520.

correction that the individual makes for the variation in distance may be either internal or external or both. Kinesthetic factors enter in because of the adjustment of the eye made in focusing and the consequent energy change. There is a tension of the musculature involved in accommodation and convergence and this may be a slight cue to constancy. Stimulus factors enter in. Greater constancy was found when boxes were used instead of discs as test objects. Higher constancy is usually found when the objects are nearer to the observer and the level of the test object with respect to the eye makes a difference in size judgment. Methodological factors also enter in. Subjects made higher scores when they saw the entire range of the variable stimulus rather than one variable at a time. Also, simultaneous perception of the standard and variable lowers size-constancy.

Hermans[11] suggests that two antecedent or accompanying conditions of the phenomenon of visual size which can be separately detected are the sizes of the retinal images and the muscular adjustment of the eyes during the retinal stimulation. Any explanation of the phenomenon must take both these sources of stimulation into account. By demonstrations and incidental experiments, Hermans illustrates that the phenomenon in question

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11 T. G. Hermans, "Visual Size Constancy as a Function of Convergence," Journal of Experimental Psychology, 1937, XXI, 145.

is conditioned upon the muscular factors involved and that the retinal factors are but a necessary concomitant.

It can be demonstrated, Locke claims[12] that a physical stimulus can go through a wide range of changes without any change in the experience related to these many stimuli. Despite the changes which affect the stimulus character throughout the various positions and illuminations, supplementary data must enter into that totality experience. It seems self evident, according to Thouless,[13] that regression to the real object could not take place if the subject had no awareness of the real character donated either by his previous knowledge of the object or by his present perception of it. He believes that it is at the physiological rather than at the psychological level that the integration of cues take place. It has been assumed by Sheehan[14] that all contributing sensory influences have no explicit representations in consciousness and it might seem justifiable to assume that much of the integrative activity which determines the phenomenon takes place at a lower, probably sub-cortical level. However, the whole response is dependent upon the inte-

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12 N. Locke, "Perception and Intelligence," Psychological Review, 1938, XLV, 335.

13 R. H. Thouless, "Phenomenal Regression to the Real Object," British Journal of Psychology, 1931, XXII, 2.

14 M. R. Sheehan, "A Study of Individual Consistency in Phenomenal Constancy," Archives of Psychology, 1938, XXXI, 8.

grating powers of a conscious subject.

With the knowledge we have of a child's limited data of experience questions arise as to what degree of perceptual constancy a five, six or seven year-old would have particularly as limited to the size constancy phenomenon.

Locke[15] has noticed that as an ascent is made along the phylogenetic scale, the organism increases in intelligence and at the same time decreases in degree of perceptual constancy.

Since complex perceptual processes are involved in perceptual constancy it might readily be assumed that for human beings there is a close relationship between Intelligence as measured by IQ test and accuracy of size perception. An attempt is made here to discover whether such a relationship exists between the child's growing habits of judging sizes and his measured intelligence. Of secondary interest is the question whether a relationship exists between size constancy and sex.

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15 N. Locke, "Perception and Intelligence," Psychological Review, 1938, XLV, 336.

CHAPTER II

RELATED FINDINGS

Numerous studies have been made on the problem of size-constancy, which problem appears to have been recognized as early as the seventeenth century in the writings of Malebranche, and to have been a subject for experimental investigation by Martius in 1889.

An exhaustive study on the problem was made by Thouless,[1] who in studying subjects to discover whether or not all showed the tendency to phenomenal regression to the 'real' object, used tests of the tendency to constancy of shape, size and brightness as related to sex, age, intelligence and temperament. His subjects were adults. He used a white circular disc (of diameter 39.7 cm.) which was supported at right angles to the table and to the subject's line of vision at a distance of 230 cm. from his eyes. A smaller disc (of 29.7 cm.) was arranged so that the subject saw it to one side of the larger disc and separated from it. The distance of the small disc from the

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1 R. H. Thouless, "Individual Differences in Phenomenal Regression," British Journal of Psychology, 1931, XXII, 234.

subject's eyes was adjusted until he reported that the two discs looked equal in size.

In his results, Thouless reports that correlation between Intelligence Quotient and test result was small and negative. The indication was that the more intelligent subjects tended to see more nearly to the stimulus character of the object, being less influenced by phenomenal regression to the 'real' character. Each individual correlation, however, was too small in comparison with its standard error to possess a sufficient degree of significance. After administering a second intelligence test to fewer subjects whose results gave a somewhat better measure of intelligence, Thouless obtained a correlation of -0.41. The probability of this correlation occurring by the chances of sampling is less than 0.01 so it is clearly significant. Therefore, he was able to say with a reasonable degree of confidence that the tendency to phenomenal regression is related to intelligence, the less intelligent subjects showing the greater tendency to perceive the 'real' characters of objects.

In relation to sex, Thouless concluded with a sufficient degree of confidence that there is a real sex difference in the tendency to phenomenal regression on the part of women who tended to see slightly nearer to the real characters of objects than did the men.

In respect to age, Thouless concludes that the tendency to see objects in their 'real' characters probably increases with increasing age.

In the study conducted by Beyrl,[2] who worked with fifty-five children from two to ten years of age with the size experiment alone, size constancy was found to show a slight developmental trend with increasing age. This developmental curve reached a plateau in the tenth year. He found size-constancy to be present to a remarkable degree at the age of two and to reach near perfection (constancy ratio of .995) at the age of ten years.

Frank[3] carried out her work with thirty children of ages ranging from eleven months to seven years. The children were trained to choose the larger of two boxes. Under condition wherein the size of the retinal image for the larger box was actually smaller than that for the smaller box, the children chose the larger box with a high consistency of performance. According to Frank's results size constancy develops very early in the young child or one might conclude that we are born with it. She feels that children's equations are no different from

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2 F. Beyrl, "Uber die Grossenauffassung bei Kindern," Zsch. Psychol., 1926, C, 344-371.

3 H. Frank, "Die Sehgrossenkonstanz bei Kindern," Psychol. Forsch., 1928, X, 102-106.

those of adults and the differences found result from the method employed.

Brunswik and Cruikshank[4] found a slight degree of size constancy in infants four to five months of age. The beginnings of size constancy are noticed at about six months although the authors state that by the second half of the first year there is a considerable approach to the establishment of size constancy. This is further confirmed by a later study made by Misumi[5] who made a study of the development of visual size constancy of 457 infants from 12 weeks to one year of age. He found that visual size constancy, although slight, became clear at about the sixth month.

Locke[6] in his unusual investigation in which he used human adults, children and monkeys as subjects, found coefficients of .79 to .90 in four year-old children. These scores were of the same order as those made by adults. There were no typical differences in the subjects studied. The scores of the monkeys overlap both those of the human adults and children.

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4 Brunswik and Cruikshank, "Perceptual Size Constancy in Early Infancy," Proc. Amer. Psychol. Asso., 1937, XLV, 18-19.

5 Jihuji Misumi, "Experimental Studies of the Development of Visual Size Constancy in Early Infancy," Jap. J. of Psychol., 1950, XX, 16-26, (English Summary).

6 N. Locke, "A Comparative Study of Size-Constancy," Journal of Genetic Psychology, 1937, LI, 255-265.

In another study[7] Locke noticed a striking relationship between the degree of perceptual constancy and the intelligence of an organism. Between these functions he can perceive an inverse correlation, his results showing that as we ascend the phylogenetic scale, the organism increases in intelligence and at the same time decreases in degree of perceptual constancy. The lower vertebrate makes his adjustment primarily by way of perceptual ability and the higher vertebrate by way of intelligence. It might be of interest to mention that Locke quotes Klimpfinger's study in which the latter found that peasants have a higher degree of constancy than educated adults. Beveridge[8] also found in size constancy that forty-four West Africans had an average constancy index of .88 compared with that of .75 for eight Europeans.[9]

Weber and Bicknell[10] used photographed discs presented stereoscopically and tested perceptual size constancy in eight children from nine to twelve years of age. A tendency towards

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7 N. Locke, "Perception and Intelligence: Their Phylogenetic Relation," Psychological Review, 1938, XLV, 335.

8 W. M. Beveridge, "Racial Differences in Phenomenal Regression," British Journal of Psychology, 1935, XXVI, 59-62.

9 These low figures resulted from applying Thouless' logarithmic correction.

10 C. O. Weber and N. Bicknell, "Size Constancy Phenomenon in Stereoscopic Space," American Journal of Psychology, XLVII, 1934, 436-448.

size constancy was found although it was not complete. Age differences in the phenomenon were small, but a large tendency was shown to see the photographed object as larger than the stimulus size.

Bruner and Rodrigues[11] state that it is evident that the value of objects affects their phenomenal appearance. That it should affect their apparent size in some instances, as with coins, they claim, is probably a function of a pairing in the environment between value and size. In relation to this, Carter and Schooler[12] used discs and coins to discover whether value and need accentuated the apparent size of objects. They discovered that there was a tendency for both larger coins and larger discs to be overestimated in relation to smaller coins and discs. The range of "distortion" was discovered to be greater for coins than for the discs.

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11 J. Bruner and J. Rodrigues, "Some Determinants of Apparent Size," The American Psychologist, 1951, VI, 317-318.

12 L. Carter and E. Schooler, "Value, Need and other Factors in Perception," Psychological Review, 1949, LVI, 200-208.

CHAPTER III

METHOD OF EXPERIMENT

Do five, six and seven year-olds show a tendency to constancy of size to the same extent? How is its amount related to intelligence or to sex? Will the child see the larger of two discs as the apparently larger even when it is very much further away than the other? In order to answer these questions a special group of subjects were chosen. The subjects selected comprised a total number of a hundred and five. Thirty of this number (fifteen boys and fifteen girls) ranged in age from five years, three months to five years, eleven months; forty-two children (twenty-five boys and seventeen girls) ranged in age from six years, three months to six years, eleven months; and thirty-three subjects (eighteen boys and fifteen girls) had an age range from seven years, no months to seven years, eleven months.

The range of the IQs of the five year-olds was from 82 to 129; of the six year-olds from 68 to 117 and of the seven year-olds from 81 to 141.

Although it was thought that a problem might present itself, particularly with the five year-olds, as far as cooperation was concerned, every subject expressed an active interest in participating with the experimenter. Since the experiment was performed during class hours, there was created another incentive on the part of the chosen ones for wishing to act as subjects.

The mental test administered to every child personally by the experimenter was given in groups of ten to twelve. The Kuhlmann-Anderson was given to all the children. However, after studying these results, it was thought that more valid results would be had from the use of the Stanford Revision of the Binet with some of the subjects. Since, in general, individual tests give better results than group tests because it is possible to adapt the particular tests given, easy or difficult, to the ability of the child, the Stanford Revision was given to the several dull and superior subjects. This was done in order to eliminate the possibility of the dull children failing to understand the paper and pencil test as well as to enable the superior children to exercise their greatest abilities in case they may not have had that opportunity in the Kuhlmann-Anderson.

For the size constancy experiment, cardboard discs of light grey color were prepared. The twenty-two discs varied from three inches to eight inches in diameter, in steps of one-fourth inch. An extra disc, five inches in diameter was prepared for the "standard." Actually, the variables below four inches and above seven inches were scarcely used since the subject's consistent judgments made it unnecessary to present those discs.

The experimental room was a classroom without furniture. At the observer's end of the room a chair was provided so that the subject faced the blackboard on the back wall. During the experiment, room lights overhead were turned on, and the lighting did not seem to show any shadows in the visual field.

Profiting by a suggestion offered by Thouless[1] concerning the technical difficulty he experienced, when he states: "A better method would have been to keep the distances constant and to present as variable a series of discs of different diameters," the experimenter presented instead of a single comparison figure to be compared with the standard at various distances, a range of variables at a constant distance.

The subject was asked to sit back in a straight-backed chair facing the rear blackboard, which was the background for the variables. This position enabled the subject to keep a more exact position of head and eyes throughout the experiment.

The child sat three feet from one experimenter who presented the "standard" disc five degrees to the left of the

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1 R. H. Thouless, "Individual Differences in Phenomenal Regression," British Journal of Psychology, 1931, XXII, 219.

subject's direct line of vision; and twenty feet from a second experimenter, who presented the variable discs in the subject's direct line of vision.

The experimenters presented the discs directly over marks made on the floor. The level of the subject's direct line of vision was measured as soon as the subject was in proper position. Then after the ready signal was given, both discs were presented simultaneously.

Due to the subject's immaturity these simple instructions were given: "We are going to show you two circles. We want you to look at his circle," (the one held by experimenter one) "and at mine, and tell us whether mine is bigger or smaller or just the same size as his. Ready? Is mine bigger or smaller or just the same size as his?" The last words, "Ready? Is mine bigger or smaller or just the same size as his?", were repeated at each variable presentation.

As each judgment was made it was immediately recorded as plus (+) for larger, minus (-) for smaller and equals (=) for equal size. A sample of the data sheet used is found in Appendix IV.

The first problem was to establish the range of the variables within which the subject's judgments of equality were included. This was done by using the regularly ascending order of presenting the variable stimuli for the first series of presentations, followed by the regularly descending order in the second series. That is, beginning with the three inch disc, the variables followed each other in orderly sequence until the eight inch disc was reached. This procedure was reversed in the second series where the presentation began with the eight inch disc and proceeded in a descending order until the three inch variable was reached. The discs were exposed each time long enough for the subject to give his answer.

Once the subject's range was thus determined, the remainder of the presentations continued in random order until all the variables which fell within the range were utilized. The same procedure was followed for eight presentations.

As previously mentioned, many of the variables outside the four inch to seven inch range were not used after the first two series of presentations. Eight subjects overestimated above the seven inch disc and only one underestimated to the three and one half inch level.

In the interest of greater reliability, variables three steps removed from either end of the zone of uncertainty were presented in each case series of random presentation, as may be seen by consulting the sample data sheet.

A two-minute interval was allowed for each subject after half the task was finished, so as to avoid lack of interest and fatigue. During this time and whenever the discs were not in use, they were kept out of sight.

Statistical data were next gathered concerning the size constancy scores and intelligence test scores. In regard to the size constancy scores, the midpoint between the upper and lower mean transition points or the "Point of Subjective Equality" for each subject was computed according to Spearman's formula and method as prescribed by Woodworth in his Experimental Psychology on page four hundred and two:

$$P.S.E. = \frac{Mg + M_1}{2}$$

Then, Means, Standard Deviations and Critical Ratios were figured between the Mean P.S.E.s for the three age groups to obtain age differences in size constancy and for the boys and girls in each age group to obtain sex differences in size constancy. The *t* scores were computed according to the formula for the significance ratio for the difference in the means of two independent small random samples, given in E. F. Lindquist's A First Course in Statistics on page one hundred and thirty-eight. In further interest, constancy ratios were also obtained for the different age groups by the Brunswik formula:

$$\frac{R - S}{A - S} = K$$

where R = Point of Subjective Equality; A = real object (5.0 inches) and S = Stimulus value (33.33) which formula is found in

Woodworth's <u>Experimental Psychology</u>, page six hundred and five.

Correlations between Intelligence and P.S.E.s were found by the Pearson Product-Moment method and the probable errors were computed.

CHAPTER IV

RESULTS AND CONCLUSIONS

Although greater P.S.E.s correspond to less constancy, that is, more removed from objectivity, allowing for fairly wide individual differences, the Point of Subjective Equality for each individual as derived by Woodworth's formula shows that the tendency to size constancy is in operation at an early age. Appendix I presents the constancy scores in terms of P.S.E.s for the girls and boys in the five, six and seven year-old groups.

The range of P.S.E.s for the five year-olds was 1.82 inches, that is from 5.26 to 7.19; for the six year-olds, the range was 2.0 inches with the scores ranging from 4.50 to 6.50, and for the seven year-olds the range was 1.68 with the scores ranging from 4.89 to 6.57.

It was interesting to note that only two subjects (boys) were found to underestimate the 5 inch standard, having scores of 4.50 and 4.89, while one subject (girl) overestimated above the seven inch disc with a score of 7.19. Twenty-one subjects overestimated beyond the 6 inch disc, while the remaining eighty-one subjects judged within one inch of the standard, yielding a mean of 5.57. Overestimation is known to be a fact, namely, more distant circles equal to a near one, look larger, even though they are retinally smaller than the nearer ones, and the greater the distance, the more the overestimation.[1]

TABLE I

MEAN OF P.S.E.s, STANDARD DEVIATIONS AND BRUNSWIK'S CONSTANCY RATIOS FOR THREE AGE LEVELS

Age Group	N	M. of P.S.E.s	S.D.	Brunswik "K"
5 yr.-olds	30	5.82	.424	.971
6 yr.-olds	42	5.65	.349	.977
7 yr.-olds	33	5.75	.444	.973
Total Group	105	5.73	.114	.974

Note: The larger the P.S.E., the smaller the Constancy score.

From Table I it is seen that the mean difference between the 5 inch standard disc and the disc judged to be equal to it by the five year-old group was .82 inches, by the six year-olds, .65 inches and by the seven year-olds, .75 inches. There is a marked difference in the standard deviation of the

1 W. Prentice, "On the Size of the Figural after-effect with Varying Distances," American Journal of Psychology, 1950, LXIII, 589-593.

six year-olds as compared with the five or seven year-old groups. The Brunswik ratio yields a constancy score of .977 for the six year-olds, thus surpassing the seven year-olds' score of .973 and five year-olds' score of .971.

TABLE II

MEAN AGE DIFFERENCES AND *t* s FOR P.S.E.s

Age Groups	Mean Differences	*t* s
Between 5 and 6 year-olds	.17	1.83
Between 6 and 7 year-olds	.10	1.07
Between 5 and 7 year-olds	.07	.63

An inspection of Table II discloses the mean age differences between P.S.E.s and gives the critical ratios for determining the significance of difference. It is easily seen that the greatest mean difference is found between the five and six year-old groups with .17, between the six and seven year old groups with .10, and between the five and seven year olds with .07 difference.

Critical ratios as found in Table II show only one difference which is close to being statistically significant, and that is for the five and six year old groups which yielded a *t* score of 1.83, being just short of the five per cent level of confidence. The difference for the six and seven year old groups has a *t* of 1.07 and is found at the 30 per cent level so that thirty times in a hundred, it could be due to chance. A *t* of .63 was obtained for the five and seven year old groups, giving a 50 per cent level of confidence which difference is purely due to chance.

As gathered from the above tables, there is an indication that a rather high degree of size constancy is found in the young child, especially since the total group has yielded a constancy score of .974. We may also assume that there is a slight relation existing between age and size constancy noting that there is an almost significant increase in constancy in the six year-olds as compared to the five year-olds; the seven year-olds, though surpassed by the six year-olds, still retain a slightly higher constancy than the five year-olds. Our finding seems to agree with Beyrl's[2] work in that age of children and size constancy score are related. He claims that there is a developmental curve for size which reaches a plateau in the tenth year. His two year-olds yielded a high constancy score of .92

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2 F. Beyrl, "Uber Die Grossenauffassung Bei Kindern," Ztsch. F. Psychol., 1926, C, 344-371.

and there was a regular increase up to a plateau of almost complete constancy .995 at the tenth year level and on to the adult. Weber and Bicknell[3] report higher constancy scores for their nine to twelve year-old children than for adults, whereas Thouless[4] states that there is a negative correlation with the older of his adult subjects making lower constancy scores than his younger adult subjects.

Therefore, we may conclude in line with the findings of others that there is a probability of an age curve in the development of the tendency to see the 'real' characters of objects as age increases, so that in spite of high constancy in the small child, there is still lacking that tendency of perfect sharpness of size constancy as found in the adult. According to Dukes[5] scant evidence given by his study of a six year old child in its "natural habitat", it was found that the youngster made considerable errors as to bodily size in spite of a general high degree of perceptual size-constancy.

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3 Weber and N. Bicknell, "The Size-Constancy Phenomenon in Stereoscopic Space, <u>American Journal of Psychology</u>, 1935, XLVII, 436-448.

4 R. H. Thouless, "Individual Differences in Phenomenal Regression," <u>British Journal of Psychology</u>, XXII, 1931-32, 216-241.

5 W. F. Dukes, "Ecological Representativeness in Studying Perceptual Size-Constancy in Childhood," <u>American Journal of Psychology</u>, 1951, LXIV, 87-93.

In studying sex differences in size constancy, it was found that the differences in the mean values of P.S.E.s for boys accounted for most of the difference due to growth, as shown in Table III. In each age group as well as the total group, the boys have a higher constancy score than the girls. There is a difference between boys and girls combined of the ages six and seven. The critical ratio is 2.55 and is significant at the one per cent level of confidence. The total group shows a significant difference between boys and girls. The critical ratio of 2.7 is significant at the one per cent level of confidence.

We may therefore conclude with a sufficient degree of confidence that there is a real sex difference in the tendency to "phenomenal regression", the boys, of ages 5, 6 and 7 years, tending to see nearer to the 'real' characters of objects than do girls.

This finding seems to be opposed to that of Thouless[6] who reports in his study that women tend to see slightly closer to the 'real' characters of objects than do men. Perhaps the girls make up for their childhood disadvantage as they grow older. There is almost certainly a different rate of intellectual development in boys and girls. Let us now turn to this

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6 R. H. Thouless, "Individual Differences in Phenomenal Regression," British Journal of Psychology, 1931, XXII, 216-241.

TABLE III

MEAN OF P.S.E.s, STANDARD DEVIATIONS
AND OBSERVED SEX DIFFERENCES

Age Groups	Sex	N	Mean of P.S.E.	S.D.	Mean Differences	*t*
5 year-olds	B	15	5.75	.257	.13	.793
	G	15	5.88	.559		
6 year-olds	B	25	5.55	.316	.26	1.79
	G	17	5.81	.60		
7 year-olds	B	18	5.66	.45	.19	1.21
	G	15	5.85	.412		
6 and 7 year-olds combined	B	43	5.60	.387	.23	2.55
	G	32	5.83	.374		
Total Group	B	58	5.64	.36	.21	2.70
	G	47	5.85	.435		

problem.

The Intelligence Quotients and P.S.E.s of the total group are presented in Appendix II. Table IV shows that, after the whole group regardless of age and sex is divided into the high, average, and low sub-groups, the correlations approach significance for the two extreme groups. It can also be seen from Table IV that there is an inverse relationship between size-constancy and intelligence at these two extremes. The high or superior group, having IQ's from 110-141, showed a correlation of minus .30 with P.E. ± .087 whereas the low group showed a plus .32 with P.E. ± . 15. The middle group gave .05 with a P.E. larger than the correlation value. There is evidently a very complex relationship here indicating that those who were more intelligent on the average, but above the normal range from 100 to 110, had a tendency for quantity of intelligence to accompany degree of constancy. On the contrary, those who were below the normal range, some extending down to the borderline for feeble-mindedness, showed the opposite tendency, namely that the higher their intelligences, the lower were their constancy scores. When the means for the three groups are considered together, both for intelligence and for constancy, there appears an overall tendency for the brighter sub-group to be <u>less accurate</u> in perception, their mean P.S.E. being 5.78; and for the dull group to be more accurate, with mean P.S.E. of 5.60. However, in obtaining critical ratios for these groups as seen in Table V, the *t* s yielded no significance.

On the whole, then, our findings confirm those of

TABLE IV

CORRELATION BETWEEN INTELLIGENCE AND MEAN P.S.E.s OF THREE GROUPS

Type of Group	Range of IQ	N.	Mean P.S.E.	"r"	P.E.
High Group	141-110	48	5.78	-.30	.87
Average Group	109-100	41	5.65	.05	.101
Low Group	98-68	16	5.60	.32	.15

Note: The larger the P.S.E. the less the constancy score.

The Groups consisted of:

High Group - 20 five year olds (10 boys and 10 girls)
14 six year olds (7 boys and 7 girls)
14 seven year olds (9 boys and 5 girls)

Average Group - 6 five year olds (3 boys and 3 girls)
21 six year olds (14 boys and 7 girls)
14 seven year olds (7 boys and 7 girls)

Low Group - 4 five year olds (2 boys and 2 girls)
7 six year olds (4 boys and 3 girls)
14 seven year olds (2 boys and 3 girls)

Thouless[7], who says that he found a small negative correlation between constancy and intelligence, although he does not state

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7 R. H. Thouless, "Individual Differences in Phenomenal Regression," British Journal of Psychology, 1931-32, XXII, 216-241.

TABLE V

STANDARD DEVIATIONS, MEAN DIFFERENCES AND
t s FOR P.S.E.s OF THREE GROUPS

Group	N	S.D.	Groups	Mean P.S.E. Differences	t
High	48	.379	Between High and Average	.13	1.50
Average	41	.427	Between Average and Low	.05	.41
Low	16	.412	Between High and Low	.28	1.67

how intelligent his group of adult subjects actually were.

Ideas in human beings arise in conjunction with sensations and have a sensory basis right from the start. Before the child has a highly developed intelligence, he has already developed a fair degree of size constancy.

Now, comparing the correlations seen in Table VI between constancy and IQ at the various ages, we find the following: Boys in the youngest age group show a significant relationship, i.e., the more intelligent they are, the less constant. At the six year level there is the same relationship, but it breaks down completely at the seven year level. For girls of the various ages there is the same trend, but although the direction of the trend is the same, the correlations are all insignificant.

But taking the boys and girls together we can also see the trend and again the correlations are not significant. If we were to interpret the trend and not try to make predictions regarding other groups or persons, we might say that as intelligence becomes more perfect, it tends to become isolated from the tendency to perceive the size of objects with constancy. These conclusions are only suggested, however, since from Table VI we see that the five year-olds have a correlation of .31 whereas the six and seven year-olds have a minus .17 and minus .13 respectively. This growing apart of the intelligence and perception scores is what we might be led to expect if we consider the abstract nature of the adult human intelligence. The correlational findings using the IQ's of all boys, all girls, and age groups corroborate those in which the total group was divided into the low, medium and high intelligence sub-groups. There we found, taking averages of sub-groups that the higher the IQ, the less was the score for size constancy, as appears in Table VI. Just why the bright sub-group should show exactly the same degree of relationship as the low group but in the opposite direction is not known. Perhaps the bright ones were

TABLE VI

CORRELATION BETWEEN INTELLIGENCE AND MEAN P.S.E.s FOR VARIOUS AGES

Age Group	N	"r"	P.E.
5 year-olds	30	.31	.110
6 year-olds	42	-.17	.10
7 year-olds	33	-.13	.114
5 year-old boys	15	.53	.126
5 year-old girls	15	.27	.16
6 year-old boys	25	.56	.092
6 year-old girls	17	-.17	.157
7 year-old boys	18	-.016	.154
7 year-old girls	15	-.22	.165
Total boys	58	.37	.076
Total girls	47	.23	.092
Total Group	105	.17	.064

able to use more of their brightness as an aid to accurate perception. The dull ones, having less to use, applied it to the perception of the "stimulus" value. This explanation is rather theoretical although it does account for the better average score for the dull group.

CHAPTER V

SUMMARY

This experiment had as its purpose the investigation of the growth of size constancy to discover whether or not there is a development in judging perceived sizes in children five, six and seven years old; whether there are any sex differences in size constancy and to learn, if possible, whether any relationship exists between this constancy and measured intelligence.

The findings may be summarized as follows:

1. There seems to be an indication that a rather high degree of size constancy is found in the five, six and seven-year old child. The present total group has yielded a constancy score of .974 while the six year-old group reached a score of .977.

2. There seems to exist a slight relationship between age and size constancy in that as age increases, greater judgment of size increases as shown by the almost significant increase in constancy in the six year-olds over the five year-olds as well as a slightly higher constancy score of the seven year-olds over the five year-olds. The fact that the six year-olds surpass the seven year-olds makes one suspect that perhaps attitudinal or other factors might have entered in.

3. There seems to be a real sex difference in children as to judgment of perceived sizes with the boys surpassing the girls in higher constancy scores. This is revealed not only in the results of the individual groups, but the total group also yielded a statistically significant difference at the one per cent level of confidence. This result does not agree with former studies with adults in which women had higher constancy scores than men. Perhaps girls differ

from boys in their rate of developing constancy of perception.

4. Correlations seem to show an inverse relationship, definite though small, of size constancy with intelligence. There seems to be an indication that, the more intelligent persons as a group tended to see more nearly to the sensory or stimulus character of the object, whereas the dull group reacted more to the concrete objective characters.

These results seem to confirm works which state that size constancy is possessed in different degrees, somewhat according to age, and that this phenomenon depends upon sex and intelligence.

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APPENDIX I

RESULTING CONSTANCY SCORES IN TERMS OF P.S.E.s FOR TOTAL GROUP

Boys	P.S.E.Scores	Girls	P.S.E.Scores
	Five-year-olds		
M.P.	5.37	M.K.	5.26
J.C.	5.40	G.S.	5.27
T.F.	5.57	C.A.	5.27
P.M.	5.59	M.S.	5.46
T.D.	5.60	D.D.	5.52
B.S.	5.62	R.K.	5.72
J.A.	5.65	S.J.	5.73
H.H.	5.65	G.E.	5.84
K.G.	5.67	C.O.	5.98
D.K.	5.71	D.S.	6.14
L.W.	5.71	D.B.	6.17
P.D.	5.78	S.D.	6.37
J.W.	5.85	B.M.	6.41
D.F.	6.09	M.R.	6.42
B.B.	6.48	K.H.	7.19
	Six-year-olds		
S.H.	4.50	S.J.	5.10
J.M.	5.03	M.H.	5.43
G.B.	5.14	B.K.	5.51
D.K.	5.15	B.G.	5.53
J.H.	5.18	M.B.	5.53
B.S.	5.25	A.C.	5.62
J.P.	5.32	J.P.	5.64
J.H.	5.34	R.M.	5.65
P.S.	5.40	B.B.	5.68
J.M.	5.43	G.G.	5.70
B.C.	5.52	A.P.	5.73

M.M.	5.53	M.M.	5.78
B.L.	5.59	L.W.	5.85
B.P.	5.59	R.M.	5.96
J.D.	5.62	D.S.	6.03
P.S.	5.67	P.C.	6.26
T.L.	5.68	M.C.	6.50
R.C.	5.72		
J.L.	5.78		
S.M.	5.82		
E.S.	5.85		
S.D.	5.90		
J.J.	5.90		
T.M.	5.93		
S.M.	6.17		

Seven-year-olds

T.S.	4.89	V.O.	5.17
B.S.	5.01	D.A.	5.37
J.V.	5.07	S.S.	5.42
J.V.	5.32	N.K.	5.53
V.V.	5.34	P.D.	5.54
R.J.	5.35	G.W.	5.62
B.S.	5.37	M.S.	5.64
B.P.	5.53	K.V.	5.64
J.M.	5.55	B.S.	5.90
M.D.	5.59	G.D.	5.99
J.M.	5.84	G.A.	6.07
T.B.	5.90	J.T.	6.21
M.M.	5.95	L.P.	6.23
T.L.	6.14	D.C.	6.37
E.N.	6.14	M.H.	6.57
E.H.	6.17		
J.D.	6.17		
L.K.	6.23		

APPENDIX II

INTELLIGENT QUOTIENTS AND P.S.E.'S OF TOTAL GROUP

N = 105

S	IQ	P.S.E.	S	IQ	P.S.E.
J.M.	141	5.84	S.M.	112	6.17
D.A.	132	5.37	R.M.	112	5.96
R.M.	129	5.59	G.G.	112	5.70
B.M.	129	6.41	L.K.	112	6.23
B.B.	125	6.48	S.D.	111	6.37
M.S.	122	5.46	S.D.	111	5.90
D.F.	121	6.09	J.P.	111	5.64
T.F.	121	5.57	B.P.	111	5.53
R.K.	120	5.72	M.M.	111	5.95
K.G.	120	5.67	B.S.	111	5.01
D.B.	119	6.17	M.H.	110	5.43
M.K.	119	5.26	B.G.	110	5.53
D.S.	118	6.14	T.B.	110	5.90
S.J.	118	5.73	D.D.	109	5.52
J.B.	118	5.32	J.H.	109	5.18
V.V.	117	5.34	M.B.	109	5.53
B.C.	117	5.52	D.S.	109	6.03
L.W.	116	5.71	M.C.	109	6.50
J.J.	116	5.90	J.D.	109	6.17
M.M.	116	5.53	R.S.	109	5.37
E.N.	116	6.14	S.S.	109	5.42
J.T.	116	6.21	T.D.	108	5.60
B.S.	115	5.90	S.M.	108	5.82
B.K.	115	5.51	P.S.	108	5.67
A.C.	115	5.62	G.B.	108	5.14
J.W.	114	5.85	T.L.	108	5.68
H.H.	114	5.65	R.M.	108	5.65
P.S.	114	5.40	G.A.	108	6.07
J.D.	114	5.62	J.H.	107	5.34
P.F.	113	5.78	V.O.	107	5.17
N.K.	113	5.53	J.P.	106	5.32
G.W.	113	5.62	B.L.	106	5.59
M.P.	112	5.37	A.P.	106	5.73
C.O.	112	5.98	L.W.	106	5.85
K.H.	112	7.19	M.D.	106	5.59

APPENDIX II (Cont'd)

INTELLIGENT QUOTIENTS AND P.S.E.'S OF TOTAL GROUP

S	IQ	P.S.E.
E.H.	106	6.17
T.S.	106	4.89
M.S.	106	5.64
D.C.	106	6.37
K.B.	106	5.64
M.R.	105	6.42
J.L.	105	5.78
J.M.	105	5.03
R.C.	105	5.72
J.M.	105	5.43
S.K.	105	5.10
J.V.	105	5.07
M.H.	105	6.57
G.E.	104	5.84
R.J.	102	5.35
B.S.	101	5.62
E.S.	101	5.85
J.A.	100	5.65
R.P.	100	5.59
J.M.	98	5.55
D.K.	97	5.71
P.D.	96	5.54
J.C.	91	5.40
G.S.	91	5.27
T.M.	91	5.93
R.S.	90	5.25
D.K.	90	5.15
P.C.	90	6.26
G.D.	88	5.99
L.P.	87	6.23
M.M.	84	5.78
C.A.	82	5.27
T.L.	81	6.14
B.B.	69	5.68
S.H.	68	4.50

APPENDIX III

IQs OF TOTAL GROUP BY AGES AND SEX

	BOYS			GIRLS		
	5 yrs.	6 yrs.	7 yrs.	5 yrs.	6 yrs.	7 yrs.
N	(15)	(25)	(18)	(15)	(17)	(15)
	129	117	141	129	115	132
	125	116	118	122	115	116
	121	116	117	120	112	115
	121	114	116	119	112	113
	120	114	112	119	111	113
	116	112	111	118	110	109
	114	111	111	118	110	108
	114	109	111	112	109	107
	113	108	110	112	109	106
	112	108	109	111	109	106
	108	108	109	109	108	106
	101	108	106	105	106	105
	100	107	106	104	106	96
	97	106	106	91	105	88
	91	106	105	82	90	77
		105	102		84	
		105	98		69	
		105	81			
		105				
		101				
		100				
		91				
		90				
		90				
		68				
M	112	105	109	112	105	106

M of Total Boys: 108 M of Total Girls: 107

M of Total Group: 108

APPENDIX IV

DATA SHEET

Name - Mary F. Sullivan Date - 4-24-51

Date of Birth - 12-11-46 Sex - Female

C.A. - 5-5 M.A. - 6-8 IQ 122

SERIAL TRIALS FOR SIZE CONSTANCY

Size of Variable	↑	↓	1	2	3	4	5	6	7	8	"g" (Greater)	"l" (Lesser)	(Equal)
8	+	+											
$7\frac{3}{4}$	+	+											
$7\frac{1}{2}$	+	+											
$7\frac{1}{4}$	+	+											
7	+	+											
$6\frac{3}{4}$	+	=	+	+	+	+	+	+	+	+			
$6\frac{1}{2}$	+	=	+	+	+	+	+	+	+	+			
$6\frac{1}{4}$	+	=	+	+	+	+	+	+	+	+			
6	+	=	+	+	+	+	+	=	+	=	.750		
$5\frac{3}{4}$	=	=	=	=	=	+	=	=	=	+	.250		
$5\frac{1}{2}$	=	=	=	=	=	=	=	=	=	=			
$5\frac{1}{4}$	=	=	=	=	=	=	=	=	=	-		.125	
5	=	=	=	-	-	=	-	=	-	-		.625	
$4\frac{3}{4}$	-	=	-	-	-	-	-	-	-	-			
$4\frac{1}{2}$	-	=	-	-	-	-	-	-	-	-			
$4\frac{1}{4}$	-	-	-	-	-	-	-	-	-	-			
4	-	-											
$3\frac{3}{4}$	-	-											
$3\frac{1}{2}$	-	-											
$3\frac{1}{4}$	-	-											
3	-	-											
											1.000	.750	

of "g" 1.000 of "l" .750 All + = 6.25 All - = 4.75

M T + to not T+ 5.875 M T - to not T - 5.063

P.S.E. 5.469

APPROVAL SHEET

The thesis submitted by Sister Agnes James Leonas, C.S.J. has been read and approved by three members of the Department of Psychology.

The final copies have been examined by the Director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Arts.

June 4, 1953
Date

Vincent V. Herr S.J.
Signature of Adviser