

SOME STIMULUS ANCHORING EFFECTS IN
YOUNG CHILDREN

by

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ABSTRACT

Children (3.4 to 5.3 years old) were asked to render bi-polar judgments of several sets of stimuli which fell at points of intermediate value along their respective stimulus dimensions. The children consistently shifted their judgments away from sets of extreme-valued anchor stimuli which were introduced just prior to their actual judgments. Strong judgmental shifts occurred relative to anchor stimuli of both poles of every dimension. The shifts appeared to be virtually independent of the age of the children, the sequence in which the opposite anchor stimuli of a given dimension were presented, the presence or absence of a memory prop, and the order in which stimuli were asked to be judged. The children also tended to exhibit relational, judgmental shifts consistent with the small stimulus changes among the intermediate-valued stimuli. The same essential findings were replicated with a sample of retardates.

INTRODUCTION

The present research was designed and conducted to test the validity of a theoretical dogma and an empirical finding supporting that dogma. Piaget (1928, p. 91) states that young children are characterized by an "incapacity for even the most elementary relativism of thought." Piaget intends this statement to apply with complete generality to the entire universe of things and thoughts which can be compared one relative to another. "In the case of country as in that of family, of brothers, and right and left, [several of the elaborately described examples from which Piaget generalizes], realism, due to the child's egocentric habit of sticking to the immediate point of view, entails a complete lack of relativity, or what comes to the same thing, a complete inability to handle the logic of relations" (p. 130). Piaget emphasizes that some concepts are intrinsically relational though children cannot apprehend their relational nature. "The child does not realize that certain ideas, even such as are obviously relative for an adult are relations between at least two terms. Thus he does not realize that a brother must necessarily be the brother of somebody, or that a part must necessarily be part of a whole, but thinks of all these notions as existing in themselves, absolutely" (p. 131). It should be noted that Piaget considers all of these relative concepts to be of equal difficulty. "The evolution of the ideas of right and left is as

complex as that of other relative notions, and obeys exactly the same laws (p. 112)."

Piaget states that relational thinking progresses through three determinant stages highly correlated with age. "There are three very definite stages in this evolution of right and left. During the first the child places himself at his own point of view, during the second at the point of others, and during the third at a completely relational point of view in which account is taken of objects in themselves (1928, p. 112)." Piaget estimates the first stage to begin at approximately age 5, the second at about age 8, and the third around ages 11 or 12. Though he acknowledges that research may alter the exact ages at which these stages are believed to begin, he states that " . . . The order in which the stages follow on one another will remain the same . . . (p. 113)."

Although Piaget does not explicitly reaffirm his present adherence to these assertions, he does not seem to renounce them or substantially depart from them in his more recent work (Piaget, 1968). The astute reader may wish to verify for himself that the six antecedent quotations have not been lifted from context so as to misrepresent Piaget's position in any way. Appendix A furnishes the reader with each quotation in its original context for this express purpose.

O'Reilly and Steger (1970) report that children 6 years and older formed relative judgments of a series of 5 weights, i.e., they ordered them correctly in the absence of an anchor (seriation) and then shifted their judgments of the entire series when an anchor was

introduced (interpreted as evidence of transitivity). However, they report that 5 year old children " . . . could not order the series or use the anchor as a point of reference (p. 1097)." O'Reilly and Steger interpret their results as being generally consistent with the research of others in the domain of cognitive development (Braine, 1959; Piaget, 1968; Smedslund, 1963) although they point out that the age at which subjects were able to perform these relational tasks was lower than has been noted before. The empirical finding germane to the present research is that "The 5 year olds did not reflect any awareness of the anchor (p. 1097)." In Piaget's terms, the 5 year olds judged absolutely, not relatively.

Social judgment theory (Helson, 1964; Sherif and Hovland, 1961) and social learning theory (Bandura, 1969; Bandura, 1971; Rosenthal and White, 1972; Rosenthal and Zimmerman, 1972) hold that judgments occur against an immediate and prior contextual background of stimulus values relevant to the dimensions being judged. According to this formulation, all judgments, even those by very young children, occur not absolutely, but relative to arbitrary though variable frames of reference. Hence, a substantial alteration of past experiences and/or a strong shift in immediate contextual properties should result in a similarly powerful displacement of the judgments of any given stimulus values falling somewhere between the end-points of any particular stimulus dimensions.

The present research sought to demonstrate that very young children (the youngest available) would shift their judgments of stimuli along a variety of very diverse stimulus dimensions relative to

different, very briefly experienced stimulus contexts. Additionally, the experimental procedures were repeated with a sample of retardates for comparison purposes.

METHOD

Five stimulus dimensions were chosen for five experiments to be run concurrently with the same subjects. Care was taken to insure that each dimension was pure, i.e., unconfounded with other dimensions not of interest. For example, since the size of a square is confounded with its area, squares were deemed impure and potentially confusing. The five dimensions chosen seemed to be dimensionally pure, obviously different one from another, and easily studied with unelaborate stimulus materials. The dimensions selected for the five experiments, in the order of their actual presentation and performance, were (1) light intensity, (2) texture, (3) facial happiness, (4) height, and (5) weight.

Experiments I to V

Subjects

Thirty-two children enrolled in a pre-kindergarten school in Tucson were used as subjects. Eight boys and eight girls were randomly chosen from each of two age groups. The younger group ranged from 3.4 to 4.2 years old (mean = 3.8 years) at the beginning of the study; the older group ranged from 4.3 to 5.3 years (mean = 4.6 years).

Stimulus Materials

The nine stimuli necessary for each experiment (dimension) were chosen arbitrarily except that care was taken to insure that three

stimuli (equal in value) clearly represented one pole of a dimension in contrast to three other (equal) stimuli representing the opposite pole. The only stipulations for the remaining three stimuli were that they clearly fall at values intermediate to the other six and that they be discriminable one from another by adults. The extreme valued stimuli were called anchor stimuli; the intermediate valued stimuli were called test stimuli.

Experiment I: Light Intensity. The nine stimuli were circles of 4 inch diameter drawn on 7 x 7 inch squares of white posterboard with a thin, black pen. Three circles were painted flat black, three circles were painted white, and three circles were painted three slightly differing shades of intermediate grey. The black circles were found to reflect approximately 3.8% of all natural sunlight striking them; the white circles were reflecting 88.5% and the grey circles 16.0%, 24.8%, and 36.9% of all natural sunlight. The dimension of interest was light intensity; the poles were labeled bright and dark; and sensory stimulation was visual.

Experiment II: Texture. The nine stimuli were 4 x 4 inch squares of aluminum oxide abrasive paper centered on 7 x 7 inch squares of white posterboard. The abrasive papers used were 600-grit waterproof (three stimuli), 36-grit regular (three stimuli), and 80-, 150-, and 240-grit regular (one stimulus of each grade). The dimension of interest was texture; the poles were labeled rough and smooth; and sensory stimulation was tactual.

Experiment III: Facial Happiness. The nine stimuli were circles of 4 inch diameter drawn on 7 x 7 inch squares of white posterboard with a thin, black pen. Two black $1/16$ inch dots, 1 and $1/2$ inches apart were placed symmetrically on either side of the vertical bisector and 1 inch above the horizontal bisector of each circle to give the appearance of a mouth. In each case, the arc or line was drawn so that the corners of the mouth were separated by 2 and $7/16$ inches. Three arcs were of 1 and $1/4$ inches radius concentric with the 4 inch circle (very happy faces). Three identical arcs were inverted with their centers of curvature located 1 and $1/2$ inches below the center of the 4 inch circle (very sad faces). One arc was of 4 inch radius with the center of curvature 3 and $3/8$ above the center of the 4 inch circle (slightly happy face). An identical arc was inverted with its center 4 and $5/8$ inches below the center of the 4 inch circle (slightly sad face). A straight line was drawn $5/8$ of an inch below the center of the remaining 4 inch circle (neutral face). The dimension of interest was facial happiness; the poles were labeled happy and sad; and sensory stimulation was visual.

Experiment IV: Height. The nine stimuli were strips (lines) of $1/4$ inch wide black embossing tape placed individually on pieces of white posterboard 14 inches high and 7 inches wide. Each strip was centered vertically on the posterboard 1 inch from the bottom. Three lines were 12 inches high; three lines were 2 inches high; and the remaining lines were 6, 7, and 8 inches high. The dimension of interest was height; the poles were labeled tall and short; and sensory stimulation was visual.

Experiment V: Weight. The nine stimuli were weights, constructed of small orange juice cans (2 and 1/8 inches in diameter and 3 and 7/8 inches in height) and varying amounts of lead. The cans were painted flat black and the tops were covered with taut pieces of black cloth sealed down with black friction tape to give them a homogeneous appearance. Three of the cans weighed 2.50 pounds; three weighed 0.06 pounds; and the remaining cans weighed 1.06, 1.25, and 1.69 pounds. The dimension of interest was weight; the poles were labeled heavy and light; and sensory information was kinesthetic/proprioceptive.

Experimental Manipulations

The study consisted of three phases spread over time during each of which all children were tested on all five experiments in series. The serial order of the experiments (listed at the beginning of the methods section) was determined randomly before the study began, was the same for all children, and remained constant across the three phases (I, II, and III). Only the first two phases were in any sense crucial to the study; Phase III was performed for supplemental purposes and was analyzed separately. The temporal delay among phases differed somewhat from child to child from pragmatic necessity (i.e., absence from school), but was never allowed to be shorter than 1 day, nor longer than 27 days. Phases I and II occurred an average of 19.6 days apart for the thirty-two children; Phases II and III occurred an average of 8.1 days apart. Collection of data through Phase II was completed 26 days after the first child was seen; data through Phase III was completed 22 days later.

Children were asked to judge each of the fifteen test stimuli once in each phase according to one of two test orders. The test orders (TO-1 and TO-2) were randomly determined such that the three test stimuli of each dimension were judged successively with the test stimulus of medial value always preceding the other two. The succession of the test stimuli for TO-1 was as follows: (1) median, brighter, darker; (2) median, rougher, smoother; (3) median, happier, sadder; (4) median, taller, shorter; and (5) median, heavier, lighter. Similarly, the succession of stimuli for TO-2 was as follows: (1) median, darker, brighter; (2) median, smoother, rougher; (3) median, sadder, happier; (4) median, shorter, taller; and (5) median, lighter, heavier. Test order was invariant for a given child across the three phases. Thus, a child who received median, brighter, darker always was presented with median, brighter, darker brightness values, always received median, rougher, smoother texture values and so forth.

In Phases I and II, three identical, relevant anchor stimuli were presented serially to the children just before they were asked to judge the three test stimuli of any dimension. In Phase III, the test stimuli were judged in the absence of any anchor stimuli. A random procedure was used to determine which anchor stimuli would covary with each other across experiments. Anchor stimuli were presented according to one of two anchor sequences (AS-1 and AS-2) to equal numbers of children of each sex and age-level. Children in AS-1 received the bright, smooth, happy, short, and heavy anchor stimuli (three of each) in Phase I, and the dark, rough, sad, tall, and light anchor stimuli

in Phase II. Children in AS-2 received the dark, rough, sad, tall, and light stimuli in Phase I, and the bright, smooth, happy, short, and heavy stimuli in Phase II.

The visual experiments were readily amenable to the provision or omission of a memory prop. Children in visual standard (VS) present judged all of the visual test stimuli (Experiments I, III, and IV) with the last, relevant anchor stimulus present and clearly visible. Children in VS absent judged the same test stimuli with all, relevant anchor stimuli unavailable for immediate comparison.

Procedure

Children were seated across from the experimenter at a small table in an office adjacent to the main playroom at the school. The stimuli were presented to the children one at a time (E holding card upright on table or child lifting can) for approximately 5 seconds with a 5 to 8 second interval between presentations. Anchor stimuli (excluding weights) were discarded in a pile face down in front of the child except for the third anchor in the VS present condition which was left face up. Test stimuli were judged while still upright (or, for weights, in the child's hand) and discarded in a pile adjacent and to the left of the anchor pile (from the child's perspective). When a new dimension was begun, previous stimuli were cleared face down to a large discard pile at the edge of the table (to the child's right). Weights remained on the table after they were lifted, but children were not permitted to re-examine them. Care was taken to insure that the anchor and test stimuli

were nearby in the VS present condition, although the anchor stimuli were lying on the table and the test stimuli were still upright in the experimenter's hand. The instructions were virtually identical across phases except for prefatory and closing remarks and the elimination of anchor-relevant instructions in Phase III. Physical stimulus presentation was contiguous with the start of a new or repeated instruction. A bipolar, categorical judgment was obtained for every test stimulus before proceeding to the next item. The instructions are reproduced below:

Okay (child's name), we're going to play some games and do some things.

Look at this circle.

Look at this circle.

Look at this circle.

Now look at this circle. Is it bright or dark?

Now look at this circle. Is it bright or dark?

Now look at this circle. Is it bright or dark?

Now we'll do something different. Close your eyes.

Touch this.

Touch this.

Touch this.

Keep your eyes closed and now touch this. Is it rough or smooth?

Now touch this. Is it rough or smooth?

Now touch this. Is it rough or smooth?

Now we'll do a new thing. Look at this face.

Look at this face.

Look at this face.

Now look at this face. Is it happy or sad?

Now look at this face. Is it happy or sad?

Now look at this face. Is it happy or sad?

Let's try something else. Look at this line.

Look at this line.

Look at this line.

Now look at this line. Is it tall or short?

Now look at this line. Is it tall or short?

Now look at this line. Is it tall or short?

Okay. Now we'll play a very different game. Lift up this can.

Lift up this can.

Lift up this can.

Now lift up this can. Is it heavy or light?

Now lift up this can. Is it heavy or light?

Now lift up this can. Is it heavy or light?

Wonderful, (child's name), we're all done, etc.

Immediately after a child completed the requisite number of judgments, the experimenter thanked him (her) and allowed him (her) to put three colored stars on the corners of a triangle drawn on a piece of paper to keep as a souvenir. This triangle task was simply to draw the child's attention away from the games before he was returned to ongoing activities with the other children.

Design

Children were randomly assigned to an anchor sequence condition (AS-1 or AS-2), a test order condition (TO-1 or TO-2), and a visual standard condition (VS present or VS absent) with the only constraint being that age and sex variations be equated across cells. The overall statistical design involved a complex $2(\text{age}) \times 2(\text{anchor sequence}) \times 2(\text{test order}) \times 2(\text{visual standard}) \times 2(\text{phase})$ factorial design with visual standard absent as a variable in the analyses of the two experiments not involving visual stimuli. There was one child of each sex in every cell of the visual experiments. It should be noted that sex was intended to be merely a control variable; sex was not deemed of present conceptual interest. All tests of significance were based on two-tailed probability estimates.

Experiments VI to X

Subjects

Thirty-two adult retardates at a training school in Tucson served as subjects. The school had divided these students into low and high ability groups, a work skills class and a pre-vocational training class respectively. The sixteen subjects from the work skills class ranged from 16 to 30 years old (mean = 21.8 years); the sixteen from the pre-vocational class ranged from 19 to 36 years old (mean = 25.2 years). Eight persons in each ability group were male, and eight were female.

Procedure and Design

The study followed the exact same format as was described for Experiments I to V except that it proved pragmatically impossible to

equalize sex across all cells, and ability group was substituted for age as a variate. The mean time between Phases I and II was 15.8 days; the mean time between Phases II and III was 18.8 days. Total elapsed time from the beginning of the study through completion of the data for Phase III was 53 days. Subjects were not given anything to distract them from thinking about the games (i.e., the triangle/star task was omitted), but were sent back to finish tasks they had been working on before entering the experimental situation. In all other respects, the procedure and design were identical to those followed with the children in Experiments I through V.

RESULTS

The child and retardate samples were considered as being independent and distinct, although of interest for purposes of general comparison. Dimensions of experiments within samples were considered to be operationally separable, but conceptually congruent. Hence, the experiments were analyzed independently although within samples the results unequivocally fit together as unified packages of research.

Mean Perceptual Contrast for Both Samples

Table 1 presents Phase I and Phase II mean perceptual contrast by experimental dimension and anchor sequence for both the children and the retardates. A mean of 0.000 represents perfect judgmental assimilation to the relevant anchor stimuli; a mean of 3.000 represents perfect judgmental contrast to the anchor stimuli. That is, if, for Phase I, all children in AS-1 had judged all three test stimuli as bright (i.e., if their judgments had been assimilated toward the bright anchor stimuli which were presented), then their mean perceptual contrast would have been 0.000. Conversely, if all of these children had judged the test stimuli as dark (i.e., if their judgments had been contrasted with the bright anchor stimuli which were presented), then their mean perceptual contrast would have been 3.000.

Table 1. Mean Perceptual Contrast for Children and Retardates.--A mean of 0.000 indexes perfect assimilation to the anchor stimuli; a mean of 3.000 indexes perfect contrast.

Experiment Number and Dimension	Anchor Sequence	Phase I	Phase II
I: Light Intensity	1	2.688	1.187
	2	1.187	2.375
II: Texture	1	2.438	1.375
	2	1.875	2.375
III: Facial Happiness	1	2.438	1.875
	2	2.125	2.375
IV: Height	1	2.750	2.687
	2	2.687	2.375
V: Weight	1	1.813	2.500
	2	2.562	2.125
VI: Light Intensity	1	2.500	2.000
	2	1.375	1.938
VII: Texture	1	2.188	1.437
	2	2.375	1.500
VIII: Facial Happiness	1	2.063	1.750
	2	1.625	1.875
IX: Height	1	2.313	2.500
	2	2.500	2.063
X: Weight	1	2.063	2.312
	2	2.125	2.188

Analyses Across Phases

Scoring and Interpretation of Data

Bright, smooth, happy, short, and heavy were arbitrarily selected as the end-point standards against which to score the appropriate, bipolar, dimensional judgments of Phases I and II. If a response judgment was congruent with its standard, it was scored zero; if it was discrepant, it was scored one. The three judgments along any one dimension in any given phase were thus added to yield scores that ranged from zero to three. The set of these summed scores obtained from any one experiment, i.e., including data from both phases for each stimulus dimension, constituted the raw data for one separate analysis of variance. Effects were further analyzed by means of Scheffé's S-test (Scheffé, 1959).

The main prediction for the several experiments was that subjects from both samples would exhibit judgments contrasting with, and therefore relative to, the anchor stimuli they saw just prior to making their judgments. In this statistical analysis, such an effect would emerge as an interaction between phases and anchor sequences. For example, in Experiment I, subjects in AS-1 were expected to judge the intermediate grey stimuli as darker in Phase I and brighter in Phase II. Conversely, subjects in AS-2 were expected to judge the same test stimuli as brighter in Phase I and darker in Phase II. Hence, according to the scoring procedure outlined above (which was necessitated because of the lack of any absolute standard for scoring), subjects in AS-1 were expected to score in the direction of three (i.e., high) in Phase I relative to a

score in the direction of zero (i.e., low) in Phase II. In contrast, subjects in AS-2 were expected to score in the reverse pattern. It should be noted that the scoring metric was not intrinsically meaningful, but was explicit in relation to scores obtained in the other phase or sequence. Any important or relevant effects of the remaining variables, given the statistical design, would only emerge as triple or higher order interactions with Phase and AS. Main effects of variables or interactions not involving both Phase and AS were negligible in the present research because they had no bearing upon relational judgments or the lack thereof. For example, a main Age effect in Experiment I could only show that, on the average, one age group consistently judged the grey stimuli as lighter than did the other group. A significant Phase x AS interaction in the absence of a significant Phase x AS x Age interaction would further indicate that both groups judged relationally to the same degree although they started from somewhat different points of departure.

Analyses on the Child Sample

The analyses of variance showed a consistent pattern of significant Phase x AS interactions across all five dimensions in the absence of any other patterns of significant effects or trends. In essence, the analyses disclosed that children judged the test stimuli in appropriate relation to the shifting anchors. In no case were there any significant main effects or interactions involving the presence or absence of an overt visual standard (VS). There was one significant

interaction involving test order (TO), i.e., a Phase x TO interaction in Experiment I ($p < .05$), which was not relevant to the present conceptual issues. The few moderately elevated F -ratios and the one significant F -ratio involving VS or TO that were found were offset by a predominant number of F -ratios near or below a value of 1.000.

Analyses on the Retardate Sample

The analyses of variance showed a consistent pattern of significant Phase x AS interactions across all five dimensions in the absence of any other nonrandom patterns of significant effects or trends. In essence, the analyses disclosed that the retardates judged the test stimuli in appropriate relation to the shifting anchors. There were a total of four significant interactions involving VS or TO in the five experiments, but they occurred in a random pattern.

Conceptually Relevant Findings

Figures 1 through 5 depict graphically the significant Phase x AS interactions obtained for the child and retardate samples for each experimental dimension. The results of the analyses of variance for the ten experiments are summarized below. Only effects which are of conceptual interest (Phase x AS interactions, and Phase x AS interactions further involving age or ability grouping) are reported in the Results section. The technical reader is referred to Appendix B for a report of those several effects not involving a Phase x AS interaction. Appendix B also includes a report on several supplementary analyses of variance performed on the data from the child sample which included sex as a variate. The supplementary analyses on the three visual experiments

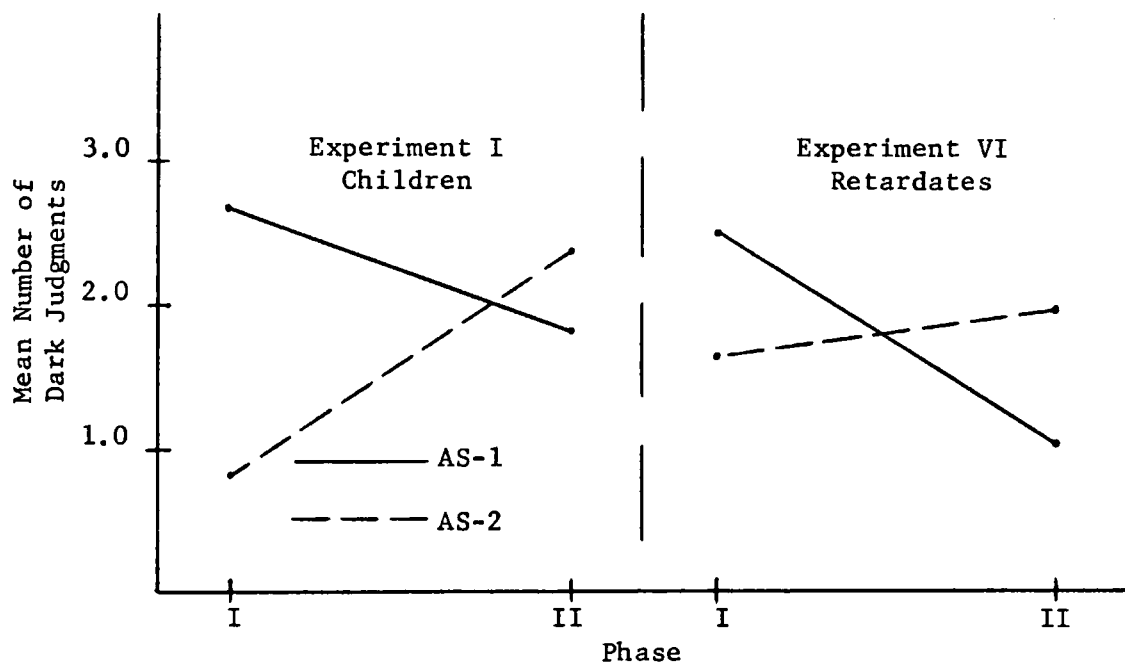


Figure 1. Relational Judgments for Light Intensity

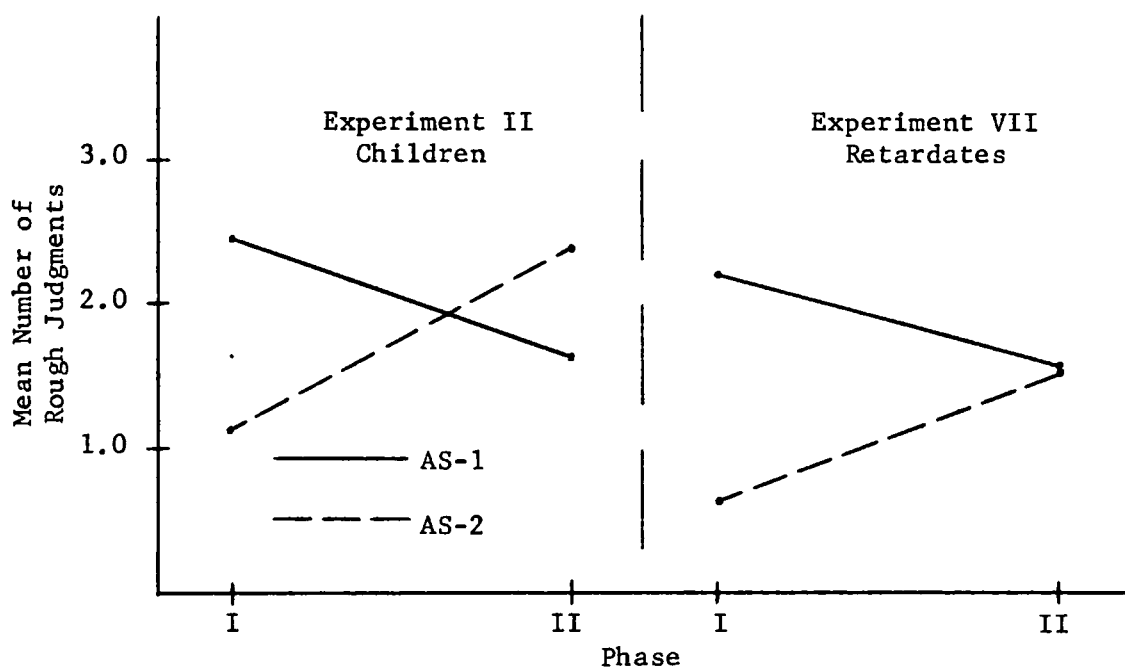


Figure 2. Relational Judgments for Texture

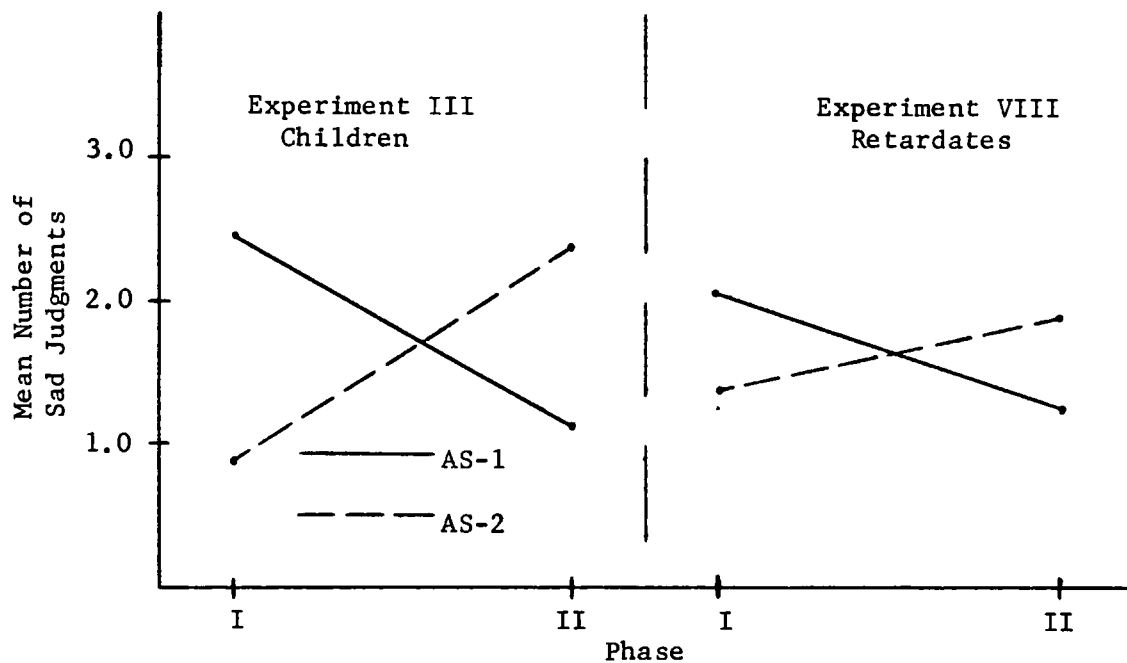


Figure 3. Relational Judgments for Facial Happiness

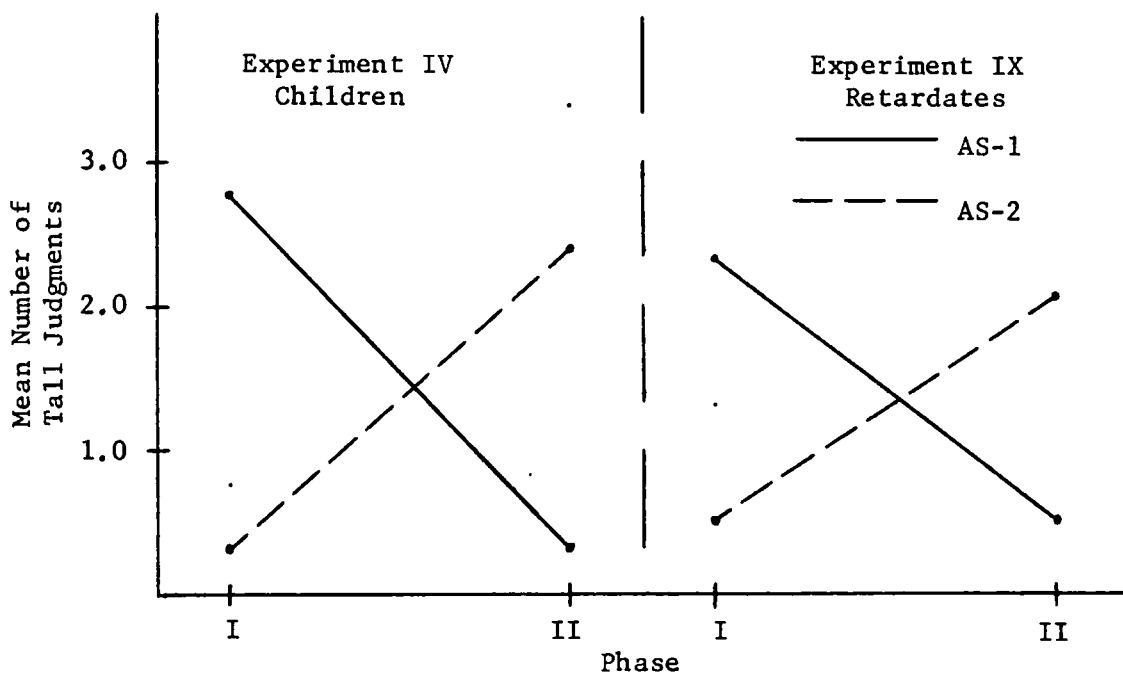


Figure 4. Relational Judgments for Height

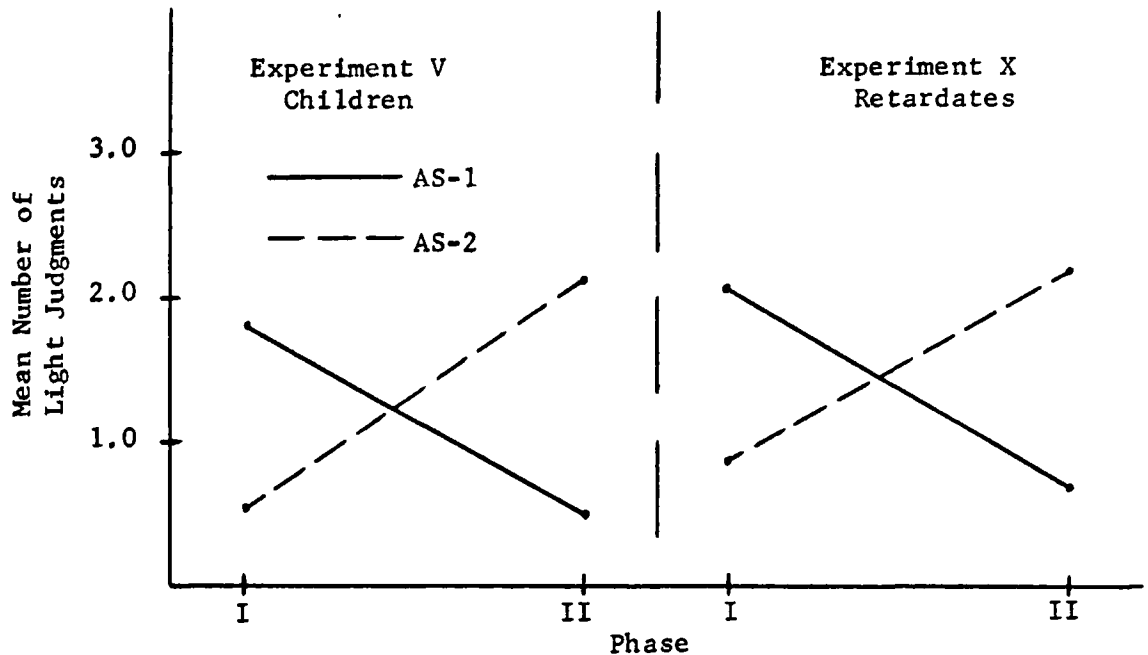


Figure 5. Relational Judgments for Weight

required pooling across the VS variate due to an otherwise insufficient number of degrees of freedom to analyze sex. Although this procedure could be legitimately criticized as statistically inappropriate, it was utilized merely to point out to the interested reader that sex seemed to be of negligible importance in the present research.

Experiment I. The analysis of variance disclosed a significant Phase x AS interaction ($F = 28.70$; $df = 1/16$; $p < .001$). Age did not enter into a complex interaction with Phase and AS. Scheffé tests revealed that the judgments of children in both AS-1 and AS-2 changed significantly across phases in the predicted direction ($p < .025$ and $p < .001$ respectively). Scheffé tests also revealed that the judgments of children in the two anchor sequences differed significantly in Phase I ($p < .001$), but not in Phase II ($p > .05$). The fact that only one of

the latter two Scheffé tests was significant merely reflects a non-significant trend towards a main AS effect, i.e., AS-1 tended on the average to give more "dark" judgments than did AS-2.

Experiment II. The analysis of variance disclosed a significant Phase x AS interaction ($F = 20.04$; $df = 1/24$; $p < .001$). Scheffé tests revealed that the judgments of children in AS-1 and AS-2 changed significantly in the predicted direction across phases ($p < .025$ and $p < .001$ respectively). Scheffé tests also indicated that the judgments of children in AS-1 and AS-2 differed in both Phases I and II ($p < .001$ and $p < .05$ respectively).

Experiment III. The analysis of variance disclosed a significant Phase x AS interaction ($F = 75.00$; $df = 1/16$; $p < .001$). Scheffé tests indicated that the judgments of children in AS-1 and AS-2 changed significantly in the predicted direction across phases (both $p s < .001$) and that the judgments of children in AS-1 and AS-2 differed in both Phases I and II (both $p s < .001$).

Experiment IV. The analysis of variance revealed a significant Phase x AS interaction ($F = 136.42$; $df = 1/16$; $p < .001$) and a significant Phase x AS x Age interaction ($F = 5.16$; $df = 1/16$; $p < .05$). The Phase x AS x Age interaction derived in part from a somewhat lesser change in the judgments of the younger children relative to the older children. Nevertheless, the changes of all AS x Age combinations were in the predicted direction (all $p s < .001$). Table 2 presents the mean number of tall judgments for all AS x Age combinations in Phases I and II and the mean judgmental shift of the groups across phases.

Table 2. Effect of Age upon Relational Judgment of Height.--The scores under Phases I and II represent the mean number of tall judgments given by the children in Experiment IV. Scores under Judgmental Shift represent the absolute change in the number of tall judgments across phases.

Age Group	Anchor Sequence	Phase I	Phase II	Judgmental Shift
Younger	1	2.625	0.625	2.000
	2	0.375	2.000	1.625
Older	1	2.875	0.000	2.875
	2	0.250	2.750	2.500

The overall judgments of the children in AS-1 and AS-2 differed in both Phases I and II (both p s < .001).

Experiment V. The analysis of variance revealed a significant Phase x AS interaction ($F = 53.20$; $df = 1/24$; $p < .001$). Scheffé tests indicated that the judgments of children in both AS conditions changed in the predicted direction (both p s < .001). The judgments of children in AS-1 and AS-2 differed in both Phases I and II (both p s < .001).

Experiment VI. The analysis of variance revealed a significant Phase x AS interaction ($F = 17.52$; $df = 1/16$; $p < .001$) and a significant Phase x AS x Group interaction ($F = 6.02$; $df = 1/16$; $p < .05$). Scheffé tests indicated that the complex interaction involving groups resulted primarily from the differential behavior of the work skills and pre-vocational groups in AS-2 across phases. The lower ability, work skills group shifted judgments in the direction opposite to that predicted (nonsignificant) and the higher ability, pre-vocational group

shifted in the predicted direction but not to a significant degree ($.05 < p < .10$). Both retardate groups shifted in the expected direction in AS-1 (work skills, $p < .05$ and pre-vocational, $p < .001$). AS-1 as a whole shifted significantly ($p < .001$); AS-2 did not ($p > .20$). AS-1 and AS-2 differed significantly in both Phase I ($p < .025$) and Phase II ($p < .01$).

Experiment VII. The analysis of variance revealed a significant Phase x AS interaction ($F = 12.52$; $df = 1/24$; $p < .005$). Scheffé tests indicated that both AS-1 and AS-2 changed significantly across phases ($p < .05$ and $p < .01$ respectively). Scheffé tests also indicated that the judgments of AS-1 and AS-2 differed in Phase I ($p < .001$), but not in Phase II.

Experiment VIII. The analysis of variance revealed a significant Phase x AS interaction ($F = 16.04$; $df = 1/16$; $p < .005$). Scheffé tests indicated that both AS-1 and AS-2 changed judgments across phases ($p < .005$ and $p < .05$ respectively). They also indicated that the judgments of AS-1 and AS-2 differed in Phase I ($p < .01$) and also in Phase II ($p < .025$).

Experiment IX. The analysis of variance revealed a significant Phase x AS interaction ($F = 57.46$; $df = 1/16$; $p < .001$). Scheffé tests indicated that both AS-1 and AS-2 shifted judgments across phases and that AS-1 and AS-2 differed in Phase I and also in Phase II (all $p s < .001$).

Experiment X. The analysis of variance revealed a significant Phase x AS interaction ($F = 59.65$; $df = 1/24$; $p < .001$). Scheffé tests

indicated that both AS-1 and AS-2 shifted judgments across phases and that the judgments of AS-1 and AS-2 differed in both Phases I and II (all p 's $< .001$).

Sequential Trends Across Three Phases

Supplementary analyses of variance were performed for each experiment to test for any trends of Phase III relative to Phases I and II. A 2(age) x 2(anchor sequence) x 2(phase) factorial design was used for Experiments I through V. A 2(ability group) x 2(anchor sequence) x 2(phase) factorial design was used for Experiments VI through X. No consistent trends were found. Results are presented in Appendix B for the technical reader.

Analyses Within Phases

Child Sample

Subsidiary analyses were performed separately on the three phases of each experiment to see if the children made relational judgments when the test stimuli themselves might serve as standards. Children always made three judgments on each dimension within a given phase. The second of these judgments could either be assimilated to (congruent response) or contrasted with (discrepant response) the first judgment; the third could either be assimilated to or contrasted with the second. The stimulus change from the first to the second stimulus was always towards one particular pole of any dimension for a given subject. The stimulus change from the second to the third stimulus was greater in magnitude and was always towards the opposite pole for the same dimension and

subject. Assimilations were scored as correct if the relative change of the test stimuli required the judgment to belong to the same response category as the previous judgment. Contrasts were scored as correct if the relative change of the test stimuli allowed the judgment to belong to the opposite response category from that of the previous judgment. That is, if a given test stimulus was brighter than its immediate predecessor which was judged as bright, then only a bright judgment (an assimilation) was scored as correct. However, if a given test stimulus was darker than its immediate predecessor which was judged as bright, then only a dark judgment (a contrast) was scored as correct. An assimilation was scored incorrect if a contrast would have been consistent with the relative stimulus change; a contrast was scored incorrect if the contrast was inconsistent with the direction of stimulus change. Again, if a given test stimulus was brighter than its predecessor which was judged as dark, then a dark judgment (an assimilation) was scored as incorrect. Similarly, if a given test stimulus was brighter than its predecessor which was judged as bright, a dark judgment (a contrast) was scored as incorrect. Each child had the possibility of giving two correct responses, or one correct and one incorrect, or two incorrect responses within any particular phase along any given dimension. Chi-square significance of change tests were used to determine whether or not relational judgments occurred significantly more often than non-relational judgments (McNemar, 1957). It should be noted that these analyses were conservative. Theory does not require a contrast to be made every time a stimulus change merely allows the

possibility of one; it does require those judgmental changes which occur to be consistent on the average with the direction of stimulus change. The scoring procedure outlined above assumes that theory demands a contrast every time one is possible and is therefore a procedure biased against the present hypotheses.

Seven of the fifteen comparisons (involving 3 phases x 5 experiments) differed significantly in the expected, relational direction (largest $p < .01$). Thirteen of the fifteen were in the expected, relational direction. The remaining two comparisons each involved equal numbers of correct and incorrect judgments. Thus, the tendency to judge in correct, relational agreement with the test stimuli was very consistent adding further support to the actual chi-square values which are presented in Table 3.

Retardate Sample

A procedure identical to that used with the child sample was employed to see if retardates used test stimuli as standards within phases. Eleven out of fifteen comparisons were significant in the expected relational direction (largest $p < .05$). Fourteen of the fifteen chi-squares were in the expected direction; the remaining comparison was in the reverse direction, but non-significant. Once again, the consistent trend within phases adds further support to the actual chi-square tests which are also in Table 3.

Table 3. Chi-square Values for Within-Phase Relational Judgments for Experiments I through X

Experiment Number and Dimension	Phase I	Phase II	Phase III
I: Light Intensity	0.500	--	--
II: Texture	3.200	0.800	1.777
III: Facial Happiness	15.059***	16.409***	15.429***
IV: Height	2.286	3.200	6.750**
V: Weight	8.100**	10.563**	10.083**
VI: Light Intensity	--	7.111**	12.500***
VII: Texture	0.000	1.786	4.900*
VIII: Facial Happiness	14.450***	16.409***	20.045***
IX: Height	0.900	7.692**	16.056***
X: Weight	9.600**	8.643**	12.500***

* $p < .05$

** $p < .01$

*** $p < .001$

NOTE: All chi-square values were corrected for continuity. Thirteen of the fifteen values for the child sample were in the expected direction, and the remaining two were tied. Fourteen of the fifteen values for the retardate sample were in the expected direction and the remaining instance was in the reverse direction. No chi-square values are reported for the ties or the reversal.

Summary of Results

Children (3.4 to 5.3 years old) consistently shifted their judgments of intermediate-valued stimuli away from sets of extreme-valued anchor stimuli which were introduced just prior to their actual judgments. Strong judgmental shifts occurred relative to anchor stimuli

of both poles of every dimension. The shifts appeared to be virtually independent of the age of the children, the sequence in which the opposite anchor stimuli of a given dimension were presented, the presence or absence of a memory prop, and the order in which stimuli were asked to be judged. The children also tended to exhibit relational, judgmental shifts consistent with the small stimulus changes among the intermediate-valued stimuli. The same essential findings were replicated with a sample of retardates.

DISCUSSION

Piaget (1928) asserted that young children cannot think relationally, that their judgments are made in an absolute sense without regard to outside frames of reference. Allegedly, they do not recognize that certain ideas (hard and soft, p. 50; fair and dark, p. 87; left and right, p. 107; etc.) involve a relation between at least two terms. Therefore, according to Piaget, young children's judgments of any set of stimuli should be rendered absolutely, i.e., they should not be influenced by any external frame of reference, implicit or explicit.

In fact, very young children exhibited powerful, relational, judgmental effects in the present study. The effects were consistent across a diverse set of stimulus dimensions and two age groups. Relational thinking was not modified by the presence or absence of a memory prop where it was possible to devise one, was not influenced at a global level by the order in which the judgments were elicited, and was negligibly affected by the alternate sequences in which the relative frames of reference appeared. The exact amount of judgmental shift and the precise distance of judgments from their respective anchors differed somewhat across dimensions, but this was expected since no effort had been made to quantitatively equate perceptual discriminability and perceptual location across stimulus dimensions. Children's judgments not only were made in relation to explicitly introduced frames of reference

(anchor stimuli), but also in relation to the previous judgments rendered (test stimuli). Even in the absence of explicitly introduced frames of reference, the children implicitly identified their own standards and tended to judge relative to those standards (the test stimuli in Phase III).

Piaget claimed in simple and qualitative terms that children cannot make relational judgments. Experiments I through V were conducted in simple qualitative form to demonstrate that Piaget was wrong. A formal, deductive derivation of this conclusion is presented in Appendix C.

O'Reilly and Steger (1970) concluded that their empirical results were consistent with Piaget's theoretical formulations, at least for children 5 years and under. In what they termed a procedure using "standard psychophysical techniques (p. 1099)," they attempted to see if children could order a series of five weights and if their judgments of the weights were affected by the presence of a light anchor. The children never hefted any actual weights; instead, the children pulled levers which lifted invisible weights. Curiously, children made judgments by pointing at pictures of five bell-shaped weights which increased linearly in size and therefore, presumably, accurately represented the amounts of heaviness just experienced through pulls. Clearly, the children 6 years and older mastered the complex representational scheme (lever = weight, picture weight; strength of pull = amount of heaviness, size of picture amount of heaviness), successfully ordered the weights, and displayed a judgmental shift of the

entire series in the presence of an anchor. The results for the 5 year old children, however, are unclear. Either they (a) could not order the series and (b) could not judge relative to an anchor, or they (c) could not discriminate the stimulus differences, or (d) could not master the representational scheme in the time allotted, or (e) just preferred to point to the smallest pictures. (The graphs indicate that the subjects pointed to the larger pictures only infrequently. Their pointing behavior was not a purely random matter.) Experiment V clearly discredits point (c) and O'Reilly and Steger's (1970) conclusion (b), suggests that one ought to reserve judgment on point (a), but offers no compelling evidence forcing choice on points (d) or (e). The O'Reilly and Steger study unquestionably suffered from several serious methodological embellishments which precluded a direct attack on their problem. In striking contrast, the present research (Experiments I through V) provides evidence in simple, straightforward fashion that relational thought is an important, general psychological capacity of very young children as would be expected from social judgment theory (Helson, 1964; Sherif and Hovland, 1961) and from social learning theory (Bandura, 1969, 1971).

The results from Experiments VI through X similarly provide evidence that retardates of two obviously different ability levels are also capable of relational judgments largely independent of props to memory, order of judgments, and the alternate sequences in which two very different frames of reference appear. No consistent differences in judgment were found across the child and retardate samples, though

there did seem to be a slight tendency for the retardates to give more judgments relative to the test stimuli, and fewer judgments relative to the anchor stimuli, than did the children. The retardate data offer no immediate implications for Piaget's theorizing or the O'Reilly and Steger study, but are reported here as of intrinsic interest and as data which need to be incorporated into any complete theory of cognitive development.

It remains to be seen whether or not very young children can make relational judgments employing a transitivity principle. However, the present empirical findings suggest the following surmise in applying a transitivity principle: All dicta which claim that young children cannot make relational judgments appear to be wrong. Piaget's preceding theoretical statements are dicta which claim that young children cannot make relational judgments. Therefore, it follows that Piaget's preceding theoretical statements are erroneous, in light of the present research results.

APPENDIX A

PIAGET IN CONTEXT

The following passages give the context of the six quotations cited from Piaget (1928) in the introduction. The quotations earlier cited are underlined to aid the reader.

But to return to the ego-centric illusion of our children's judgments. In virtue of the "innocence" of his judgment, the child reasons as though he were the only thinker in question; his point of view about his family seems to him the only one possible and excludes all others. For him therefore it is not a subjective point of view, but that of absolute reality. Consequently, as he is not conscious of his own subjectivity, or more simply of himself, he places himself on a completely different plane from his brothers, and this is what prevents him from seeing that he is a brother to his brothers on precisely the same grounds as they are brothers to him.

Thus when all is said and done, it is once more to the ego-centrism of thought that we must appeal in order to explain the incapacity for even the most elementary relativism of thought. To understand a relation--that, for instance, of brother to brother--means thinking of at least two points of view at the same time, those of each of the brothers. Absolute notions like those of "boy," etc. presuppose only one point of view. The judgment "Paul is a boy" remains the same whatever may be the perspective adopted.

The full importance of the ego-centric illusion will now be manifest. The explanation just given with regard to the notion of brother holds for all relative notions. If for the child things are absolutely dark or fair, and so on, it is because up to a certain age the child fails to realize this very simple fact that one of his companions whom he holds to be big, or dark, or horrid may perfectly well be regarded by a third party as small, or fair, or nice, without the third party being necessarily either a fool or a knave (1928, pp. 91-92).

The relativity of left and right in connexion with the actual objects emerges far more slowly, and here again we must beware

of being misled by appearances when we begin to question the children. Thus question 9 (finding whether a coin is to the right or the left of a pencil) is solved at the age of 7 (nearly 70% at the age of 6). But it is obvious that in such cases the child is judging objects only in relation to himself. The adult does the same, and all logicians know that the notions of right and left cannot be defined without referring implicitly or explicitly to the position of one's own body. But the difference is that when the coin and the pencil are presented to the adult, he will say that the coin is to the left of the pencil, whereas the child will simply say that it is to the left, in the absolute sense of the word. The shade of difference is not verbal but from the logical point of view essential, and its importance is proved by the fact that the child does not pass test 11 before the age of 11 precisely because he does not understand the expression to the left of as applied to the relation between two objects. The success of test 9 at the age of 7 is therefore in no way a proof that the child has realized the relativity of the ideas of right and left in connexion with objects taken by themselves.

One ought to have asked the child--this did not occur to us until after the experiment had been completed--to go to the other side of the table after having said that the coin was to the left of the pencil and to have added, "Now is the penny to the left or to the right of the pencil?" It would be interesting to repeat the experiment along these lines. The proof of the non-relativity of the notions of right and left is therefore supplied by the results of tests 11 and 12. By placing three objects in a row before the child and asking him to state exactly how these objects stand to one another, we force him to discover the relativity of the ideas of position. The key, which is between the coin and the pencil, can no longer be said to be "to the right" or "to the left" in the absolute sense of the word; it is to the right in relation to the coin and to the left in relation to the pencil. Left to himself, the child will say that the key is "in the middle," but we then ask him more explicitly: "Is the key to the left or to the right of the penny? And of the pencil?" If the child is not accustomed to make use of the notions of left and right in relation to objects taken by themselves, this expression "to the left of" will be unintelligible to him. And this is precisely what proves to be the case in experiment. This test is not passed till the age of 11. At 9 only about 15% of the children understand it at all.

The age of 11 is therefore very important as marking complete assimilation of the notion of right and left as applied to objects in themselves. Test 12, it is true, is not passed until a year later, but this interval is easy to explain.

For test 12, having the same logical structure as test 11, calls in addition for retention of the data by means of a certain topographical memory (knowing the position of three objects in a row which have been presented for half a minute). It is simply a matter of imagining the relations instead of merely seeing them.

It is interesting to note that tests 11 and 12 supply a complete confirmation of the results previously obtained by means of Burt's test, and which were summarized in Chapter II, §4: "Edith is fairer than Suzanne; Edith is darker than Lili. Which is the darkest of the three, Edith, Suzanne, or Lili?" Now this test bearing upon colour and our tests 11 and 12 have exactly the same logical structure, viz. the comparison of the middle unit of a series of three to the two extreme members of the series. We have been criticized however for making use of this test of Burt's, for it is one that requires a considerable effort of attention, even on the part of adults, if the phenomena which it brings under observation are to belong to the psychology of logical relations and not merely to the psychology of attention. Our answer to this was to point to the facts and to show how once the child has read the test often enough, once he has it sufficiently engraved upon his mind and difficulties of attention no longer exist, the logical difficulty still subsists of understanding how a little girl can be at the same time fairer than a second and darker than a third. We are now, moreover, in a position to give a still better answer to prove the child's inability to deal with the logic of relations, and that is the answer suggested by tests 11 and 12, or at least by test 11 alone. This test is very simple from the point of view of attention. To begin with, it must be played instead of being spoken i.e. the child has the objects before his eyes as he speaks. In the second place--and this is most important--there is no need during the whole of this test for the child to think of the three objects at once. He is asked six successive questions, which he answers separately: "Is the pencil to the left or to the right of the key? . . . etc." At the same time this test has the same logical structure as that about the colour of the girl's hair.

Now the answers obtained were found to be the exact equivalents of those obtained by means of the Burt test. In the first place, the Burt test is successful on the average between the years of 11 and 13, if the child is given time to think; and this age corresponds with that of our tests 11 and 12. But the analogy is most striking from the point of view of the mechanism of the answers. In the case of the colours, the child's fallacy (in logical parlance) consists in treating the relations, "fairer than," etc. as judgments of membership (Edith is fair or dark,

Suzanne is fair, Lili is dark). Exactly the same thing happens in the case of the right and left. The child asserts that the coin is to the right and the pencil to the left, but these terms are not in any sense relational. Consequently in the case of the colours the child does not know what to do about Edith--she is both fair and dark! Similarly in the present case the child cannot understand how the key (the middle object) can be both to the left of the coin and to the right of the pencil. He simply states it to be "in the middle!" If he is forced to be more precise and is made to say whether the key is to the left of the coin, he will also say that it is to the left of the pencil. If one begins with the pencil, and the child pronounces the key to be to the right of the pencil, he will answer the question: "Is the key to the left or to the right of the penny?" by saying that the key is also to the right. In a word, the key is to the left or to the right in the absolute sense of the word, and cannot be both at the same time. Thus the analogy is complete between Burt's test and our tests 11 and 12. The evolution of the ideas of right and left is as complex as that of other relative notions, and obeys exactly the same laws.

What conclusion can we draw from these facts? Do they admit of the proposed explanation which consists in tracing the non-relational character of childish ideas back to the ego-centricity of thought? It would seem that we can. There are three very definite stages in this evolution of right and left. During the first the child places himself at his own point of view, during the second at the point of others, and during the third at a completely relational point of view in which account is taken of objects in themselves. The process is therefore precisely that of the gradual socialization of thought--ego-centrism, socialization, and finally complete objectivity. The curious thing is that the three stages are determined by ages which happen to correspond to the ages of important changes in the child's social life, viz. 7-8, diminution of ego-centrism, and 11-12, the stage of rules and of thought which has become sufficiently formal to reason from all given points of view. Later on we shall show that these three stages also mark three phases in the development of reasoning properly so-called: "transduction," primitive deduction, and completed eduction.

Even if these ages come to be modified by subsequent research, the order in which the stages follow on one another will remain the same, and this order of succession is the only important consideration for general psychology (1928, pp. 109-113).

This is not the place to examine children's ideas on the origin of countries, which is a completely different subject, but here

are a few examples of these conceptions, which show how far removed from spatial relations is the interest of the child.

Schla (7;11) considers that "France belongs to another man [than Switzerland].--And does Switzerland belong to a man? --No, yes, to the man who wanted to give us passports." According to Stu (7;8) a country is "a big flat surface.--What is that?--A drawing.--Does it really exist?--In earth." According to Fröh (age 7) building contractors make countries as the need for them arises. Pro (age 8) says that you recognize countries by their railway stations "because it is written in the stations." Similarly Cont (age 9), "It is marked [in the stations].--And if you walk there?--It is on the roads, it is marked up, there is a sign-post."

In a word, just as in regard to his family the child made no attempt to get outside his own immediate point of view, so here he posits as something absolute his purely nominal conception of what is meant by a country. He is then led by this nominalistic realism to locate a country, not on a spatial plane capable of sustaining the relations of part to whole, but on an imaginary plane where things are thought of as absolute in themselves and without relations one to another, or at any rate without any beyond such vague and undifferentiated relations as those of "property" ("this going with that").

In the case of country as in that of family, of brothers, and of right and left, realism, due to point of view, entails a complete lack of relativity, or what comes to the same thing, a complete inability to handle the logic of relations.

III. CONCLUSIONS

What conclusions about the child's capacity for reasoning can we draw from these facts? In the discussion on the ideas of brother, of right and left, of family and country we were concerned only with the schematism of judgment. The task that now confronts us is the synthesis of all this material with the material contained in Chapters I and II.

The chief conclusion of Chapter I was that the child, owing to the difficulty he experienced (a difficulty due to ego-centrism) in becoming aware of his own thought, reasoned only about isolated or particular cases; generalization and consequently any sustained deduction do not come naturally to him. He juxtaposes successive judgments instead of connecting them, so that there is a lack of internal necessity about his thought. Even when the child comes to generalize and deduce with less difficulty, formal deduction is still a closed book to him,

because he cannot shake off his personal beliefs nor reason from assumptions suggested from the outside.

Our subsequent study of the judgment of relation gave complete confirmation of these results by showing their universality from a different angle.

The conclusion to which we are finally led is this. The child does not realize that certain ideas, even such as are obviously relative for an adult are relations between at least two terms. Thus he does not realize that a brother must necessarily be the brother of somebody; that an object must necessarily be part of a whole, but thinks of all these notions as existing in themselves, absolutely. Or again he defines a family, not by the relation of kinship which unites its members, but by the space they occupy, by the immediate point of view from which he sees them grouped around him in a house. It should be noted that such behaviour is universal, and that the list of examples might have been added to indefinitely. We are indebted, for example, to the kindness of Mme Passello, a Geneva school-mistress, for the knowledge of the fact that at the age of 7 the notions of "friend" and "enemy" are still devoid of relativity. An enemy is "a soldier," "someone who fights," "a horrid person," "someone who is horrid," "someone who wants to hurt you," etc. It is therefore not a person who is an enemy in relation to someone else, but an enemy in himself. Similarly for a friend.

We discovered innumerable examples of the same kind with Mlle. Hahnloser in connexion with the word "foreigner." At the age when children can say that foreigners are people from another country (about 9-10), they are still ignorant of the fact that they are themselves foreigners for these people. All the more reason therefore for their ignorance of the reciprocity of this relation when the term is reserved for people coming from another country but living in Geneva. Such examples could be multiplied indefinitely (1928, pp. 129-131).

APPENDIX B

SOME TECHNICAL ASPECTS OF THE DATA

Every conceptually irrelevant test which attained statistical significance at the $p = .05$ level or better is reported in this section. The supplementary sex analyses on the child sample are included. Results relevant to the trend of Phase III are also reported.

Conceptually Irrelevant Significant Results

Child Sample

Experiment I. Both a significant AS main effect ($F = 4.85$; $df = 1/16$; $p < .025$) and a significant Phase x TO interaction ($F = 5.45$; $df = 1/16$; $p < .05$) were obtained. The AS main effect indicated that AS-2 subjects gave more dark judgments than did AS-1 subjects. The Phase x TO interaction indicated that whereas TO-1 subjects gave more dark judgments than TO-2 subjects in Phase I, the reverse was true in Phase II.

Experiment IV. A significant AS x Age interaction was obtained ($F = 6.40$; $df = 1/16$; $p < .025$). The interaction effect indicated that whereas younger subjects gave more tall judgments in AS-1 than in AS-2, the reverse was true for older subjects.

Retardate Sample

Experiment VI. A significant main Phase effect occurred ($F = 7.52$; $df = 1/16$; $p < .025$) indicating that more dark judgments occurred in Phase I than in Phase II. A significant Phase x Group x VS interaction was obtained ($F = 7.52$; $df = 1/16$; $p < .025$) indicating that whereas the work skills group contributed to the phase effect only in the VS absent condition, the pre-vocational group contributed to it only in the VS present condition.

Experiment VII. A significant main AS effect occurred ($F = 6.15$; $df = 1/24$; $p < .025$) indicating that more rough judgments occurred in AS-1 than in AS-2.

Experiment VIII. A significant Phase x TO interaction was obtained ($F = 6.15$; $df = 1/16$; $p < .025$) indicating that whereas more happy judgments occurred in Phase I than in Phase II for TO-1, fewer happy judgments occurred in Phase I than in Phase II for TO-2.

Experiment IX. A significant AS x TO x Group interaction was found ($F = 4.80$; $df = 1/16$; $p < .05$) indicating that the work skills group gave more tall judgments than the pre-vocational group in every AS and TO combination except AS-2, TO-2 where the trend was reversed.

Experiment X. A significant main Group effect was obtained ($F = 5.73$; $df = 1/24$; $p < .025$) indicating that the work skills subjects gave more light judgments than the pre-vocational subjects. A significant AS x TO interaction ($F = 4.59$; $df = 1/24$; $p < .05$) indicated that whereas TO-1 subjects gave more light judgments than TO-2 subjects in AS-1, the reverse was true in AS-2.

Sex Analyses on the Child Sample

Supplementary analyses of variance were performed for Experiments I through V using a 2(age) x 2(sex) x 2(test order) x 2(anchor sequence) x 2(phase) factorial design with 2 subjects per cell. It should be noted that it was necessary to pool across the VS present and absent conditions in Experiments I, III, and IV in order to obtain 2 subjects per cell for the analysis. This procedure may be rightly criticized on statistical grounds as an inappropriate means of obtaining the requisite number of degrees of freedom, since VS was already examined as a legitimate variable in the visual experiments. However, since there were no VS manipulations in the non-visual experiments (i.e., Experiments II and V), there were a sufficient number of degrees of freedom to ask legitimate questions about sex in those instances. Analyses are reported on all five experiments for the reader interested in sex effects merely as suggestive evidence that sex was of negligible importance in the present research. The procedure followed was a conservative one, since spuriously significant results due to alpha-slippage were against the present hypotheses.

Findings on Sex

The only significant test involving sex was a Phase x AS x Age x Sex interaction in Experiment 4 ($F = 5.44$; $df = 1/16$; $p < .05$). There were no consistent trends towards significant sex effects across the five experiments, and most of the F -ratios involving sex were near or below 1.000. Scheffé tests indicated that the Phase x AS x Age x Sex

interaction derived from the relative inaction of two groups. The younger males in AS-2 changed judgments in the predicted direction on the average, but the change was not significant ($p > .10$). The younger males in AS-1 changed somewhat more in the predicted direction ($p < .025$). The children in the remaining AS x Age x Sex combination evidenced still more dramatic judgmental shifts across Phases I and II in the predicted direction (all p 's $< .001$). In essence, the relational judgmental shifts observed in the children seemed to occur independent of sex.

Trends in Phase III

Analyses of variance were performed across all three phases for all experiments. Scheffé tests were used to determine if Phase III judgments differed significantly from Phase I and Phase II judgments for AS-1 and AS-2. Unless stated otherwise, Phase III judgments regressed back towards Phase I from Phase II judgments. Probability levels reported below are based on the Scheffé tests, and only significant differences are reported, i.e., if an effect is not reported, it was not significant.

Child Sample

Experiment I. There were significantly more dark judgments in Phase III than in Phase I for AS-2 subjects ($p < .001$). There were more actual dark judgments in Phase III than in Phase II for AS-2 although not significantly more, i.e., Phase III judgments did not regress towards Phase I, but differed from Phase I even more than did Phase II.

Experiment II. In AS-1, there were more rough judgments in Phase III than either Phases I or II, but only the difference between Phases II and III was significant ($p < .025$). In AS-2, there were significantly more rough judgments in Phase III than Phase I ($p < .025$).

Experiment III. In AS-1, there were significantly more sad judgments in Phase III than in Phase II ($p < .005$). In AS-2, there were more sad judgments in Phase III than in Phase I ($p < .001$).

Experiment IV. In AS-1, there were significantly more short judgments in Phase III than in Phase I ($p < .001$). In AS-2, there were more tall judgments in Phase III than in Phase I ($p < .025$) and fewer tall judgments than in Phase II ($p < .005$).

Experiment V. In AS-1, there were more heavy judgments in Phase III than in Phase I ($p < .001$). Phase III did not regress back towards Phase I, i.e., there were more actual heavy judgments in Phase III than in Phase II. In AS-2, there were more heavy judgments in Phase III than in Phase II ($p < .001$).

Retardate Sample

Experiment VI. In AS-1, there were more bright judgments in Phase III than in Phase I ($p < .005$).

Experiment IX. In AS-1, there were more short judgments in Phase III than in Phase I ($p < .005$) and fewer short judgments than in Phase II ($p < .05$). In AS-2, there were more tall judgments in Phase III than in Phase I ($p < .05$) and fewer tall judgments than in Phase II ($p < .05$).

Experiment X. In AS-1, there were more heavy judgments in Phase III than in Phase I ($p < .01$) and fewer than in Phase II ($p < .05$). In AS-2, there were more heavy judgments in Phase III than in Phase II ($p < .05$).

APPENDIX C

A SIMPLE EXERCISE IN LOGIC

The four premises in the present exercise are derived from Piaget (1928) and the present research. The interested reader should consult the Results section, Appendix A, and/or Piaget (1928) to check on their veracity.

Premises:

1. If Piaget's theory about young children's thinking is correct, then young children do not think relationally.
2. The statement that young children do not think relationally is equivalent to the statement that young children make only absolute judgments.
3. If young children make only absolute judgments, then, experimentally, children would not judge stimuli relative to just previously introduced contextual stimuli.
4. Experimentally, children judge stimuli relative to just previously introduced contextual stimuli.

Solution:

Let T = Piaget's theory about children's thinking is correct.

R = Young children think relationally.

A = Children make only absolute judgments.

E = Experimentally, children judge stimuli relative to
just previously introduced contextual stimuli.

Given:

1. $T \rightarrow \sim R$
 2. $\sim R \leftrightarrow A$
 3. $A \rightarrow \sim E$
 4. E
-

Formal Logical Operations:

5. $(\sim R \rightarrow A) \cdot (A \rightarrow \sim R)$ (2, material equivalence)
 6. $\sim R \rightarrow A$ (5, simplification)
 7. $T \rightarrow A$ (1,6, hypothetical syllogism)
 8. $T \rightarrow \sim E$ (7,3, hypothetical syllogism)
 9. $\sim(\sim E)$ (4, double negation)
 10. $\sim T$ (8,9, modus tollens)
-

Conclusion:

Piaget's theory about children's thinking is not correct.

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