DOCUMENT RESUME

ED 142 994 CS 003 642

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TITLE	Alot about "Big, Little, and Same": The Relationship between Quantity Discrimination and the Comprehension and Production of Language.
PUB DATE	76
NOTE	38p.; Paper presented at the Annual Meeting of the Canadian Psychological Association, 1976; Due to print quality some parts of the document may be marginally legible
EDRS PRICE	MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS	*Child Language; Comprehension; *Concept Formation; *Language Development; *Language Research; Preschool Education; Problem Solving; *Thought Processes

ABSTRACT

Two studies were conducted, with three-to-five-year-olds, to assess the relationship between language comprehension and production and the development of quantity concepts. The asymmetry of acquisition of adjectives, "big" and "little," was also assessed, as well as differences in the acquisition of the underlying concepts. In Experiment 1, it was demonstrated that the child's ability to understand relative magnitude differences and quantitative equality precedes the comprehension of the words "big," "little," and "same." In Experiment 2, it was demonstrated that verbal cues involving relational terminology did not facilitate problem solving for the three-year-olds but did for four-year-olds. Also, successful problem solution preceded the ability to produce language about quantity. In general, asymmetries between the adjectives representing positive and negative poles of a dimension were found to be present in linguistic tasks rather than in conceptual ones. The results suggest that, for the quantity concepts, language and thought function independently in the early stages of concept development of the young child, but become increasingly related with development. (Author)

ALOT ABOUT BIG, LITTLE, AND SAME: THE RELATIONSHIP BETWEEN QUANTITY DISCRIMINATION AND THE COMPREHENSION AND PRODUCTION OF LANGUAGE[1]

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The relationship of language to early conceptual development has been described in a variety of theories (summarized in Blank, 1974; Macnamara, 1972; Nelson, 1974). According to the proponents of some of these approaches, language plays little, if any role in the development and structure of the thought of the young child. Among these is the Piagetian position (e.g., Inhelder & Piaget, 1964; Pascual-Leone & Smith, 1969; Sinclair-de-Zwart, 1969) that the development of cognitive structures occurs independently of language. According to Piaget, language is not a necessary condition for the emergence of operational thought, although both language and thought may depend on the development of the same underlying mechanisms of symbolic functioning. Similar viewpoints have been expressed by Furth (1964, 1966, 1971), Lenneberg (1967), Macnamara (1972), and Olson (1970b). Alternatively, according to other approaches, language is viewed as important to cognitive development. Vygotsky (1962) postulated an initial independence of language and thought, then the convergence of these abilities when the child is approximately two years old. From then on, thought processes are largely dependent on the child's mastery of language. Bruner (1964, 1966) also has assigned a critical role to language in cognitive development.

The relationship of cognition to language has been explored in a number of studies which have examined the order in which given concepts and language associated with them are acquired. The assumption of such studies is that if concepts precede the relevant language, then one can conclude that the concepts probably provide a basis for the acquisition of the related language or at least that language does not play a necessary role in the acquisition of the concepts. Quantity and logical concepts provide an opportunity to assess the language-thought relationship because non-linguistic techniques exist to assess the concepts. In the area of quantity concepts for example, Beilin and Kagan (1969) found that children's performance on a task involving the discrimination of one from two objects to be superior to their ability to produce the correct plurals of nouns, possessives, and verbs. Koff and Luria (1973) found that children were able to learn the concept of middle size before they could comprehend and produce comparatives expressing the relationship between objects of different sizes. For the development of logical concepts, Pascual-Leone and Smith (1969) found that children's ability to convey information about class membership was determined by the logical structure of the task, not by the language available to them. Similarly Jones (1972) found that general verbal ability and the use of tentative statements were not related to the ability to solve certain logical problems. Weil (1970) found that the development of time concepts preceded the ability to understand the past progressive tense and terminology such as "before" and "after" in relationship to a sequence of events. However, Bruner (1964) found that failure to transpose a 3 x 3 matrix was related to certain inconsistencies in the child's use of relational language and Scholnick and Adams (1973) found that the ability to reverse a classification matrix was not a necessary prerequisite of the ability to comprehend the passive grammatical structure, which presumably involves a reversal of the active forms.

The purpose of the present series of studies was to assess the relationship between the young child's quantity concepts and his understanding of certain words related to quantity. An important departure from previous studies was that language and related concept abilities were tested on the same set of stimuli, thereby increasing the probability that these tasks were measuring related structures. Experiment 1 of the present series was designed to assess the sequence of the development of elementary quantity concepts and the understanding of language about quantity. Discrimination learning tasks were used to assess the concepts of relative magnitude differences and quantitative equality. Children's responses to relational terminology were used to assess their understanding of quantitative language.

The concept of relative quantity difference was measured by Siegel's (1971) magnitude discrimination learning task. The child is required to select which of two sets has the greater or, for counterbalancing, fewer number of objects. The number of objects in each set varies from trial to trial so that the response is not merely to a single stimulus but is assumed to be mediated by a concept of relative size. In the corresponding language task, the child's understanding of the words "big" and "little" was tested with the same stimuli. These particular words, while not the most grammatically appropriate ones, were chosen because preschool children have difficulty in comprehending "more" and "less" (Donaldson & Balfour, 1968; Griffiths, Shantz, & Sigel, 1967; Siegel & Goldstein, 1969). "Bigger" and "littler" are also difficult (Koff & Luria, 1973) for young children. The understanding of numerical equality was determined by an equivalence task (Siegel, 1971) in which the child is required to discriminate sets of objects which are numerically equal. In the corresponding language task, the child's understanding of "same number" was tested with the identical set of stimuli.

While Experiment 1 was designed to assess the sequence of development of language and thought, the other two studies were designed to examine related questions of the relationship of language to thought, the degree to which a relevant word influences concept acquisition and whether a child can learn to respond to a word representing a concept. In Experiment 2, the role of language in concept development was assessed by manipulating the presence or absence of a specific verbal cue to the nature of the solution. In Experiment 2, the child's production of terminology related to quantity was examined for these particular stimuli, and the relationship of the linguistic skills to the performance on the concept tasks was assessed.

Experiment 1

Method

Subjects. The subjects were 102 children enrolled in half-day nursery schools in Hamilton, Ontario. There were 45 three year olds, 21 boys and 24 girls, and 57 four year olds, 29 boys and 28 girls. The nursery schools served predominantly white, middle class, urban areas.

Design. Each child performed four tasks; magnitude-concept, magnitude-language, equivalence-concept, and equivalence-language. The tasks were administered to each child in one of eight orders, which varied the order of magnitude or equivalence (first or second) and concept or language within each of these (first or second). Each child was tested individually in a small room at the school.

Concept tasks. The two concept tasks, described below, were complex discrimination learning tasks. Both these concept tasks were tested with a Behavioral Controls 400-SR programmed learning apparatus. The response alternatives appeared under a clear plastic press panel and the child responded by pressing the panel of his choice. The position of the correct alternative varied randomly from trial to trial. Correct responses were rewarded with tokens which could be exchanged for a small toy at the end of a session. A non-correction procedure was used. The only instruction that the child received was that selection of the correct alternative would result in some "play money" that could be exchanged for a toy. No relational terminology was used in the instructions. Criterion was 9 out of 10 consecutive correct responses. If criterion was not reached in 50 trials, the task was terminated.

Magnitude concept task. There were 50 stimuli for this task; each stimulus consisted of two sets of dots of unequal number arranged in a horizontal line, each set containing from one to nine dots. The particular numbers in each stimulus varied from trial to trial; the combinations were selected randomly from the 36 possible combinations of the numbers between one and nine, taken two at a time. Approximately one half of the children were reinforced for selecting the stimulus with the larger number of dots and the remainder were reinforced for selecting the stimulus with the smaller number of dots.

Equivalence concept task. The 50 sets of stimuli for this task each consisted of a sample and four alternatives; only one of the alternatives was identical in number to the sample. Both the sample and the alternatives had between one and nine dots.

Language tasks. Both language tasks used stimuli identical to their corresponding concept task. These stimuli were presented to the child on 5" x 7" index cards. For each stimulus, the children were asked about the word in question. They were not given any feedback about the correctness of their response, but they were told several times during the task that they were doing very well.

Magnitude language task. The stimuli for this task were identical to those in the magnitude concept task, except that there were only 25 trials, chosen randomly from the set of 50. For each stimulus, the child was asked to select the "big" or, for counterbalancing "little" set.

Equivalence language task. The stimuli for this task were identical to the equivalence concept task except that there were only 25 trials, chosen randomly from the set of 50. For each stimulus the child was asked to select the group of dots that had the "same number" as the sample.

Results

Criteria for success on the tasks were determined by calculating the probability of performance being significantly different from chance ($p > .05$). The criterion for passing the magnitude and equivalence concept tasks was nine out of ten consecutive correct responses. If a child did not reach criterion in 50 trials, he was considered to have failed the task. A score of 15 or more correct out of 25 for the equivalence language task (4 choice) and 18 or more out of 25 (2 choice) for the magnitude language task, was required for a passing score on these tasks.

Insert Table 1 about here

The frequencies and x^2 (binomial expansion, depending on the size of the expected frequencies) values for the relationship between success and failure on the language and concept tasks (McNemar test, Siegel, 1956) are shown in Table 1. Clearly, the concepts of quantitative equality and difference, as measured in the present study, developed before understanding of the relational terminology in question, specifically the words, "big" "little" and "same".

The concept of differences in magnitude may be a necessary condition for understanding the relational terminology "big" and "little" when applied to the same stimuli. The same is true of the concept of numerical equality and the word ~~"same"~~ when same refers to numerical identity. These findings are clear from the large percentage of children in the pass concept, fail language cells and the small numbers (in two cases, 0) subjects in the pass language, fail concept cells. Thus, if a child failed the concept task, there was no chance of success in the equivalence language test and a very small chance in the magnitude language test. Only three of the 102 children showed a reversal of this trend in that their language developed before the corresponding concept; in these cases, the magnitude concept. While all of these three children failed the magnitude concept task, they consistently selected the wrong alternative on almost every trial, rather than responding randomly. In all cases, they were reinforced for the selection of the littler group, yet consistently selected the bigger one. This pattern of responding, which was not noted in any other subjects, appears to indicate the presence of a concept rather than complete confusion about the difference between the stimuli.

To analyze order effects, success rates were examined in the groups who had either the concept or the language tests first, and with one exception, there were no differences. The one exception was the four year olds, in the case of the equivalence task. A significantly higher percentage of these children passed the language task when it was administered after the concept task, than when it was administered prior to the concept task (81.25% vs. 56.00%, $z = 2.07$, $p < .04$, two tailed). Since in this case, the success on language task was greater after having learned the concept than before it, learning the concept appeared to facilitate solution of the language task. Since there were no cases in this study in which the concept acquisition was facilitated by having the language task first, this is indirect evidence that training the concept may enhance language. There were also no significant differences between either the children's learning of the concept representing bigger or littler or their comprehension of the words big or little. There were no differences between the proportion of boys and girls passing each task.

Discussion

The concept tasks in this study were, of necessity, learning tasks with feedback provided for correct responses, since this seemed to be the most reasonable way to assess concepts non-verbally in the young child. It could be argued that the children did not actually possess the magnitude and equivalence concepts when they started the task, but acquired it in the course of the discrimination learning. There are two kinds of evidence which weaken the case for this interpretation. First, the children who passed the concept task did so in relatively few trials. The mean number of trials to attain criterion for those who succeeded were as follows: 3 year olds-magnitude, 8.57; 3 year olds-equivalence, 7.15; 4 year olds-magnitude, 5.04; 4 year olds-equivalence, 6.96. Therefore, if there is learning involved in the concept tasks, it is quite rapid. In addition, the probabilities of correct responding in the precriterion trials for those who succeeded do not change from trial to trial. The pre-criterion data do not suggest gradual acquisition, although these data obviously do not preclude more all-or-none learning. As for the possibility of differential motivation in the language and concept tasks, because of the presence of reinforcement in concept task, if this were the case, certain differences between orders of task administration should have been found (Crespi, 1944). The shift from reward to non-reward should have produced a decrement when the language task was administered after the concept test. In fact, there were no order effects, except in one group in which the concept first, language second group performed better than the group which had the tasks in the reverse order, opposite to the above prediction.

On the basis of the present results, it seems quite clear that, for the preschool child, concepts of numerical equality and inequality are learned before the child displays the ability to comprehend relational terminology about the same set of stimuli. The understanding of the language depends on the existence of the concepts, and, as a corollary to this, the concepts exist independently of language, at least the language investigated in the present study. Clearly, the Piagetian position is supported. It should be noted that Blank (1974) presents evidence for the fact that while visual and spatial concepts may not depend on language, non-visual concepts appear to be dependent on language, even in the young child. Obviously, generalizations about the relationship of thought and language must depend on the empirical studies of a variety of concepts, both visual and non-visual ones.

Experiment 2

The conclusion that the acquisition of certain quantity concepts occurs prior to the development of the comprehension of the relevant language is suggested. However, the reinforcement differences between the concept and language tasks are a possible factor in the differential performance. Therefore, the role of language was assessed in Experiment

2 by varying certain aspects of the operation of linguistic factors within the concept learning task. To the extent that this language-thought independence exists, and if cognitive operations develop before the appropriate language, then concept acquisition, at least early on, should not be facilitated by language. Evidence of the role of linguistic control of cognitive operations in the young child, under six years old, is equivocal. Some studies have found little effect of subject generated or externally given verbal cues (e.g., Conrad, 1971; Flavell, 1970; Olson, 1970a, Osler & Madden, 1973; Reese, 1962; White, 1965), while other studies, such as those of Blank and Bridger (1964) and Kendler and Kendler (1962), have found that verbal cues facilitated the acquisition of certain concepts. One of the purposes of Experiment 2 was to determine the degree to which verbal labels could facilitate the acquisition of these quantity concepts. This role of language was assessed by administering the complex discrimination problems described previously to groups of three and four year old children with instructions which described the solutions, depending on which was appropriate to the task, as the "big", "little", or "same number" alternative (Cue condition). Control groups (No cue condition) performed the identical task without the verbal cue. If these concepts exist prior to the relevant language then, at least in the early stages of concept development, the verbal cue should not facilitate solution. However, if the verbal cue can influence the problem solving, then language must be viewed as facilitating thought.

The child's comprehension of a particular word is tested by the above technique; a related question about the relationship between language and thought concerns the degree to which a child can generate language about quantity in relation to the stimuli used in these problems and whether or not this language production is related to problem solution. To the extent that a discrepancy between language and concepts exists, then language production and concept attainment should not be related. In addition, if thought occurs prior to language, then the child should be able to solve the problem before he can produce quantity language in relation to these stimuli. The child's ability to describe these stimuli with meaningful language about the quantitative relationships was examined in an attempt to determine the degree to which language production is related to the ability to solve these problems.

Another purpose of this experiment was to investigate certain aspects in the development of the child's language about quantity. H. Clark (1970) has postulated three stages in the acquisition of relational terminology. In the first stage, children use this terminology in the nominal sense; a relational word or adjective is used to denote membership in some global class, but comparative properties are absent from the description. Children at this stage might say of two unequal groups, "They are both the big one". In the second stage, both polar terms of some dimension are interpreted to mean refer to the most extended, or positive, end of the dimension, e.g., both "more" and "less" are interpreted as meaning "more" (e.g., Donaldson & Wales, 1970; Donaldson & Balfour, 1968; Klatszky, Clark, & Macken, 1973; Palermo, 1973). In the final stage, children can use these words correctly. The present study represents an attempt to apply these analyses to the young child's language about quantity.

These hypotheses were examined with a variety of stimuli, designed to measure the development of the child's ability to separate the dimensions of number and length. Since it has been found that young children confuse number and length (Gelman, 1972; Lawson, Baron, & Siegel, 1974; Pufall & Shaw, 1972; Siegel, 1974), the relationship of language and quantity concepts of numerical equality and difference was investigated with a variety of stimuli. Stimuli were used in which length and number were perfectly correlated, length provided no information about number, and length and number were negatively correlated. These tasks were used to examine the hypotheses (Bever, 1970; Clark, 1973; Slobin, 1973) that children's cognitive and perceptual skills provide the basis for early language acquisition. The consequence of these theories, is that as the underlying difficulty of the task increases, so does the probability that language will not be produced and comprehended in relation to that cognitive ability.

Method

Subjects. The subjects were white middle class children from nursery schools and day care centers in Hamilton and Burlington, Ontario. For the magnitude tasks, there were 180 preschool children (60 three year olds, 30 boys and 30 girls, 120 four year olds, 57 boys and 63 girls). For the equivalence tasks, the subjects were 80 preschool children, 24 three year olds (13 boys, 11 girls), and 56 four year old children (28 boys and 28 girls). Independent samples, from different schools, were used for the magnitude and equivalence tasks. The magnitude and equivalence tasks were each administered by a different experimenter, in both cases, a white adult female.

Tasks and design. Both the magnitude and equivalence tasks were discrimination learning tasks similar to those of Experiment 1, but instead of the programmed learning apparatus, the stimuli were presented to the child on 5" x 7" index cards. An individual child was only administered one task, magnitude or equivalence, and was randomly assigned to one of the conditions within each task.

Magnitude. For each of the three magnitude tasks, 40 stimuli were used, each with two vertical rows of dots. The particular numbers used on each stimulus were selected randomly from all the possible combinations of the numbers two through nine. For each task, the stimuli were presented in a predetermined random order. The tasks were as follows:

Magnitude-Same Density (Mag-SD). The dots in each set were equidistant and thus, the row with the greater number of dots was longer.

Magnitude-Same Length (Mag-SL). The rows of dots in each set were the same length, irrespective of the number of dots in each set.

Magnitude-Different Length, Density (Mag-Diff. L-D). The set of dots with the greater number was shorter in length than the set with the smaller number of dots.

A representative stimulus from each task is shown in Figure 1.

Insert Figure 1 about here

The subjects were assigned to one of four independent groups. These were the absence or presence of the verbal cue (Cue vs. No Cue) and, within each of these groups, one half of the subjects were reinforced for choosing the more numerous set (labelled "big" for the Cue condition) and one-half for the set with fewer objects (labelled "little" for the Cue condition). The instructions for each condition were as follows:

Cue. "Here is a picture. Here is another picture. (The experimenter pointed to each one in turn). If you pick the big (little, when appropriate) picture, you will get some play money. When you have enough play money, you can buy one of these toys."

No Cue. "Here is a picture. Here is another picture. (The experimenter pointed to each one in turn). If you pick the correct picture, you will get some play money. When you have enough play money, you can buy one of these toys".

Correct responses were reinforced with a coin. For the first five trials, if the child did not select the correct one, the experimenter told the child his choice was wrong and then pointed to the correct one and told the child it was the correct one. Two nursery schools did not want the children to receive the toys, so these children only accumulated coins. It appeared that the children in these schools did not perform differently from the others, so the data from these schools was included with the others.

Three different task orders were used. For each of these four groups, there were five year olds given each order and ten four year olds given each order. Each child was administered 40 trials.

Equivalence. For each of the four equivalence tasks, there were 40 stimuli, each of which contained three horizontal rows of dots. The top half contained one row, called the sample, and the bottom half had two rows only one of which was equal in number to the sample. The particular numbers were selected randomly from all possible combinations of the numbers two through nine. For each task, the stimuli were administered in a predetermined random order. The four tasks were as follows:

Equivalence-Same Density (Equiv-SD). The dots in the sample and two alternatives were equidistant and thus, the sets with the greater number of dots were longer.

Equivalence-Same Length (Equiv-SL). The sample and the alternatives were all equal in length, irrespective of the number of dots in the set.

Equivalence-Different Length, Same Density (Equiv-Diff L-SD). The correct alternative (identical in number) was a different length from the sample. The incorrect alternative was the same density as the sample.

Equivalence-Different Length-Same Length (Equiv-Diff L-SL). The correct alternative was a different length from the sample. The incorrect alternative was the same length as the sample.

A representative stimulus from each task is shown in Figure 1.

The subjects were assigned to one of two conditions (Cue vs. No cue), type of cue/concept (Big vs. Little), and task (SD, SL, and Diff. L-D) was performed on these data. For the three year olds, there were no significant differences in error rates as a function of condition or type of cue/concept. There was a significant task effect (F (2, 112)=7.64, $p < .005$); the SD task was significantly easier than the other two

(Duncan's multiple range test, $p < .05$). For the four year olds, there were significant effects of condition (F (1,116) = 46.49, $p < .001$), type of cue/concept (F (1,116) = 22.44, $p < .001$) and a significant interaction between these two variables (F (1,116) = 10.11, $p < .005$). There were no differences in error rate for the Big and Little concepts in the No Cue condition, but there were significant differences between the effectiveness of Big and Little in the Cue condition. There was also a significant effect of task (F (2,232) = 7.96, $p < .001$); the SD task was the easiest, the SL task more difficult, and Diff. L-D the most difficult (Duncan's multiple range test, $p < .05$).

Equivalence task analysis. The mean number of errors for each age group is shown in Figure 2. Mixed model analyses of variance for condition (Cue vs. No cue) and task (SD, SL, Diff. L-SD, Diff. L-SL) were performed separately for each age group. For the three year olds, there were no effects of tasks or condition ($F < 1$). The majority of the three year olds were performing at, or near, chance levels (20 errors). For the four year olds, there were significant effects of Cue (F (1,54) = 8.17, $p < .005$) and task (F (3, 162) = 4.41, $p < .01$) and no significant interaction (F (3,162) = 1.25). The Diff. L-SL task was significantly more difficult than the other three (Duncan's multiple range test, $p < .05$). For either the magnitude or the equivalence tasks, there were no significant order effects or significant differences between the performance of boys and girls.

Language analysis. The subjects' responses to the language production task were scored for the presence or absence of correct quantity response by two independent raters. Examples of appropriate responses were

"The big one", "The one with more dots" (magnitude), or "They both have the same number" (equivalence). Inappropriate responses were such statements as, "I wanted to", "I like that one", "The ones that have two", "This has four and this has seven". Failures to respond were also included in this category. The relationship between success and failure on each task (criterion was 9 out of 10 consecutive correct responses) and production of quantity language was calculated by the McNemar test. For the three year olds, successful performance on two of the magnitude concepts tasks (SD) and (Diff. L-D) occurred prior to the ability to produce the appropriate quantity responses. Significant numbers of children passed the concept tasks and failed the language production tasks. The same was true for the four year olds on the MAG-SD task and the equivalence SL and Diff. L-D tasks. For the other tasks, there were no significant relationships between quantity language production and concept solution.

The language samples from the magnitude tasks were analyzed to determine the nominal or relational qualities of the child's descriptions of the stimuli. Analysis of the linguistic descriptions of the equivalence stimuli showed that if a quantity language was used, it was relational. For the magnitude task, the children's responses were classified in one of three categories: nominal (e.g., "the big (little) one", "it's too big", "they are both big (little)"), relational (e.g., "the big picture has more dots than that one", "this is more bigger", "this has more (less) dots"), and other (including no response). For the three year olds, 15% of the responses were nominal and 3% were relational. There was no significant difference in error rates between the children who used nominal or relational responses except for one task, MAG-SD in the Cue-Little condition. The relational responders made significantly fewer errors than the nominal ones. (Duncan's multiple range test). In addition, a number of children in this study demonstrated a response pattern which may be representative of an intermediate stage proposed by H. Clark (1970) in which children use a single word to denote both ends of a polar dimension, for example, "more" is understood to mean both "more" and "fewer". This response pattern consisted of selecting the wrong alternative on most of the trials (at least 35 out of 40). Of the three year olds, 6 out of the 30 children who were administered the Little tasks did this on at least one of the tasks. No three year old did this in the Big tasks. Nine four year olds showed the same response pattern in the Little conditions and four did in the Big condition. Their verbalizations in the language production task were, for the most part, correct; for example, in the Little groups, they stated that they were selecting the littler stimulus, although, in fact, they were consistently selecting the more numerous of the two groups. Therefore, they used the antonym to refer to the concept. Since most of the confusions occurred in the Little conditions, and "little" was interpreted as meaning "big", this response pattern could be a result of the child's linguistic confusion of assigning one term, usually the positive one, to both ends of the dimensions.

To determine whether or not there were tendencies in the children's linguistic response to refer to the positive, as opposed to the negative end, of the dimension, responses in the language production task were classified as positive (e.g., big, more, taller), negative, (e.g., little, less, short) mixed (use of both types of terminology), or irrelevant or no response. These data are shown in Table 2. Clearly, for both the

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Insert Table 2 about here

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three and four year olds, in the Big conditions (both Cue and No cue), there were significantly more references to the positive end of the dimension. Even in the Little conditions, there were more responses to the positive end of the dimension, although the differences were not significant.

Discussion

For the younger children, a verbal cue did not facilitate the learning of numerical similarity or difference; for the older children, it did. These data suggest that in the early stages of quantity concept formation, language and thought function independently and language has no facilitating effect on thought. Problem solution occurred prior to language production for some of the tasks, for others they were not related. In the case of the four year olds, the facilitating effects of a cue can be considered evidence for verbal mediation. In this case, the argument for the independence of language and thought cannot be made; it would appear that the older children could use this language cue to help them to solve the problem. However, even in the older age group, there were many children who could arrive at the correct solution but could not describe either how they did so, or the critical dimensions, of the stimuli in any meaningful way. It should be noted that one of the stimuli was available during the production task, so that memory failure was not a significant factor in poor performance.

As children mature, they are more likely to use comparative rather than nominal, non-relational terminology. Occasionally, another use of language occurred which was suggestive of an intermediate level of responding. In these cases the child would use the same word to refer to opposite ends of a dimension and combine this word with a different adjective or modifying phrase to refer to each extreme of the dimension. For example, the children say such things as, "this is big and this is a little bit big", "this has a little bit lotsa dots and this has lotsa lotsa dots", "these are wider in and these are wider out", "those are farther together and they're almost together", "it's too long and it's not too long", "this is long and this is a bit long" (pointing to the shorter of the two stimuli). This type of usage may account for the child's error in labeling opposite ends of the same dimension with the same word. If he gets confused and forgets the modifier, the type of errors that Clark (1970) and Donaldson and Wales (1970) describe could quite easily result.

While there is clear evidence for asymmetry in the acquisition of positive and negative relational terminology, the same asymmetry is not apparent in the acquisition of the concepts. There were no differences between the acquisition of the Big and Little concepts in the No cue condition, but Big facilitated concept attainment more than Little did in the Cue condition. In Experiment 1, the Big and Little concepts were of equal difficulty. The asymmetries appear to be more related to language acquisition rather than to the acquisition of the concepts, again suggesting an independence of language and thought. The failure to find asymmetry in concept acquisition parallels the finding of Cole, Gay, Glick, and Sharp (1968) that the Kpelle people, in whose language there is a predominant use of the positive as opposed to negative terminology to refer to size, showed no asymmetry of transposition of a size concept.

The order of task difficulty replicates the findings of Siegel (1974) in which the child gradually learns to separate and coordinate the dimensions of length and number. The Mag-Diff. L-D task, in which length and number are negatively correlated, and this required the coordination of these two dimensions, was especially difficult. One of the children verbalized this problem with this task, "this one is bigger (pointing to the more numerous, more dense set) but this one is two so it's smaller". Another child said, "it's big because if you get mixed up you know it's big". It is apparently the relationship of these two dimensions that creates the difficulty with the understanding of number.

The results of the present study are relevant to certain issues in language acquisition. The development of the child's perceptual and cognitive skills has been suggested as the basis for his early language acquisition (Bever, 1970; E. Clark, 1974; Slobin, 1973). The present study suggests that conceptual development, in this case the ability to recognize numerical equality and inequality, occurs prior to the child's acquisition of relational terminology and is necessary, but not sufficient, for this acquisition. In addition, these data partially support the assertion that relative cognitive complexity determines the order in which language will be acquired. The magnitude concept represents a simpler, more basic quantity concept than the equivalence one (for a further discussion of this point see Brainerd, 1973; Siegel, 1974). Clearly, the magnitude concept was the easier one. Understanding of the words big and little preceded the understanding of same number, at least for the younger children in this study. This difference is evidence for the fact that words for the more complex concepts are learned later than words for the simpler ones.

The results of these studies strongly suggest that initially language and thought function independently in the young child, and that as the child develops, the concepts and language tend to become more related. The implications of these findings for the assessment of cognitive operations in the young child are quite clear; concepts on a non-verbal, probably perceptual level, before language has any relationship to them. Therefore, to the extent that the results from these experiments are generalizable to other concepts, measurements of cognitive skills which rely on the understanding of language or the production of linguistic responses will underestimate the cognitive abilities of the young child. These studies demonstrate that children can process information about relative and absolute size in a meaningful way and assimilate new instances of these concepts, yet not necessarily be able to respond to or produce language about quantity.

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Footnotes

1. This project was supported by Grant MT-3773 from the Medical Research Council of Canada. The author wishes to thank the following people for their assistance in providing subjects: Mrs. G. Wissman of the Ancaster Day Care Center, Mrs. B. DePelham of Live Wires Co-op Nursery School, Mrs. H. Spencer of Temple Anshe Sholom Nursery School, Sister Mary Damascene of All Souls Day Nursery, Mrs. B. McWhirter of the Cariad Day Nursery, Mrs. Raftery of Little Mountaineers Nursery, Mrs. J. Sandilands of St. Mark's Nursery School, Mrs. A. Jenkins of the Lynden Nursery School, Mrs. R. Lemke of the Hamilton Day Care Center, Mrs. H. Doyle of the Hansel and Gretel Nursery School, Mrs. C. Marshall of the Small Fry Nursery School, Mrs. M. Whitworth of the Honey Bears Nursery School, Mrs. W. Walsh of the Huntington Park Nursery School, Mother Mary John of the Infant Jesus Nursery, Mrs. B. Davis of Jacks' and Jills' Preschool, Mrs. B. Crump of the Knox Day Care Center, Miss J. Powell of the Mother Goose Preschool, Mrs. J. Gerstenberger of the Nash Road Day Nursery, Mrs. I. Tinson of the Normanhurst Cooperative Preschool, Mrs. P. Bottrill of St. James Cooperative Nursery School, and Mrs. Lucki of Playtime Day Nursery.

The author also wishes to thank Sophie Berenbaum, Arlene Fox, Judith Brand, and Marian Winegard for their assistance in the data collection and analysis, and Jon Baron and Daphne Maurer for their helpful suggestions on earlier versions of the manuscript.

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Table 1

Concept and Language Performance (No. of Subjects): Experiment 1

Group	Pass Language, Pass Concept	Fail Language, Pass Concept	Pass Language, Fail Concept	Fail Language, Fail Concept
Magnitude				
3 year olds***	15	20	2	8
4 year olds***	37	17	1	2
Equivalence				
3 year olds*	7	4	0	34
4 year olds**	40	8	0	9

*$p < .06$
**$p < .004$
***$p < .001$

Table 2

Asymmetry of Language Production in Magnitude Tasks:

Experiment 2

3 year olds	Proportion of Responses Positive	Negative	Mixed
Cue-Big*	.27	.02	.04
No Cue-Big**	.09	0	0
Cue-Little	.09	.09	.09
No Cue-Little	.07	.02	.02

4 year olds	Proportion of Responses Positive	Negative	Mixed
Cue Big*	.42	.05	.09
No Cue-Big*	.32	.04	.08
Cue Little	.21	.14	.16
No Cue-Little	.14	.09	.10

Significance of difference between positive and negative

* $p < .001$

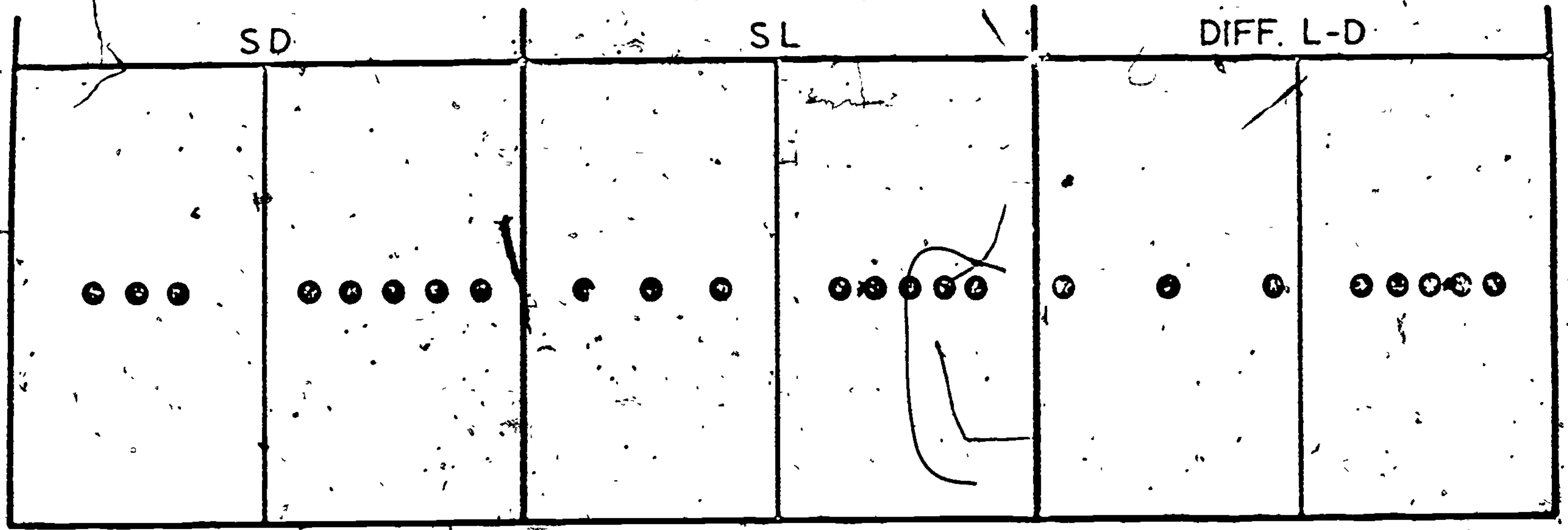
** $p < .03$

Figure Captions

Figure 1. Representative stimuli from each of the tasks.

Figure 2. Mean number of errors as a function of condition and age. (Experiment 2).

MAGNITUDE



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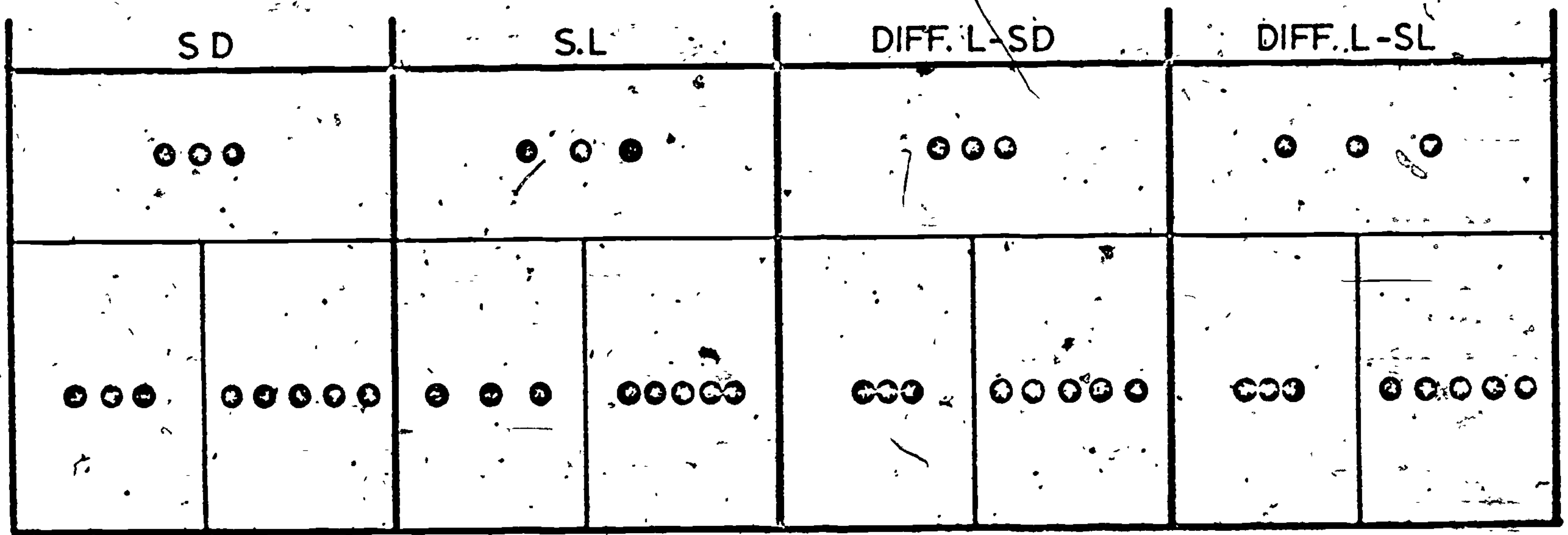

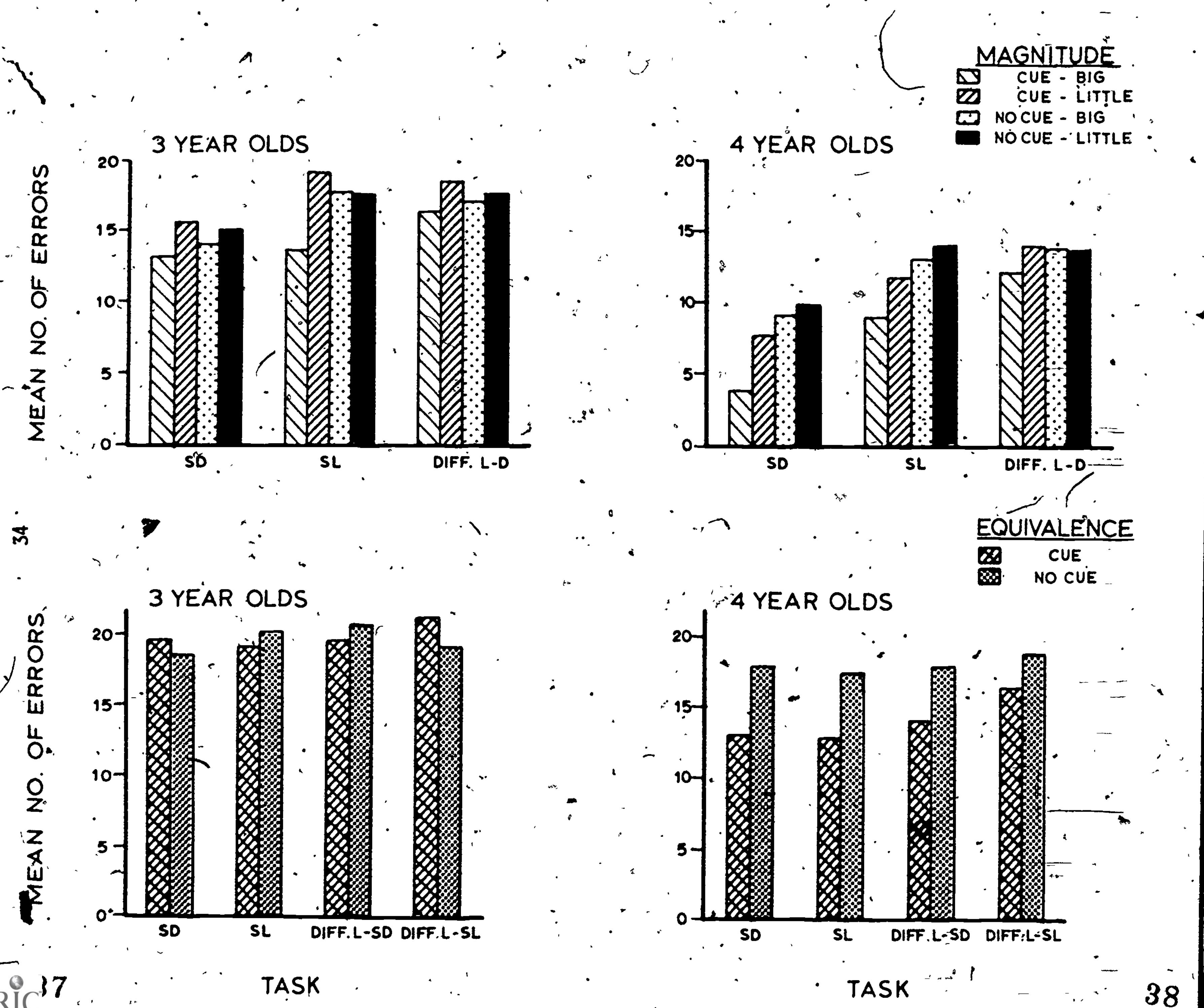
MAGNITUDE
CUE - BIG
CUE - LITTLE
NO CUE - BIG
NO CUE - LITTLE
3 YEAR OLDS
4 YEAR OLDS
MEAN NO. OF ERRORS
0
5
10
15
20
SD
SL
DIFF. L-D
EQUIVALENCE
CUE
NO CUE
3 YEAR OLDS
4 YEAR OLDS
MEAN NO. OF ERRORS
SD
SL
DIFF. L-SD
DIFF. L-SL
TASK
TASK