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In order to investigate what concepts young children acquire that break down their inability to view spatial situations objectively, three groups of 16 children each were administered two tasks (1) a box task, in which the child was asked to predict the location of objects upon a change in his location, and (2) a Piagetian task, in which the child was asked to identify the arrangement of objects from another's position. The children were grouped on the basis of age, 44 to 60 months, 61 to 71 months, and 72 to 78 months. The major hypothesis was that a high positive relationship existed between a young child's accuracy in predicting object locations when (1) the child was moved to various positions and (2) when another (in this case, a doll) was moved to various positions while the child remained in the same position. This hypothesis was not supported, but the box task was much easier than the Piagetian task. The Piagetian finding that children below 7 years of age usually cannot take the viewpoint of another was corroborated in this study. (WD)

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Relation of Spatial Egocentrism and Spatial Abilities of the Young Child*

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Relation of Spatial Egocentrism and Spatial Abilities of the Young Child

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In Piaget's theory of intellectual development, there is one process which is posited as being crucial to the young child's increasing understanding of reality: the waning of egocentrism. The construct of egocentrism refers to the young child's lack of awareness of perspectives other than his own. "Perspective" may refer to a wide variety of information. For example, the role attributes of other people are usually ignored by the child so that when he communicates to another child, an adult, a blind person, etc., his message remains the same, i.e., he does not change his message depending on the characteristics of the listener. "Perspective" may also have the more literal meaning of the spatial viewpoint of others. Thus, the young child viewing an array of objects believes that the objects near him are also near to a person across the table from him.

The classic study of egocentrism as a developmental phenomenon was done by Piaget (1956). The spatial analogue of egocentrism was employed in which children viewed a mock landscape of three mountains of various sizes and were asked to imagine what a doll "saw" at various locations around the

landscape. The purpose was to describe children's ability to reconstruct the scene from various locations as it varied with the age of the child. It was found that prior to seven years of age, approximately, children usually assume that the doll sees what they see regardless of where the doll is placed. Children younger than five were found not to understand the instructions sufficiently to work at the task.

These normative-descriptive data raise an important question: what concepts does the young child acquire that make possible the emergence of spatial objectivity around seven years of age? In the initial attempt to study this question (Shantz & Watson, 1967), it was hypothesized that the ability to predict what another sees from various locations is based upon and develops from the subject's own experience in object relations. Specifically, it was suggested that the child's awareness of himself as an object within a world of objects organized spatially about him begins with gross discriminations which follow a certain order of increasing specificity and organization. The very young child has no expectancy regarding change in object appearance with change in his spatial position. The first step toward decreased egocentrism would be the child's recognition that objects and their arrangements look different from various spatial locations, but no specific expectancies as to how objects appear. That is, he operates on a simple "same" vs. "different" expectancy. Next, the differences expected by the child are differentiated into

specific object-subject relations, but the relations are not yet organized into a total spatial framework. This latter concept is the final stage of development. In summary, it was suggested that the ability to predict another person's viewpoint follows the same developmental steps as subject-object predictions, but how this projective ability begins and how it relates to subject-object relations has not been explored.

In order to assess spatial expectancies, a new method was developed based on Charlesworth's proposition (1966) that the presence of cognitive structures can be evaluated by the child's response in situations where expectancies are violated, i.e., "unlawful" or trick situations. In a spatial task, for example, the child views a simple landscape scene and then, with the landscape covered, he walks to the opposite side. The landscape is rotated while the child walks so that when it is uncovered the child is confronted with the original perspective rather than the reverse perspective. If the child has some expectancy of a "different" view or a specific view in mind, he will show surprise, perplexity and/or amusement, either verbally or facially. In the initial study (Shantz & Watson, 1967), it was found that about half of the sample of 48 subjects between three and five years of age clearly differentiated between the trick and veridical conditions by their verbal statements. Fourteen of these subjects went further to infer that the the discrepancy between what they saw and what they expected

was caused by moving or turning the objects. There was no significant relation between the recognition of a trick and the age of the child in this sample.

These data indicate then that within the preschool age range there are about an equal number of children who have not yet established any expectancies relating object appearance and viewer position, and those who have at least sufficient expectancies to recognize "unlawfulness" when it occurs. The question then arises as to how specific expectancies are in the preschooler. The focus of the present study is to assess the ability of the young child to make specific predictions of the location of objects after he has moved to various positions. It was suggested previously that such subject-object relational concepts are the basis for being able to identify others' points of view. Therefore, the major hypothesis of this study is that the ability to correctly predict object locations after the child moves is highly related to his ability to predict object arrangements from the doll's position in the Piagetian task.

Method

Subjects. Three groups of 16 Ss each (N = 48) represented three age levels: Group I, 72 to 78 months; Group II, 61 to 71 months; and Group III, 44 to 60 months. In Group I 14 Ss were kindergarteners, 2 first-graders; Group II, 12 kindergarteners, 4 in nursery school; Group III Ss were all in nursery school. The sample consisted of 29 boys and 19 girls.

The older Ss were attending kindergarten or first grade in one suburban Detroit school, and all the younger Ss attended the Merrill-Palmer nursery school.[1] All children in kindergarten are included in the sample with the following exceptions: 1 S refused testing, 1 S was absent at the time of final testing, and 10 Ss who had been randomly selected for pre-testing. First-graders and nursery school Ss were randomly selected from their classrooms.

Equipment.

Box task. This task was developed to assess S's ability to predict the location of objects after he had changed his location. It also provided for the assessment on two trials of S's ability to recognize a "trick" event.

A 10 x 10 x 5 inch box was attached to a two foot high table. The box lid had nine 2 x 2 inch holes cut out of it, forming a 3 x 3 matrix, with a small lid covering each hole. The box contained a 12 inch diameter posterboard base on which a miniature house, tree, and streetlight were located. At 0^{o} orientation, the house was under the middle lid in the "top" row (furthest from S); the tree was under the left lid in the middle row; and the streetlight was under the right lid in the bottom row (nearest to S). By means of a set of pulleys, the entire landscape could be rotated through 180^{o} by E out of S's view.

Piagetian task. This task was a modification of Piaget's classic landscape task. It assessed S's ability to identify the arrangement of objects from another's posi-

tion (represented by a doll).

A round landscape with a miniature school, flag, and sandbox was employed, the objects being located at about the same points as the objects in the box task. At 0° orientation, the school faced S in the far, center position; the flag was to the left and in front of the school; and the sandbox was to the right of the school and nearest to S.

Various perspectives of this landscape served as choices in the task. The choices were colored 7½ x 5 inch photographs of the standard scene from four positions: 0° (south), 90° to S's left (west); 180° (north), and 270° (east). A fifth photograph represented an impossible perspective in that the objects had been rearranged from lower right to upper left in the following sequence: school, sandbox, flag.

The five photographs were mounted on a 28 x 14 inch posterboard, three on the top row and two on the bottom. There were a total of four such boards for the four major trials with the various views randomly positioned. The choice board for trial 4 was also used for the first, criterion trial in which S selected the view he saw ("south").

A girl or boy doll was used, depending on the sex of S, to elicit what S thought the landscape view would be from the four positions. The doll was "seated" on a small stand so as to be looking down upon the scene from about 30°, the same angle at which the photographs were taken and approximately the angle at which S actually viewed the standard.

Procedure. Ss were tested individually in two sessions, one for each task. Ss were randomly assigned to one order condition: box task administered first, Piaget task second, or the reverse order.

At the time the experimenter (E) was introduced to the children in the classroom, she briefly described what they would be asked to do and characterized the tasks as puzzles. Several hours were spent by E in the nursery school prior to individual testing in order to gain rapport with the youngest Ss. During individual testing there was one adult observer in the testing room in addition to E, and in the case of 8 Ss there were two observers. A tape recorder was used to record all verbalizations during the administration of the box task.

Box task. The instructions given to each S were as follows:

> This is my puzzle box. Inside is a house and a yard. (Removes cover) See, here is a house, a tree and a streetlight. And here's a cover for the box with little doors in it you can open (lifts one of the lids). First, look in the box to see where everything is.
>
> Look in and remember where the house is (E points), where the tree is (E points), and where the streetlight is (E points). Remember where everything is. Then I put the cover on (E placed cover on) and you point to the door that the house is under. Which one is the house under? (S points) Now I'll put this thing here (puts paper clip on lid) to show that you think the house is under here. Now which door is the tree under? (E puts paper clip on lid pointed to) That shows you think the tree is under there. (Procedure repeated for streetlight).
>
> OK, now look under this one to see if the house is under there (E removes paper clip). Now put the door back. Now look under this

> one to see if the tree is under there. (E removes paper clip). Now look under this one to see if the streetlight is under there. Now look at everything in the yard (E removes entire lid for about 10 seconds or until S indicates he is through looking). Remember where everything is. (E replaces cover)
>
> Now walk around to here (E points to opposite side of the table, 180° orientation). Now, which one is the house under? (E places paper clip on designated lid for this and following choices) Which one is the tree under? Which one is the streetlight under? (After S chooses and looks under each door in order, E removes entire lid). Let's look at the entire yard. OK, now come back over here (E points to original position, 0° orientation) and look at it again (E removes entire lid for Trial 3 and 5 only). Look where everything is. (Questions continue as previously.)

A trial consisted of the S's prediction of where the three objects were and his checking his predictions by looking under the three doors selected while S was at one position. A total of six trials were administered in the same order for all Ss as presented in Table 1.

Insert Table 1 about here

If S did not choose the correct three doors on Trial 1, he was given up to five trials at 0° to reach criterion. If by the fifth trial he did not choose correctly, testing was discontinued. This procedure was used to insure that all Ss had sufficient memory to accurately locate the objects when covered without S having moved.

Piagetian task. The standard landscape was in view when S entered the room, almost directly in front of S to avoid its being seen from any other direction than 0° ("south"). The

choice boards were faced down. The following instructions were given:

> Here is a school. Here is a flag, and here is a sandbox. And here are pictures of these things. (E holds up Trial 4 choice board to S's right, not blocking the standard scene.) The pictures show how these things look from different places around the table. Look at this picture, this one, etc. (E points to each in succession from upper left to lower right.)
>
> Now you are looking at these things from here. (E points to where S sits.) One of these pictures shows what you see from here. Which picture shows what you see from here? (S selects) (If S erred, E said, No, look carefully again and find the one that shows just what you see. If S again chose incorrectly, E indicated the correct picture.)
>
> All right. Now here is a boy (girl) doll sitting on this. Watch. (E places doll at east position.) The doll is looking at this. What does the doll see? One of these pictures (E presents new choice board) shows what the doll sees from there. Look at this picture, this one, etc. (E points to each as before.) Which picture shows what the doll sees from there? (E removes board). (After the remaining three trials are completed, E says, Now we are all done. Let's go back to class.)

All Ss were administered the trials in the following order: self (south), east, south, north, and west as the doll was placed at each of these locations except in the first trial. Total time of administration for most Ss was ten minutes.

Dependent variables. Three types of responses were used as measures of box task performance: accuracy in predicting object locations; relevant verbal responses and relevant facial responses to the two trick trials. Two types of measures were used for the Piagetian task: the number of trials failed and a weighted error score. A more quali-

tative analysis of the types of errors on both tasks was also done.

Box task. The first measure was the number of errors S made in predicting the location of the three objects (three subtrials) on Trials 2 through Trial 6. Thus accuracy scores could range from 0 to 15 errors. Trial 1 was a presentation of the standard and therefore was excluded from the error count. The second type of data was relevant verbal statements by S immediately following his lifting each of the three doors for Trials 2 through 6 as taken from verbatim transcripts of the tape recordings. Relevant verbalizations included indications of surprise, amusement or perplexity whether these were vague references to something being different than expected or were specific references to something having moved or turned. The third type of data were relevant facial responses immediately after the doors were removed or the entire cover was removed. Amusement was defined as a laugh, chuckle, or smile which appeared to be in response to what was being viewed (as compared to "social smiles" at E); perplexity was defined as a frown, squinting or questioning look immediately after raising each door; and surprise was defined as a widening of the eyes, mouth dropping open, or startle (e.g, a "double-take"). For data analysis, the occurence of any one of these three types of responses was considered a relevant facial response. On 8 Ss observed by both observers there was 89% agreement as to the occurrence or non-occurrence of a relevant facial response on each of the 15 trials per subject.

Piagetian task. This was assessed by two types of data: the number of errors excluding Trial 1 (possible range from 0 to 4), and the type of error made. The latter was scored by the following weighting system: correct responses = 0; choice of an incorrect view from north, east, or west = 1; impossible view selection = 2; south choice = 3. The rationale of this system was that, as Piaget noted, the youngest Ss tend to assume that the doll sees what they, the Ss, see regardless of the doll's position. Since this was deemed the most immature response, it was weighted as the most extreme error. The impossible choice, on the other hand, suggested that S knew the doll at least saw something different than he, S, saw, but was not capable of predicting exactly what that difference would be. Thus, the impossible view was seen as slightly less immature a response than the south view. Likewise, a selection of one of the directional views (north, east, west), while incorrect, appeared to be an attempt to actually predict a specific viewpoint for the doll, S having recognized that the doll would see something different and S having some notion of what that difference would be. At the least, S selected a picture in which the relations among objects remained veridical whereas the impossible picture presented different internal relations of objects on the landscape. The possible range of weighted scores is 0 to 12, the latter being the selection of "south" for each of the four trials.

Results

The major hypothesis of this study was that a high positive relationship exists between a young child's accuracy in predicting object locations when (1) the child has moved to various positions and (2) when a doll is moved to various positions and the child does not move. The hypothesis, evaluated by the number of errors on the box task and the Piaget task, was not supported ($X^2 = 2.18$, $p > .10$). The second assessment involved the number of box task errors and the weighted scores on the Piagetian task. Again, the hypothesis was not supported ($X^2 = 0.76$).

The distribution of scores on the two tasks shown in

Insert Figure 1 about here

Figure 1 sheds some light upon the lack of relationship. Half of the total sample of 48 Ss had no errors on the 15 subtrials on the box task, i.e., perfect performance; 19 Ss of the total sample failed all of the trials on the Piaget task, and an additional 17 Ss passed only one trial. That is, for the majority of Ss the box task was extremely easy and the Piaget task extremely difficult. This lack of variability has the statistical effect of severely limiting the size of a correlation. In summary, then, within the age range tested, there is no relationship between the accuracy in predicting locations of objects when S moves, and when he does not move but only "imagines" object-locations from another position.

The second question posed is whether there is any rela-

tion between the recognition of an unlawful object arrangement ("trick" trial) and the child's ability to imagine what the doll saw from various locations. Relevant verbalizations on Trial 4, the first trick trial, were used to assess this, e.g., "It's different!", "It moved," "How did it turn around?". Of the 15 Ss who verbalized such recognition of unlawfulness, significantly more (N=12) had performed correctly on one or more trials on the Piaget task than those who had completely failed the Piaget task (N=3), ($X^2 = 3.51$, $p < .10$). However, this relationship did not hold in the case of Trial 6, the second trick trial, nor did it when using the Piaget weighted scores for Trial 4 or Trial 6 (all X^2's ≤ 1.0).

Facial responses of surprise, perplexity, and/or amusement were scored for 28 Ss. The relationship of such relevant facial responses on the first trick trial (4) to performance on the Piaget task was not significant ($X^2 = \leq 1.0$ for both errors on Piaget task, and weighted errors).

It should be noted at this point that the various measures of performance on the box task were not significantly related: number of errors and verbal responses on Trial 4 ($X^2 = 2.42$); number of errors and facial responses on Trial 4 ($X^2 = 1.14$); and the same measures on Trial 6 also did not reach significance ($X^2 = \leq 1.0$). However, there was a significant relation between the occurence of verbal responses on Trial 4 and facial responses on Trial 4 ($X^2 = 4.75$, $p < .05$). It seems reasonable that a child who showed surprise, amusement or perplexity would make a statement indicating some awareness that the landscape looked incorrect to him. But it must also be noted that the relationship may be somewhat

spurious in that the observers in the room could hear, of course, what the child said at the time they were judging facial responses. It is noteworthy that even though the facial and verbal responses are highly related, only the verbal responses relate to the Piaget task performance.

It was expected that children's ability to correctly predict object locations when they moved around the landscape would improve as age increased. This was not found to be the case: there was no significant difference between the three age groups in correctly predicting object location, as evaluated by the Kruskal-Wallis one-way analysis of variance ($H = 1.25$, $p > .10$). As the distribution of scores suggests, the majority of children performed perfectly on this task, including 7 of whom were in the youngest group. Thus, between the ages of 3 years, 8 months and 6 years, 6 months, it appears that children generally have a well-established ability to locate objects when they have moved about in space.

Piaget indicated in his study of egocentrism using the three mountains that children below 7 years of age usually cannot take the viewpoint of another (the doll). This finding was corroborated in the present study. There were no significant differences between age groups on the number of trials failed on the Piaget task ($H = 0.91$, $p > .10$), and again, as the distribution of scores indicates 36 of the 48 Ss either failed all trials or passed only one trial.

There are some data to suggest (Shantz & Smock, 1966) that when children are faced with spatial problems they may

perform better if they deal with objects prior to pictures in the task. Thus the order in which Ss were administered the box task and Piaget task was assessed to determine whether the order had any significant influence on performance. It did not: the number of errors on the box task for Ss administered that task first and then the Piaget task, versus Ss under the reversed order, indicated no significant difference (Mann-Whitney U test, $z = 0.90$). Likewise, the weighted Piaget scores for the two groups indicated no significant difference ($z = 0.38$).

A more descriptive analysis of performance on the box task and Piaget task yield some additional information. First, in the case of the box task, 9 Ss made one or more errors on Trial 2 which indicates that a relatively small percentage of the total sample had difficulty making the reversals when they walked around 180°, i.e., "near objects" became far away, those to the left were now on S's right, etc. On Trial 4 Ss were tricked at 180° position, and yet on Trial 5 at 0° only 10 Ss performed incorrectly. On Trial 6 at 90°, however, 15 Ss made one or more errors. This increase might have been due to two factors: (1) greater difficulty children have in accounting for object relations when they move 90° vs. 180°, and/or (2) given the unlawfulness they experienced in Trial 4, they may have doubted their ability to predict or tried to "out-guess" what they now thought was a trick game.

An analysis of subtrials indicated that when Ss erred, they did so most often when trying to locate the tree. The well-established principles of memory being greatest for

items that are first and last in a series (primacy and recency effects) probably account for this finding in that the child always located the objects in the sequence of house, tree, light.

The types of responses Ss made on the Piaget task are of interest also. First, correct responses were given most often (N=23) when the doll was placed at south, then west (N=10), then north (N=6), and finally at east (N=3). That is, starting at south there is a clockwise progression of increasing difficulty in correctly matching the position with the perspective. The types of errors (a total of 150) Ss made were highly similar for all three age groups. Specifically, south was chosen in errors most often (N=70), corroborating Piaget's findings that children tend to think the doll sees what they see. The second most frequent error choice (N=40) was the impossible perspective. It seems reasonable to suggest that Ss who selected this picture had some notion that the doll didn't see what they saw (south perspective), but they did not know exactly what that perspective was. They therefore chose the "most different" picture, the impossible one. The next most frequent error choices, in order, were west (N=16), east (N=13), and finally north (N=11), all three of which were much less frequent errors than the south and impossible choices.

Discussion

The predicted relationship between the two types of spatial abilities was not supported by the data. Instead it was found that predicting the location of objects when

the child moves is a very easy task for most 3½- to 6½-year olds, but predicting the location of objects when the move is only symbolically represented is a very difficult task for this age child. The discrepancy in performance on the two tasks is particularly striking in light of the similarity of the basic stimulus array for both tasks, i.e., three related objects placed in almost identical positions on each array. Likewise, the basic task was highly similar in each situation, to predict object locations from various positions. In light of these similarities, it would seem that there are certain differences in the tasks which have important theoretical and methodological implications. First to be considered are two major differences which seem to relate to certain cognitive abilities of the child. Finally, some specific methodological differences in the tasks will be discussed.

The first, apparently significant difference between the two tasks is the fact that in the box task the child made predictions of object locations when the objects were not in view (covered), but in the Piaget task the standard array was constantly in view. This factor of screening or leaving unscreened the "standard" situation has been studied with conservation problems, and it has been found that when the standard is screened and children make predictions about the effects of some transformation of the standard (such as pouring water from a short, wide glass to a tall, narrow one), their predictions are much more accurate than in the unscreened condition (Bruner, Olver, Greenfield, et al., 1966). That is, the screening of objects during and after transformations

essentially removes interfering information. But the child's ability to handle this so-called "interfering information" while at the same time dealing with the effects of the transformation is the very point of conservation and egocentric concepts. That is, that he must learn to inhibit his initial response to the standard and shift attention to the transformed standard (Flavell, 1961). In the egocentrism task, the ability under test is the child's overcoming the impact of the standard or his own point of view to consider another's point of view. A systematic study of the effects of total screening versus partial screening versus no screening would clarify the importance of this factor in egocentric functioning.

The second major difference in the two tasks is that in the box task the child himself moved to various locations, whereas in the Piaget task moves had to be represented symbolically. It seems reasonable to assume that the effects of moving physically are much clearer to the child than the effects of moving "symbolically." This requires empirical study, however. It would be of theoretical value to know the effects on performance of four types of "moves" with a covered landscape, for example: the child moving to new locations, the child remaining but the standard being moved, both remaining motionless with the child symbolically representing moves of himself and moves of the standard.

Finally, there are two more specific differences in the tasks which may have created a spurious discrepancy in the difficulty level of the two tasks. First, in the Piaget

task the landscape consisted of objects whereas the choices of various landscape perspectives were photographs. The shift from the three-dimensional standard to the two-dimensional choices may have increased the difficulty of the task, as is suggested by data comparing problem solution with objects versus pictures in spatial problems (Shantz & Smock, 1966) and classification problems (Sigel, Anderson & Shapiro, 1966). The second factor which may have unduly increased the complexity of the Piaget task is the rather difficult verbal instructions required, i.e., to imagine what a doll sees. Indeed, young children can not understand the instructions sufficiently to perform the task (Piaget, 1956). The instructions can only "make sense" to the child if he has some vague notions that the doll would indeed see something different than he, which is the very concept being assessed.

It is clear from the present data that children who are adept at predicting object locations when they move have much more difficulty predicting the effects of symbolic moves. How much more difficult this latter task is depends in part on whether the methodological factors discussed do have significant influence. A clearer assessment of the hypothesis of this study would be possible by simplifying the egocentrism task. For example, a card with green on one side and red on the other might be presented to the child with the instructions to show the red side to the examiner. This would require him to orient the card so that he saw green while the examiner saw red. Tasks of this sort have been developed by Flavell (1961) and found to apply well to pre-

school children. The clarification of these emerging objective abilities is an important goal for developmental research, particularly for the implications these abilities have as to how children begin to represent or symbolize motoric actions.

Lastly, it would be of value to examine the relationship of egocentrism to certain social variables, such as the sociometric status of the child among his peers, and socio-economic class membership. Such relationships would clarify some of the effects of egocentrism in the social, as well as the physical, "realities" confronting the young child.

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Footnote

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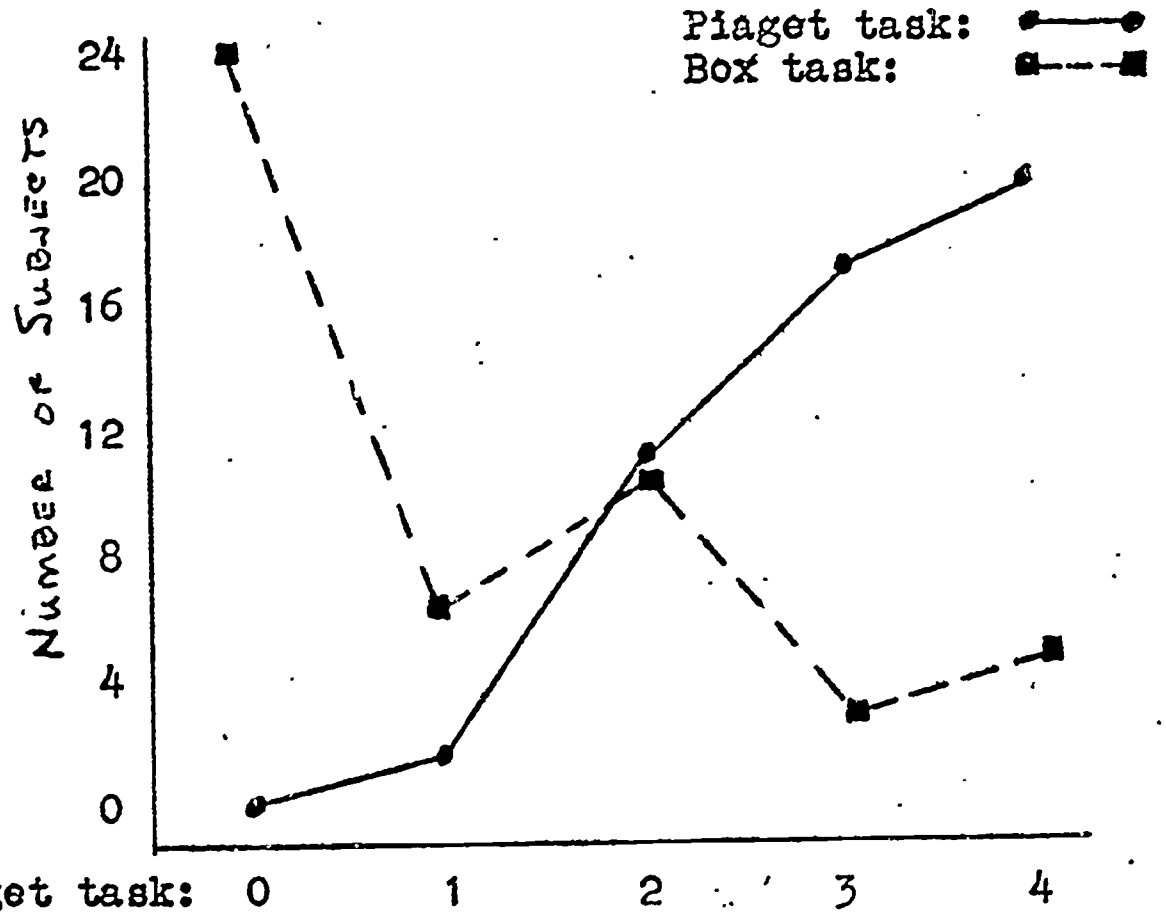
Table 1

Spatial Positions of Subject and Stimulus for Each Trial of the Box Task

	Trials					
	1	2	3	4	5	6
S's position	0°	180°	0°	180°	0°	90°
Landscape position	0°	0°	0°	180°	0°	180°
Type of trial	Real	Real	Real	Trick	Real	Trick



Total Number of Errors

Fig. 1. Distribution of error scores on two tasks for total sample of Ss (N=48).