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ABSTRACT

This paper examines the developmental stages of haptic perception (the process of recognizing objects by the sense of touch alone), and attempts to clarify some conflicting results of studies of the effects of memory and object type. The paper also presents a specific study of haptic perception in 144 preschool and kindergarten children from various socioeconomic levels. The children were randomly assigned to two memory conditions and one of three object groups (Familiar, topological, or Euclidean). Training stimuli for the experiment consisted of two sets of three familiar objects. Each child played a "Can you find it?" game in attempting to recognize and choose a standard object that had previously been presented. Test stimuli were three sets of plastic objects corresponding to the three object groups under examination. Procedures were similar to those used in training with one modification in timing to determine the effect of memory. Results provided partial support for Piaget's theory of haptic perception. Data was analyzed to determine the effects of age, object type, difficulty level, sex, and memory on the development of haptic perception. (SDH)

AN EXAMINATION OF PIAGET'S STAGES OF HAPTIC PERCEPTION IN YOUNG CHILDREN

BY

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THESIS

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I. INTRODUCTION

Haptic perception refers to the process of recognizing various objects by the sense of touch alone. Children proceed in ascertainable stages which may be related to the age of the children (Piaget and Inhelder, 1956). Piaget has suggested that the development of haptic perception follows the following stages: recognition of familiar objects first, topological objects second, and Euclidean objects third. In addition, Piaget paid particular attention to the developmental nature of shape perception--how one perceives of various shapes. Before the recognition of various objects by the sense of touch cues alone is possible, Piaget concluded that children start to construct or build up primitive spatial relationships. These relationships are primitive in the sense that they are purely internal to a particular figure whose intrinsic properties they express. Elementary spatial relationships are topological in nature and include:

1. Proximity (features are all close together or the "nearby-ness" of elements),
2. Separation (elements of the object are distinguished from each other),
3. Order (which Piaget and Inhelder see as a synthesis of proximity and separation, and when two neighboring though separate elements are ranged one before another),
4. Enclosure or surrounding (one element may be perceived as surrounded by others), and
5. Continuity and discontinuity (elements are visible in broad outline, and parts of figures are placed close together rather than linked).

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Topological relationships are first in order of appearance because they are inherent in the simplest ordering of actions from which a shape is abstracted. Examples of topological forms which correspond to these relationships and to the most elementary form of actions would be irregular surfaces pierced by one or two holes, open or closed rings, and two intertwined rings. A child feeling an open ring would consider this figure in isolation of anything else and would probably remember the openness of the object. More complex spatial relationships are of the Euclidean form and entail the conservation of straight lines, angles, curves, and distances. The Euclidean shapes possess structures which refer, either explicitly or implicitly, to a general system of organization. The more complex spatial relationships involve the problem of locating objects or their configurations relative to one another in accordance with general perspective systems. The Euclidean objects, such as the square, rhombus, rectangle, and parallelogram, are not viewed in isolation but are thought of in relation to a "point of view." For example, a corner of a square being felt by a child, is viewed not in isolation but as a part of the whole object where all features of the square are relative to one another. Hence, the more complex nature of identifying Euclidean forms make these objects more difficult for children to recognize and discriminate.

Generally, Piaget refers to beginning construction of a haptic perception task when a child incorporates within his image systems the object being felt. In addition, Piaget and his collaborators have supplemented their observational method with a method of getting the child to deal with concrete objects in various ways while the investigator directs

questions designed to bring out the child's intentions or conceptions of what he is doing. For an experimenter to add much knowledge to this theory would be a difficult job. An investigator can look at the child and observe what the child does overtly when engaged in a haptic task. However, since these methods vary from S to S, and the methods have not been specified clearly, getting a child then to tell what he is really doing is very difficult indeed.

From Piaget and Inhelder's initial studies on haptic perception with children from two to seven, numerous theoretical issues and experimental problems were investigated further by others (Fisher, 1965; Lovell, 1959; and Page, 1959). Page (1959) tried to replicate, as closely as possible Piaget and Inhelder's experiment on haptic perception. Page used common familiar objects: a ball, comb, spoon, and topological and Euclidean objects as described earlier. The objects with Euclidean properties were further divided into three groups of increasing difficulty. When the child had named the objects felt, he was asked to identify them among a collection of figures if he was a younger child, or to draw the figures if he was older. Page's work indicated that haptic perception developed according to the Piagetian stages. Page postulated that the facility with which topological forms are recognized suggested that their qualities are identified by movements concerned with images retained by neuro-muscular combination in areas that are more primitive than those concerned with the Euclidean forms. Page stated that a child's verbal description was generally associated with something that was meaningful to the child. Furthermore, the closer the verbal description was to the object felt, the more precise the child's image was of the shape.

Page's results on the development of exploratory handling of shapes were rather complete. Success in either identification or reproduction of the forms was closely related to the type of exploratory handling exhibited by the child being tested. Although Page made certain improvements over the work of Piaget, Page's work did not lend itself to quantitative analysis, or concise experimental procedures. Stimuli were not varied from one child to another, like Piaget did, and the conditions for each child were the same except further testing was not pursued when it would clearly lead to the child's complete failure. A verbalization problem also existed since children differ in their ability to verbalize. Page's judgment as to the level of the children's haptic perception was too subjective. Page did not take those children that he did not think could be successful through an entire procedure, even though he should have done so.

In Lovell's (1959) follow-up study of Piaget's work, Lovell's Ss certainly identified shapes that displayed topological relationships more easily than Euclidean shapes. Lovell used a wide array of stimuli in the topological and Euclidean groups; he used a rhombus, a four and a six-pointed star, semi-circle, notched semi-circle, one closed ring, two intertwining rings, etc. However, Lovell's evidence did not support the theory that it was the topological relationships or properties which enabled the Ss to identify certain shapes more easily than other shapes. Lovell found that curved Euclidean figures were not any more difficult for a child to recognize than topological objects. This finding was only partially accurate, since curved figures are the first Euclidean shape, right after the

most difficult topological object; and Piaget says children master these first in that developmental hypothesis. Thus, Lovell was basically speculating when wondering if it was the topological properties which enable Ss to identify certain objects. Lovell's results further suggest that holes, curves, points, corners, ins, and outs, etc., in Euclidean space aid in identification. Lovell's data led him to agree with Piaget and Inhelder on the view that straight sided Euclidean shapes with relatively long sides and few corners were the hardest to identify. Another disconfirming result was that on almost all the tasks, Lovell's Ss tended to perform on a higher level than Piaget's Ss of the same age. Piaget said that up to four years of age children cannot distinguish between a circle, square, because these shapes are all closed; and he believed that closed shapes were more difficult, and according to his stages children should not be able to recognize these until age 4 years-6 months to 6 years-0 months. Some of Lovell's varying results might have been due to the fact that second year undergraduate students served as Es.

Peel's (1959) examination of Page's work on haptic perception suggest that researchers should determine whether the development from topological to Euclidean is largely one of maturation of muscular and sensory control, mainly independent of exercise, or whether it can be accelerated by providing extensive experience.

Fisher (1965) discussed the "non-manipulative paradox" and the "topological-primacy hypothesis." The paradox and hypothesis may both be considered as being a hypothesis relating to the stages of development of haptic perception in children. Referring to familiar objects, the

"non-manipulative paradox" is the first stage in haptic perception development in which the very young child up to the age of about two and one-half years is presented with objects or shapes for tactile examination, and makes little or no attempt to maximize the available information relating to their spatial configurations. Paradoxically, they are able to identify by touch cues alone, many objects with extremely complex spatial configurations. In Fisher's first experiment, he used common objects and wooden replications of all the objects, carved as close as possible, exactly the same size, shape, and weight as the originals. He controlled for texture by carving these wooden replicas of the objects. Children were randomly presented with the model and original object on two occasions. Photographs of the objects were available to aid the Ss identify the object. Then Ss were told to tell E what was felt. Findings revealed that Ss recognized the original objects more frequently than the models. Hence, the results suggested that important cues for recognition of objects at this age are textural rather than spatial.

In testing the topological-primacy hypothesis, which states that children recognize topological objects before Euclidean ones, an experimental and control group were used. Ss in the experimental group were taught nonsense "names" for each shape. Then each S was asked to identify each topological and Euclidean shape that was placed into his hands in random order, either by nonsense name or by pointing to drawings of the shapes mounted in the wooden frame. The control group was allowed approximately the same amount of visual experience to the shapes and then asked to identify by pointing to the objects only. Ss in the experimental group were

able to identify the Euclidean or linear objects more readily than topological shapes. It was not discussed in enough detail as to why the availability of a name influenced S's recognition ability; though recognition of Euclidean objects increased, recognition of topological objects decreased. Fisher did make one speculation as to the interpretation of this data; it seemed possible that the experimental procedure was such as to include operations which to some extent inhibited any implicit mediation processes involved, which is used more in recognition of the topological forms. Fisher says that not only is Piaget's theory on construction of a visual image correct, but an addition process is involved when identifying a shape pattern. Fisher calls this process "naming," which is a mediation process involving the use of language.

Fisher's study was much more experimental in design than previous work. All Ss were presented the same shapes, and procedures were standardized. However, in matching Ss in the control group, they were matched only by age and this factor was only matched roughly. For example, a subject aged 2 years-3 months was matched with a subject in the experimental group aged 1 year-10 months. In addition, other variables, such as sex and experience, not considered might have caused differences between the two groups. Like Page (1959), Fisher did not take into consideration the children's verbalization ability in his study with the familiar objects.

The present study was an attempt to examine, under carefully experimental conditions, the developmental stages of haptic perception. Specifically, the study attempted to clean up previous work in the area. Lovell (1959), Fisher (1965), and Page (1959) presented conflicting data,

which this study attempted to sort out to find out whether or not the child's conception of space does begin with topological concepts which were transformed concurrently into concepts of projective and Euclidean space. Their data disagreed as to whether Ss recognized objects with topological properties more easily than objects with Euclidean properties.

Piaget (1956) and Page's (1959) theories on haptic perception are fairly consistent. Both feel that verbalization aids the child's memory. Also Piaget says that children build up images that aid this memory further, and Page stated that the development of exploratory handling, aided the child's success in either identifying or drawing a shape. Fisher (1965) suggested that textures aid the child in recognition of familiar objects and that visual image and naming aid the child in recognition of the more difficult objects. The visual image hypothesis is not very reasonable in an experimental setting, because of its abstract nature. The present investigator suggested that a memory component was a more reasonable explanation for what aids a child in recognition of an object; it was hypothesized that the memory component was a factor that aids in recognition. If there was no lapse of time between a child feeling an object and making a selection, then his successes should be greater than if time did elapse. Since previous work in this area did not systematically look at effects of a retention interval, this was needed. Standardizing the amount of time a subject was allowed to feel an object, was another factor that has not been looked at experimentally. Likewise, after determining the amount of time the children at different age levels manipulate objects, the standardized time of 15 seconds was specified as the maximum amount of time allowed all

Ss. There would be no reason to say that there was a differential amount of time allowed that could have accounted for various S's recognition ability. Texture of stimuli was controlled for; all objects were made of plexiglass or plastic. To insure that differences in the children's verbalization ability would not be of concern, the Ss had the option to say which object was the correct choice or to "pick up" the correct object. Opposed to Piaget (1956) and Page's (1959) work, procedure and stimuli used were standardized. To make sure that no differential treatment of Ss was possible as in Lovell's (1959) study, only one E tested all Ss. A training phase was designed to insure that S understood the task required, and each S had to meet a specified criterion defined by a statistical criterion method, before going into the original test. Positions were marked on the apparatus shelf to make sure E arranged test stimuli in the exact same location for each S. A much more complete quantitative analysis was performed on the data, and an overall controlled environment was designed to look more accurately at Piaget's work on haptic perception.

II. METHOD

Subjects

The Ss were 144, 3 years-0 months to 5 years-11 months old children from Champaign-Urbana nursery schools and public school kindergarten classrooms. Ss were randomly assigned to one of the two memory conditions and one of the three object groups, with each group having an equal number of males and females, and younger and older children. The younger group ranged in ages from 3 years-0 months to 4 years-6 months, with a mean age of 3 years-8 months. The older group ranged in ages from 4 years-6 months to 6 years-0 months, with a mean age of 5 years-1 month. Ss were from various socioeconomic levels.

Stimuli

Training stimuli consisted of two sets of three familiar objects each. Set 1 was composed of 1 plastic cup, 1 wooden clothes pin with metal fixture, and 1 metal key. Set 2 included 1 plastic block, 1 small hard-plastic dog, and 1 small plastic fire engine with one metal wheel centrally located for locomotion.

Test stimuli consisted of three sets of plastic objects. As shown in Fig. 1 the familiar objects were one 3-1/2 inch plate, one 4-1/2 inch comb, and one 4-1/2 inch spoon. The topological and Euclidean objects were cut from 1/4 inch plexiglass, measuring approximately 4 inches in length. No length dimension exceeded five inches, which was within hand span for even the youngest children.

Insert Fig. 1 about here

Apparatus

A wooden screen with a cloth curtain opening was used to prevent the child from seeing the stimuli. The 20-1/2 x 25 inch cloth curtain was nailed to the bottom board except where the S reached under the 9 inch center opening to feel the objects. A Clebar stop watch was used to limit the S from feeling the object for more than 15 seconds during presentation of the standard stimulus. The stop watch was also used to measure the 10 sec retention interval during the memory condition phase of the experiment.

Procedure

E escorted each S from his classroom to the test room and introduced herself. S was tested individually and after being brought into the testing room, was first introduced to the "Can You Find It Game" and picked a prize for which to work. S was seated facing the screen, and E was seated on the opposite side of the screen. Each S went through two phases of the experiment: training and testing.

Training trials. The training phase was designed to insure that S understood the task required. Each S was given two problems consisting of familiar objects. Bogartz (1965) devised a method for determining criterion for learning task of various probabilities. The criterion of learning on the training problems was 7 correct responses in 8 successive trials.

S had to achieve success on each training problem within 44 trials in order to remain part of the sample.

Each trial consisted of a presentation of one standard stimulus followed by two opportunities to pick that standard from two other choices. For example, a subject receiving standard stimulus A, would select A from A, B, and C stimuli. Then E would mix up the order of the three test stimuli, and S would again attempt to select A. S could feel each standard stimulus for a maximum of 15 seconds during the training and testing phases of the experiment. However, during training, no time elapsed between Ss first and second opportunity to select the correct stimulus. All standard and test stimuli were presented haptically.

Each S was given the following instructions:

> "This is the 'can you find it game'. You get to feel things, but you do not get to see them." [E then gives S one standard stimulus.] "Feel this good until you know it well and when you know how it feels, you can put it down. Now put your hands on your side of the table. I am going to put two more things over here and I want you to find the one I just let you feel. Here they are." [E takes child's hands and directs them over all three objects.] "When you find the one that I just let you feel, say 'that's it' or put it down on the table. Put your hands back on the table and I will mix them up to see if you can find again the same one I let you feel at first. Here they are." [E again directs child's hands over the three objects.] "When you find the one I let you feel at first, say 'that's it' or put it down."

If S made the correct choice, he was told, "good." If S made the incorrect choice, he was told, "no, that's the wrong one." E always instructed S to put his hands back on his side of the table so that he could not hold onto an object before all three objects were arranged in their randomized location on the floor of the apparatus shelf. Three positions were marked on the shelf to assist E in arranging test stimuli in the same location for each S.

Testing trials. During the three test trials, each S was presented only one stimulus set and either the memory or minimal memory conditions. The instructions were similar to instructions during training except before presenting the first standard stimulus, E said, "Now I will give you some new things to feel." Also after the S had felt the standard stimulus, E either waited 10 seconds before presenting the three test stimuli if S was assigned to the memory condition; or immediately presented the test stimuli if the S was assigned to the minimal memory condition. Ss had two opportunities to correctly select each of the three standard stimuli, which were included as test stimuli. During each trial E did not give comments as to whether S was correct or incorrect. E told S twice during each session that he was doing fine. Also if S asked, E said that he was doing fine. Order of presentation for both the standard and test stimuli was randomly pre-assigned during training and testing.

III. RESULTS

Test trial data were analyzed in a 2 (Age) x 2 (Sex) x 2 (Memory) x 3 (Object) analysis of variance, as shown in Table 1. All factors are between-subject factors. The analysis revealed highly significant main order effect of Age ($F = 64.32$, $df = 1$, $p < .01$), indicating that older S's performance on haptic tasks were better than younger S's. Hence, the age hypothesis was substantiated.

Insert Table 1 about here

A highly significant overall difference ($F = 70.20$, $df = 2$, $p < .01$) was found for Objects. Total scores were compared using the Tukey (a) post-hoc method. The hypothesis that the three sets of stimuli would vary in difficulty level was partially confirmed in that the familiar objects were significantly easier to recognize than the topological and Euclidean objects ($p < .01$) (Winer, 1962). However, the topological and Euclidean objects were essentially the same.

As illustrated in Fig. 2, the differences were obtained for younger and older S's scores and the different sets of test objects presented. The highly significant Age x Object effect ($F = 7.95$, $df = 2$, $p < .01$) revealed that older children performed better than younger children on some objects.

Insert Fig. 2 about here

The Age x Object effect was due largely to a ceiling effect. Individual comparisons between the three object sets and age using the Tukey (a) procedure

showed that the older and younger Ss did not differ on the familiar objects, but the older Ss did better than younger Ss on the topological and Euclidean objects ($p < .01$). These results also partially support the developmental hypothesis. One would expect older children to do better on the objects than the younger children. Though the difference between topological and Euclidean objects were in the right direction, as expected; the effects were not significant for old or young Ss.

Main order effect of Sex ($F = 4.60$, $df = 1$, $p < .05$) was found to be significant, indicating that girls did better on the haptic task than boys.

The results of the Memory effect were not significant. Therefore, further analysis was performed on trial data to determine if there were differences between the first and second half of trials. These data also did not reveal any significant results.

The results of the Memory x Object effect ($F - 3.87$, $df = 2$, $p < .05$) indicated that differences existed between the memory conditions and the various objects. Reasons for these differences, however, are not clear. Ss did perform better in the memory condition on Euclidean objects than on the topological objects. Whereas in the minimal memory condition S's performance was just the opposite. The significant interaction might have been due to this reversal and also to a highly significant Object effect. The object variable could have been responsible for some of the differences in the memory condition for the topological and Euclidean objects.

IV. DISCUSSION

The present investigation assisted in supporting the literature on age changes in haptic perception (Abravanel, 1968; Fisher, 1965; Gliner, 1967; and Zaporozhets, 1965). Piaget and Inhelder (1956) suggested that tactual discrimination of shapes required an active searching operation if such discrimination was to occur. The results do substantiate the hypothesis that perceptual discrimination increased with age.

A second hypothesis was only partially confirmed. It was theorized that the three stimulus sets would be of increasing difficulty from familiar to topological and lastly to Euclidean. However, S's performance was not as expected from Piaget's theorizing and previous findings. Although the analysis revealed that topological and Euclidean objects were the same, some have found clear support that objects corresponding to the three stages, despite the fact that the chronological ages might have differed (Fisher, 1965; Lovell, 1959; and Page, 1959). The biggest reason for disagreement might be that different stimuli were used by other researchers. Fisher (1965), Lovell (1959), and Page (1959) used topological and Euclidean shapes that were much more dissimilar. The topological shapes were irregular and asymmetrical contours; some having holes of varying sizes in their surfaces, others were open and intertwined rings. The Euclidean objects were those with rectilinear and curvilinear outlines, such as squares, diamonds, and circles. The toplogical and Euclidean stimuli used in this research were physically the same except that the topological objects had the centers cut out.

Some other possibilities are available as to why the present study found dissimilar results. The retention interval and the amount of time allowed to feel a standard stimulus were standardized, insuring uniformity for all Ss. None of the previous work was as systematic in studying haptic perception. Page (1959) and Lovell (1959) varied the procedures within studies for different age level children. In this research, procedure and stimuli used did not change for Ss. Also, all stimuli were presented haptically only. Other researchers would utilize haptic and visual perceptions. After a child had named an object felt, he was asked to select the object from a collection of figures or to draw a picture of the object. Some of the children were asked to do both, but on different occasions. Using this type of procedure presents many more problems than a standardized method, and confoundings are also inevitable. One does not know if the results were caused by the procedure and stimuli used, method of exploration of the S, or his age. That is why consistency is of utmost importance. This study does not have these confoundings of age and object variables; these were controlled for in the original design.

It was evident that a ceiling effect was present for familiar objects. Most Ss had received the maximum test trial score of six, indicating that the familiar objects were too easy. One hundred percent or 24 older Ss obtained maximum scores. Although two-thirds or 16 of the 24 younger Ss obtained maximum scores, only three of the eight remaining Ss did not obtain a score of five. These results indicated that most of these children were able to select the familiar objects without much difficulty.

It was hypothesized that the minimal memory condition would be

easier than the memory condition. But a significant Memory effect was absent probably because the retention interval of 10 seconds was not long enough to make any difference. Therefore that hypothesis remained unsubstantiated. Perhaps researchers interested in haptic perception research and in memory would study the effects of a longer retention interval on S's performance.

In general, the results do provide a basis for future research in the area of haptic perception. Research findings have been fragmentary and a more sophisticated design is needed. Difficulty in replicating Piaget's work arises for varicus reasons. Piaget's research approach is one in which the primary effect is directed toward an assessment of what a child does when presented with a problem and why the child verbalizes what he does about his behavior. Consequently, this research approach has been criticized by many persons interested in Piaget's work because the methods are not standardized and little effort is made to evaluate statistically the behavioral differences obtained (Flavell, 1963). In Piaget's haptic research the exact stimuli used, many times, are unknown. Keeping in mind that Piaget's work has won commendation for psychologists and educators, the theories are worth exploring.

In conclusion, the present investigation provides partial support for Piaget's theory of haptic perception. Future research must examine stages, allowing for more variation between the topological and Euclidean objects. Albeit not investigated in this research, future studies could examine whether or not labeling objects facilitated discrimination learning in a haptic task. Ss, in the present study, that had labels for objects

being felt, almost always made the correct choice. This label effect could have also been responsible for the superiority of the familiar shapes, which must be more easily labeled. Bush and Cohen (1970) stated that labels of any kind may have served to keep S's attention focused on the stimuli. Page (1959) stated that success in either identification or reproduction of the forms was closely related to the type of exploratory handling exhibited by the child being tested. Future research might also look at S's method of exploration in determining the methods that aid in successful completion of the task. Finally, Peel (1959) mentioned that the more experiences we could provide of materials and questioning at the appropriate time for children, the better we may be preparing them for later classroom experiences. Implications of haptic perception in educational settings should be considered in order for any real progress to be made in the field.

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Table 1

ANALYSIS OF VARIANCE SUMMARY TABLE FOR THE TEST TRIAL SCORES WITH FACTORS: AGE, SEX, MEMORY CONDITION, AND STUMULUS OBJECT

Source	DF	Mean Square	F Ratio
Age (A)	1	70.84	64.32**
Sex (S)	1	5.06	4.60*
Memory (M)	1	1.17	1.07
Object (O)	2	77.31	70.20**
A x S	1	.06	.06
A x M	1	.17	.16
A x O	2	8.76	7.95**
S x M	1	1.17	1.07
S x O	2	2.02	1.83
M x O	2	4.26	3.87*
A x S x M	1	.56	.51
A x S x O	2	1.02	.93
A x M x O	2	1.34	1.22
S x M x O	2	.13	.12
A x S x M x O	2	.77	.70
Error (Between)	120	1.10	---
Total	144		

* $p < .05$
** $p < .01$

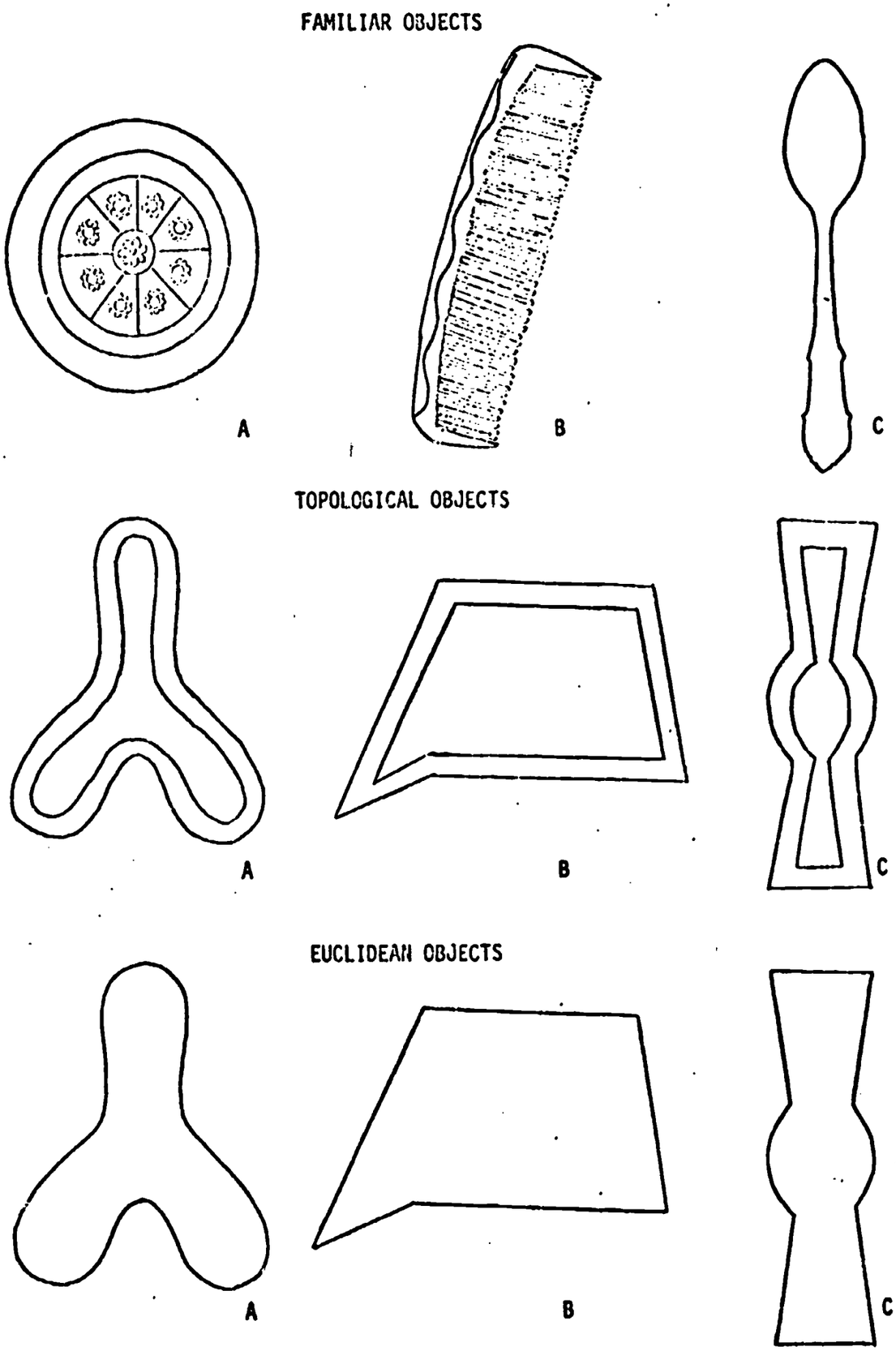

Figure 1. Stimuli used in the experiment.

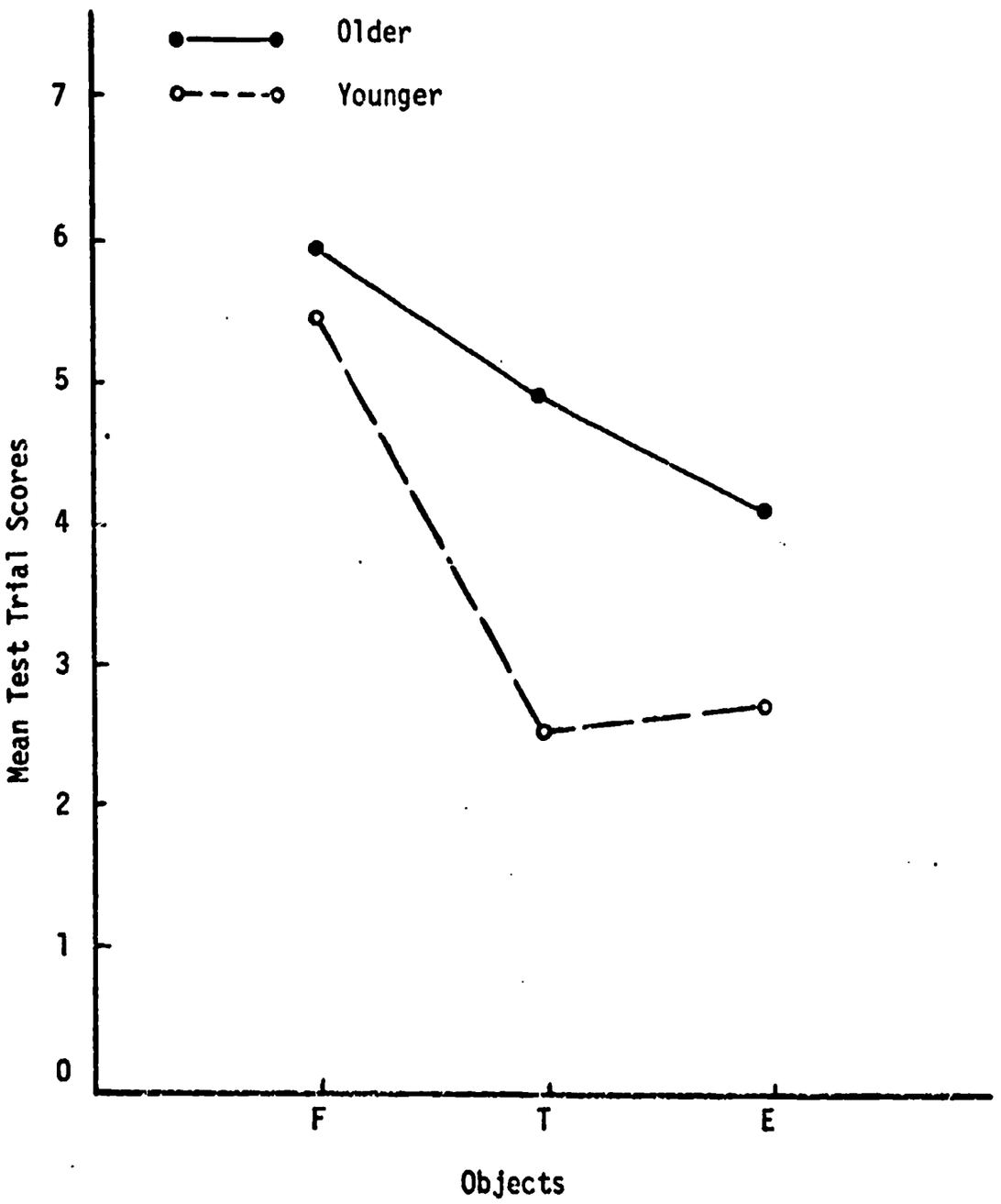

Figure 2. Mean test trial scores for younger and older Ss as a function of the object condition.

APPENDIX

KEY TO RAW DATA TABLE
(Testing Data)

Column A Subject Number

B Age: 1 = Younger, 2 = Older

C Sex: 1 = Male, 2 = Female

D Memory Condition: 1 = Memory, 2 = Minimal Memory

E Stimulus Set: 1 = Familiar, 2 = Topological, 3 = Euclidean

I Score for first half of trials

II Score for second half of trials

N Total number of correct trials

A	B	C	D	E	I	II	N	A	B	C	D	E	I	II	N
1	1	1	1	1	3	3	6	14	1	1	1	3	3	2	5
2	1	1	1	1	3	3	6	15	1	1	1	3	1	1	2
3	1	1	1	1	2	3	5	16	1	1	1	3	1	1	2
4	1	1	1	1	3	3	6	17	1	1	1	3	1	2	3
5	1	1	1	1	2	3	5	18	1	1	1	3	2	0	2
6	1	1	1	1	3	3	6	19	1	1	2	1	3	3	6
7	1	1	1	2	2	1	3	20	1	1	2	1	2	2	4
8	1	1	1	2	1	0	1	21	1	1	2	1	3	3	6
9	1	1	1	2	0	2	2	22	1	1	2	1	3	3	6
10	1	1	1	2	1	0	1	23	1	1	2	1	3	3	6
11	1	1	1	2	0	2	2	24	1	1	2	1	1	2	3
12	1	1	1	2	0	2	2	25	1	1	2	2	1	0	1
13	1	1	1	3	1	1	2	26	1	1	2	2	2	2	4

A	B	C	D	E	I	II	N
27	1	1	2	2	2	1	3
28	1	1	2	2	1	1	2
29	1	1	2	2	3	1	4
30	1	1	2	2	1	1	2
31	1	1	2	3	2	3	5
32	1	1	2	3	2	0	2
33	1	1	2	3	2	2	4
34	1	1	2	3	0	0	0
35	1	1	2	3	1	0	1
36	1	1	2	3	0	1	1
37	2	1	1	1	3	3	6
38	2	1	1	1	3	3	6
39	2	1	1	1	3	3	6
40	2	1	1	1	3	3	6
41	2	1	1	1	3	3	6
42	2	1	1	1	3	3	6
43	2	1	1	2	3	2	5
44	2	1	1	2	1	2	3
45	2	1	1	2	3	3	6
46	2	1	1	2	2	2	4
47	2	1	1	2	2	2	4
48	2	1	1	2	1	1	2
49	2	1	1	3	1	2	3
50	2	1	1	3	3	3	6
51	2	1	1	3	2	2	4
52	2	1	1	3	1	2	3
53	2	1	1	3	2	2	4
54	2	1	1	3	3	3	6
55	2	1	2	1	3	3	6
56	2	1	2	1	3	3	6
57	2	1	2	1	3	3	6

A	B	C	D	E	I	II	N
58	2	1	2	1	3	3	6
59	2	1	2	1	3	3	6
60	2	1	2	1	3	3	6
61	2	1	2	2	3	2	5
62	2	1	2	2	1	3	4
63	2	1	2	2	2	3	5
64	2	1	2	2	1	3	4
65	2	1	2	2	3	3	6
66	2	1	2	2	2	1	3
67	2	1	2	3	2	1	3
68	2	1	2	3	2	2	4
69	2	1	2	3	2	2	4
70	2	1	2	3	2	2	4
71	2	1	2	3	2	3	5
72	2	1	2	3	3	1	4
73	1	2	1	1	3	3	6
74	1	2	1	1	3	3	6
75	1	2	1	1	2	1	3
76	1	2	1	1	3	2	5
77	1	2	1	1	3	3	6
78	1	2	1	1	2	3	5
79	1	2	1	2	1	1	2
80	1	2	1	2	0	2	2
81	1	2	1	2	0	2	2
82	1	2	1	2	2	1	3
83	1	2	1	2	1	0	1
84	1	2	1	2	1	1	2
85	1	2	1	3	1	1	2
86	1	2	1	3	2	2	4
87	1	2	1	3	3	2	5
88	1	2	1	3	1	1	2

A	B	C	D	E	I	II	N
89	1	2	1	3	2	2	4
90	1	2	1	3	1	2	3
91	1	2	2	1	3	3	6
92	1	2	2	1	3	3	6
93	1	2	2	1	3	3	6
94	1	2	2	1	3	3	6
95	1	2	2	1	3	3	6
96	1	2	2	1	2	3	5
97	1	2	2	2	1	2	3
98	1	2	2	2	0	2	2
99	1	2	2	2	2	2	4
100	1	2	2	2	2	3	5
101	1	2	2	2	2	1	3
102	1	2	2	2	3	2	5
103	1	2	2	3	3	3	6
104	1	2	2	3	2	1	3
105	1	2	2	3	1	1	2
106	1	2	2	3	1	1	2
107	1	2	2	3	2	0	2
108	1	2	2	3	1	0	1
109	2	2	1	1	3	3	6
110	2	2	1	1	3	3	6
111	2	2	1	1	3	3	6
112	2	2	1	1	3	3	6
113	2	2	1	1	3	3	6
114	2	2	1	1	3	3	6
115	2	2	1	2	3	3	6
116	2	2	1	2	3	3	6
117	2	2	1	2	2	1	3
118	2	2	1	2	2	2	4
119	2	2	1	2	3	3	6
120	2	2	1	2	3	3	6
121	2	2	1	3	3	1	4
122	2	2	1	3	1	2	3
123	2	2	1	3	3	1	4
124	2	2	1	3	2	2	4
125	2	2	1	3	3	3	6
126	2	2	1	3	2	1	3
127	2	2	2	1	3	3	6
128	2	2	2	1	3	3	6
129	2	2	2	1	3	3	6
130	2	2	2	1	3	3	6
131	2	2	2	1	3	3	6
132	2	2	2	1	3	3	6
133	2	2	2	2	3	3	6
134	2	2	2	2	2	3	5
135	2	2	2	2	3	2	5
136	2	2	2	2	2	3	5
137	2	2	2	2	3	3	6
138	2	2	2	2	3	3	6
139	2	2	2	3	2	2	4
140	2	2	2	3	3	1	4
141	2	2	2	3	2	2	4
142	2	2	2	3	2	3	5
143	2	2	2	3	2	1	3
144	2	2	2	3	2	3	5

Table 2

ANALYSIS OF VARIANCE SUMMARY TABLE FOR FIRST AND SECOND HALF TRIAL SCORES WITH FACTORS: AGE, SEX, MEMORY CONDITION, STIMULUS OBJECT, AND TRIALS

Source	DF	Mean Square	F Ratio
Between subjects			
Age (A)	1	35.42	64.32**
Sex (S)	1	2.53	4.60*
Memory (M)	1	.59	1.07
Object (O)	2	38.66	70.20**
A x S	1	.03	.06
A x M	1	.09	.16
A x O	2	4.38	7.95**
S x M	1	.59	1.07
S x O	2	1.01	1.83
M x O	2	2.13	3.87*
A x S x M	1	.28	.51
A x S x O	2	.51	.93
A x M x O	2	.67	1.22
S x M x O	2	.07	.12
A x S x M x O	2	.39	.70
Error (between)	120	.55	---

Table 2 (continued)

Source	DF	Mean Square	F Ratio
Within subjects			
Trials (T)	1	.03	.08
Age (A) x T	1	.003	.009
Sex (S) x T	1	.17	.44
Memory (M) x T	1	.09	.22
Object (O) x T	2	.97	2.50
A x S x T	1	.28	.73
A x M x T	1	.59	1.52
A x O x T	2	.07	.17
S x M x T	1	.42	1.09
S x O x T	2	.17	.44
M x O x T	2	.07	.17
A x S x M x T	1	.003	.009
A x S x O x T	2	.32	.83
A x M x O x T	2	.48	1.25
S x M x O x T	2	.05	.12
A x S x M x O x T	2	1.13	2.92
Error (within)	120	.39	---

* $p < .05$

** $p < .01$