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ABSTRACT

This document reports on a study of how the eye and the hand become functionally coordinated during growth. A specific question researched is "How do children use their hands as perceptual tools for exploring objects in order to acquire information about them?" It was assumed that a pre-school child would have evolved a form of eye-hand cooperation, and given a shape recognition problem, would show how he has produced a division of labor between the work done by his hands and the work done by his eyes. A procedure was formulated that would allow comparison of what hand exploration is like under haptic perception, with what hand exploration is like when the S may perceive shape through the combined use of haptic plus visual exploration. Two sets of materials were used--a set of wooden shapes and a set of 10 free-form solid shapes. Sixty children between 4 and 5 years were studied in connection with both sets of materials. It was found that the children used their hands as pedestals more than as perceptual tools; the dominant approach was to use the hands to position the object for visual inspection. The quality of hand use was almost fully subordinated to the function of visual inspection. The children showed minimal haptic exploration of the objects. (Not available in hard copy due to marginal legibility of original document.) (CK)

The Companion Roles of Touching and Viewing for Shape Discrimination By Young Children

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(Paper delivered at Eastern Psychological Association, New York, 1971)

This morning, I would like to discuss the relationship between the hand and the eye as perceptual tools in young children.

There has been a good deal of recent interest in the problem of how the eye and the hand become functionally coordinated during growth. Much of the research has been looking quite naturally at the origins of hand-eye coordination during infancy.

I became interested in a related problem at a somewhat later point in development (around ages 3 and 4). The question I asked was "How do children use their hands as perceptual tools for exploring objects in order to acquire information about them?" Also, I was eager to find out something about the changes in perceptual activity that take place during growth, and, even further, to determine whether such changes in the process of using the hands or the eyes for perception are correlated withthe level of a S's perceptual achievement.

We were able to present evidence for changes in the way that the hands are used to explore surfaces or objects when a child was required to perceive shapes, textures or metric properties of objects (such as their lengths or circumferences). We were also able to relate process to achievement, to some degree, by showing that developmentally more advanced forms of perceptual activity were at least associated with more differentiated perceptual achievements. (Abravanel, 1968).

With this descriptive information as background, we approached the problem that I would like to discuss today. We wondered whether we could compare how the hand is used for perceiving when it (1) functions alone -- without vision - and (2) in combination with active touch perception; i.e., the situation where it is possible to both look at and haptically explore a surface or object.

We assumed that the pre-school child would certainly have evolved a form of eye-hand cooperation, and, given a shape recognition problem, he would show us how he has produced a division of labor between the work done by his hands and the work done by his eyes.

In order to study this problem we formulated a procedure that would allow us to compare what hand exploration is like under haptic perception alone, with what hand exploration is like when the S may perceive shape through the combined use of haptic plus visual exploration. We filmed haptic perception with 16 mm. motion picture film under these two conditions.

Slides 1 through 5

We studied the problem with two sets of materials. The first, was a set of wooden shapes - presumably unfamiliar - and the second was a set of 10 free-form solid shapes originally designed by James Gibson. We assumed that the first set of wooden objects would present an easier discrimination task, while the second set of sculptured solids would pose a more difficult discrimination. We wanted to observe haptic perception with both an easier and more difficult discrimination.

METHOD

Subjects

Sixty children between 4 and 5 years were studied in connection with both sets of materials. They were primarily middle-class children residing in metropolitan Washington, D. C. and the sample was predominantly white. [redacted]

Procedure

Each child was assigned randomly to one of three groups: Visual Standard - Visual Comparisons, Haptic Standard - Visual Comparisons, Haptic + Visual Standard - Visual Comparisons.

Visual-Visual. The standard and two comparison objects (one of which was equivalent to the standard) were presented in the frontal-parallel plane, and the child made his equivalence match on the basis of visual inspection alone.

Haptic-Visual. The standard was perceived haptically and the comparisons visually. A screening device separated standard from comparisons and made it impossible for the S to see the object he was handling.

Haptic + Visual Standard - Visual. Here the S was encouraged to explore the standard both haptically and visually, and to make an equivalence match as in the other conditions.

RESULTS

The next slide presents results for the wooden objects. The means indicate average accuracies of standard and equivalent comparison.

TABLE 1

The Haptic - Visual match was the most difficult of the three, which is consistent with the findings of most research comparing haptic with visual shape perception in young children, older children or adults. It produced significantly less accurate matching than was found in either Gp. II or Gp. III. The more critical comparison is between Gps. II and III, however, and here we find no significant difference in the success of shape matching.

If we turn next to the findings for the solid sculptured shapes, we find that the task was, indeed, made more difficult with these shapes, but the pattern of relative difficulty was the same as for the wooden objects. Once again, Gp. I was significantly less accurate than either Gp. II or Gp. III. No significant difference was found between Visual perception of an object and Visual + Haptic perception.

These results are quite similar to some recent findings by Butter and Zung (1970) at the University of Massachusetts where Ss were presented with a variety of shapes under reasonably similar conditions.

Descriptive Findings About Process.

We were filming exploratory movements of the hand under Haptic-Visual and Haptic + Visual - Visual conditions with the hope of finding out how perceptual activity would vary when the child had an opportunity to combine looking and touching, with the situation where he could discover shape only by touching. This is the comparison of Gp. I and Gp. III. We were surprised to find that for 18 of the 20 Ss in Gp. III (Haptic + Visual -Visual) the children used their hands as pedestals more than as perceptual tools. The dominant approach was to use the hands to position the object for visual inspection. In most cases, this meant simply using the hand to orient and direct the object for visual regard, but not using it for purposes of exploration, such as tracing, or gripping parts, or modeling the hand to the surface of the object.

Even the considerably complex and difficult to discriminate solid sculptured shapes were treated in this way. The quality of hand use was almost fully subordinated to the function of visual inspection. The children showed minimal haptic exploration of the objects.

These finding surprised us; we expected to find that haptic perception would be given a larger role -- more of an exploratory function, rather than simply an orienting one - when combined with visual perception.

Of course, in the condition where haptic and visual perception were separated [Gp. I] the hands were used for perceiving object shape - albeit, not with very great accuracy, but this is consistent with earlier work on the

difficulty young children have in discriminating unfamiliar, complex shapes by hand alone (cf. Zinchenko and Lomov, 1960).

Five-Year-Olds.

The findings presented were largely repeated in a study of the same paradigm with five-year-old children. Our results showed that these older children performed more accurately than their counterparts one-year younger. However, the descriptive findings were very similar. The five-year-olds also used their hands primarily in the service of vision when given an opportunity to both haptically and visually explore the shapes.

A Further Condition: Haptic + Visual Standard - Haptic Comparisons. -

More recently, it occurred to us that a different pattern of hand-eye cooperation might occur if the comparison objects were presented haptically rather than visually - as we had done up to then. We reasoned, that presenting the comparisons haptically might increase the difficulty of the task (which it does), might counteract any pre-established set or pre-disposition to perceive the standard only visually in the situation where the S is permitte to use both eyes and hands.

Results.- With 20 four-year-olds, we found only three who did much with their hands as exploratory tools, and we couldn't be certain that even these few Ss weren't picking-up our expectation of how they "should" perform, rather than using their hands and eyes in their most preferred combinations or non-combinations. The consistent finding is that the large majority of Ss chose to attempt the shape differentiation of the two haptic comparisons largely on the basis of the information that they obtained visually of the standard object.

DISCUSSION

We are tempted to conclude that at least for the perception of shape, by age 4-years (and, perhaps considerably earlier) the kind of cooperative relationship or division of labor achieved between hand and eve is one where the hand directs the object - and maybe rotates or positions it - for visual inspection. The visual system, on the other hand, is given the task of making the perceptual differentiation.

This generalization may be limited and apply only to some properties of objects, such as shape, and not to others, such as texture or hardness.

As a point of speculation, we wonder why the S in our critical condition doesn't use his hands for perceptual purposes. One explanation may be that even the 4-year-old is quite convinced of his powers of intersensory transfer, and "believes" that he can make such transfers with vision alone. It's as if he has no need for haptic information in the situation.

Another possibility is that at this level of development, the youngster doesn't yet know how to use hand and eye cooperatively and with useful division or labor, but that later he will learn to do so. I think that we will be able to test this possibility.

Yet a third possibility - and, my last for today - is that when exploring by hand and by eye in a combined fashion, there may be a problem of inconsistent or not totally compatible information pickup by the two systems. What the hand picks-up as somewhat different from what the eye picks up, and the two kinds of information may not be easily reconciled or integrated. Therefore, the S avoids using both perceptual systems, and gives the job over to one - the visual system.

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EXPERIMENT 1

WOODEN PLANAR SHAPES

	Standard	Comparisons	Mn. Correct	S.D.
Gp. I	HAPTIC	VISUAL	6.35	1.56
Gp. II	VISUAL	VISUAL	9.00	.89
Gp. III	HAPTIC + VISUAL	VISUAL	8.95	.86

Trials = 10

N = 60

Gp. II & Gp. III Gp. I, p .01

(Based on Newman-Keuls Multiple Comparisons)

EXPERIMENT 2

Solid Sculptured Shapes

	Standard	Comparisons	Mn. Correct	S.D.
Gp. I	HAPTIC	VISUAL	5.00	1.79
Gp. II	VISUAL	VISUAL	8.50	1.07
Gp. III	HAPTIC + VISUAL	VISUAL	8.35	1.11

Trials = 10

N = 60

Gp. II & Gp. III Gp. I, p .01

(Based on Newman-Keuls Multiple Comparisons)