DOCUMENT RESUME

ED 127 018 PS 008 713

AUTHOR Meyer, William J.; Dwyer, Michael
TITLE The Interaction of Stimulus Orientation and Age.
PUB DATE [70]
NOTE 26p.

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS *Age Differences; Cognitive Development; Discrimination Learning; *Early Childhood Education; Eye Fixations; Eye Movements; Middle Class; *Perceptual Development; Preschool Children; *Research; Research Methodology; *Visual Perception; *Visual Stimuli
IDENTIFIERS *Components of Cognitive Competency Program

ABSTRACT

This study examined age differences in children's visual fixation and search strategies of two dimensional visual stimuli. The hypotheses tested were: (1) that no age differences exist in general search strategies regardless of stimuli position, (2) that age differences could be expected with respect to the number and duration of visual fixations, and (3) that older children, because they presumably have more experience with the properties of two-dimensional representations, will evidence fewer fixations and shorter fixation duration. Subjects were 18 middle class children; nine in the young group (mean age 3 years 7 months) and nine in the old group (mean age 4 years 10 months). Stimuli were a triangle and a keyhole shape. The corneal reflection and the stimulus were simultaneously recorded on film. The stimuli were presented twice to each child in each orientation (focal point up and focal point down), with order of stimuli randomly determined. Data were recorded and translated into a computer program, and two components of the data were examined: fixation densities and duration of fixations. In general, these analyses seem to suggest that older children make somewhat more fixations on the focal point and discriminative features of the stimuli and that they, like the younger children, find the focal point more compelling when it appears at the bottom. The study is discussed in relation to similar experiments conducted by Ghent-Braine and others. (SB)

Program Title: Components of Cognitive Competency

Work Unit: The Interaction of Stimulus Orientation and Age

William J. Meyer and Michael Dwyer

Syracuse University

THE INTERACTION OF STIMULUS ORIENTATION AND AGE

William J. Meyer and Michael Dwyer

Ghent-Braine (1965) reported data suggesting that five-year-olds, in contrast with three-year-olds, use a strategy of vertical scanning (top-to-bottom) regardless of particular stimulus properties. In her study, she employed a keyhole-like stimulus and a triangle. She reasoned that the round portion of the keyhole, and the apex of the triangle (see figure 1) were highly compelling focal features of the stimuli for the young children. Each stimulus also contained certain distinctive features which differentiated it from other similar stimuli in a matching-to-sample task. The stimuli were presented to the children in the upright position (the distinctive features were located at the bottom) and in an inverted position (the distinctive features were located at the top). Thus, for the younger children when the focal point was at the top, she hypothesized that they would begin their scanning at that point and work down finally encompassing the distinctive features. When the focal point is located at the bottom, they would start at that point and then also scan downward thus missing the distinctive features (it is unclear why, in this situation, the child would scan downward except for the assumption that downward vertical movement is a "natural" event). In all cases, the older children were expected to start at the top, regardless of focal point location, and systematically scan downward. In this way the older children would always observe the distinctive stimuli. The Ghent-Braine experiment was designed to demonstrate the existence of an age x stimulus interaction and this hypothesis was supported.

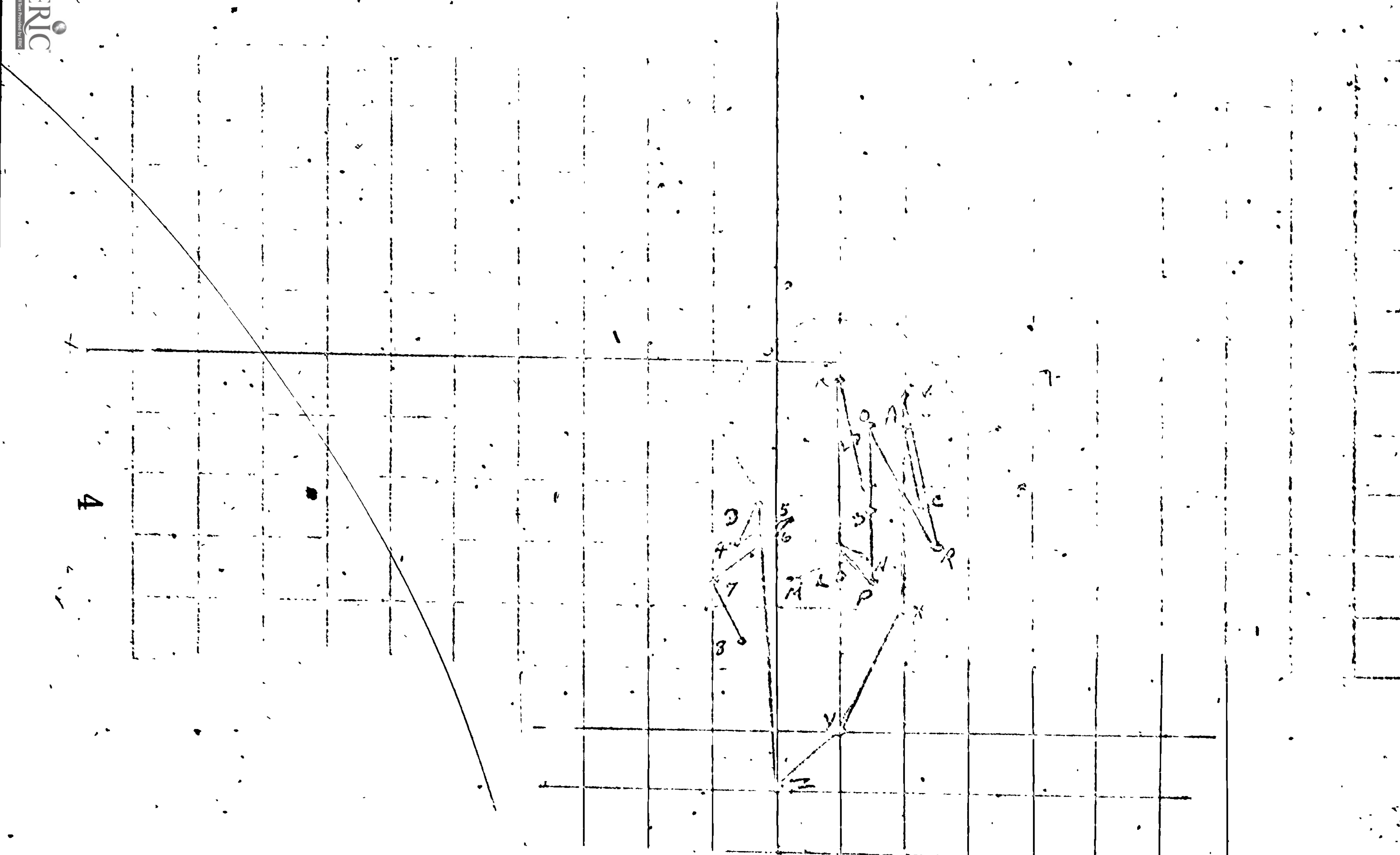
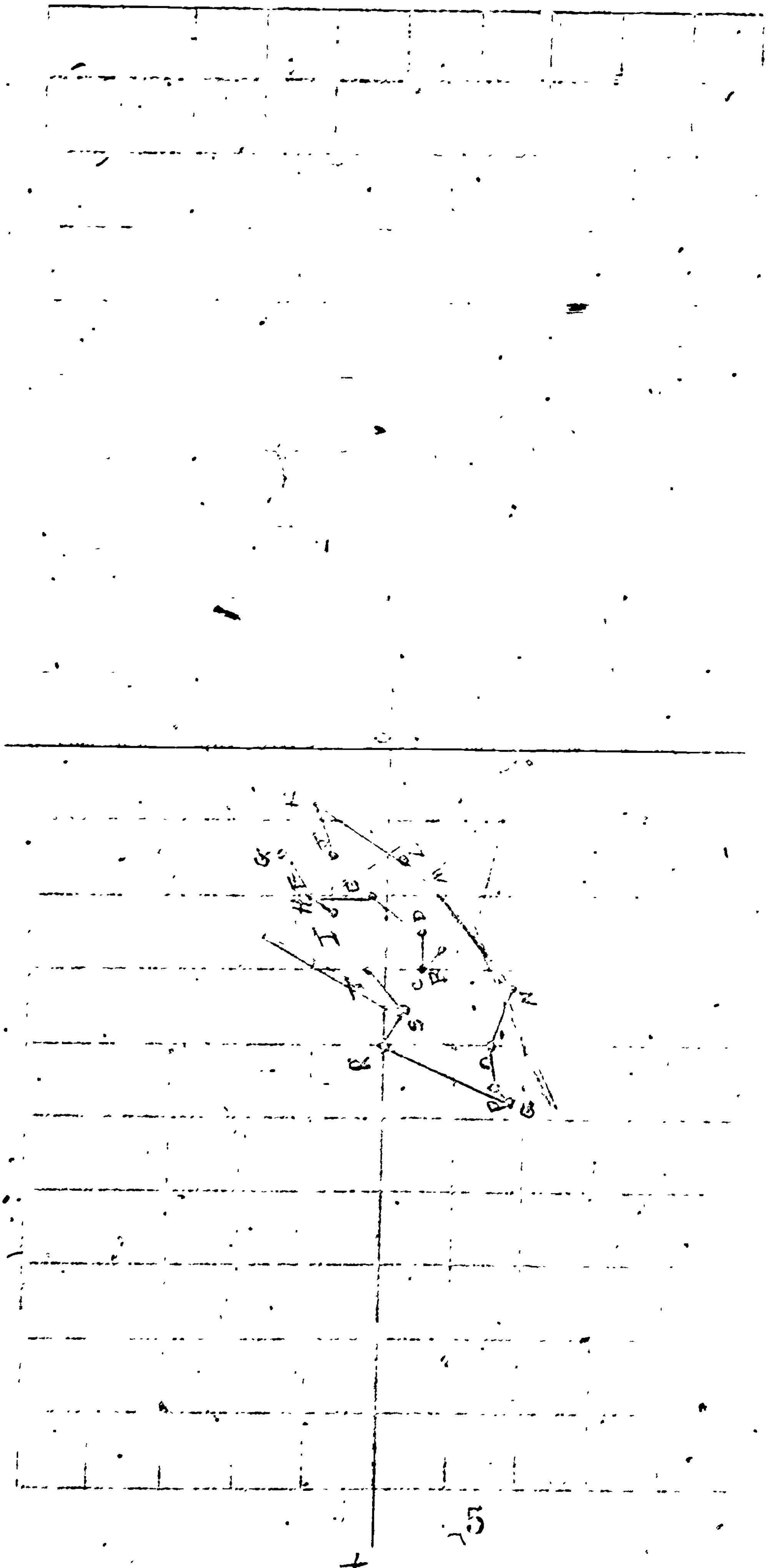


Figure 1. . Eye movement patterns for the keyhole in the upright position.



Braine's design and procedure is excellent but is ambiguous with respect to the actual search patterns used by the children. It is possible, for example, that the younger children did in fact examine the discriminative features but did not make use of them in the matching task. From our viewpoint, visual scanning behavior seems more understandable in terms of an interaction between the schemas available to the child and the nature of the stimuli. In this context, it can be argued that a person's pattern of eye movements (sequence of fixation points) reflect his hypotheses about the nature of the stimulus which in turn are a function of the instructions received about the problem. For example, in a task used by Vurpillot (1968) the children were shown six pictures of houses and asked to find the one "that is different". She found that the children tended to examine specific detailed attributes of each stimulus. This procedure is indeed crucial for success on this task and was clearly age related. Olson (1970), in his important study of the concept of "diagonality", examined eye movement patterns using two problem conditions: recognition (a matching-to-sample task) and reproduction. With respect to the recognition task Olson concludes:

> "It may be concluded that the older children saw more in their limited visual search of the diagonal than the younger children saw in their more elaborate search.... In line with the conclusions of the earlier chapters, it may be suggested that both groups note the general configuration but the older Ss, recognizing it as the diagonal, notice how the components, the checkers, give rise to the general effect of a diagonal; the

younger not knowing the concept of the diagonal, do not see it in terms of the specific components. Yet one of those components is crucial to the subsequent recognition. The difference, then, is not in the visual search but in the information drawn from it."

(Olson, 1970, p. 155)

Performance on the reproduction task generated more subject variability, but essentially supported the conclusions already stated. Very similar conclusions can be drawn from a study by Mackworth and Bruner (1970) who also measured eye movement patterns using a recognition task quite different from Olson's.

With respect to the Ghent-Braine study, it is conceivable that for the younger children, when the stimuli were in the inverted position, the focal point becomes the distinctive stimulus because the inverted position is unique to them. In this case, real (three-dimensional) keyholes and triangles cannot "stand up" if placed upside down on the surface. The inverted stimulus is perhaps less distracting to the older children because of greater experience with two-dimensional stimuli. Unlike Ghent-Braine, we would not expect age differences in the general search strategies employed with the stimuli regardless of position. Age differences are expected with respect to the number of fixations and in duration of fixations. Because the older children presumably have had more experience with the properties of two-dimensional representations, it is anticipated that the older children will evidence fewer fixations and shorter fixation durations.

Method

<u>Subjects</u> The sample was comprised of 18 middle-class children. The young group (mean CA = 3-7) consists of 9 children and the old group (mean CA = 4-10) makes up the balance of the sample.

Apparatus The equipment used in this study is basically that developed by Mackworth (Mackworth, 1967; Mackworth and Mackworth, 1958; and Mackworth and Thomas, 1962). The essential feature of the technique is the use of corneal reflections. Corneal reflections are achieved by means of a light source directed to the left cornea which then reflects a dot of light on the stimulus. The corneal reflection and the stimulus are simultaneously recorded on 16 mm black and white film using a motor driven Beaulieu camera at a rate of 16 frames/second. A television camera is also used for the purpose of constant monitoring of the system. In order to produce the desired accuracy of $\pm$ 1/2° of visual arc ($\pm$ 1/2 inch at a viewing distance of 20 inches) requires that the subject not move his head at all. This aspect of our procedure was the most difficult to achieve and we finally decided that no compromise with the strictest of procedures was possible. Thus, it was necessary to use a bite-bar -- the subject is required to bite into what is essentially dental impression material. When this material hardens, the child can leave the equipment and return, fitting his teeth into the impression, providing a standard head adjustment. (Despite our misgivings that young children would object to this procedure, or gag, the children without exception enjoyed it expressing considerable interest in the impressions.) The bite-bar is attached to the main support arm of the equipment. In addition there is a head rest and a chin support each of which can be adjusted to provide for individual variations in size and proportion. It should be noted that there are problems with the procedure which appear to result from the sheer bulk and appearance of the equipment -- some of the younger children initially resist approaching

it. This problem can usually be resolved by the simple process of permitting the children to freely explore the equipment on their own. In addition, we used two female assistants who were familiar to the children and who were always present during the adaptation and experimental periods. This procedure was totally successful with our youngest children and proved almost unnecessary with the older children, five years and over. A final problem with the youngest children involved their inability to stay rigidly motionless for extended periods of time. We found it necessary to provide recesses every five minutes, on the average.

As already noted, the crucial feature of the corneal reflection procedure is that the subject's head remain absolutely immobile. This feature is crucial because, in order to achieve maximum accuracy, the fixation points, in a sequence, must derive from the initial eye orientation. A movement of the head during a trial, for example, could cause fixations to seemingly occur totally off the stimulus; a meaningless bit of data. Calibration is achieved by having each subject look at the center of a "calibration stimulus" consisting of crossed lines. Adjustments are made on the light sources so that the reflection from the cornea is centered exactly on the point where the lines cross.

<u>Procedure</u> Each child was seen individually in a room located within the school. The stimuli were presented twice to each child in each orientation (focal point up, FcPU, and focal point down, FcPD). Thus a total of 8 experimental stimuli were presented to each child. The order of stimulus presentations was completely random over subjects. All procedures described in the apparatus section were used.

Following the calibration procedure the subjects were given the following instructions:

"Now I am going to show you some more pictures. I want you to look at them very carefully because I am going to ask you questions about them later. Be sure to look at each picture carefully."

The recognition procedure used by Ghent-Braine was not employed in this study because of the considerable problem of recalibration required.

Results

A major problem in working with eye movement recordings is the reduction of the data to a form amenable for analysis. There does exist a system for directly translating fixation coordinates into computer language but this system was not available to us. We developed a method involving the manual recording of coordinates and fixation durations, which though time consuming, can be readily translated into a computer program. Briefly, the procedure involves superimposing an acetate transparency of the stimulus over the screen of a Zerox microfilm reader. The transparency also contains 1/2 inch squares. The film containing the eye-movements is then projected on the transparency so that each spot of light (corneal reflections) can then be located on the enlarged grid. Each frame of film is examined in this way. Duration of fixations is determined by counting the number of frames in which the corneal reflection does not move more than one square. After this process is completed, the data is coded for computer analyses (the computer program was developed by David Connell).

The major output features of the program are:

A. Listing of data - the coordinates extracted from the film giving the positions (with reference to the grid) of the distinctive features of the stimulus and the eye marker spot.

- associated with the list is a graphic representation of the coordinates (examples of the output are given later in the report). The symbols used in the graph (indicated in the above list) are:

  alphabetic - distinctive feature of stimulus

  dot (period) - position of eye marker dot observed in a single frame

  asterisk - position of a fixation - <u>defined</u> as the appearance of the eye dot in the same position for two or more successive film frames.

B. Listing of Fixations - this is a listing of the coordinates of fixations as defined above.

- associated with this list is a second graph which represents the position and <u>sequence</u> of the fixations. The sequence is indicated by assigning an alphabetic symbol to each fixation. If there are more than 26 fixations, a new set of numeric symbols picks up where the alphabetic symbols left off.

These are zero through nine. Should more than 36 fixations occur, the alphabetic sequence begins again and so on. (the short viewing times usually allowed rarely are enough to permit the subject to make many more than 25 to 30 fixations)

- an important feature of this program is that, when two coordinates are less than one-quarter of a grid unit away from each other in any direction they are normalized into a value equal to the first coordinate. For example, if in one frame the value (+ .100(x), + 1.00(y)) is obtained, and in the next frame the eye marker spot is at position (+1.25(x), + 1.25(y)), the value of the resultant fixation is (+1.00(x), + 1.00(y)). This normalization process reduces variation due to extraneous sources such as mechanical distortion, or experimenter biases that might occur during the extraction process. Notably, inherent in this procedure, the criteria for defining a fixation are met thus this normalized value is included within this second list of fixations.

C. Dependent Measures (This comes first in the output)

1. Subject code - e.g. Ss#, age, treatment group, etc.

(Note: The following are in terms of grid units

1/2° of viewing arch = 1/2 inch)

2. Delta X = horizontal distance travelled

$\frac{\text{Delta X}}{\text{Delta T}}$ = proportion of total distance taken up by horizontal saccades.

3. Delta Y = vertical distance travelled

$\frac{\text{Delta Y}}{\text{Delta T}}$ = proportion of total distance taken up by vertical saccades.

4. Total track length = (self-explanatory)

5. Total time elapsed - this value is arrived at by noting the filming rate in frames per second and multiplying this value by the number of seconds the subject views the stimulus.

6. Tot number of fixations

7. Fixation number - fixations are numbered 1 through N.

8. Begin - end - the number of the frame in which the fixation was first noted (begin) and the number of the frame in which it was last in the same position (end)

9. XPOS - the X coordinate of that fixation

10. YPOS - the Y coordinate of that fixation

11. Block (Val) - the grid reference within the program is such that each block in the grid is numbered. The value associated with it equals the number of times a fixation landed in this block. (This measure was not used in this pilot, but will be used in the future)

12. Length - duration of the fixation is milliseconds

13. Dist. - distance (in grid units) to the next point of fixation

14. Angle - angle of the saccade to the next point of fixation

15-16. Slope - slope deviation of angle to the next fixation (these measures not used - but will be useful in the future in getting at the nature of the saccades produced by the Ss e.g., straight, curved, angular, etc.)

17. Fixation ratio - proportion of total viewing time taken up by fixation time

18. Average Fixation duration - (self-explanatory).

This output is in the form of print out, and in the case of the dependent measures - print out and punched output. The punched output is then utilized in any statistical design deemed appropriate.

In general then this program accomplished a number of important tasks.

1. It systematically portrays the physical relationship between the stimulus and the resultant eyetrack.
2. Graphic data is immediate and accurate.
3. It produces immediately and in final form, the dependent measures that before required long tedious hours of summing, subtracting multiplying and dividing an inordinate amount of basic data.
4. It produces punched output readily utilized in statistical computer packages.

For the purposes of this report two components of the data were examined: fixation densities, and duration of fixations. We also examined the angle displacement of each saccade (this measure indicates the general direction of eye movements, vertical or horizontal) but this measure is not reported in detail because there was little subject variability; almost all movements were vertical (up or down) most likely because of the nature of the stimuli.

Although the major focus of this study is on the children's visual responses to the discriminative features and the focal point, an initial analyses was made of the total number of fixations regardless of where on the stimuli they may have occurred. The mean number of fixations for the total sample on both stimuli in both orientations was 8.2 (SD = 3.8). A comparison between age groups indicated that the younger children had more fixations (M_y = 9.8, SD = 4.2 and M_o = 6.7, SD = 2.8). This difference is statistically significant (t = 2.4, df = 16, $p < .05$). These results are consistent with the expectation that younger children would examine more aspects of stimuli but, as will be seen later, their strategies are not as efficient as those of the older children.

The mean fixation time for all the children over both stimuli and all aspects of the stimuli in both orientations was 325 milliseconds (msecs) (SD = 290). The younger children had shorter fixations (M_y = 317 msecs, SD = 301) than the older children (M_o = 333 msecs, SD = 242). This difference, though suggestive, is not statistically significant (t = 1.4; df = 16, $p < .10$). Apparently younger children look at more aspects of the stimuli and for slightly longer periods of time than the older children.

The major analyses is concerned with the physical locations of the child- [illegible] fixations on the stimuli in the different orientations. Since there was [illegible] notion that young children scan differently, namely in a predominantly [illegible] direction, we first examined the directionality of eye movements for [illegible] as a function of orientation. Summarized in Table 1 are the [illegible] for up and down movements as a function of CA and location of the [illegible]. It should be immediately clear that neither CA or orientation [illegible] the frequency of up and down movements. Thus it seems that children [illegible] both directions which is contrary to Ghent-Braine's position.

Table 1

Percent Up-Down Direction of Initial Scan

for Young and Old Children as a Function of Stimulus Orientation

	Young		Old	
	Up	Down	Up	Down
[illegible]	50	50	46	54
[illegible]	53	47	46	54

[illegible] be noted, however, that we permitted our subjects time to examine the [illegible] whereas Ghent-Braine used a relatively short exposure time ranging from [illegible] milliseconds to 200 milliseconds. It is possible that within the constraint of the short exposure duration, the younger children in fact did scan downward from the focal point. In the case where the focal point was at the bottom, the younger children would not have in fact viewed the discriminative features. Clearly any inferences about age differences in scanning patterns must be carefully qualified in terms of the methods used in presenting the stimuli.

Summarized in Table 2 are the means (M) and standard deviations (SD) of fixations at the focal point (Fcl) and distinctive features (DF) for all stimuli. The data are also classified in terms of the orientation of the focal point, top or bottom. Examination of the age differences, summing over all

Table 2

Means and Standard Deviations of Number of Fixations as a Function of Focal Point and Distinctive Features and Stimulus Orientation

	Young				Old			
	Fcl		DF		Fcl		DF	
	M	SD	M	SD	M	SD	M	SD
FcPU	2.8	2.7	5.2	4.2	3.6	3.3	8.2	7.6
FcPD	4.5	3.4	4.0	3.7	6.4	5.2	3.2	2.3

variables, shows a slightly higher number of fixations for the older, in contrast to, the younger children. This result is in contrast to our earlier results where the younger children had more overall fixations (focal point, distinctive features, plus all other features of stimulus). Specifically, approximately 50% of the younger children's fixations were on other attributes whereas this occurred only 20% of the time among the older children. As noted earlier, the older children are more skilled at knowing where to look than the younger children. The data also shows that both age groups find the focal point more compelling (they fixate on it more often) when it is located at the bottom rather than the top. This effect is somewhat stronger for the older children. Conversely, the

children examined the distinctive features more frequently when they appeared at the bottom of the stimulus. This latter finding is entirely consistent with Ghent-Braine's views though the data do not show that this is a function of scanning in one direction.

Analyses of the data in Table 2 involved one between groups variable (CA) and two within groups variables (orientation and Fcl/DF). The procedures for the analyses are described in Weiner (1962, p. 338). None of the main effects (age, orientation, Fcl vs DF) were statistically significant nor was the Fcl/DF x age interaction. The orientation x age interaction was significant ($F = 4.6$, $df = 1/16$; $p < .05$) as well as the triple interaction age x Fcl/DF x orientation ($F = 4.9$, $df = 1/16$; $p < .05$). The two way interaction is a function of the older, in comparison with the younger children making more fixations when the focal point was up and the younger children making more fixations when the focal point was down rather than up. The triple interaction is primarily a function of the older children fixating more on the distinctive when the focal point was at the top. The interaction of orientation x Fcl/DF was significant ($F = 6.2$, $df = 1/16$; $p < .05$). Inspection of the means indicates a very clear tendency for the children to examine the DF more frequently when the focal point was at the top and to examine the Fcl when the focal point was at the bottom. This interaction is the strongest evidence for our notion that the inverted focal point is a compelling stimulus attribute.

In summary these analyses seem to suggest that older children make somewhat more fixations on the focal point and discriminative features of the stimuli and that they, like the younger children, find the focal point more compelling when it appears at the bottom.

It should be obvious to the reader that the preceding analyses confounded stimuli — the keyhole and triangle. This was purposely done in order to develop a more stable estimate of fixation behavior and because it did not seem possible to adequately define an error term which included three within groups variables. However, inspection of the data indicated that there was an effect attributable to stimuli which is rather interesting. The relevant means are presented in Table 3. The most striking feature in these data is that the effects of stimulus orientation with respect to location of fixations

Table 3

Mean Number of Fixations for Each

Age Group as a Function of Stimulus, Orientation, and Fcl/DF

	Young				Old			
	Keyhole		Triangle		Keyhole		Triangle	
	Fcl	DF	Fcl	DF	Fcl	DF	Fcl	DF
FcPU	3.5	4.8	2.0	5.5	5	8.7	2.3	7.7
FcPD	6.0	2.5	3.0	3.5	9.7	1.3	3.0	5.0

(Fcl or DF) occurs with respect to the keyhole. In other words, it appears that most of the variance accounted for in the significant two- and three-way interactions is a function of the keyhole stimulus. Note that when the focal point is up many more fixations occur for the distinctive features rather than on the focal point. When the focal point is down, however, more of the fixations are made on the focal point. This occurs only for the keyhole. With respect to the triangle, there appears to be little or no orientation

effect. Further, the orientation effect for the keyhole stimulus appears to be stronger for the older children.

The fixation-duration data are summarized in Table 4. These data are the means of each child's mean fixation time summed over all stimulus presentations but only for the focal point and distinctive features. Inspection of the data indicates that the overall average fixation time was 378 milliseconds (msecs) (SD = 312) with the younger children making somewhat shorter fixations (M = 365 msecs) (SD = 320) than the older children (M = 391 msecs) (SD = 305). Further examination of the data suggests that more time was spent per fixation looking at the focal point in the downward position and the distinctive features when the focal point was located at the top of the figure. An ANOVA

Table 4

Means and Standard Deviations of Fixation Durations for each Age Group as a Function of Orientation and Fcl/DF

	Young				Old			
	Fcl		DF		Fcl		DF	
	M	SD	M	SD	M	SD	M	SD
FcPI	.363	.247	.375	.261	.380	.301	.419	.312
FcPD	.392	.271	.330	.291	.408	.315	.359	.285

involving one between groups variable (CA) and two within groups variables (orientation and Fcl vs DF) supports the impression of a significant orientation x Fcl/DF interaction ($F = 5.2$; df 1/16; $p > .05$). The main effects of age, orientation, and Fcl/DF were not statistically significant. The age x Fcl/DF and the age x orientation interactions were slightly short of significance ($F = 3.9$; df 1/16; $p < .10$; $F = 4.2$; df = 1/16; $p < .10$, respectively).

Similarly, the triple interaction age x orientation x Fcl/DF was not significant ($F = 4.1$; $df = 1/16$; $p < .10$).

Finally a comparison was made between fixation durations for the keyhole and triangle stimuli, separately. The data are summarized in Table 5. These data indicate that fixation durations were longer for the keyhole than the triangle and, as was the case for the fixation frequency data, the age interactions are more a function of the keyhole than the triangle stimulus.

Table 5

Mean Fixation Durations for the Keyhole and Triangle Stimuli for Each Age Group as a Function of Orientation and Fcl/DF

	Young					Old			
	Keyhole		Triangle			Keyhole		Triangle	
	Fcl	DF	Fcl	DF		Fcl	DF	Fcl	DF
FcPU	.412	.425	.401	.390		.422	.441	.393	.396
FcPD	.437	.362	.289	.297		.463	.398	.297	.319

Discussion

In terms of the initial narrow focus of this study, the data permit some tentative conclusions. To the degree that the procedures relate to Ghent-Braine's, the data lend some support to her conclusions. Specifically, it is clear that the children found the inverted focal point a rather compelling stimulus, especially for the keyhole. Ghent-Braine does not report data for each stimulus separately, but, on the basis of our data, it may be that her results are primarily a function of the keyhole. Our data do not lend support to her conclusion: "This change (sic: the age difference) appears to be interpreted best as a change in the part used as the starting point for scanning various parts of the figure -- the 'focal' part for 3-year-olds, and the top of the figure for older Ss" (Ghent-Braine, 1965, p. 156). According to our results the younger children in fact do examine the discriminative features and the focal point, albeit they have more fixations on the inverted focal point. One might argue, however, that Ghent-Braine's position is reasonable remembering that her presentation time was very short and therefore her younger Ss went immediately to the focal point.

One of the problems raised by our data, relative to Ghent-Braine's data, is that we failed to find a significant main effect for CA, although there were several interactions involving age. One might have anticipated an age effect because the older children in Ghent-Braine's study performed better on the matching-to-sample task which required attending to the discriminative features. It was the case, in our data, that the older children did attend more to the discriminative features but only when they were at the bottom (focal point was at the top). But the Ghent-Braine effect was found when the focal point was

at the bottom and in that condition our data suggest little difference between age groups in attending to the distinctive features. It would seem, therefore, that her age differences are not a function of a failure to examine the distinctive features (a perceptual function) but rather a function of estimating the correct discriminative feature (a cognitive function).

Before we develop our position further, it will be necessary to integrate our findings with other relevant studies. Certainly with respect to the efficiency of scanning, our data are in agreement with Mackworth and Bruner (1970) and Olson (1970). Our younger children had a smaller percentage of fixations on the potential discriminative features (focal point and the discriminative features) than the older children. Mackworth and Bruner found that children, in contrast with adults, made more fixations on irrelevant details whereas the adults were considerably more likely to quickly and frequently locate their fixations on the high information areas. Similarly, Olson found that his younger children viewed significantly fewer discriminative features than the older children and, consequently, performed less well on the matching-to-sample task. These results are entirely consistent with ours as well as with those recorded by Ghent-Braine. Interestingly, however, were the findings that even though the children may have looked at the critical feature they were more likely to forget what that feature was in the matching-to-sample task and therefore made an error. Olson concluded that the problem in this task then may be in "knowing what to look for". This conclusion is supported by the fact that on repeated trials, after the children knew what to look for, the search patterns of both age groups became more efficient. It would seem then, that these three experimental studies are in general agreement with respect to age differences in search patterns.

Our view of the meanings of the data in this report, as well as the work of Mackworth and Bruner and Olson, is that perceptual processes, as indexed by search patterns (fixations, fixation durations), are a reflection of the cognitive schemas available to the child with respect to the stimulus being presented. Specifically, we are suggesting that children will fixate more often on those attributes of the stimulus that do not readily fit an existing schema; such as, the focal aspect of the keyhole stimulus when in the inverted position. It is impossible from our data to know <u>why</u> the children found this feature of the stimulus compelling, but as suggested earlier the notion of a curved object standing erect may not have readily fit an existing schema among the children of this age. An alternative interpretation, but one inclusive of the former interpretation, is that the children were less familiar with the keyhole stimulus in general, in contrast to the triangle, and were, therefore, less certain of which features were discriminative. The latter interpretation is supported by the fact that the children were less "distracted" by the inverted triangle than by the inverted keyhole whereas logically there would be no reason to suppose that the inverted triangle would be more stable than the inverted keyhole. Thus the explanation for the observed behaviors would seem to rest more on cognitive, as opposed to perceptual, inefficiencies.

One further observation seems relevant here. If our interpretation of the data is correct, then it would seem that the eye movement methodology, despite its technical complexities and time-consuming characteristics, is a worthwhile enterprise. Specifically, it is our contention that the search patterns uncovered in this and other related studies are a reasonably good reflection of the cognitive processes employed by children when engaged, at least, in visual tasks.

The possibilities for using the procedures with children of diverse characteristics should be obvious. For example, the available data, from this and other related studies, <u>suggests</u> that those who view reading problems as a function of "visual-motor dysfunction" may well be over simplifying matters. Their data are based almost entirely on the performance of children on motor-copying tasks, such as the Bender-Gestalt, where it is assumed that poor performance is a perceptual dysfunction. This in fact may not be the case but, rather, may well reflect the child's inability to adequately define the distinctive features of a particular stimulus display. If this were to be the case, and there are no data known to us directly relevant to this question, then one could logically raise questions about the usefulness of training children on a perceptual-motor task as opposed to a more generalizable approach of teaching children a strategy of attending to distinctive features.

References

Ghent-Braine, Lila Age changes in the mode of perceiving geometric forms. Psychonomic Science, 1965, 2, 155-156.

Mackworth, N. and Mackworth, J. Eye fixations recorded on changing visual scenes by the television eye marker. Journal Optometric Society of America, 1958, 48, 439-445.

Mackworth, N. and Thomas, E. Head-mounted eye-marker camera. Journal Optometric Society of America, 1962, 52, 713-716.

Mackworth, N. A stand camera for line-of-sight recording. Perception and Psychophysics, 1967, 2, 119-127.

Mackworth, N. and Bruner, J. How adults and children search and recognize pictures. Human Development, 1970, 13, 149-177.

Olson, D. R. Cognitive Development N. Y.: Academic Press, 1970.

Vurpillot, E. The development of scanning strategies and their relation to visual differentiation. Journal of Experimental Child Psychology, 1968, 6, 632-650.

Weiner, B. J. Statistical Principles in Experimental Design. New York: McGraw-Hill, 1962.