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ABSTRACT

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VISUAL PREFERENCES OF DOWN'S SYNDROME AND NORMAL INFANTS[1]

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The selective visual responses of infants have received extensive investigation during the past twelve years (see reviews by Bond, 1972; Kessen, Haith, and Salapatek, 1970; McCall, 1971). While some visual preferences remain invariant with age, such as for patterned over unpatterned stimuli, others are age-related. For example, Fantz (1958) found that while infants under two months of age favored a horizontal striped pattern, after age two months all infants showed a preference for a bull's eye configuration instead. Other developmental changes in selectivity have been reported (e.g., Brennan, Ames, and Moore, 1966; Carpenter, 1969; Fantz, 1965; Greenberg, 1971; Greenberg and Weizman, 1971; Horowitz and Paden, 1969; Karmel, 1969; Lewis, 1969; Thomas, 1965).

Fantz and Nevis (1967a, 1967b) tested and found support for the hypothesis that the time of appearance of certain visual preferences might be related to rate of development of perceptual-cognitive functioning and perhaps to future intellectual potential. They selected two groups of infants expected to differ in future intelligence and tested them weekly with 18 pairs of visual targets over the first six months of life. They found that infants being raised in an infant home, born to unwed mothers of presumed low-average IQ, developed certain visual preferences several weeks later and showed an overall significant difference from the offspring of university faculty. While the groups differed in postnatal experiences (and perhaps prenatal conditions) as well as in genetic endowment, the very early age of some differential results argued against a purely experiential explanation.

Others have also suggested that there is a relationship between early changes in selective attention and cognitive development (Cohen, in press;

Greenberg, 1971; Jeffrey, 1968; Lewis, 1970, McCall, 1971), with the frequent implication that individual or group differences in attentive responses at certain ages might be of predictive value. As a further test of this idea, the comparison of Down's Syndrome (DS) and normal infants appears to be promising. While it is not certain when the cognitive impairment accompanying DS first appears, there is evidence that by 3 months of age DS infants are retarded in various behaviors intended to assess mental development (Carr, 1970). In the present study, 8-month-old DS and normal infants were compared in the relative amount of looking at one of the two members in each of 13 pairs of stimulus targets. The stimuli were selected primarily from those employed by Fantz and Nevis. In order to reveal any possible relationship between visual preferences and ability to resolve patterning, a gross measure of visual acuity was included. The hypothesis was that both groups would evidence pattern vision capacity but that they would differ in strength or direction of visual preferences.

METHOD

Subjects

The subjects were 20 DS infants (diagnosed by chromosomal count), 9 female and 11 male, mean age 34.4 weeks, SD 2.7 weeks; and 20 normal controls, mean age 31.6 weeks, SD 1.4 weeks. All Ss lived at home. The criteria of selection included absence of oculomotor defect or severe organic disease for DS infants, and for normal infants absence of any known abnormalities or disease and a minimum Developmental Index of 90 in both Mental and Motor scales of the revised Bayley Scales of Infant Development (Bayley, 1969). The mean Developmental Index in the Mental Scale was 101.7 for the normal infants and 48.2 for 18 DS infants tested; the corresponding mean scores in the Motor Scale were 104.8 for the normals and 57.0 for the mongoloid Ss.

Apparatus and Stimuli

Data were collected by means of the visual preference apparatus used by Fantz and Nevis (1967a, 1967b) and Fagan (1970), and similar to that of Miranda (1970). The main component is a portable chamber covering the visual field of the subject and providing a homogeneous background for two stimuli on a slanting surface above and in front of the S. This surface is hinged at the bottom to allow it to be pulled back for changing stimuli, while at the same time another surface below and at right angles to the first comes up to cover the opening and hide E from S. The inside of the chamber was lined with light-diffusing blue felt against which the stimuli stood out distinctly. Observations were made through a ¼-in. peephole located midway between the stimuli.

The stimuli were 13 pairs of visual targets, all mounted on aluminum plaques lined with felt matching that of the testing chamber. Three pairs consisted of a homogeneous 5-in. gray square paired with each of three squares (of same overall reflectance as the gray) of alternating black-and-white stripes of either 1/16, 1/32, or 1/64-inch in width. Of the remaining ten pairs, seven were the same as those pictured in Fantz and Nevis (1967a, 1967b) and Fantz (1970). In three of the latter pairs depth or solidity cues were varied. Specifically, in Pair 4 a board covered with colored patterned plastic and slanting out towards S was presented with a similar board flat against the background; in Pair 6 a three-dimensional head model was paired with a flat outline of the same, both painted white; and lastly, in Pair 15 a solid head model with painted black features was opposed to a nonglossy photograph of the same. In another three pairs the arrangement of pattern elements was varied. Specifically, in Pair 5 25 3/4-in. white squares were arranged either in a checkerboard pattern against the blue-felt background of the plaques or build up in a lattice pattern; in Pair 12 there were nine black face-like features on a white oval, either in the correct facial arrangement or in an irregular and scrambled arrangement; and in Pair 14 an irregular arrangement of 18 3/4-in. black squares on a 4½-in. white background was presented with a regular, lattice arrangement of the same squares. The last pair used from those of Fantz and Nevis (Pair 8) consisted of a schematic face (same as in Pair 12) paired with a non-glossy achromatic photograph of a woman's face. The latter pair, labeled as a difference in "brightness-contrast," also differed in other ways such as number and sublety of pattern details and depth cues. Figure 1 is a photograph of the three remaining patterned pairs of this study, not illustrated previously. In each of these Circular-Linear Pairs, ½-in. wide horizontal bars were paired with concentric circular forms, varying in continuity of the curved elements over the three pairs, and consequently in number of elements and angles. The length of the contour was roughly equal in the 2 members of each of these three pairs; the black-white ratio was equated in Pair C-L1 and was closely similar in the other two pairs.

Procedure

The initial two minutes of a testing session were used for another experiment (Miranda, 1970a) involving a 60-sec. familiarization exposure to one of six stimulus patterns unlike any of the present stimuli and four subsequent 10-sec. exposures of this pattern with novel patterns. This was immediately followed by the present experiment. All Ss were tested at home, at the beginning of a waking period when possible, or at least in an apparently alert and contented state. The 13 pairs of stimulus targets were administered twice to all Ss, on consecutive testing days for all except 4 DS infants given the second test 2 or 3 days later. All infants were held by an assistant approximately 12 inches from the center peephole. Most of them were in a canvas infant seat with a partially-restricting head holder. A few normal infants refused to stay in the seat and sat directly on the assistant's lap.

Each pair of stimuli was presented for two consecutive 10-sec. exposures, with right-left positions reversed for the second exposure. The stimuli were presented in the same sequence each day, but on the second day the initial positions were reversed. The same sequence was used for all Ss to reduce variability, since the critical comparison was between groups rather than among the pairs of targets.

Fixations -- operationally defined as the superposition of the center of the pupil of either eye with the corneal reflection of one of the stimuli -- were recorded by finger switches activating markers on a Rustrak event recorder. Interobserver agreement for this response has been high for both older infants (Fagan, in press; Saayman, Ames, and Moffett, 1964; Brennan, Ames, and Moore, 1966) and neonates (Miranda, 1970b). Due to the consistently high visibility of the irises that is characteristic of DS infants, plus their low activity level and low distractibility, they were at least as easy Ss from which to record unambiguous responses as the normal sample. A triangular multicolored target on the bottom of the stage, unlike any employed in the study, tended to attract the infant's view to the center during the approximately 10-sec. periods while the stimuli were being changed or reversed. The exposure timer was started upon fixation of one or the other stimulus.

RESULTS

The basic data were the cumulated response times to each target over the 20 seconds that the target had been exposed on each day (responses of less than 2 seconds out of the 20 seconds of exposure were discarded, affecting less than 5% of the data from each sample). These basic data were analyzed in two ways. First, the total response time during the 40 seconds of exposure on the two sessions was totalled for each pair of stimuli to compare the response level between groups and stimulus pairs. Second, the percentage of the total response time for a pair that was directed to one of the two targets was determined on each day separately and averaged for the two days, to compare the groups and the stimulus pairs in degree and direction of selective attention. The second analysis, of most importance, is presented first.

Differential Fixation Within Pairs

The percentages for one member of each pair were entered into a 2 (groups) by 13 (pairs of stimuli) analysis of variance. The degree of differential fixation varied reliably between normal and DS infants, F (1, 38) = 9.25, $p < .005$; over stimulus pairs, F (12, 456) = 14.98, $p < .001$; and in the interaction of groups x stimulus pairs, F (12, 456) = 5.38, $p < .001$. The meaning of these findings is elucidated in Table 1, giving the mean percent fixation time for one pattern of each pair by each group, the probability (two-tailed t test) of this being a chance result (50%), and in the last column, the probability (two-tailed t test) of no difference between the mean group percentages for each target.

The DS group showed a preference in only three pairings -- two striped over gray pairs and one solid over flat pair -- while the normal group failed to show a significant differential for only two pairings -- both in the element arrangement category. Also, the degree of direction of differential differed considerably among the pairs of targets in both groups (stimuli pairs effect) and between groups (pairs by groups interaction). The between-group comparisons, most directly pertinent for the present purpose, show no reliable difference for the three acuity pairings or the three pattern arrangement pairings. Significantly higher differentials were shown by the normal Ss for two of the three solid over flat pairings, even though the DS group also favored the solid object in each case. Each of the three circular-linear pairings brought out a strong bull's eye preference by the normal group, a chance response by

DS infants, and a reliable group difference. A final significant group difference was shown with the brightness-contrast pairing as a resultant of a preference in normal Ss for the photograph and a favoring of the black-and-white pattern for DS infants. In short, group differences were most marked in the tendency of normal but not DS infants to look selectively at circular rather than linear patterns and at stimuli rich in detail, shading, and other variables indicative of solidity and subtle patterning.

Total Fixation Among Pairs

Since the stimulus pairs were always shown in the same sequence and for the same length of time, it was possible to test for group differences in total level of responding. This level appeared to be unrelated to the position in the sequence. For example, pairs shown in 1st, 2nd, 12th, and 13th ordinal positions ranked in length of response 10th, 4th, 8th, and 9th, respectively, for the DS Ss and 7th, 4th, 3rd, and 9th for normal Ss.

Another 2 x 13 analysis of variance brought out significant effects both for groups, $F\ (1, 38) = 10.51$, $p < .005$, indicating that the DS group looked longer than the normal Ss overall; from stimulus pairs, $F\ (12, 456) = 34.45$, $p < .001$, showing that certain stimulus pairs commanded greater attention from both samples; and from a groups x stimuli interaction, $F\ (12, 456) = 5.31$, $p < .001$. These results were further specified by two-tailed t tests between the groups' average seconds of response to each stimulus pair (the latter given in Table 2 along with the probability of no group difference). The DS sample looked significantly longer than the normal Ss at 6 of the 13 pairs, while the normal group responded at a significantly higher level in only one case -- a solidity pairing. The level of responding seemed to be unrelated to differential fixations within pairs for each group as well as between groups.

Thus, of the 6 stimulus pairs in which normals showed a significantly higher response differential than the DS, the DS infants showed a higher total response than the normal for pairs C-L1, C-L2, and C-L3, and less for only Pair 6.

Compairing responsiveness among the stimulus pairs, both normal and DS infants were attracted least by the acuity pairings. Among the remaining pairs two comparisons are of particular interest. First, while both groups were overall more attentive to the three stimulus pairs containing solid objects than to the seven pairs of flat patterns (t = 9.64, $p < .001$ for normal Ss and t = 2.23, $p < .05$ for DS Ss) the solid-flat differential was significantly larger in the normal infants (t = 4.91, $p < .001$). The second comparison was for Pairs 8 and 12, containing face-like two-dimensional patterns, versus the remaining 5 pairs of two-dimensional abstract patterns. Again, even though both groups showed a significant (t = 8.24, $p < .001$ for normals and t = 2.67, $p < .05$ for DS) differential favoring the face-like patterns, the differential was higher (t = 3.06, $p < .01$) for the normal sample.

DISCUSSION

The results indicate a difference between eight-month DS and normal infants in selective visual attention. Even though the mongoloid infants gave longer attention to the stimulus patterns overall, probably due to less manual and body activity and less attention to extraneous parts of the situation, the normal infants showed more differential fixation. Among the pairs of stimuli, normal infants showed relatively more attention than DS infants to those containing solid objects than those with only two-dimensional patterns, and to those containing face-like patterns than those with only abstract patterns. Both results are suggestive of greater responsiveness to stimuli of behavioral significance by normals, presumably due to the greater effectiveness of early visual experiences in facilitating their perceptual-cognitive development.

Group differences in relative fixation of one of the two members of a stimulus pair, the measure for which the experiment was designed, were more definitive. The largest and most consistent difference was the preference for circular over linear configurations by normal infants, compared to chance responses by DS infants. This included three such pairings differing in continuity of the circular contours and consequently differing in whether the circular or linear form was more "complex" (as defined by number of elements and angles, with contour length approximately equated). A second type of stimulus variation eliciting group differences was solid vs. flat stimuli. A solidity preference was present for each of the three pairings by the normal group, as in previous results showing the same solidity preferences at least by six months of age (Fantz and Nevis, 1967b) while for the DS infants a significant differential was present in only one case. This suggests that early visual experiences are more effective in normal than DS infants for developing this adaptive response. A third group difference was in the pairing labeled "brightness-contrast," resulting from the selection of the face photograph by normals and a tendency for the selection by DS infants of the black-and-white schematic face -- the pattern preferred by much younger normal Ss (Fantz and Nevis, 1967a). The lack of group differences for the three pairs differing in arrangement of the same pattern elements is no doubt explained by lack of substantial differential responses by either group. Other results (Fantz, 1970) agree in showing decreased attention after six months of age to similar variations in pattern arrangement that had at earlier ages brought out clearcut preferences with normal infants.

Goldiamond (1959) has suggested that the results of many comparisons of performance on perceptual-cognitive tasks between normal and mentally-retarded subjects have been clouded by differences in sensory capacities. Acuity measurements provided relevant information in the present experiment. The results from both groups showed greater attention to the striped targets than to the patch of gray of equal reflectance, indicating that DS infants can see and have a predilection for patterned surfaces, as is true in normal infants of various ages. The measurements obtained are only rough estimates of thresholds and so should be interpreted with caution. The lack of intergroup difference in response differential to the three sizes of stripes included does not necessarily imply equal acuity. The fact that the normal sample showed a reliable preference for the 1/64-in. stripes, but the DS did not, suggests that this pattern may have approached the minimum-separable threshold for Down's Syndrome infants but not for normals. Therefore the possibility that a small group difference in resolving capacity would have been evidenced by using more finely graded pattern sizes must be considered in the interpretation of the group differences with other stimulus variations. This conservative interpretation is also necessary in view of results from DS children indicating inferior visual capacities (cf. Eissler and Longenecker, 1962; Gardiner, 1967).

Among the group differences in relative fixation of the two stimuli, Pairs 4 and 6 (solidity) and 8 (brightness-contrast) include stimulus variations that could involve visual acuity or other peripheral visual functions such as accommodation, convergence, stereoscopic vision, movement parallax, and discrimination of texture and brightness gradients. But it is difficult to attribute the most marked group differences, relative to circular vs. linear patterns, to such visual capacities for several reasons. The width of line was the same for all of these patterns (¼-in.) and much wider than that of the narrowest stripes (1/32-in.) differentiated by the DS sample in the acuity pairings. Other visual abilities that might be involved in depth or "complexity" discriminations were not required here. And yet the group difference for each of the three pairings was larger than that for any depth or acuity pairing. In the Fantz and Nevis study (1967a, 1967b), the age of appearance of a similar circular over linear preference elicited the most marked difference between selected samples of infants expected to differ in later intellectual achievement but not in visual capacity.

That mongoloid infants should be found to perform differently from normal infants at eight months of age is hardly startling since these infants are distinguishable at birth, usually by clinical signs and certainly by chromosomal count, and since the present DS subjects were found to be retarded on the Bayley Developmental Scales. Instead, our findings have their significance first, in showing the value of the visual preference method for studying experimentally the early stages of the developmental process leading to mental retardation in DS and other high-risk populations; and second, in supporting the hypothesis of a relationship between the development of visual preferences and perceptual-cognitive functioning.

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FOOTNOTE

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TABLE 1

Samples' Percent Fixation Times of one Target (underlined) in each Stimulus Pair and Probabilities (two-tailed t test) of no difference from chance

Stimulus Variation	Pair No.	Targets	Down's Syndrome %	Down's Syndrome P	Normal %	Normal P	DS-Normal Comparison P
Patterned over Plain	Ac.1	1/16-in. stripes - Gray	80.8	.001	74.6	.001	n.s.
	Ac.2	1/32-in. stripes - Gray	67.9	.02	70.6	.001	n.s.
	Ac.3	1/64-in. stripes - Gray	55.6	n.s.	60.0	.05	n.s.
Solid over Flat	4	Slanting board - vertical board	58.9	n.s.	74.0	.001	.05
	6	Solid white head model - flat outline	66.3	.001	78.4	.001	.05
	15	Solid featured head model - photo	53.4	n.s.	61.8	.001	n.s.
Circular over Linear	C-L 1	circular pattern - linear pattern	51.8	n.s.	73.9	.001	.001
	C-L 2	circular pattern - linear pattern	46.3	n.s.	69.9	.001	.01
	C-L 3	circular pattern - linear pattern	56.1	n.s.	74.6	.001	.001
Element Arrangement	5	Checkerboard - Lattice	51.8	n.s.	49.8	n.s.	n.s.
	12	Schematic face - Scrambled face	55.5	n.s.	55.6	.05	n.s.
	14	Lattice - Irregular	50.3	n.s.	55.4	n.s.	n.s.
Brightness-contrast, etc.	8	Face photograph - Schematic face	44.2	n.s.	59.0	.01	.01

TABLE 2

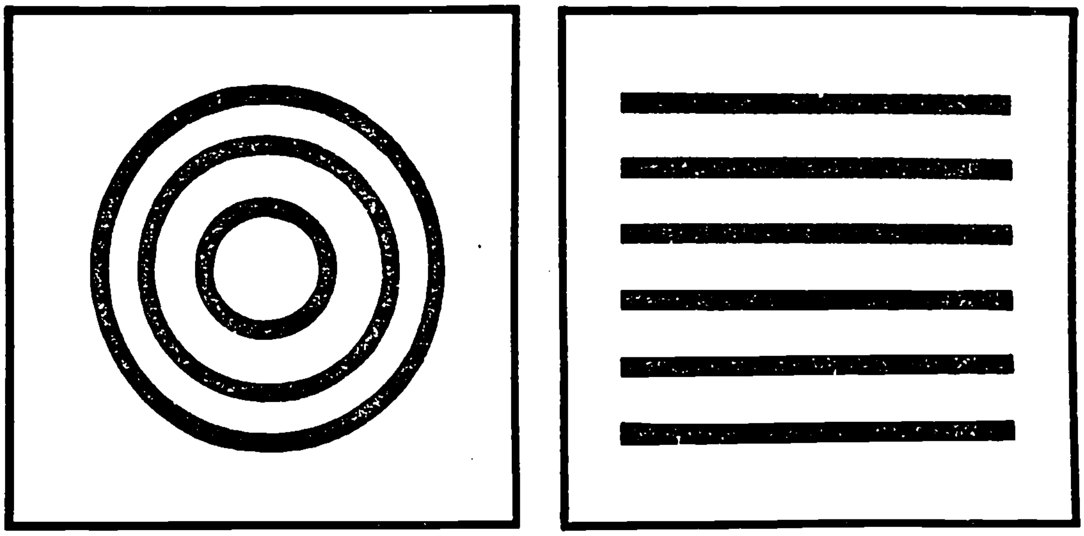
Samples' Average Fixation Time
(in seconds) of each Stimulus Pair
and Probabilities of Chance Differences

Stimulus Variation	Pair	Down's Syndrome	Normal	P
Pattern over Plain (Acuity)	Ac.1	10.6	7.3	.001
	Ac.2	8.0	5.9	n.s.
	Ac.3	7.1	6.9	n.s.
Solid over Flat	4	13.6	12.2	n.s.
	6	12.2	14.8	.05
	15	15.6	15.9	n.s.
Circular over Linear	C-L 1	12.6	9.7	.02
	C-L 2	13.4	8.4	.001
	C-L 3	12.6	7.0	.001
Element Arrangement	5	9.8	7.3	.05
	12	12.8	11.4	n.s.
	14	10.7	7.9	.02
Brightness-contrast, etc.	8	14.9	14.9	n.s.

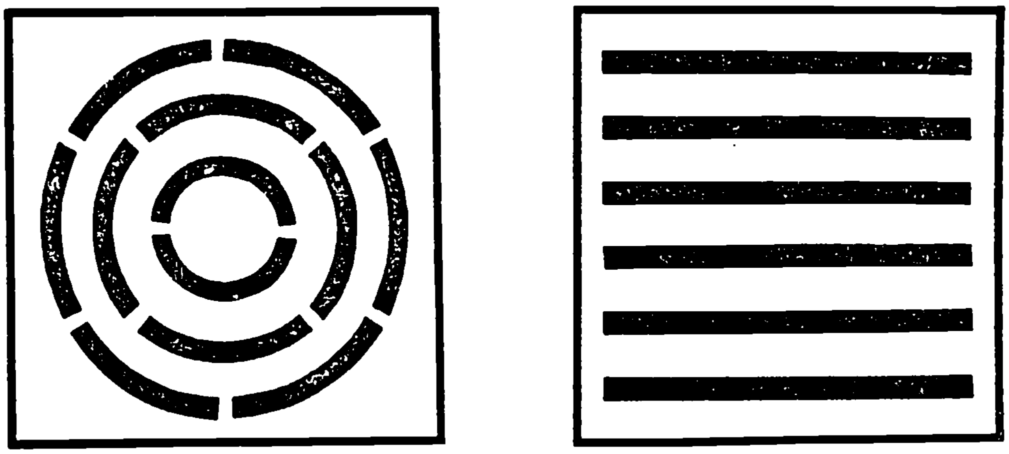
FIGURE LEGEND

1. The three Circular-Linear Pairs. Each pattern on its white squared card was shown against a uniform blue felt background.

PAIR C-L 1



PAIR C-L 2



PAIR C-L 3