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Pioneering research has shown that infants are capable of perceptual discrimination and has provided some indication of the nature of the discrimination; that is, what stimuli are differentiable. Studies have demonstrated that significant effects exist, in stimulus-pair comparisons, for age of infant, speed of movement of stimulus during perception, and for the age-speed interaction. The stimulus involved was checkerboard designs. It has been discovered that the looking pattern of infants varies with age: The younger infant takes fewer but longer looks, while the older infant takes more but shorter looks. It has also been found that younger infants are more likely, when finally shifting their gaze, to shift it back to the first stimulus. This factor cuts into the reliability of using pair-comparisons for measuring infant stimulus preference, especially because trial times are often brief (about 30 seconds). It is possible to measure preference by just presenting one stimulus and recording fixation time. It was discovered that 10-week-old children looked at the most complex of three checkerboard stimuli the most and the least complex stimulus the least. This was also found true of 20-week-old children. Eight-week-old children preferred the medium complexity stimulus. A hypothesis now under investigation is that younger than 8-week-old children will look at the least complex stimulus the most. (WD)

METHODOLOGICAL ISSUES IN THE STUDY OF AGE DIFFERENCES IN INFANTS' ATTENTION TO STIMULI VARYING IN MOVEMENT AND COMPLEXITY [1]

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The pioneering studies in an area often show merely that differences exist. Whenever this is done in a new area, a major contribution is made -- and by this token the rest of us will be forever indebted to Staples, Berlyne and Fantz. But the pioneering phase soon gives way to the more painstaking, and often more exasperating task of tracking down what the differences mean. So, in the case of infants' visual fixation responses, some of the most stimulating data were those of Fantz, showing that infants looked more at faces than at plain-colored circles, more at checkerboards than at plain squares by the age of two months, and more at stripes than at a bullseye at less than two months, but the reverse at later ages. These facts showed us some possible dimensions to which infants might be responding; they showed us the possibilities of age differences; and, above all, they gave us a method long-needed.

But now, firmly established in the second phase, we face a lot of just plain hard work in order to get anywhere near to understanding the full significance of the original exciting results. In our own work we have been interested in age differences in response to various dimensions of stimuli-specifically, to movement, complexity and novelty. Needless to say, our work on these dimensions has not been without headaches. But before discussing the pathology of the situation, let us illustrate that one can sometimes obtain nice neat orderly data. At McMaster, Mrs. Carole Silfen has been working on infants' visual responses to moving stimuli. The infants, voluntarily brought by their parents to the laboratory, were placed in a "baby box" in which they lay on their backs looking up at the box ceiling. A 1/4" peephole was

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centered in the chamber ceiling 18" above the infant's head. Centered 18" to the right and left of the peephole were two belts which could be individually moved at different speeds. The belts were made of white sailcloth, painted with black and white checkerboard designs composed of 1 1/2 inch squares. Each belt presented a flat viewing area of 9" x 12" to the infant. The belts ran on rubber rollers attached to the chamber ceiling and were driven by two Lafayette variable speed motors. Speed was controlled by dial regulators adjusted manually. Two hooden hinged covers kept the upper view of the belts hidden from the experimenter.

When the S looked directly up at the peephole, a window blind which had been obscuring the stimuli was slowly released, exposing them to view. At this moment, an assistant started a stopwatch and the recording equipment for a 30 second trial. The experimenter, looking through the peephole, recorded the amount of time that each stimulus belt was fixated, by pressing a button that corresponded to that stimulus. The two buttons, attached to the top of the chamber, independently activated two channels of a Rustrak event recorder.

A modified method of limits was used in the stimulus presentations. During each 30 second trial one stimulus remained stationary while the other moved from top to bottom of the visual field. Table I shows the order of presentation of the speeds used.

Five age-groups -- 7 weeks, 11 weeks, 16 weeks, 20 weeks and 24 weeks -- were run at different times. The total N was 56, with from 9 to 13 babies in each group.

An additional group of 11 16-week old babies was used as a control group to test for the possible effects of motor noise or vibration on the infant's looking time. In the control trials, both stimulus belts were shielded from the subject's view by stationary checkerboards were identical to the patterns presented by non-moving belts. Otherwise, the apparatus and procedure were identical to those in regular experimental trials. The subject could not see the stimulus move, but he c could hear any noise and feel any vibration its movement made.

The results for all ages and for the control group are shown in Figure I. The vertical axis in the figure represents the percent of total looking time which was spent looking at the moving stimulus, regardless of the side on which it was presented. The horizontal axis shows the speed of movement in inches per second.

The results of the control trials reveal no significant effects of noise or vibration upon the infants' looking time.

Analysis of variance comparing all groups shows significant effects of age ($p < .001$), speed ($p < .001$) and an age x speed interaction (p .025). A linear trend analysis of the age x speed interaction term shows that there are significant differences among the slopes of the different age groups in Figure 1 (p .005). The variance in each individual age group is attributable to a significant linear trend, and the slopes of the best-fitting straight lines increase with age between 7 and 16 weeks. The decline of slope at later ages seems attributable to the fact that older groups hit high levels of preference for the moving stimulus at low speeds, and after that level off.

Although our analysis shows that discrimination of movement is present and increases with age, the question of whether or not we are actually measuring absolute thresholds of movement by this method is, of course, open to question. The question could be more satisfactorial answered by extending the present method up the age scale until it could be compared with the results obtained by a different method - e.g., the learning method used by Carpenter and Carpenter. However, it is fair to say that at present there is nothing to indicate that what we have are <u>not</u> threshold measurements. We have an orderly increase with age in the expected direction. If we use the conventional 75% level as a measure of threshold, the results are satisfactory. The older the baby, the slower the stimulus is moving at the time he first shows a 75% preference for it.

Table 2 shows another way of analyzing the data. Using a Sign test, we can test the number of babies who look at the moving more than at the non-moving stimulus at each speed, and show that the 24 week-old group shows preference for movement at the slowest speed, the 16 and 20-week olds show significant preference first at the next-to-slowest speed, the 11-week-olds first at the 3rd slowest speed, while the

7-week olds, wven at the fastest speed used, reach only the .07 level of significance using a one-tailed sign test.

Mrs. Silfen is now going on to investigate the role of the complexity of the moving stimuli, by changing the size of the squares in the checkerboards used.

Let me digress for a discussion of the virtues of the checkerboard as a stimulus for this type of research. One problem that haunts anyone trying to work on a dimension like stimulus complexity is the problem of definition. Information theory has not turned out to be very helpful, if one can judge from the work of Attneave on adults. However, there is the interesting problem of whether one has the right to assume that adults' judgments correspond to the complexity judgments babies would make if they could. Several research workers have suggested the use of stimuli scaled for psychological complexity, in view of the fact that physical definitions have often worked out unsatisfactorial in adult research. And Thomas, in an article in press in Child Development, used adult judgments to scale the visual stimuli shown to infants - a human figure, a face, a checkerboard and stripes. But we remain unconvinced, having had our fingers burnt once in this regard. Miss Adrienne Moffett, in an unpublished M.A. thesis at McMaster, had adult subjects judge the complexity of the set of 6 stimuli she had shown to 3-month-old infants. The stimuli were composed of black lines on a white background, arranged so as to divide an outline square into different numbers of rectangular parts. There was significant agreement among infants (based on their looking times); there was significant agreement among adults in their judgments; but the order of complexity judged by adults did not correspond to whatever dimension it was that the babies were responding to. At the least, one can say that the value of using adult judgments to specify stimulus dimensions has not yet been used widely enough to prove its usefulness.

And that's why we like checkerboards. Not only have checkerboards been used widely in infant fixation studies, but they allow the easy control of keeping black and white areas equal while breaking the total area into more and more parts. In addition, definitions of complexity in terms of number of turns, number of parts or amount of contour do not contradict each other. Finally, adult judgments of complexity are very clear, and agree with these physical difinitions in calling most complex that checkerboard with the largest number of squares in it. For these reasons, we have found it most satisfactory in our work on movement and in our work on complexity to use checkerboards as stimuli.

However, choice of a stimulus and stimulus dimensions are not the only problems facing the experimenter. Basic to all studies involving age differences is the problem of finding response measures and experimental procedures which offer a fair comparison among the different age groups.

We have been intrigued but disturbed to find that there are different patterns of looking used by subjects of different ages. In our hunt for the most useful measures of visual preference, we have ended up agreeing with other researchers that either total time or the percent of looking time spent looking at one stimulus is the best measure, depending on the stimulus presentation procedure used. But we have also found, unfortunately for the purposes of age comparisons, that the total time is arrived at by different paterns of looking in older vs. younger babies. The younger baby takes fewer but longer looks, whereas the older baby takes more but shorter looks. Table 3 illustrates this for two different studies, done at different places by different experimenters and involving different stimuli. The result of the two are remarkable congruent. In each case, with increased age the number of separate looks increases while the aveage span of looking decreases. The total looking time. being the product of these two opposing measures, appears a bit more stable over the age range than either of them are individually, but it generally declines with age.

In addition, while babies older than 7 weeks show about a 50-50 split between looking back at the same stimulus they've just looked at during a trial and looking at the other one, the 7-weeks baby is much more likely to look back at the one he just looked at. Table 4 shows the results of two different movement studies, the first of which is the study that was reported earlier in this paper, and the second of which is a previous study using a much smaller range of speeds. The data presented are the mean proportion of switches from looking at one stimulus to looking at the other within the same trial.

The younger infant, then, is more likely to hold his fixation on one stimulus for a long time, and, when he does shift his gaze, shift it back to the same stimulus. It appears to us that while the older infant may be capturing stimuli with his visual behavior, the younger infant is being captured by the stimuli.

Finally, it appears to be quite unlikely that within a 30-second trial the 7-8 week old infant is going to look at both of the stimuli in a pair. Table 5 presents data, again from two different experiments, on the percentage of trials in which the subject looked at both stimuli in a pair. Although the absolute level is different in the two different studies, the pattern is clear. 7-8 week olds are much less likely than are older babies to look at both stimuli. Even in the movement study, they looked at both only 49% of the time, and for non-moving patterns of cross-hatched black lines on a white background they looked at both only 17% of the time.

These results cause us some worry. We have been convinced by Kessen and Hershenson's argument that pair comparisons is the design to use to demonstrate transitivity and thereby establish the dimension to which infants are responding. But on very practical grounds we worry about the results of a "pair comparisons" study in which both members of a pair are not looked at. Certainly one would not feel too secure witha pair comparisons study in which the adult subject said after having perceived the first member of a pair "No, thanks, I won't bother with the second one, but this one is worth 7". It's a legitmate method, but it's not pair comparisons. And different age groups are making use of this alternate method to different degrees. For this reason it seems questionable to compare their results.

We have found that it is possible to get around this problem in infants 10 weeks or older by repeating the trials until the subject does make a comparison within a 30-second trial. However, with subjects younger than this, the number of re-runs needed becomes impossibly cumbersome, considering the limited patience of the young infant. For this reason, the remaining results we have to present are based on a single stimulus procedure. We agree that conceptually it's not as good as pair comparisons, but we also know that different age groups of subjects carry out a true pair comparisons procedure to different extents. Rather than have what amounts to older subjects run under pair comparisons compared to younger subjects run under single stimuli, we prefer to run all of them under a common method they can do -- single stimuli. We are willing to admit that perhaps after investigation, our "problem" will turn out to have been a pseudo-problem. Operationally, we are treating all infants equally. Sould be worry that their looking patterns change with age? Perhaps the infant does not need to look directly at both stimuli to be making a choice between them. However, for the present, rather than to assume that choice of method won't make any difference in the results obtained, we intend to compare results obtained by pair comparisons to results obtained by other methods wherever possible.

Now to our own work on complexity. There are only a few infant studies that have specifically varied the complexity dimension of stimuli (Berlyne, Moffatt, Thomas, Spears). In spite of the fact that these studies are not directly comparable to one another because of the different ages and stimuli used, they generally agree in finding some evidence for the hypothsis that more complex stimuli are preferred over less complex stimuli. It is not, then, unreasonable to find that this hypothesis has often been used as a post hoc explanation for results in other studies - e.g., several experimenters, finding their infant subjects to show a strong preference for a face stimulus have noted that this does not necessarily indicate the subjects' recognition of face qua face, but may merely reflect the fact that the face is a fairly complex stimulus, and infants are known to prefer complex to simple stimuli.

However, the facts of the matter on complexity appear to be somewhat more complicated. Last year Hershenson reported that a group of newborns preferred the least complex of a set of 3 checkerboard stimuli. Hershenson's subjects preferred the least complex (2 x 2) black and white checkerboard to the intermediate (4 x 4) and the intermediate to the most complex (12 x 12), although only the difference between the least and most complex was significant.

Since we were already in the process of investigating age differences in response to complexity, it seemed significant to us that Hershenson's subjects were newborns. We decided to try to repeat Hershenson's study on an older group to see what we would get. At U.B.C. Mrs. Wendy Brennan presented Hershenson's 3 checkerboards to 8 10-week old subjects in a single stimulus procedure. Each of the 3 stimuli was presented to the infant for 4 30-second trials in random order, and his looking times were recorded.

The results are shown in Table 6. It can be seen that 10-week old subjects looked at the most complex significantly more than at the intermediate and at the intermediate more than at the least complex stimulus. In fact, each individual subject's results were in this same order. In marked contrast to these results are those of Hershenson's newborns, who preferred the least complex to the most complex. We felt, from the results of this study, that we were on the track of age differences in preference for complexity.

But there were the differences in subject population, experimenters, and stimulus presentation procedure--Hershenson had used a pair comparisons procedure. We realized that we must have firmer demonstrations to prove our point. We therefore started a new study, in which the goal was to find 3 different age groups such that the youngest would prefer the simplest of 3 checkerboards, the "middle-aged" group would prefer the stimulus of intermediate complexity, and the oldest group would clearly prefer the most complex stimulus. Right now we are 2/3 of the way through this study,

So far we have run a group of ten 20-week olds and a group of seven 8-week olds on a set of three checkerboard stimuli that extend over a wider range of complexity than the ones used by Hershenson. The new stimuli were three 6-inch square black and white checkerboards, the least complex containing 2 x 2 squares, the intermediate 8 x 8 and the most complex 24 x 24 squares. Each stimulus was presented for four 30-second trials arranged in random order. The length of time the infant looked at the stimulus was recorded for each trial.

The results for these two age groups are shown in Figure 2. It can be seen that the 20-week olds looked at the most complex stimulus most, next at the intermediate, and least at the least complex. Each individual subject ordered the stimuli in the same way and an analysis of variance is significant at the .01 level by a Newman-Keuls test.

The results of the 8-week olds are different. As expected, the stimulus they looked at most was less complex than that looked at most by the older subjects. Each of the seven subjects looked most at the intermediate stimulus. Analysis of variance is significant, and all differences among pairs of stimuli are significant at the .01 level by a Newman-Keuls test.

To make sure that our 8-week-old subjects were having no trouble seeing the tiny 1/4" squares in the most complex checkerboard, we also included in their stimuli a plain gray square of the same overall reflectance as the half-black - half-white checkerboards. As can be seen, the gray stimulus elicits very little attention from 8-week olds, and we are certain that they are able to discriminate even the most complex checkerboard.

We should note that the idea that preference for complexity increasing with age is far from being an original idea. Those interested in this area should look at the work of Berlyne, and of Dember and Earl, where age differences are implied if not actually stated. In addition, Thomas's study had much the same hypothesis, and his general results are congruent with ours. However, as he himself notes, his use of stimuli that vary on several different dimensions simultaneously makes the exact meaning of his results open to question.

We are still running our youngest group of subjects, so the final results are not in. However, we feel that we already have a good start on our hypothesis that the level of preferred complexity increases with age. If this is actually so, it seems that *post hoc* explanation of experimental results of infants' visual fixation studies by reference to the complexity of the stimuli used is suspect. According to the ranges of complexity and age used, one can probably legitimately reach *any* conclusion from "Infants prefer less complex stimuli" to "Infants prefer more complex stimuli".

BIBLIOGRAPHY

Attneave, F. Physical dterminants of the judged complexity of shapes. J. exp. Psychol., 1957, 53, 221-227.

Berlyne, D.E. The influence of the albedo and complexity of stimuli on visual fixation in the human infant. Brit. J. Psychol., 1958, 49, 315-318.

Carpenter, B. and Carpenter, J.T. The perception of movement by young chimpanzees and human children. J. comp. physiol. Psychol., 1958, 51, 782-784.

Dember, W.N. and Earl, R. Analysis of exploratory, manipulatory, and curiosity behaviors. Psychol. Rev., 1957, 64, 91-96.

Fantz, R.L. Pattern vision in young infants. Psychol. Rec., 1958, 8, 43-47.

Hershenson, M. Visual discrimination in the human newborn. J. comp. physiol. Psychol., 1964, 58, 270-276.

Kessen, W. and Hershenson, M. Ocular orientation in the human newborn infant. Paper presented at A.P.A. symposium on Studies of attention in infants, August, 1963.

Moffett, Adrienne M. Stimulus complexity as a determinant of visual attention in infants. Unpublished M.A. thesis, McMaster University, 1963.

Spears, W.C. Assessment of visual preference and discrimination in the four-month old infant. J. comp. physiol. Psychol., 1964, 57, 381-386,

Staples, Ruth. The responses of infants to color. J. exp. Psychol., 1932, 15, 119-141.

Thomas, H. An experimental study of infant visual fixation responses, Child Developm., 1965 (in press).

TABLE 1

STIMULUS PRESENTATION ORDER

MOVEMENT STUDY

	Left stimulus	Right Stimulus
Trials 1, 18	2.5 in./sec. (6°59')	Stationary
2, 17	1.9 in./sec. (5°22')	Stationary
3, 16	1.1 in./sec. (3°3")	Stationary
4, 15	.4 in./sec. (1°12')	Stationary
5, 14	Stationary	Stationary
6, 13	Stationary	.4 in./sec
7, 12	Stationary	1.1 in./sec.
8, 11	Stationary	11.9 in./sec.
9, 10	Stationary	2.5 in./sec

TABLE 2

MOVEMENT STUDY

NUMBER OF Ss PREFERRING MOVEMENT/STATIONARY

Age	N	Speed of movement (in./sec.)			
		.4	1.1	1.9	2.5
7 weeks	12	5/7	8/4	8/4	9/3
11 weeks	11	8/3	9/2	11/0***	11/0***
16 weeks	13	10/3	12/1**	13/0***	13/0***
20 weeks	11	7/4	11/0***	11/0***	11/0***
24 weeks	9	8/1*	9/0**	8/1*	9/0**

* = .05)
** = .005(Sign test (2-tailed)
*** = .001)

TABLE 3

PATTERNS OF LOOKING

Movement Study

	# Looks	xx Average Span	= Total looking time
7 weeks	70.2	3.5	245.7
16 weeks	83.4	2.9	241.9
24 weeks	105.2	1.5	157.8

Stationary patterns

	#Looks	x Average Span	= Total looking time
8 weeks	31.7	2.8	87.8
16 weeks	51.3	1.35	69.3
24 weeks	53.5	1.25	66.9

TABLE 4

MEAN PROPORTION OF SWITCHES

(Switches / Switches + Non-switches)

	Movement Study 1	Movement Study 2
7 weeks	.33	.27
11 weeks	.55	
16 weeks	.51	.53
20 weeks	.44	
24 weeks	.49	.50

TABLE 5

PERCENTAGE OF TRIALS
ON WHICH BOTH STIMULI WERE FIXATED

	MOVEMENT	STATIONARY PATTERNS
7 - 8 weeks	49% (7 weeks)	17% (8 weeks)
16 weeks	78%	60%
24 weeks	76%	63%

TABLE 6

COMPLEXITY STUDY I
(10-WEEK-OLD SUBJECTS)

STIMULI	MEAN LOOKING TIME IN SECONDS
Least complex (2 x 2)	34.9
Intermediate (4 x 4)	64.4
Most complex (12 x 12)	90.1

Analysis of variance $p < .001$

Newman-Keuls: all differences $p < .01$

FIGURE I

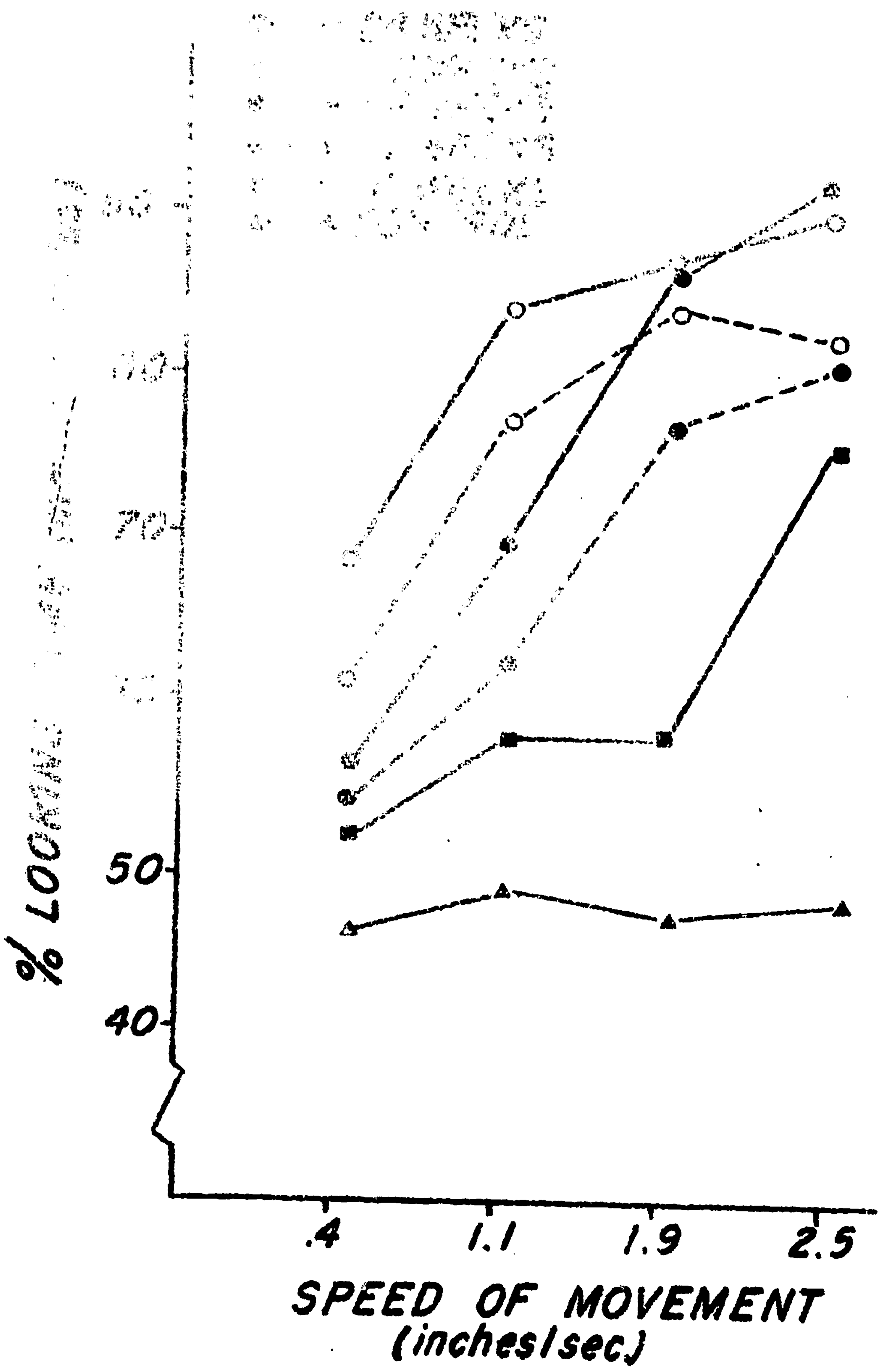
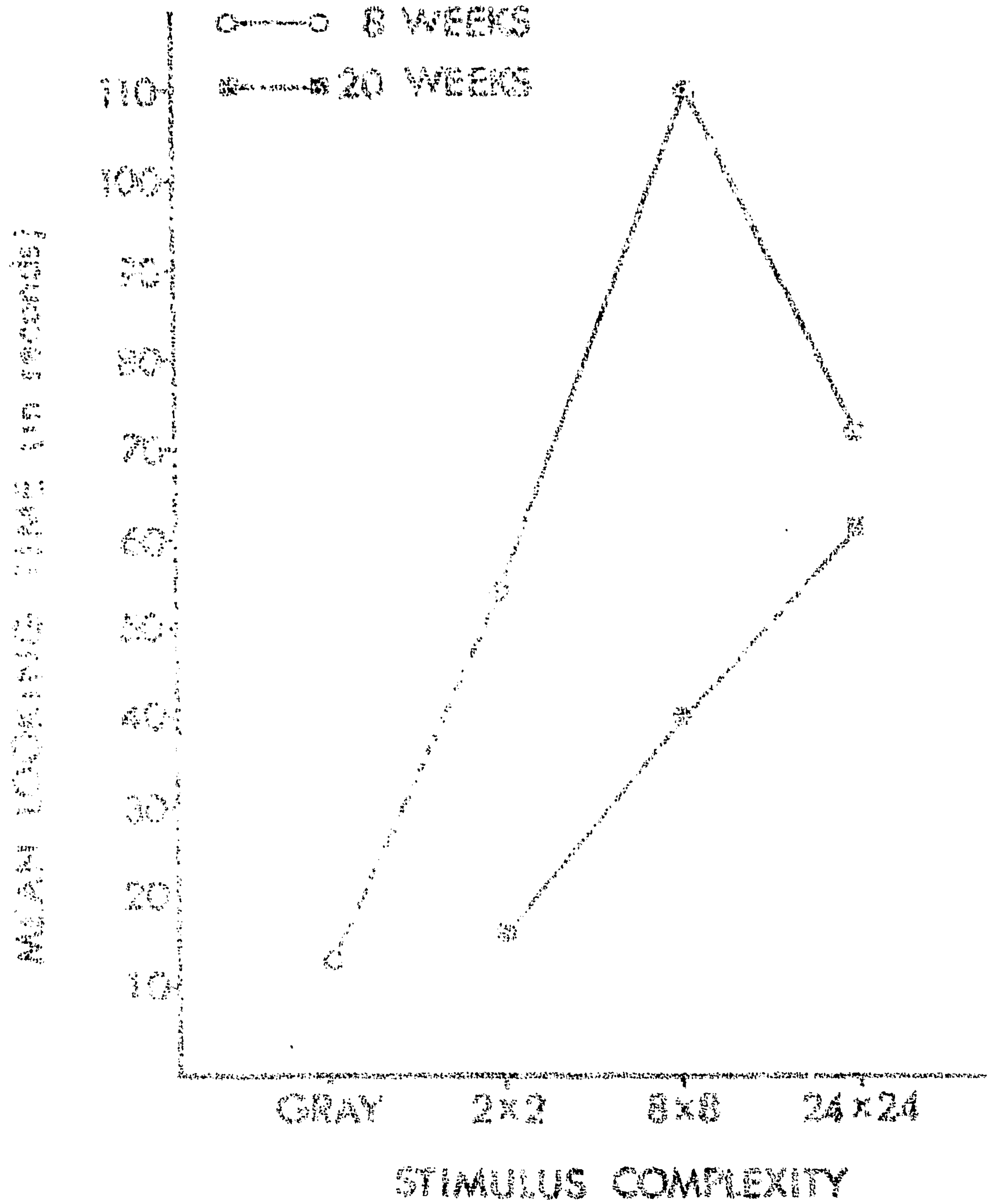


FIGURE 2


8 WEEKS
20 WEEKS
110
100
90
80
70
60
50
40
30
20
10
GRAY
2x2
8x8
24x24
STIMULUS COMPLEXITY