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ABSTRACT

The primary purpose of this study was to examine whether a general perceptual model developed by Vitz and Todd (1971), capable of dealing with multiple determinants of attending, is useful for understanding infant attending. The model, previously used in research with adults, assumes that perception can be represented as a stochastic sampling process, and proposes that the total number of trials necessary to sample a figure is a measure of that figure's complexity. The relationships of age and sex to complexity preference were also explored. Three stimuli differing in complexity were presented to forty-one 8-, 10-, and 12-week-old infants, and total fixation times recorded. Overall, the infants fixated longer on the more complex stimuli; however, while preference for the most complex stimulus was clear for females at all ages, there were suggestions that males' preference for complexity increased gradually with age. In addition, overall fixation times declined with age for males but not for females. These results are interpreted as providing support for the utility of the Vitz and Todd model. Although the effects of complexity differed for males and females, as defined by the model, complexity did appear to play a role in mediating infant attention. Sex differences in development are discussed in terms of hypothesized differences in attending styles. (Author/SS)

Models of Complexity and Infant Attention

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Abstract

The major purpose of this study was to test the applicability of a model of figural complexity proposed by Vitz and Todd to infants. In addition we also wished to explore the relationships of age and sex to complexity preference. Three stimuli differing in complexity were presented to forty-two 8, 10, and 12 week-old infants, and total fixation times recorded. Overall, the infants fixated the higher complexity stimuli longer; however, while preference for the most complex stimulus was clear for females at all ages, there were suggestions that males' preference for the complex increased gradually with age. In addition, overall fixation times declined for males with age but not for females. These results are interpreted as providing support for the utility of the Vitz and Todd model, and the developmental sex differences are discussed in terms of hypothesized differences in attending styles.

Models of Complexity and Infant Attention

An important issue in the study of infant visual perception and cognition concerns how best to describe those features of visual patterns which govern attention: are they to be characterized in terms of global properties, such as complexity (e.g., McCall, 1971; Greenberg, 1977), and if so how are they to be defined, or are they to be described in terms of individual determinants, such as contour density (Karmel, 1969, 1974), size, or number of elements (e.g., Fantz & Fagan, 1975).

One fact which is becoming increasingly apparent, largely due to the work of Fantz and Fagan (1975), and Greenberg and his colleagues (Greenberg & Blue, 1975; Greenberg, 1977), is that there are multiple determinants of infant attending: hence although some determinants may be interrelated, no single stimulus property governs attending exclusively, and any successful model of infant attending will have to encompass such multiplicity.

The primary purpose of the current study was to examine whether a general perceptual model developed by Vitz and Todd (1971), which is capable of dealing with multiple determinants of attending, is useful for understanding infant attending, since previous research with the model has focused on adults. Briefly, the model assumes that perception can be represented as a stochastic sampling process, and proposes that the total number of trials necessary to sample a figure is a measure of that figure's complexity. Figures are described and sampled in terms of three basic, elementary classes of geometrical properties: interior lines, angles and component areas. Sampling proceeds hierarchically, and begins with lines and ends with areas. The number of sampling trials, and thus complexity, increases with the number of elements in each class, and the variation in the magnitude of the elements. There is a correction for symmetry so that the more symmetrical a figure is, the less complex. (Readers are referred to Vitz and Todd, 1971, for a fuller description of the model and for supporting evidence.) While the current version of the model is restricted to the perception of straight-line figures, a revised version of the model currently being developed will be able to encompass curvilinear elements (Vitz, Note 1).

The potential advantage of the model lies in the fact that complexity corresponds to the perceptual demands made by stimuli, characterized in terms of a small number of elementary features into which less basic features can be translated. In effect, it provides a single framework within which a wide variety of diverse stimuli can be described and integrated in terms relating to underlying perceptual-cognitive mechanisms and capacities. Because the model acknowledges the interrelationship of figural elements and the organizational and integrative nature of perception, it preserves some of the important advantages of complexity-based models of attending. At the same time, it keeps the precision provided by conceptions which emphasize the discrete and additive nature of stimulus elements in determining attending.

In order to examine the utility of the model we examined the relationship between attentional preference and complexity in infants between 8 and 12 weeks of age. This also permitted us to investigate, using stimuli different from the checkerboard patterns typically employed, whether preference for complexity increases with age in this age-range. There is currently a question as to whether observed age changes in this regard are better described in terms of complexity (Greenberg, 1975, 1977), or in terms of the decreasing importance of element size and the increasing importance of element number with age (Fantz & Fagan, 1975). Since element size and number covary with complexity in the checkerboard stimuli often used in such investigations, age changes in response to these properties and not increasing complexity per se, could explain the relationship of complexity preference to age.

Finally we were also interested in any sex differences which might emerge, since in our previous work (e.g., Greenberg & Weizmann, 1971) females have demonstrated stronger preferences for complexity than males.

Procedure

Subjects

The subjects were 41 infants, thirteen 8-week olds (seven males, six females), fourteen 10-week olds (seven males, seven females), and fourteen 12-week olds (seven males and seven females). Three additional subjects were discarded from the study because of continual fussing, crying or sleeping.

Apparatus

The apparatus employed in this study has been described elsewhere (Greenberg & Weizmann, 1971). Basically, it consists of a padded bassinett placed inside a uniform white test chamber. Infants are placed on their back in the bassinett, and stimuli mounted on a white masonite board, are inserted into an overhead slit 21 cms above the middle of the infant's head. Two lights focused on the stimulus from each side provide illumination. A pane of one way glass, behind the infant's head and adjacent to the stimulus board allows an observer to observe and record the direction and duration of the infant's gaze.

Stimuli and Procedures

Three stimuli differing in complexity value were adapted from those presented by Vitz and Todd (1971, p. 215) by photographing black versions of the figures on a white background and printing them on non-glossy paper (see Figure 1).

Insert Figure 1 about here

As can be seen in Figure 1, all three patterns have six sides and six interior angles, but the variability of the line and angle magnitudes, and the degree of asymmetry increases with figural complexity. We endeavoured to equate area as much as possible in the three figures. The actual areas, from the simplest to the most complex figure were 7.6, 7.5 and 8.6 cms^2 respectively. The corresponding total contour lengths were 15, 26.7 and 23.3 cms.

Each of the six possible pairs (counting all possible left-right arrangements) of the three stimuli was mounted on a separate stimulus board and each pair member was placed 5 cms to the right or left of center respectively.

The six stimulus pairs were presented for 12 thirty-second trials in one of four random sequences. The sequences were constructed so that each of the six pairs had to be presented once in each six-trial block, with each individual stimulus pattern appearing a total of four times in each block.

One experimenter stood at the foot of the chamber inserting the stimulus boards, while a second observed and recorded the infant's fixations to each stimulus on a portable event recorder. Trials did not start until the infant was gazing upward, with his/her head at midline. The stimulus boards were coded on the back so that neither experimenter was aware of the stimulus pair to be presented. Correlations computed to check inter-observer reliability averaged over .90, which is typical of previous reliabilities we have found using this technique.

Results

Log total fixation times for each stimulus served as the basic data for analyses. Since complexity was a repeated measures factor, Multiple Analysis of Variance procedures were employed in analyzing those findings in which it figured (McCall & Applebaum, 1973; Bock, 1975, ch. 7). Because restrictions on the degrees of freedom limited the possible number of individual comparisons between the various levels of complexity to two, the three complexity scores were transformed into two new linear combinations providing two contrasts: one comparing the low and moderate complexity stimuli with one another, and the second comparing the mean of the above two stimuli with the high complexity stimulus.

The age and sex factors were analyzed employing standard Univariate Analysis of Variance procedures, using Trend Analysis to examine changes in patterns of visual attention over age.

The results of the MANOVA indicated that complexity was a significant determinant of fixation time, $F(2, 33) = 3.287$, $p < .05$. (The mean total fixation times in seconds to the three stimuli, in increasing order of complexity, were 60.67, 69.46 and 78.04.) Univariate F-tests of individual contrasts indicated that most of this effect was due to the difference between the two less complex stimuli and the most complex one, $F(1, 34) = 5.78$, $p < .02$.

There were several other findings which emerged in the analysis. The first was a significant linear trend of age, $F(1, 18) = 12.284$, $p < .01$, indicating an overall decline in attending from eight to twelve weeks. As suggested by Figure 2, which depicts age changes in attending separately for males and females, however, this general decline only appeared to occur for males, a suggestion confirmed by a significant sex x linear trend of age interaction, $F(1, 34) = 3.53$, $p < .05$.

Insert Figure 2 about here

The last finding was of an interaction between sex, complexity and the linear trend of age, $F(1, 33) = 2.079$, $p < 14$, which univariate F-tests of individual constrasts indicated was located primarily in the contrast between the low and moderate complexity stimuli, $F(1, 34) = 4.033$, $p < .05$. Although this finding does not reach conventional levels of significance, it is suggestive, and if real, has important implications for the interpretation of the other findings. As depicted in Figure 2, it suggests that while complexity preferences emerge early and are stable for female infants over time, they are not as strong and manifest some change in males during this same age period.

In order to clarify these findings further, separate analyses parallelling the overall analysis were conducted for males and females. The only significant or near significant finding for females was for complexity, $F(2, 15) = 2.84$, $.10 < p < .05$. Tests of individual comparisons indicated that the major differences in attending were between the high complexity stimulus and the mean of the other two, matching the results of the overall analysis. As suggested above, neither complexity preferences nor fixation times in general appeared to change with age for females.

For males on the other hand, complexity was not significant or near significant, but the complexity x linear trend of age interaction, $F(2, 17) = 2.02$, $p < .16$, closely paralleled the three-way interaction described above. The univariate F-tests of individual contrasts indicated, as they did in the overall analysis, that age changes in attending to the two less complex stimuli $F(1, 18) = 3.69$, $p < .07$, accounted for this interaction. As Figure 2 indicates, the difference between the two stimuli appeared to diminish with age. This characterization of these age-changes may be somewhat incomplete, however, because not all of the important potential contrasts could be carried out: Figure 2 suggests that the decline in attending to the moderate complexity stimulus coincides with a relative increase in attending to the high complexity stimulus. The fact that this leads to a reversal in preference for the two stimuli by 12 weeks suggests that what may be occurring is a shift in preference from moderate to higher degrees of complexity.

Finally, as expected from the significant age and age x sex effects found in the overall analysis, general attending in males declined from eight to twelve weeks, as evidenced by a significant linear trend of age, $F(1, 18) - 12.284$, $p < .01$. While as noted above, changing complexity preferences may have influenced the shape of the curves describing the decline, the general decline itself appears to exist over and above this influence (see Figure 2).

Discussion

The results from the current study are encouraging insofar as the Vitz and Todd model is concerned: females consistently preferred the highest level of complexity at all three ages, while there are strong indications that males only gradually come to shift their preferences from moderate to higher levels of complexity. Hence although its effects may have differed for males and females, complexity as defined by the model did appear to play a role in mediating infant attention. While much more work needs to be done to establish the utility of the Vitz and Todd model as a framework for studying infant visual information processing, in general the results thus far are promising.

Further, while it is possible that the 8-week old males responded to the stimuli on the basis of contour, since the intermediate-complexity stimulus they preferred possessed more contour than the high-complexity stimulus (although the differences in contour were very slight), the results generally indicate that configural features, over and above such attributes as size, contour, or number, constitute important determinants of attention in this age range. This finding is consistent with that of Ruff and Turkewitz (1975), who report that variables relating to shape become more important than size after 9 weeks of age.

It is especially interesting that the difference among the stimuli and the consequent differences in attending can, to a considerable degree, be characterized in terms of differences in symmetry and the amount of variation in element magnitude. Properties such as symmetry and regularity of arrangement have often figured prominently in definitions of complexity (McCall, 1971), and intuitively do appear to be part of the meaning of the concept; with the exception of Fantz and his colleagues (see Fantz, Fagan, & Miranda, 1975), however, most investigators (Karmel, 1969; Moffett, 1969; McCall & Melson, 1969) have not found such properties to be major determinants of attending, and recent definitions of complexity (e.g., Greenberg, 1975, 1977) have not emphasized them. The current findings are in agreement with those of Fantz, however, and suggest that features such as symmetry can mediate infant attending, at least when their influence is not obscured by other stimulus attributes.

Developmentally, as indicated above the picture is one of marked consistency for females, in terms of fixation times as well as complexity preference, coupled with an apparent gradual increase in preference for higher degrees of complexity by males. Although the evidence for this shift on the part of the males is not conclusive, it is highly suggestive. It does seem clear, in any case, that the female infants' response to complexity were stronger and more consistent than their male counterparts. While sex differences in complexity mediated attending are not always reported, when they are, they are generally consonant with those reported here (e.g., Greenberg & Weizmann, 1971; Cohen, L. B., DeLoache & Rissman, 1975.

Although these data do not permit an unambiguous determination of the general relationship between age and complexity preference, the fact that the sex differences were developmental in nature is interesting since most reports of sex differences in this area, such as those in the studies cited above, involve simple differences in the strength of complexity preference at particular ages. McCall (1973, however, has reported developmental sex differences similar to those described here, with females being more advanced than males, in infants' responding to visual discrepancy. Obviously, however, the effects of stimuli representing a wider range of complexity need to be investigated if the relationship between sex and complexity preference is to be clarified further. It is possible that an age-complexity relationship for females parallelling that for males would have emerged if stimuli representing higher levels of complexity than those employed here were utilized.

With regard to the explanation of the sex differences found in this study, several previous investigators (e.g., McCall, 1971; Greenberg & Weizmann, 1971; Wachs, 1977) have suggested that female infants may be less distractable and more able to attend selectively to specific stimuli than males. This hypothesis is highly relevant to the current findings, since such selectivity on the part of females could lead to a stronger and/or earlier sensitivity to differences among stimuli and stronger preferences for complex stimuli, perhaps coupled with greater ability to process such stimuli. Support for this hypothesis comes from a number of studies suggesting that females attend more selectively and/or are less distractable than males (e.g., Cohen, S. E., 1974; Cohen, L. B. et al., 1975; Sigman, 1976; Caron, A. J., Caron, R. F., Minichiello, M. D., Weisz, S. J., & Friedman, S. L., 1977; Wachs, 1977; Moshe, Doan & Weizmann, Note 2), and that they may be more advanced than males in some aspects of visual information processing (McCall, 1973), involving long-term familiarization to stimuli.

It should be noted that the above hypothesis concerning sex differences differs considerably from the one suggested by Cohen and his colleagues (e.g., Cohen & Gelber, 1975). Althouth both are based in part on evidence for greater female perceptual selectivity, Cohen has coupled this evidence with findings from studies of short-term habituation which suggest that males habituate more readilty than females (Cohen & Gelber, 1975); on this basis he has suggested that females respond to and store information about a stimulus on the basis of its reinforcement value and interest, while males are more apt to process and store information about specific stimulus properties. Alternatively, our interpretation of some of the sex differences in habituation studies stresses the role of differences in styles of attending, especially as they interact with procedural variables (see Moshe, et al., Note 2). While further discussion of the two hypotheses are beyond the scope of this paper, and resolution of the issues raised by them may be premature in any case, further work on this problem may not only clarify the nature and importance of sex differences in this case, but may also shed light on questions concerning individual styles of attending.

Finally, since findings of an overall decline in attending to experimental stimuli with age are typical in this age-range (e.g., Fantz, & Fagan, 1975), the problematic feature of the sex differences in overall attending at older ages is the continued high level of attending by 12-week old females.

The hypothesis stated above suggests that heightened female attending would be expected if the stimuli were particularly interesting. Evidence for this explanation comes from a study by Sigman (1976) who found that 8-month old females attended longer to novel stimuli than their male counterparts, and from a study by Weizmann, Cohen, L. B. and Pratt (1971), who reported similar findings in 6 and 8 week old infants when they were in mildly novel environments, which under the above hypothesis might be expected to increase male distractibility and augment sex differences.

If, however, the above explanation is correct, then it is not clear why no sex differences in overall attending at 8 weeks were found in the current study. It may be that the higher general levels of attending to the stimuli at younger ages obscured these differences, and it was not until the "base level" of attending decreased that the differences in selectivity became clear. Alternatively, the stimuli, because of their unusual nature and the gradually increasing importance of configural variables with age, may have been collectively more attractive at older ages; their greater selective responsivity might have forestalled any decline in attending for the older females and resulted in heightened sex differences.

Reference Notes

1. Vitz, P. Personal communication, November 1978.

2. Moshe, M., McK.Doan, H., & Weizmann, F. Intertrial invervals habituation learning in three day old infants. Manuscript submitted for publication, 1979.

References

Bock, R. D. Multivariate statistical methods in behavioural research. New York: Mc-Graw-Hill, 1975.

Caron, A. J., Caron, R. F., Minichiello, M. D., Weisz, S. J., & Friedman, S. L. Constraints on the use of the familiarization-novelty method in the assessment of infant discrimination. Child Development, 1977, 48, 747-762.

Cohen, L. B., DeLoache, J. S., Rissman, M. W. The effect of stimulus complexity on infant visual attention and habituation. Child Development, 1975, 46, 611-617.

Cohen, L. B. & Gelber, E. R. Infant visual memory. In L. B. Cohen & P. Salapatek, (Eds.). Infant perception: From sensation to cognition. Vol. 11. New York: Academic Press, 1975.

Cohen, S. E. Developmental differences in infants attentional responses to face-voice incongruity of mother and stranger. Child Development, 1974, 45, 1155-1158.

Fantz, R. L. & Fagan, J. F. Visual attention to size and number of pattern details by term and preterm infants during the first six months. Child Development, 1975, 46, 3-18.

Fantz, R. L., Fagan, J. F., & Miranda, S. B. Early visual selectivity. In L. B. Cohen, & P. Salapatek (Eds.). Infant perception: From sensation to cognition. Vol. 1. New York: Academic Press, 1975.

Greenberg, D. J. & Weizmann, F. The measurement of visual attention in infants: A comparison of two methodologies. Journal of Experimental Child Psychology, 1971, 11, 234-243.

Greenberg, D. J. & Blue, S. Z. Visual complexity in infancy contour or numerosity? Child Development, 1975, 46, 357-363.

Greenberg, D. J. Visual attention in infancy: Process methods and clinical applications. In I. Uzigiris & F. Weizmann (Eds.). The structuring of experience. New York: Plenum, 1977, 211-235.

Karmel, B. Z. The effect of age, complexity and amount of contour on pattern preferences in human infants. Journal of Experimental Psychology, 1969, 7, 339-354.

McCall, R. B. & Melson, W. H. Attention in infants as a function of magnitude of discrepancy and habituation rate. Psychonomic Science, 1969, 17, 317-319.

McCall, R. B. Attention in the infant: Avenue to the study of cognitive development. In D. Walcher & P. L. Peters (Eds.). Early childhood: The development of self-regulatory mechanisms. New York: Academic Press, 1971, 102-140.

McCall, R. B. Encoding and retrieval of perceptual memories after long-term familiarization and the infant's response to discrepancy. Developmental Psychology, 1973, 9, 310-319.

Moffett, A. Stimulus complexity as a determinant of visual attention in infants. Journal of Experimental Child Psychology, 1969, 8, 173-179.

Ruff, H. A. & Turkewitz, G. Developmental changes in the effectiveness of stimulus intensity on infant visual attention. Developmental Psychology, 1975, 11, 705-710.

Sigman, M. Early development of preterm and full-term infants: Exploratory behavior in eight-month-olds. Child Development, 1976, 47, 606-612.

Wachs, T. The optimal stimulation hypothesis and early development: Anybody got a match. In I. Uzgiris & F. Weizmann (Eds.). The structuring of Experience. New York: Plenum Press, 1977, 153-179.

Weizmann, F., Cohen, L. B. & Pratt, R. J. Novelty, familiarity and the development of infant attention. Developmental Psychology, 1971, 4, 144-154.

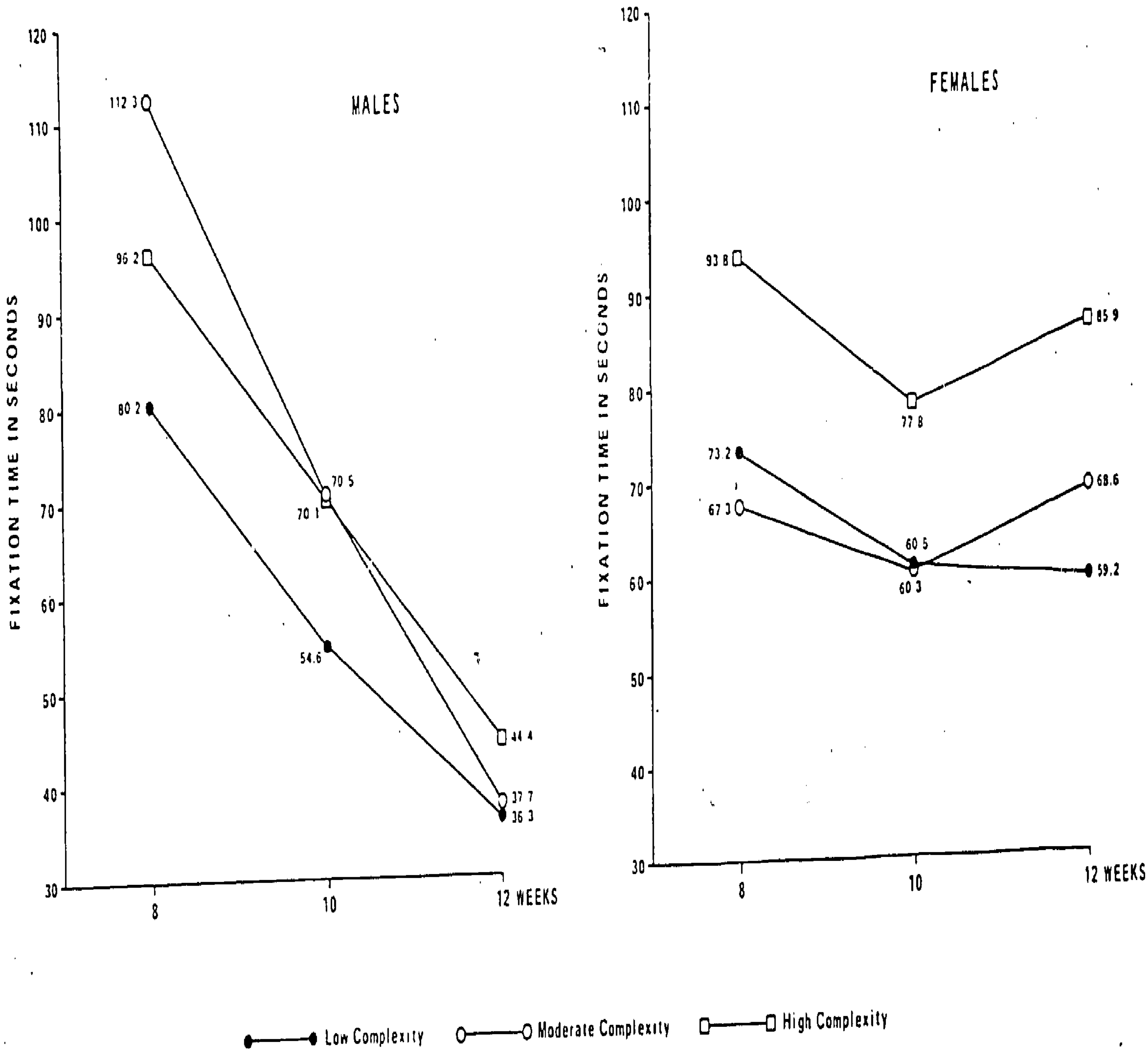
Vitz, P. C. & Todd, T. C. A model of the perception of simple geometric figures. Psychological Review, 1971, 78, 207-228.

Figure Caption

Figure 1. Visual stimuli arranged in increasing order of complexity.

Figure Caption

Figure 2. Fixation time as a function of stimulus Complexity, Sex and Age.


MALES
FEMALES
FIXATION TIME IN SECONDS
120
110
100
90
80
70
60
50
40
30
8
10
12 WEEKS
112 3
96 2
80 2
70 5
70 1
54.6
44 4
37 7
36 3
93 8
77 8
85 9
73.2
67 3
60 5
60 3
68.6
59.2
Low Complexity
Moderate Complexity
High Complexity