Degree of stimulus complexity and habituation of visual fixation in infants¹

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Three groups of 3½-month-old infants were presented with varying and repeated exposures of visual stimuli. For each group a different checkerboard pattern, i.e., 2 x 2, 12 x 12, or 24 x 24, served as the repeated stimulus. Visual fixation of each pattern declined significantly both during repetition and upon subsequent reexposure, the amount varying inversely with the complexity of the stimulus. In addition, infant girls showed steeper decrements than boys.

In a previous study of observing behavior in 3½-month-old infants (Caron & Caron, 1968), it was demonstrated that repeated exposure of a stimulus (2 x 2 or 12 x 12 checkerboard pattern) produced decrement in visual fixation and that the amount of decrement obtained was dependent on the complexity of the stimulus (2 x 2 > 12 x 12). These results were consistent with evidence that infants of this age "prefer" checkerboards in increasing order of complexity, i.e., 24 x 24 > 8 x 8 > 2 x 2 (Brennan, Ames, & Moore, 1966). Since the more complex 24 x 24 pattern had not been used in the earlier study, a complete correspondence between infant visual "preferences" and habituation effects could not be established. In the present experiment, therefore, a wider range of complexity values was examined in order to determine whether decrements in the fixation of repeated stimuli would also show a transitive relationship, i.e., 2 x 2 > 12 x 12 > 24 x 24. As before, the design involved the juxtaposition of varying and repeated exposures of stimuli to permit assessment of postrepetition shifts in fixation and of response recovery.

METHOD

The fine details of apparatus and procedure have been described elsewhere (Caron & Caron, 1968). Briefly, each S was seated within a test chamber whose ceiling contained a 7 x 7 in. viewing area for stimulus projection. Es were able to observe the infant's eyes through peepholes located on either side of the target area. The duration and number of fixations on a given stimulus were recorded by pressing a button which activated an event recorder. The criterion of fixation was the reflection of the pattern over S's pupil. Interobserver reliability, determined for 15 Ss, was .94.

There were 15 successive 20-sec exposures with no intertrial interval other than that provided by the advance of the projector. Trials 1-4 constituted a continuously varying array of multicolored geometric designs (Trial 1 was warm-up), Trials 10-12, a second varying array closely matched with the first in such aspects as size of detail, color, shape, etc., and Trials 14-15 were novel, abstract art photographs. On Trials 5-9 the same stimulus (either a 2 x 2, 12 x 12, or 24 x 24 red and white checkerboard) was repeatedly exposed and this stimulus was reexposed on Trial 13.

The total sample included 96 Ss, 14-16 weeks old (median age, 104 days). There were 16 boys and 16 girls in each of three experimental groups which differed only in terms of the particular checkerboard pattern used for repetition. The data of 50 Ss (13 boys and 12 girls in each of Groups 2 x 2 and 12 x 12) had been obtained previously (Caron & Caron, 1968). For purposes of the present study, 46 new Ss were tested—seven cases (three boys and four girls) in each of the 2 x 2 and 12 x 12 groups and 32 (16 boys and 16 girls) in the 24 x 24 group.²

RESULTS

Figure 1 summarizes the total fixation time (TF) data for each stimulus group (top half of figure) and for each sex group (bottom half). Two-way analyses of variance (Stimulus by Sex) indicated that there were no main or interaction differences on any of the initial variable exposures (Trials 1-4). However, on the first presentation of the to-be-repeated stimulus (Trial 5) a significant Stimulus effect appeared ($F = 7.16$, $df = 2/90$, $p < .005$), the 24 x 24 group fixating longer than both the 12 x 12 and 2 x 2 groups ($p < .05$ and $p < .01$, respectively, by Duncan multiple range tests).

A three-factor mixed analysis of variance of the five repetition trials (5 to 9) yielded an overall Stimulus effect ($F = 38.14$, $df = 2/90$, $p < .001$), the 24 x 24 group continuing to fixate longer than both the 12 x 12 and 2 x 2 groups, and the 12 x 12 group longer than the 2 x 2 group ($p < .01$, in each case, by Duncan tests). A trend analysis of the repetition trials revealed that the linear slopes for the three stimulus groups were significantly different and transitively ordered ($F = 31.24$, $df = 2/90$, $p < .001$). The slope of the 2 x 2 group was steepest (-2.05), that of the 12 x 12 group, next steepest ($-.72$), and of the 24 x 24 group, least so ($-.32$), each successive difference being significant ($p < .01$ and $p < .05$, respectively, by Duncan tests). Wilcoxon matched-pairs signed-ranks tests indicated that whereas the 2 x 2 group had declined significantly from its Trial-5 level on Trial 6 ($p < .01$), the 12 x 12 group did not do so until Trial 8 ($p < .01$), and the 24 x 24 group, until Trial 9 ($p < .02$). The

Fig. 1. Mean total fixation during varied (1-5, 10-12, 14-15) and repeated (6-9, 13) 20-sec trials for stimulus and sex groups.

trend analysis also showed that the linear slopes of the sex groups were significantly different ($F = 5.88$, $df = 1/90$, $p < .025$), that of the females being steeper than that of the males (-1.26 vs $-.80$, respectively).

A mixed analysis of Trials 9 and 10 revealed that fixation recovery on Trial 10 was significantly different for the three stimulus groups ($F = 15.57$, $df = 1/90$, $p < .001$). The increment for the 2×2 group was greater than that for both the 12×12 and 24×24 groups ($p < .01$ in each case), but the latter two did not differ from each other. Wilcoxon tests indicated that the increment for each individual stimulus and sex group was significant ($p < .05$ for the 24×24 group; $p < .01$ for all other groups), thus demonstrating that the preceding decrements were due neither to general nor to sensory fatigue.

The reappearance of the previously repeated stimulus (Trial 13) again produced differential and transitively ordered decrements in TF. A two-factor analysis of the relative decrease from Trial 5 to Trial 13 $[(5 - 13)/5]$ yielded significant main effects for Stimulus ($F = 9.79$, $df = 2/90$, $p < .001$) and for Sex ($F = 10.42$, $df = 1/90$, $p < .005$). Thus, the 2×2 group, as expected, again declined more steeply than both the 12×12 and 24×24 groups ($p < .05$ and $p < .01$, respectively) and the 12×12 group showed an intermediate decrease (though not quite significantly different from the 24×24 group). The decline of the girls here, also, was steeper than that of the boys.

Finally, analysis of Trials 13 and 14 indicated that recovery on Trial 14 was significantly different for the three stimulus groups ($F = 19.02$, $df = 2/90$, $p < .001$) and for the two sex groups ($F = 11.28$, $df = 1/90$, $p < .005$). The increment for the 2×2 group was, as before, greater than that for both the 12×12 and 24×24 groups ($p < .01$, in each instance) and that for the 12×12 group, greater than that for the 24×24 group ($p < .01$). The increment for the females was larger than that for the males. Wilcoxon tests again demonstrated that recovery was significant for each stimulus and each sex group ($p < .01$, in each case).

DISCUSSION

The results, taken together with those of Brennan, Ames, & Moore (1966), suggest that the more complex a checkerboard

pattern the more likely it is not only to recruit but also to maintain the attention of 14- to 15-week-old infants. At least this is the case for the range of density values presently employed. The fact that the habituation data were transitively ordered indicates, moreover, that a single physical dimension (correlated with checker density) was the effective controlling variable (cf. Hershenson, 1967). In addition, the marked differences in response to the repeated and novel stimuli subsequent to the repetition period attest to the discriminative competence of the infants.

Finally, the sex differences in magnitude of habituation merit comment. It is not uncommon to find infant girls described as showing greater differentiation between stimuli or as habituating more rapidly than boys. On this basis, they are often said to be "maturationally ahead" (cf. Kagan & Lewis, 1965; Kagan, Henker, Hen-Tov, Levine, & Lewis, 1966). It would seem premature, however, to interpret the steeper decline of the girls in this study as evidence of precocious perceptual development, since none of the many other possible determinants of these differences (e.g., sampling artifacts, differences in overall adaptation to the test situation, etc.) have been ruled out.

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NOTES

1. Supported in part by USPHS Grant HD 01605-3 from NICHD. The assistance of Roberta Caldwell and Elizabeth Bond is gratefully acknowledged.

2. Preliminary analyses indicated that the performance of the new Ss in the 2×2 and 12×12 groups was no different from that of infants tested earlier.

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The high linear relationship between the two measures ($r = -.949$) suggests that the use of the STOP method as the index of problem difficulty would lead to conclusions that do not differ markedly from those reached using the number of correct responses in 50 trials. The estimated mean savings in trials run per S using the STOP criterion was 20.8, a savings of more than 40% of the trials run under the other method.

SOME FINAL CONSIDERATIONS

One practical limitation on the procedure is that tables of critical values for the binomial test are not readily available for probabilities other than $\frac{1}{2}$, particularly for trial lengths over 25. A similar practical restriction applies to extending the present procedure beyond a 100-trial maximum. The suggested format for the data sheets, with their broadening pattern of points and barriers, would make it difficult to construct acceptable data sheets for trial lengths much beyond 100.

Finally, it should be noted that the terms, ".05 or .01 levels of significance," should be avoided when interpreting the criterion level of the STOP method. The binomial test is ordinarily applied to a single complete sequence of observations rather than to progressively larger subsequences. It is true in the present usage of the binomial test that when a .05 (or .01) criterion barrier is crossed, the probability of this

level of performance occurring by chance in exactly that many trials is less than .05 (or .01), but the STOP procedure does not specify the exact trial on which a barrier will be crossed. Consequently, the probability that S, by chance, would cross a criterion barrier at any one of the possible crossing points is greater than the level of significance used for establishing the individual criterion points. The practical effect of using the binomial test in the present manner is to control Type I errors by requiring S to reach a progressively more stringent criterion as the number of trials run increases.

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NOTE

1. This research was supported in part by Research Grant No. HD-1454 from the National Institute of Child Health and Human Development.