Effects of early visual conditions on stimulation-seeking behavior in infant rhesus monkeys¹

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Operant responding for complex visual stimuli showed expected changes as a function of visual deprivation manipulations in infant rhesus monkeys reared with normal pattern vision. Infants reared with restricted access to patterned light showed no systematic changes consequent to the same manipulations.

The occurrence of behavioral anomalies in mammalian infants reared in environments impoverished in exteroceptive stimulation has been well documented. Studies include effects upon a broad spectrum of behaviors following social isolation (e.g., Fuller, 1967), and upon specific performances mediated by a particular sensory modality, e.g., visual responses following total deprivation of patterned visual stimuli (e.g., Riesen et al, 1964). However, some studies suggest that *problem-solving* performances are not necessarily impaired by early isolation or sensory restriction, provided that testing is conducted in a familiar environment (e.g., Wilson & Riesen, 1966).

Discrepancies in postdeprivation performances may be better understood if the effects of early impoverishment of stimulation upon the reinforcing properties of variations in the environment are examined. Generally, reinforced behavior is strengthened by deprivation and weakened by satiation of the reinforcing agent. The following experiment was conducted to determine if early visual pattern deprivation would affect the subsequent reinforcing properties of patterned stimuli in infant monkeys. Specifically, the effects of periods of deprivation and satiation of patterned visual stimuli upon lever-pressing for visual stimulation were investigated in four infant monkeys. One pair had been reared in an impoverished visual environment; the other with continuous access to complex visual stimuli.

Subjects and rearing conditions. The Ss were four infant rhesus monkeys, three males and one female, born in the laboratory and separated from their mothers within 15 h of birth. Each animal was reared from its first day in a mother-surrogate chair which functionally approximates many of the features of the natural mother monkey (Held & Bauer, 1966). The infant (1) is held in an upright position; (2) is firmly supported around its trunk by a padded cylinder; (3) has a furry substance attached to a sturdy frame for its hands and feet to grasp; and (4) has continuous access to milk from a nipple. The chairs were enclosed in air-filtered and heated Plexiglas cubicles. No significant illnesses or muscular weaknesses were observed.

S1 and S2 were reared with unrestricted visual access to the laboratory environment until the beginning of the experiment at 98 and 90 days of age, respectively (unrestricted Ss). S3 and S4 were reared with limited access to patterned visual stimuli. Their heads were permanently enclosed in translucent chambers containing only the milk bottle until the start of this experiment at 119 and 108 days, respectively (restricted Ss). The front of the chamber was replaced by a viewing screen for projection of visual stimuli during testing. S1 and S2 were placed in a similar chamber for testing only. Prior to the start of the experiment, as conditions of another study, all Ss had received a weekly maximum of 10 min of experimenter-controlled visual stimulation and a weekly maximum of 10 min of visual stimulation as reinforcement for lever pressing. In another part of this study the restricted animals had access to unpatterned white light reinforcement 1 h daily for 30 days immediately prior to the present experiment.

Procedure. All animals were run under a fixed ratio (FR) contingency of foot-lever responding reinforced by the projection of complex visual stimuli. The reinforcement duration was 20 sec. They were tested for 1 h daily except weekends. The reinforcing stimuli were 80 different, colored 2 x 2 slides of abstract and representational paintings and sculpture from the collection of the National Gallery of Art (Slides I). To control for stimulus satiation in the unrestricted group, a second set of 80 similar slides was also used (Slides II). Each successive reinforcement delivered a new picture; orders of presentation were randomized between sessions.

For developmental comparisons, testing was initiated within the first four

months for all animals. However, because of the timing of their births, the testing on the unrestricted monkeys was completed prior to the start of testing for the restricted infants. No difficulties were encountered in conditioning the former to an FR 8 requirement, which was set to reduce the likelihood of rapid satiation. However, S3 and S4 had very weak performances at higher ratio values, and were consequently tested at FR 2. Because of this difference, the data are presented in mean number of reinforcements per session, rather than in rates of responding. A maximum of 180 reinforcements per session was possible for S1 and S2, but their obtained session totals were well below this limit. The effects, if any, of the ratio discrepancy are probably to minimize the differences in obtained reinforcements between the two groups due to the higher "cost" of FR8.

To assess the effects of access to visual pattern stimulation during early rearing, testing for stimulation seeking was interpolated after subsequent periods of relative deprivation and free access (satiation) to visual stimuli. The deprivation and nondeprivation conditions were identical to those of

Fig. 1. Mean number of visual reinforcements received during a 1 h stimulation-availability period for individual Ss. Shading indicates visual pattern deprivation. All time periods are two weeks, except for the first presentation of Slides I and the presentation of Slides II for the unrestricted animals.

restricted and unrestricted rearing; i.e., the imposition and removal of the translucent isolation enclosures. Each S was initially run under its original rearing conditions with respect to visual restriction (pretest). The pretest period was followed by two weeks of a reversal in visual conditions for one animal in each group, and of a continuation of the pretest condition for the other. The Ss were maintained under these conditions without testing for two weeks. Then two weeks of testing with the same conditions continuing in force was conducted. Following the completion of testing under the first set of deprivation manipulations, deprivation conditions were reversed for each animal, and the same sequence of procedures as in the previous phase of the experiment was repeated. The treatments were counterbalanced for order of changes within groups, for both phases of the experiment.

Results and Discussion. The results are presented in Fig. 1. Temporary deprivation in animals reared under unrestricted conditions enhanced stimulation-seeking behavior. After the non-deprivation periods there was a reduction in stimulation-seeking from prior levels. For the restricted infants one animal, S3, showed an almost total absence of stimulation-seeking regardless of deprivation manipulations. The second animal, S4, progressively decreased in stimulation-seeking over the experiment, irrespective of visual conditions. Under all comparable conditions the unrestricted animals exceeded the restricted infants in number of reinforcements obtained in an hourly session. The Slides II data showed no consistent effects of novel stimuli from the same stimulus class.

None of the differences between reinforcement periods for the restricted animals were significant. Differences between the second and third, and third and fourth presentations were significant for both unrestricted Ss (sign test, $p < .05$). Although data were

insufficient for a meaningful statistical test between the first (pretest) and second slide presentations for the unrestricted animals, differences were in the expected direction.

It seems unlikely that differences between the groups can be attributed to the discrepancies in FR values. Also, the differences cannot be ascribed to a generalized depression of behavior with S3 and S4, because these infants had previously generated relatively high response rates for unpatterned white light. Rather, the results of this initial study suggest an impairment in stimulation-seeking for complex visual materials as a consequence of early restriction in pattern vision. Additional work is necessary to explicate the mechanism involved. A possibility is that early experience is an important condition for establishing the reinforcing properties of visual patterns.

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