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ABSTRACT

The purpose of the present study was to investigate more directly the effects of content and repetition of contingent visual feedback on a discrete operant pulling response and accompanying visual attention in 24 six- to seven-month old infants. Simultaneous recording was made of infant operant behavior and visual attention. Results indicated significant learning as reflected in the looking-and-pulling measure across ten-minute sessions. In addition, increased responding was shown to faces as compared to the other feedback conditions. The results emphasized the need for incorporating systematic observation and analysis of visual attention in operant learning studies using visual reinforcement. (Author/SET)

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Abstract

Visual stimuli varying in content and degree of repetition were made contingent upon a hand-pulling response in six and seven month old infants. Simultaneous recording was made of infant operant behavior and visual attention. Results indicated significant learning as reflected in the looking-and-pulling measure across ten minute sessions. In addition, increased responding was shown to Faces as compared to the other feedback conditions. These results emphasize the need for incorporating systematic observation and analysis of visual attention in operant learning studies using visual reinforcement.

Monitoring Attention During Operant Conditioning in Six and Seven Month Old Infants[1]

Barbara Strain and Peter M. Vietze

The major emphasis in operant research with infants has been to demonstrate that a particular behavioral response can be brought under operant control (Horowitz, 1968). Employing a range of sensory feedback events and operant responses at various age levels, investigators have repeatedly demonstrated behavioral change within the operant paradigm (Horowitz, 1968). Over and above these demonstrative studies, some research on the critical parameters of actual behavioral acquisition processes has recently appeared (e.g., Millar, 1972; Watson, 1967).

Few free-operant research designs have examined the effects of contingent visual stimulation on infant attention as well as on the defined "appropriate" operant response. While Caron (1967), Millar (1972), and Rheingold, Stanley, and Doyle (1964) have made reference to visual attention during operant conditioning for sensory feedback, they report no systematic measures of attention. Fenson (1971), however, did record and analyze visual attention to contingent sensory stimuli as well as operant bar pressing in a study with six and seven month infants.

Visual perception research with infants, using differential fixation and habituation paradigms, has determined that from the neonatal period infants discriminate and are selectively responsive to prefamiliarized, redundant stimuli compared to unfamiliar, novel or varying stimuli (e.g., Friedman, 1972). However, since a "presented" stimulus often may produce

consistent differential fixation due to eliciting and/or reinforcing properties (Caron, Caron, & Caldwell, 1971) generalizations concerning the functional relationships between these sensory stimuli and infant behavior cannot easily be made.

The purpose of the present study was to investigate more directly the effects of content and repetition of contingent visual feedback on a discrete operant pulling response and accompanying visual attention in six to seven-month old infants. The merits of selecting a manipulative response (pressing, pulling, turning) as the desired operant with older infants have been noted (Millar, 1972; Reese & Lipsitt, 1970). This response is generally discrete and can be automatically recorded, is not tied closely to eliciting stimuli, and allows a standard environmental space in which the infant can be relatively unrestricted and unsupervised.

Method

Subjects:

Twenty-four healthy, alert infants, 12 6-month olds (mean age=189 days) and 12 7-month olds (mean age=219 days), participated in an individual laboratory session. The Ss, 12 males and 12 females, came from middle-income families. Seven additional infants who fussed prior to completion of the session were excluded from the data analysis.

Apparatus:

Visual stimuli were presented by means of a pre-programmed slide projector, rear-projecting images onto a 30.77 cm square translucent plexiglas screen, 41.56 cm from the infant's eyes and centered in a flat-blue plyboard portable observation structure. On each side of the back of this structure were small one-way observation mirrors as well as concealed pressure-sensitive air pouches, each controlling a fluidic switch. Attached to

each of these right and left side switches was one end of a 46.15 cm white ribbon; the other ends were pinned to the infant's right and left sleeve-cuffs. Ss sat in an infant feeding table; mothers were 6 feet away and directly behind their infants. A definite pull (.05 p.s.i.) with either hand was necessary to close the switch and initiate immediate onset of the rear-projected visual feedback for a pre-set duration, varying from 1.5 to 2.5 seconds. Response measures were simultaneously recorded on a 4-channel Rustrak Event Recorder.

Three types of visual feedback were used to define the experimental groups: chromatic slides of young children's faces, chromatic slides of objects common to the infant's home environment (e.g., cup, ball), and achromatic abstract line drawings. Projected images were equated for brightness and size.

Design and Procedure:

The 12 experimental Ss were randomly assigned to one of six groups formed from the factorial combinations of stimulus content (faces, objects, lines) and stimulus redundancy (repeating, changing). For Ss in the "repeating" conditions the same slide was the contingent feedback for every pull; for Ss in the "changing" conditions, a different slide, up to a maximum of 20 different slides, was shown contingent upon the pulling response.

Each session lasted 10 minutes. The infant's first pull initiated a one-minute baseline period, followed by a six-minute conditioning phase in which visual stimulation was immediately contingent upon a pulling response, and a three-minute extinction phase.

Three control groups were also included. A Baseline Group (N=4) in which no feedback was given was used to establish a 10-minute rate of

spontaneous pulling activity, an Illumination Group (N=4) included to isolate the reinforcing effects of patterned visual feedback from those of light-onset and illumination change, and a Noncontingent Group (N=4) in which Ss were yoked to individual Ss in both experimental faces groups. The latter group was a control for possible eliciting effects of visual stimulation on the infant's pulling.

Three behavioral measures were recorded throughout each 10-minute session: frequency and duration of visual fixations recorded by an observer using a silent push-button; and frequency of fixated operants. The fixated operant, or simultaneous pulling and looking, is a measure of frequency and timing of infant attention to the visual feedback contingent on pulling.

Visual attention measures were simultaneously recorded by two Os for ten infants. Interobserver reliability using Pearson's r ranged from .84 to .99, with a mean of .93.

Results

In order to establish initial equivalence of Ss across experimental and control conditions, experimental Ss who were grouped by the three types of content were compared to the three control groups. A one-way ANOVA indicated that the six groups did not differ on fixated operants, frequency of fixations, or duration of fixations during the baseline period.

A Content X Repetition X Phases ANOVA carried out for mean fixated operants per minute across the three phases (Baseline, Conditioning, and Extinction) revealed a significant effect for Phases ($F=17.89$, $df=2/12$, $p < .001$). This indicates that Ss in the experimental groups showed an increase in fixated operants from a base rate of 1.08 to 4.26 during Cond-

itioning, and a decrease to 1.05 during Extinction. Content and repetition of stimuli had no significant effects on fixated operant measures during conditioning.

To evaluate the stability of responding between Baseline and Conditioning, a Content X Repetition X Phases ANOVA was conducted for mean fixated operants per minute across four phases (Baseline and three 2-minute blocks of Conditioning). A significant effect for phases was revealed (F=12.65, df=3/18, $p < .001$) indicating that fixated operants showed a large increase from Baseline (mean=1.08) to the first phase of Conditioning (mean=4.21) with no change in phase two (mean=4.21) and only minimal change in phase three of Conditioning (mean=4.38). A similar analysis performed on the three two-minute phases of conditioning revealed no significant effect indicating a stable rate of responding during conditioning. Finally, an ANOVA (Content X Repetition X Phases) was performed on the mean fixated operant responses per minute for Conditioning and Extinction. In this ANOVA only the effect for Phases was significant (F=28.64, df=1/6, $p < .01$) indicating a reliable decrement in responding from Conditioning to Extinction. A Content X Phases ANOVA was carried out with two three-minute Conditioning Blocks as the repeated factor using fixated operants as the dependent measure. This analysis revealed a marginally significant interaction between Content and Phases (F=4.08, df=2/9, $p < .054$). Related measures t-tests were calculated for the three content groups. Only Faces showed a reliable increase across the two Conditioning phases (t=4.94, df=10, $p < .01$).

In order to test for changes in frequency of fixated operants across the 10-minute session for subject in the three control groups a Groups X Phases ANOVA was carried out. Results revealed no significant changes in frequency of fixated operants across the three phases (Baseline, Cond-

itioning, and Extinction).

Three-way ANOVA's with repeated measures on Phases (Baseline, two 3-minute blocks of Conditioning, Extinction) were undertaken for the two attentional response measures. There was a significant Phases effect for frequency of fixations ($F=31.02$, $df=2/18$, $p < .001$), and for duration of fixations ($F=18.79$, $df=3/18$, $p < .0002$) indicating greater visual attention during Conditioning than during Baseline or Extinction.

ANOVA's comparing experimental contingent-Faces Ss and control non-contingent--Faces Ss were carried out on the three behavioral measures. Results for fixated operants showed significant effects for Groups ($F=10.23$, $df=1/4$, $p < .03$), for Phases ($F=5.74$, $df=3/12$, $p < .01$), and a significant Groups X Phases interaction ($F=4.40$, $df=3/12$, $p < .025$). However, analyses with attentional measures indicated there were no significant differences between subjects receiving contingent and noncontingent stimuli on frequency or duration of fixations.

Discussion

The results of the present study showed clearly that all experimental subjects demonstrated an increase in fixated operants during conditioning as compared to baseline and a decrease in their level of responding during extinction. Moreover, a significant increase in fixated operants was shown during conditioning when Faces, as contrasted with Objects or Line Drawings, were the contingent stimuli.

When the visual fixation measures of frequency and duration were analyzed, it was found that attention increased for both measures during the conditioning phases and decreased during extinction. Comparison between the experimental Faces group and the Noncontingent-Faces Control Group also indicated that while the attentional responses for the two groups were similar, a

conditioning effect for fixated operants was seen only for the experimental subjects.

The only previous study using visual feedback which took attentional behavior into account during conditioning was reported by Fenson (1971). In that study, however, neither baseline nor extinction periods were included so that results are difficult to evaluate. In addition, these results indicated a decline during conditioning of "adjusted bar pressing," while the present results indicate a stable or increasing rate of responding for the fixated operant response.

The potency of Faces as reinforcing stimuli is reflected by an increase in fixated operants across conditioning. This may be explained by the salience of faces for six and seven month old infants. During this period, the infant responds differentially to faces in his environment. Thus, faces acquire increased attentional value. The results show that the fixated operant is sensitive to differences in the reinforcing efficacy of different visual stimuli.

These results emphasize the need for incorporating systematic observation and analysis of visual attention in operant learning studies using visual reinforcement.

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