

THE UNIVERSITY OF MANITOBA

AUDITORY AND APPETITIVE STIMULI AS POTENTIAL
REINFORCERS OF A HEADTURNING RESPONSE IN
NONAMBULATORY PROFOUNDLY RETARDED
ADOLESCENTS

by

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Abstract

The nonambulatory profoundly retarded (NPMR) are those individuals who are untestable on standardized I.Q. tests, totally dependent on others for all basic needs, extremely limited in their responses to external stimulation, severely impaired neuromuscularly, unable to move by any other means other than simple twisting, and unable to maintain a seated position. A number of researchers have described the many problems encountered in attempting to find reinforcing stimuli for this type of child. The present study investigated the effects of three auditory and three appetitive reinforcers on the rate of headturning with NPMR adolescents. The three auditory stimuli were country and western music, social reinforcement, and chime tones; the three appetitive stimuli were ice-cream, chocolate pudding, and sugar milk solution.

The three subjects were NPMR adolescents who were capable of some head movement. Each weekday the subjects were brought to the training room for a 16 minute session. The experimenter was present in the room to deliver the appetitive stimuli but was not present during the presentation of auditory stimuli. The subject was fitted with an adjustable cap attached to a cable which transferred rotational movements of the head to a wheel which operated a microswitch allowing automatic recording of headturning movements. A tape recorder presented the auditory stimulus when a headturn was made; appetitive stimuli were spoon fed by the experimenter.

There were six phases in the study: (a) an initial baseline phase, (b) a test phase using the three auditory stimuli until one or

none of these stimuli proved effective, (c) a reversal phase, (d) a second baseline phase with the experimenter present, (e) a test phase using each of the three appetitive stimuli until one was found to be effective or none were found to be effective, and (f) a second reversal phase. The schedule employed was continuous reinforcement. The rate of responses and reinforcements per minute were calculated for each session. Three collateral responses, arm movements, vocalizations, and whether the subject's eyes were open or closed, were also observed at one minute intervals during the first half of the study.

The contingent presentation of chocolate pudding resulted in an increase in rate of headturning by one subject but auditory stimulation did not affect her response rate. A second subject increased her rate of headturning when country and western music was available but the appetitive stimuli were ineffective. The third subject was not found to increase her rate of headturning when the three auditory or three appetitive stimuli were introduced.

The results indicate that the type of reinforcement found to be effective is idiosyncratic to the NPMR individual. In the present study both auditory and appetitive stimuli were found to be potentially reinforcing.

Introduction

The nonambulatory profoundly retarded are a special group of persons within the population of retarded individuals. This population has been identified by Landesman-Dwyer and Sackett (1978) who described the nonambulatory profoundly retarded (NPMR) as those individuals who are (a) untestable on standardized I.Q. tests, (b) totally dependent on others for all basic needs, (c) extremely limited in their responses to external stimulation, (d) severely impaired neuromuscularly, (e) unable to move by any means other than simple twisting, and (f) unable to maintain a seated position. Due to their mental handicap and numerous physical defects, these children are usually unable to function in a family environment and must be institutionalized. Andrews (cited in Stimson, 1967) found that two-thirds of institutions for the retarded were providing mainly custodial care for the multiply handicapped. Some are placed in front of a television set or moved from their beds to a wheelchair for part of the day. Since they are unable to move around freely, the number of operant responses that might allow these children to interact with their environment is limited. Furthermore, as Rice (1968) stated it is very difficult to locate an adequate reinforcer for these children.

Finding adequate reinforcers is extremely important for several reasons. Remington, Foxen, and Hogg (1977) suggest that if adequate reinforcers for NPMR children can be isolated then it might be possible to teach some basic self-help skills which would reduce the proportion of time nursing staff need to dedicate to purely custodial activities. Reinforcement procedures could also be used to remove self-destructive activity which is commonly found in the profoundly retard-

ed population. Murphy and Doughty (1977) suggest that operant procedures might be effective in alleviating deficits in voluntary motor responding, which could have physical therapy benefits in terms of prevention of further atrophy and improvement of muscle tone and strength. These techniques could also be useful in preparing nonambulatory profoundly retarded individuals to participate in educational activities requiring manipulative interaction with their environment.

Problems encountered in attempting to find reinforcing stimuli for this type of child have been described by a number of researchers (Bailey & Meyerson, 1969; Rice, 1968; Rice & McDaniel, 1966; Rice, McDaniel & Denney, 1968). Food has limitations not only because of present institutional requirements that access to nourishment be noncontingent, but also because in practice it is inconvenient to dispense by hand, delivery is not easily automated for liquids or spoon feeding, and satiation may be rapid. Sensory reinforcement provides an alternative to appetitive stimuli that is easily automated to allow control of the stimulus. Kish (1955) has described sensory reinforcement as a primary reinforcement process resulting from the response contingent presentation or removal of stimuli of moderate intensity. Some researchers have successfully used sensory reinforcers with this type of child (Bailey & Meyerson, 1969; Friedlander, McCarthy & Soforenko, 1967; Murphy & Doughty, 1977; Remington, Foxen, & Hogg, 1977; Rice, McDaniel, Stallings, & Gatz, 1967; Fehr, Wacker, Trezise, & Lennon, Note 1). A number of sensory and appetitive reinforcers have been studied and will be described in greater detail in the following sec-

tions.

Operant Conditioning Studies

Fuller (1949) demonstrated that an 18 year old subject, termed a vegetative idiot, could be conditioned to move his right arm to a vertical or nearly vertical position. The right arm was chosen because the author observed that he moved it about a third as frequently as his left arm. The subject spent his days lying on his back, could not roll over, and never moved his trunk or legs. He was observed to open his mouth, blink, and move his arms, head and shoulders.

The initial experiment began with the subject being deprived of food for 15 hours. When he moved his right arm, a small amount of the sugar milk solution was injected into his mouth. This was the main procedure followed throughout the two experiments in which the subject took part. In the first experiment an assistant recorded the response; whereas, in the second experiment, a polygraph was used to record arm and head movements. Fuller found that, by the end of the fourth and final session of the second experiment, the subject would make definite and discrete responses at a rate of three per minute. During extinction response rates fell to the baseline level.

Piper and MacKinnon (1969) used operant conditioning techniques with a 15 year old profoundly retarded tube-fed female. She was conditioned to raise her right arm to a nearly vertical position over 30 days. She was deprived of food for 6 hours and then her evening meal was used as the reinforcing stimulus. The reinforcing substance was eight ounces of fluid divided into 16 one-half ounce reinforcements per session. It was tube-fed through a cannula that had been perman-

ently implanted in her stomach through the abdominal wall. They found that the subject increased her arm raising at a relatively consistent rate over the 30 days.

Rice et al. (1968) used operant conditioning techniques with two severe cerebral palsy subjects who were functioning at a behavioral level corresponding to that of a normal three month old child. The objective was to increase the operant rate of an arm movement. Rice et al. (1968) were able to reinforce the small components of the desired arm movement response until the complete act of lifting up the arm was performed. Ice-cream was an effective reinforcer for one subject and movies acted as a positive reinforcer for the other subject. This study was not one of systematically testing a number of stimuli. No description of how the different reinforcers were determined was given.

Bailey and Meyerson (1969) report on the use of vibratory stimulation as a reinforcer. They set out to determine if vibration could be used on a long term basis to maintain a lever pressing response in a profoundly retarded crib-bound child. Their experiment consisted of baseline training during which responses did not produce vibratory stimulation, 21 days of training during which vibration was introduced, and 23 days of extinction. They report that during the 21 days of reinforcement the mean number of responses was more than 1000 per day. During extinction, however, the reduction in lever pressing was drastic with responding dropping to 400 lever presses per day by the end of the first week and to the baseline level of 135 lever presses during the last seven days of extinction. They conclude that vibration was an effective reinforcer for lever pressing over relatively long periods of

time with no noticeable decrement in effectiveness.

Murphy and Doughty (1977) designed a study to investigate whether particular operant procedures would be effective in establishing controlled arm movements in profoundly retarded, multiply handicapped students. They also recognized the possibility of using vibratory stimulation as a reinforcer. The first four weeks of training, during which a downward pull produced five seconds of vibration, resulted in increased rates of responding to an average of 31 responses per session. The next condition, during which an FR 5 schedule was introduced, produced a decrease in rate of responding to an average of 13 responses per session. However, they report that continued application of these procedures was accompanied by an acceleration of response rate to an average of 34 responses per session by the end of the investigation.

Remington et al. (1977) examined auditory reinforcement in four profoundly retarded multiply handicapped children. The study attempted to locate a method of selecting a stimulus with sustained reinforcing properties from a range of auditory stimuli. The children were assessed by the Bayley Infant Development Test and were found to exhibit a mean MA (Motor) of 5.2 months and a mean MA (Mental) of 5.4 months. The average CA of these subjects was 12.8 years. The manipulandum consisted of an omnidirectional lever with an attached 4 cm diameter ball which was mounted over the subject's chair within easy reach. A response was recorded whenever the ball was displaced by 8 mm or more. The reinforcement was a two to five second presentation of spoken/sung nursery rhymes, South American drum music, or country blues music.

Two reinforcers were found for three of the four subjects, while

the fourth was relatively indifferent to all auditory stimuli. For two of the subjects, 5 seconds of rhyme music was reinforcing, while for the fourth, 3 seconds of blues was found to be reinforcing. All three of these subjects responded on low fixed ratio schedules.

An attempt to keep the duration of the reinforcement delivery as short as possible, so that the subject would have less opportunity to emit nonreinforced responses during reinforcer presentation, failed because: (a) on occasion, the subject did not appear to notice the reinforcement, and (b) the onset of the auditory stimulus sometimes elicited a startle response which had not subsided when the stimulus terminated.

These studies are those which have used nondiscriminative operant conditioning techniques with profoundly retarded, multiply handicapped subjects. All have been successful in conditioning some individuals to make the desired response using sensory or appetitive stimuli as reinforcers.

Discrimination Studies

A study by Friedlander et al. (1967) evaluated the behavior of two severely retarded institutionalized children. The first was a 29-month old Down's Syndrome male child with subsidiary cardiac defects who was placed in the 0-10 month range on the Cattell Infant Intelligence Scale. The second subject was a 40 month old male who suffered from multiple congenital defects including cleft palate, bilateral hip dysplasia, left club foot, microcephalus, and multiple anomalies of the dorsal spine and pelvis. He was tested by the Gesell Developmental Schedule and placed in the 24-40 week range.

The apparatus was a compact, portable instrument system which consisted of a play panel attached to an ordinary baby playpen, a response recorder, and a control unit. On the play panel were two large, transparent response knobs, each containing a row of subminiature lamps, loudspeakers, and a door chime. The small red lights blinked continuously in each of the response knobs. A response consisted of a 2 oz. pressure force on a knob. Responses to one knob resulted in tones of an ascending order from an organ; the position of the feedbacks was shifted every three minutes.

Both boys demonstrated highly selective responding. The first subject, who remained in the testing playpen for 36 minutes made 749 responses with 1160 seconds of total response duration. The ratio of his response duration for the sustained feedback (organ) to momentary feedback (chime) was 3:1. The second subject, considered the more seriously handicapped was placed in the playpen for 15 minutes. He made 185 responses, which covered slightly less than five minutes response time altogether. The ratio of his response duration for the sustained feedback over the momentary feedback was 3.5:1. The first subject's response durations were .71 seconds for the momentary feedback and 2.6 seconds for the continuous feedback; whereas, the second subject produced response durations of .66 seconds for the former, and 2.59 seconds for the latter.

Fehr et al. (Note 1) provided four profoundly retarded, multiply handicapped, nonambulatory and nonverbal subjects, 13 to 17 years old, with three kinds of stimuli that they could obtain by pressing three levers positioned in front of them. Lever 1 activated a buzzer, lever

2 activated a vibrator cushion, and lever 3 activated a 100 watt, white bulb which illuminated a translucent, Plexiglas panel. Only one stimulus could be activated at one time and each stimulus presentation lasted 4 seconds. The results indicated that all children were responsive to the three stimuli, but not equally so: a clear preference for vibratory stimulation emerged in the middle sessions but by the end of training each subject responded most frequently to the lever producing the auditory stimulus, with visual stimuli being least preferred. During extinction responding fell to very low levels.

Remington et al. (1977) examined whether differential response rates reflecting preference could be obtained by varying the nature of the reinforcing stimulus. This study employed two subjects who had participated in the experiment described previously. The reinforcers were 5 seconds of nursery rhymes and 5 seconds of a 70 dB, 500 Hz pure tone. The method initially chosen to assess preference was a mixed schedule of reinforcement. During the second phase, a discriminative stimulus was added to produce a multiple schedule procedure. This stimulus consisted of a fluorescent room light kept at full intensity during pure tone components, but reduced to half strength when nursery rhyme components were presented.

A multiple schedule (rhyme 5 seconds-tone 5 seconds) produced a response ratio of 1.42 in one subject and .71 in the other subject, indicating that the first subject preferred the nursery rhyme reinforcer to the pure tone reinforcer and the second subject preferred the pure tone reinforcer to the nursery rhyme reinforcer. The main drawback to the use of the multiple schedule as a preference assessment technique

is that there exists the possibility that responding in one component could be adventitiously reinforced by onset of the second, preferred component.

Haskett and Hollar (1978) examined the responsiveness of four profoundly retarded children to sensory reinforcement. In the first of two experiments, a lever press produced visual stimulation by illuminating the control room. A sequence of four 10 minute components, R R - d o R R , were given during each session of the first phase of the study. In R the light remained on as long as lever pressing was maintained; whereas, during R no illumination occurred. This phase continued until both subjects exhibited clear differences in responding during R and R . Results indicated that a reliable discrimination between the two components was achieved by the fourth session for one subject and by the seventh session for the second subject. This phase was followed by a reversal in the order of components (R R R R), lasting five sessions for one subject and four sessions for the second subject. The third phase consisted of a return to R R R R for four sessions. A fourth phase of continuous extinction (R R R R) was followed by a fifth phase, in which only response dependent components were scheduled (R - d d d d i d i i d i d). Next, sessions of R R R R or R R R R components were given. In R components, response-independent illumination was scheduled. Results indicated that response rates were higher in R than R components.

The second experiment consisted of three experimental phases in which music was used. Two profoundly retarded subjects participated in this study. Each session consisted of two 10 minute components. The

first phase consisted of three sessions in which response contingent music was scheduled in both components ($R^d R^d$). Phase two involved sessions with contingent onset of music in one component and contingent offset of music when the lever was pressed during the other component (R^d). Phase three consisted of sessions in which R^d and R^i components each occurred once in random order within each session. It was clear that the auditory stimulus was more reinforcing for one of the subjects. During the second phase this subject discriminated the R^d component from the R^i component as his responding to the lever during the R^i components was at a very low level in comparison to R^d responding. For the second subject, the reinforcing properties of music were not demonstrated.

Haskett and Hollar also examined the frequencies of three collateral behaviors - vocalizing, stereotyped floor patting, and smiling. These three behaviors were not found to be reliably associated with most experimental conditions. In the behavior of two of their four subjects, an effect associated with changes in experimental conditions was observed. In one subject, the initial stages of new experimental conditions produced an increase in vocalizing; whereas, for a second subject an increase in smiling behavior was seen to occur in the initial change from continuous R^d to $R^d R^d$ conditions during the second experiment.

Present Study

From this review, it appears that in recent experiments the use of food or taste reinforcers with NPMR individuals has been ignored in favor of sensory reinforcers. Although sensory reinforcers have been