

THE UNIVERSITY OF MANITOBA

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

by

LINDA G. SCHWARTZ

A THESIS

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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

found for many subjects, this type of reinforcement has been ineffective for others. Previous studies have utilized either auditory or appetitive reinforcers in operant conditioning experiments with this population, but none of the experiments to date have systematically compared these two different kinds of reinforcers within the same subjects. Rice et al. (1968) did not systematically test the same stimuli with both of their subjects; an appetitive stimulus was used as a reinforcer for one child and a sensory stimulus was used as a reinforcer for a second child.

The present study contributes to the research in this area by developing a procedure for evaluating the effects of a relatively larger number of stimuli. In the present experiment each subject was exposed to both auditory and appetitive reinforcers. Within each type, up to three stimuli were used: 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. With this procedure, the possibility that subjects whose behavior is not affected by sensory reinforcers might react to contingent appetitive stimuli could be explored.

The choice of the various stimuli was determined after reviewing the available literature in the area. Remington et al. (1977) and Haskett and Hollar (1978) found music to be an effective reinforcer for several subjects. Fehr et al. (Note 1) found that their subjects showed as increasing preference over training sessions for chimes as compared with vibratory and visual stimulation. Remington et al. (1977) found spoken/sung nursery rhymes reinforcing for one of their two sub-

jects; however, no other experiment with this type of child has used spoken social reinforcement as a possible reinforcing stimulus. Fuller (1949) found a warm sugar-milk solution to be an effective reinforcing stimulus. Ice-cream was an effective reinforcer for one of the two subjects studied by Rice et al. (1967). Chocolate pudding was chosen as the third type of appetitive stimulus on the basis of comments by the mother of one of the subjects that her profoundly retarded child enjoyed this dessert.

The present study investigated the effects of contingent auditory and appetitive reinforcers on the rate of a headturn response. The subjects were three NPMR adolescents who were capable of some head movements. There were six phases in the study: (a) an initial baseline phase, (b) a test phase using each of the three auditory stimuli until either one or none of these stimuli proved effective, (c) a reversal phase, (d) a second baseline phase prior to using the appetitive stimuli, (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. Three collateral responses consisting of 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.

Method

Subjects

The subjects participating in the present experiment were three NPMR female residents of the St. Amant Centre in Winnipeg. These three NPMR subjects were assigned to 3-West on the basis of their severe mental and physical handicaps. All three subjects were totally dependent individuals who lacked speech and communication skills. They were non-ambulatory, crib bound and tube fed.

Subject 1 was 21 years old. At 2 years of age she was diagnosed as suffering from viral encephalitis and secondary brain damage, resulting in profound retardation. She was an extremely deformed microcephalic with quadrephegia and had a marked scoliosis to the left side. She was found to have considerable flexion contractures in the lower extremities, including hips and knees, and the left hip was completely dislocated.

Subject 2 was an 18 year old female who suffered from Aicardi's Syndrome. This syndrome is characterized by a failure in development of the corpus collosum and by some blindness due to desions in the eyes. She was also a microcephalic and had general spasticity and a seizure disorder. She could track objects and light close to her face and could hear.

Subject 3 was 16 years old. She had suffered from bacterial meningitis at one month of age. Her severe physical handicaps included bilateral high dislocation of the hips, an "S" scoliosis, and flexion contractions on her elbows and wrists.

Apparatus

These subjects were tested in a research room in the Psychology Department. This room was approximately 2.5 m long and 1.9 m wide. They lay in a supine position on a stretcher. Each subject was fitted with an adjustable cap attached to a cable which transferred rotational movements of the head to a cogged wheel which operated a microswitch. A headturn was defined as having occurred when the wheel was moved one notch, about five degrees. The number of headturns and number of reinforcements were recorded on counters and an event recorder. A Sony tape recorder was connected to electromechanical control equipment in such a way that the recorder delivered the auditory stimulus automatically when a headturn was made. During the appetitive stimulus phase of the experiment a light on the experimenter's control box came on when a criterion response was made.

The auditory stimuli consisted of cassette recordings of (a) country and western music, (b) social reinforcement consisting of the experimenter saying, "Good girl", "That's the way", "What a clever girl", and (c) chime tones produced by recording a doorbell. The appetitive stimuli consisted of (a) Laura Secord chocolate pudding, (b) vanilla ice-cream in individual Dixie cups, and (c) a sugar milk solution consisting of 4.1 g of sugar dissolved in .1 litre of milk.

All the electromechanical control equipment was located in a room adjoining the testing room. This room was equipped with a one way mirror to observe other activities of the subjects (arm movements, whether their eyes were open or closed, and vocalizations).

Procedure

There were six major phases in the study: a baseline phase, a phase using contingent auditory stimuli, a reversal phase, a baseline phase prior to using the appetitive stimuli, a phase involving contingent appetitive stimuli, and a second reversal phase. The schedule employed was continuous reinforcement and duration of the reinforcement was 6 seconds. The two phases involving response contingent stimuli included the testing of up to three different auditory or appetitive stimuli. The experimenter was present in the testing room to deliver the appetitive stimuli, but was not present during presentation of auditory stimuli.

Each weekday, the subjects were brought separately to the training room for a sixteen minute session. In this room they were fitted with the adjustable cap and left lying on the stretcher. The room lights were left on during the entire session.

The procedure used to test the stimuli is outlined in a flow diagram in Figure 1. The baseline procedure consisted of recording the number of headturn movements, no reinforcement was given during this phase. The first auditory stimulus was introduced to one subject per day over three successive days. This procedure was decided upon to counteract any events which may have occurred prior to the subjects being removed from the ward for the first auditory stimulus session. The subject with the least variable baseline data (Subject 1) received eight sessions, Subject 2 received nine baseline sessions, and Subject 3, the subject with the most variable baseline data, received ten baseline sessions. Since all three subjects were found to display headturn

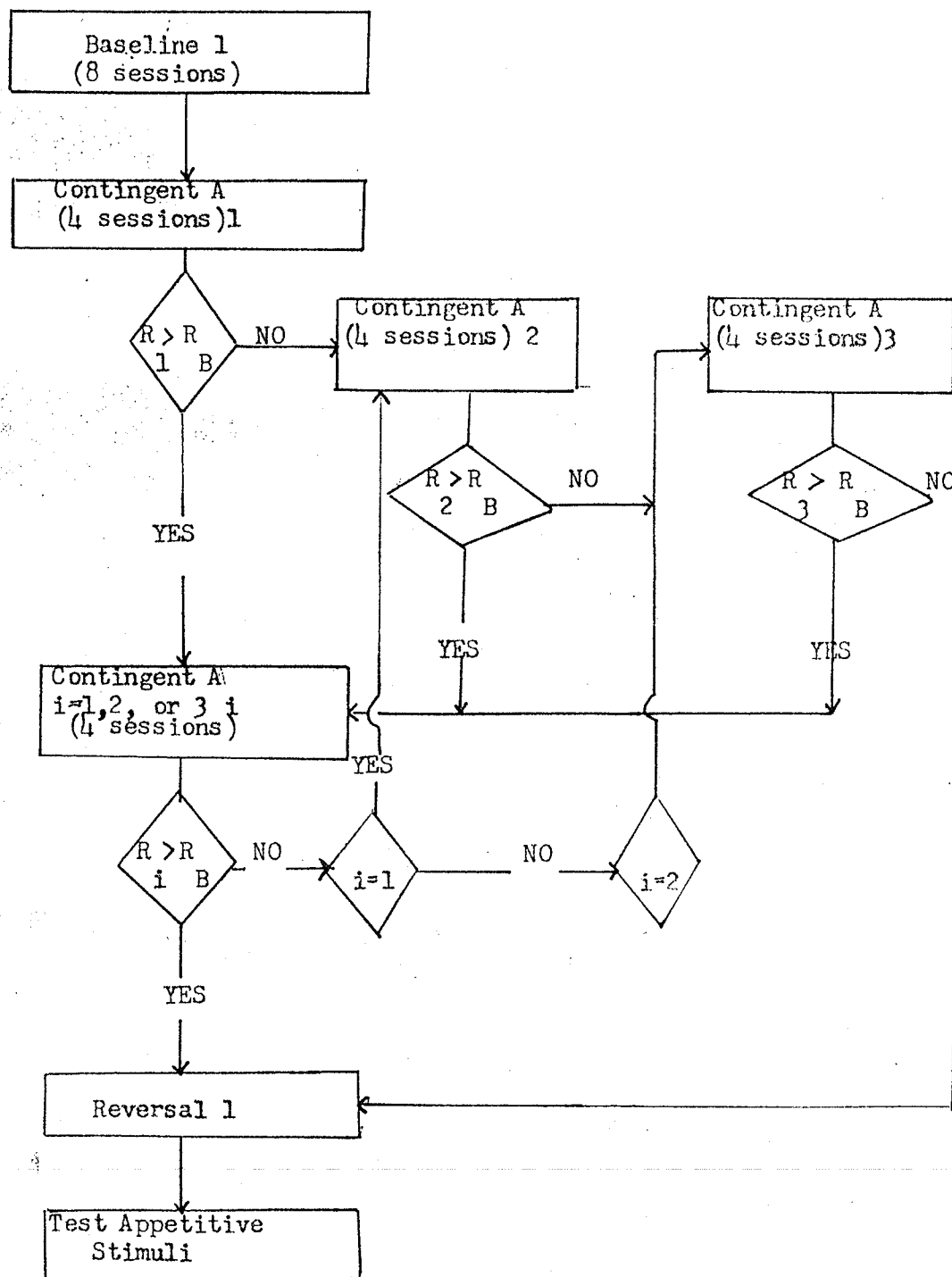


Figure 1. Flow diagram showing major steps in the procedure for testing country and western music (A_1), social reinforcement (A_2), and chimes (A_3) by comparing the response rates produced by these stimuli (R_1 , R_2 , R_3 , respectively) with the baseline rate (R_B).

movement during this phase the next phase consisted of using one of the three auditory stimuli as a reinforcer for four sessions. The first auditory stimulus (A_1) was country and western music. If results indicated an increase in response rate ($R_1 > R_B$) with this first auditory stimulus, a further four test sessions were given to examine the stability of the change in behavior. If results over the additional four test sessions indicated a stable change in behavior with A_1 , the first reversal phase was begun. Failure to maintain an above baseline rate of responding with A_1 resulted in implementation of contingent social reinforcement (A_1). If social reinforcement was ineffective, chimes (A_2) were introduced. If no consistent change in behavior was obtained with any of the three auditory stimuli, the Reversal 1 phase was conducted for 8 sessions - no stimuli were presented during this phase.

Following Reversal 1, a four session baseline phase was used to test the effects of the experimenter's presence on headturning. During these four sessions, the experimenter sat in the testing room orienting herself to the side from which she would deliver the appetitive stimuli. The same procedure described for testing the auditory stimuli was followed using the three different appetitive stimuli. Following each headturn, a $\frac{1}{4}$ of a teaspoon of the first appetitive stimulus, chocolate pudding, was fed to each subject. The number of reinforcements given was recorded by the experimenter who pressed a button on the control box as she delivered the reinforcement. If an increase rate was found to occur over the first four sessions using this stimulus, a further four test sessions followed. If no change in behavior was seen to occur (results being comparable to baseline rates), the study continued

using the second appetitive stimulus, ice-cream, as the reinforcer. If ice-cream did not change the response rate, a final series of four sessions commenced using sugar milk solution as the reinforcer. The final phase, Reversal 2, consisted of eight baseline sessions during which the experimenter again sat in the testing room, orienting herself to the side from which she had fed the subject, but not delivering appetitive stimuli.

The number of headturn responses and the number of reinforcements were recorded for each session. The rate of reinforcement was calculated by dividing the number of reinforcements by the time left in the session when the total reinforcer presentation time had been removed ($\text{Number of reinforcements} / (16 - (\text{Number of reinforcements} \times 6/60))$).

Three collateral responses were observed during the first half of the study. These behaviors were arm movements, vocalizations, and whether the subject kept her eyes open or closed. An arm movement was defined as any arm movement in any direction; a vocalization was defined as any audible sound except a cough, sneeze, hiccup, yawn, teeth grinding, heavy inhalation or exhalation; eyes open was defined as the subject's eyes being open at the minute observation. During each minute each subject was monitored for these responses and they were recorded on the data sheet.

Results

The rate of headturning and rate of reinforcement were calculated at the end of each session and graphed for each subject. During baseline and reversal sessions, rate of reinforcement was based on the number of reinforcers that would have been delivered if reinforcers had been available. Headturns made during the six second reinforcer presentation time were also recorded and included in the rate of headturning; however, these responses were not reinforced and did not influence the rate of reinforcement measure. A criterion response was reinforced only if it occurred after the end of the six second reinforcement presentation period.

Subject 1

Figure 2 shows the number of headturns per minute and number of reinforcements per minute in each session for Subject 1. During Baseline 1, number of headturns per minute ranged from 0 to 1.1 and the number of reinforcements per minute ranged from 0 to .39. During country and western music, responding began to increase; an extra session (session 13) was included to see if this pattern could be maintained but performance dropped sharply. Rate of headturning ranged from 0 to 2.5 and rate of reinforcement ranged from 0 to .74 over the four sessions. The next four sessions with social reinforcement produced results similar to the baseline sessions with .19 to .74 headturns per minute and .13 to .39 reinforcements per minute. Chime tones, the final auditory stimulus, produced an increased rate of responding in sessions 18 and 19; however, response rates fell over the last two sessions using this stimulus. The results with chime tones were .19 to 2.69 headturns per

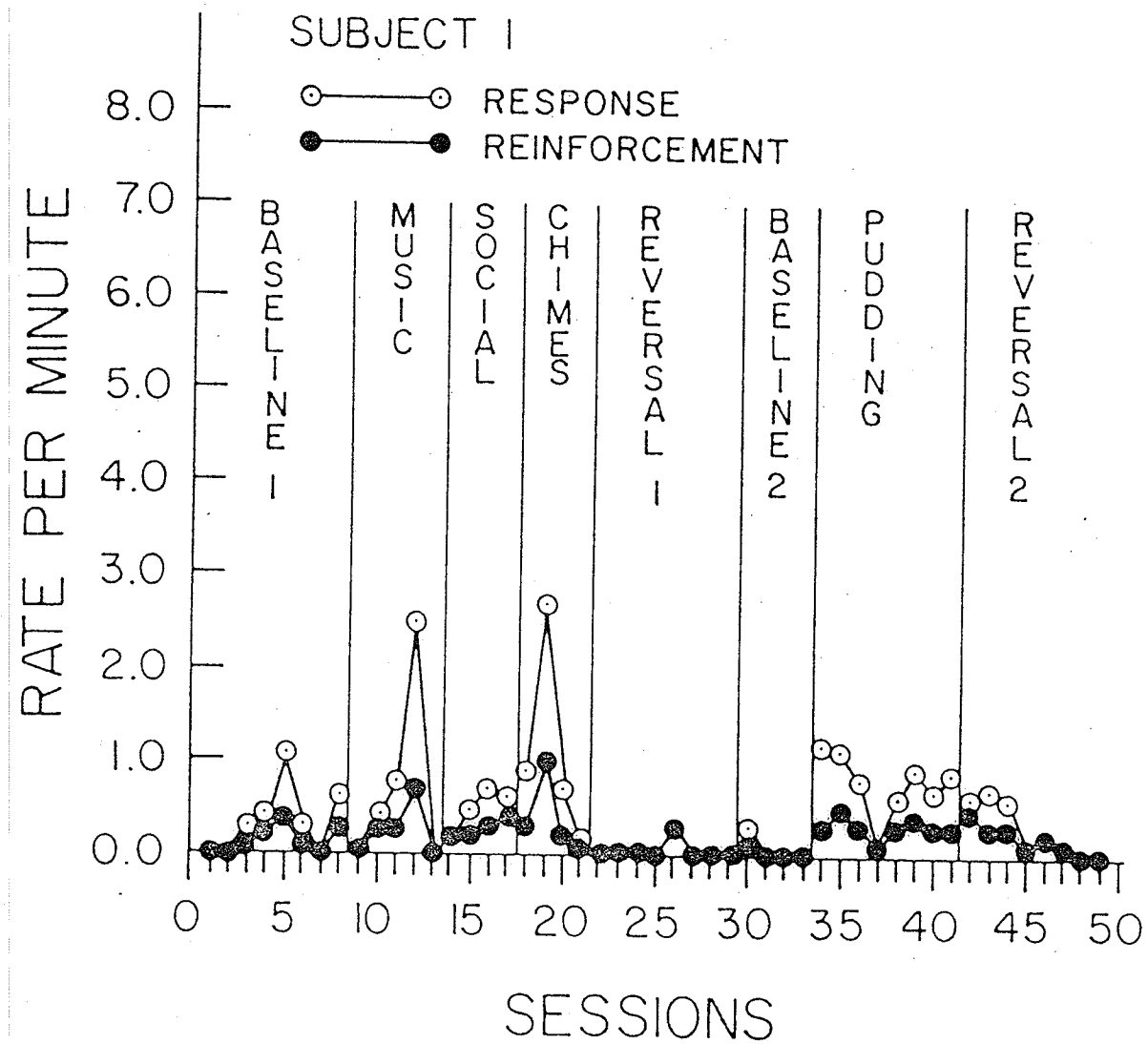


Figure 2. Rate of headturns and reinforcement per minute for Subject 1.

minute and .13 to .97 reinforcements per minute. This subject did not respond during seven of the eight Reversal 1 sessions.

Baseline 2 followed the reversal condition to examine whether the experimenter's presence would have an effect on responding. As Figure 2 indicates, no effect was found and results were comparable to the previous reversal condition. The first appetitive stimulus introduced, chocolate pudding, produced an increase in responding. Both rate of headturning and rate of reinforcement were higher than Baseline 2 rates and the elevated rate was maintained over three of the initial four sessions. A further four sessions were included to examine the stability of this change in behavior. Response rate in the fifth session rose to levels seen in the first three sessions. Number of headturns per minute using chocolate pudding as the appetitive stimulus produced results ranging from .13 to 1.19 headturns per minute and from .06 to .53 reinforcements per minute. Responding over the first three sessions of the Reversal 2 phase was higher than in Baseline 2; however, responding fell to levels similar to Baseline 2 in the fourth session and remained at this level. This final reversal condition resulted in 0 to .69 headturns per minute and 0 to .53 reinforcements per minute. During some sessions, when chocolate pudding was used, this subject would grind her teeth together as soon as the adjustable cap was put on her head and she immediately made a headturn. This behavior continued to occur during the first four sessions of the Reversal 2 phase.

Three collateral responses were observed during the first half of the study - arm movements, vocalizations, and whether the eyes were open or closed. These responses were monitored at one minute intervals

over the 16 minute sessions. Figure 3 shows the number of intervals in which arm movements, vocalizations, and closed eyes were observed during the first 35 sessions. The only pattern of change was that the subject's eyes were closed for six or more intervals in six of the eight Baseline 1 sessions but were closed for this number of intervals in only one of the 25 sessions following Baseline 1. This subject made only one arm movement and no vocalizations.

Subject 1 did not increase her rate of headturn movements in any of the auditory stimulus conditions; during the chocolate pudding sessions her rate of headturning increased as compared with Baseline 2 performance.

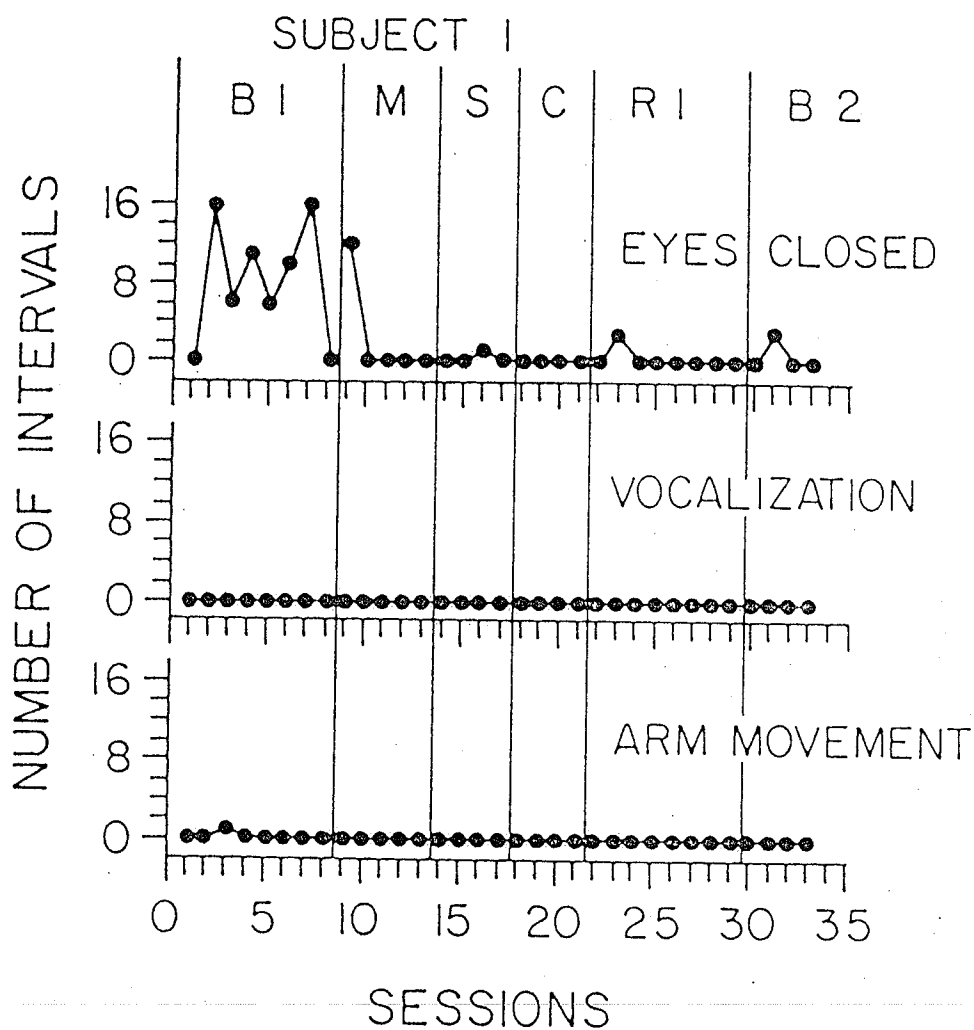


Figure 3. Number of one-minute intervals during which collateral responses occurred during Baseline (B.), Social¹ Reinforcement (S), Chimes (C), Reversal 1 (R1) and Baseline 2 (B2).

Subject 2

Figure 4 shows the number of headturns and number of reinforcements per minute for Subject 2. During the nine baseline sessions, the number of headturns per minute ranged from .06 to 1.79 and the number of reinforcements per minute ranged from .06 to 1.03. When country and western music was introduced, responding showed a steady increase over a further four test sessions. During the last four sessions of country and western music, response rates were consistently higher than Baseline 1 rates. The next condition, Reversal 1, resulted in a decrease in responding for the first three sessions as compared with the last four sessions of country and western music but response rates were variable during the remaining five reversal sessions and were not consistently below rates during the music condition. Headturns per minute ranged from .26 to 2.75 over the Reversal 1 sessions. The range of headturns per minute was 2.45 compared to a range of headturns per minute in Baseline 1 of 1.73.

During Baseline 2, when the experimenter was present in the testing room, responding did not change from Reversal 1 levels. Over these four sessions the number of headturns per minute ranged from .29 to .81. Ice-cream was the first appetitive stimulus introduced. As can be seen from Figure 4, results using ice-cream for four sessions were from .12 to .50 headturns per minute and .06 to .53 reinforcements per minute. The range of headturns per minute using ice-cream was only .38 as compared with 1.32 in Baseline 2. Since this rate was not greater than Baseline 2, chocolate pudding was introduced over the next four sessions. With chocolate pudding, the number of headturns per minute

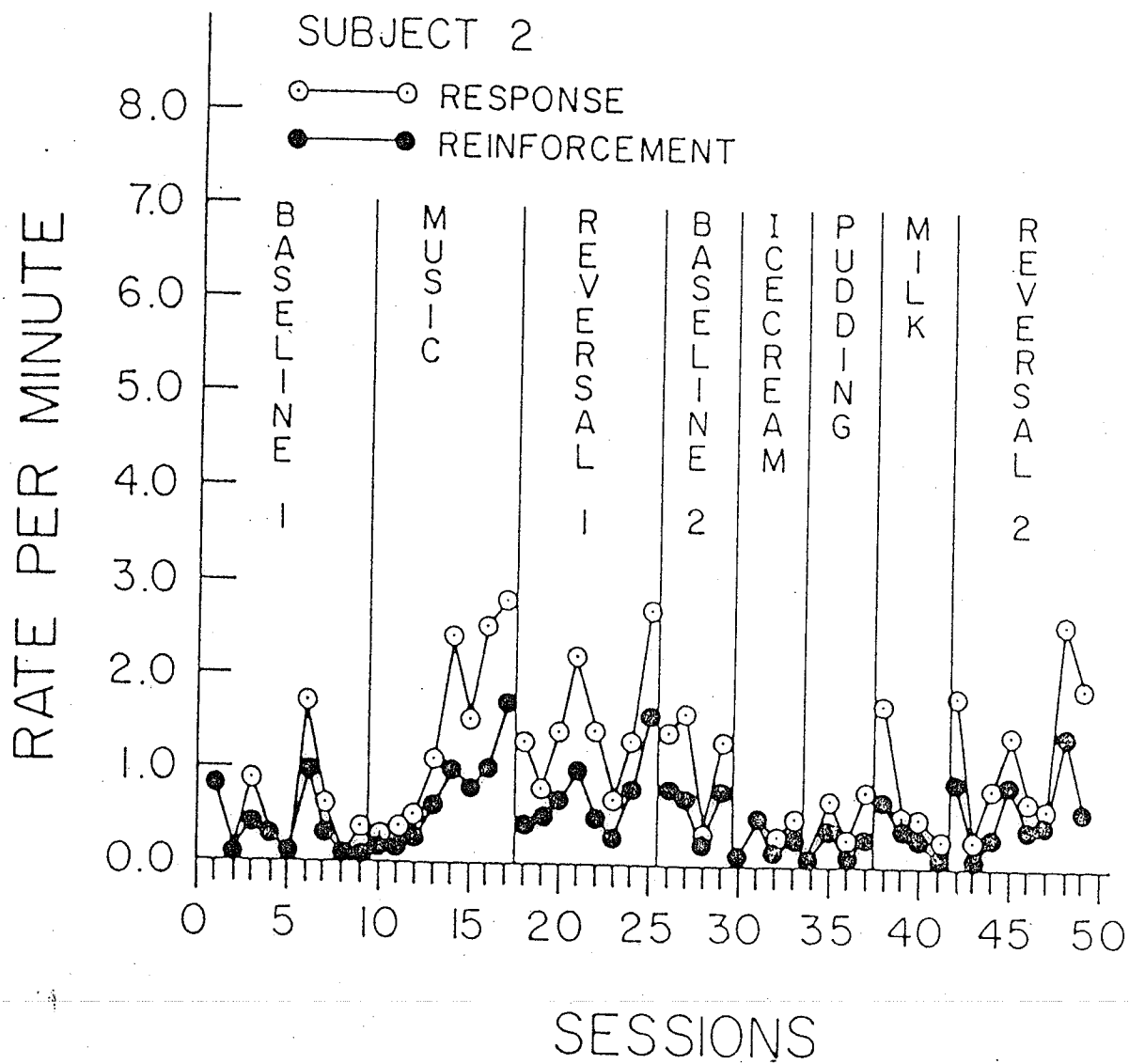


Figure 4. Rate of headturns and reinforcement per minute for Subject 2.

ranged from .06 to .81. The rate of headturning was lower during ice-cream and chocolate pudding than during Baseline 2. The final appetitive condition, using sugar milk solution, produced results of .25 and 1.89 headturns per minute and from .13 to .68 reinforcements per minute. During the first session using the sugar milk solution, responding rose to a higher level than in the other two appetitive conditions; however, it fell during the last three sessions of this condition. Response rates during the final condition, Reversal 2, were similar to Baseline 2 rates. Reversal 2 yielded results for number of headturns per minute ranging from .25 to 2.56 and reinforcements per minute ranging from .13 to 1.35 over the concluding eight sessions.

Figure 5 shows the number of one minute intervals in which arm movements, vocalizations, and closed eyes were observed. Subject 2 was the only subject who made arm movements and kept her eyes open during all sessions. The stimulus manipulations did not appear to produce any changes in these behaviors.

This Subject's headturning was affected by an auditory stimulus, country and western music. However, her behavior could not be brought under reinforcement control using any of the three appetitive stimuli.

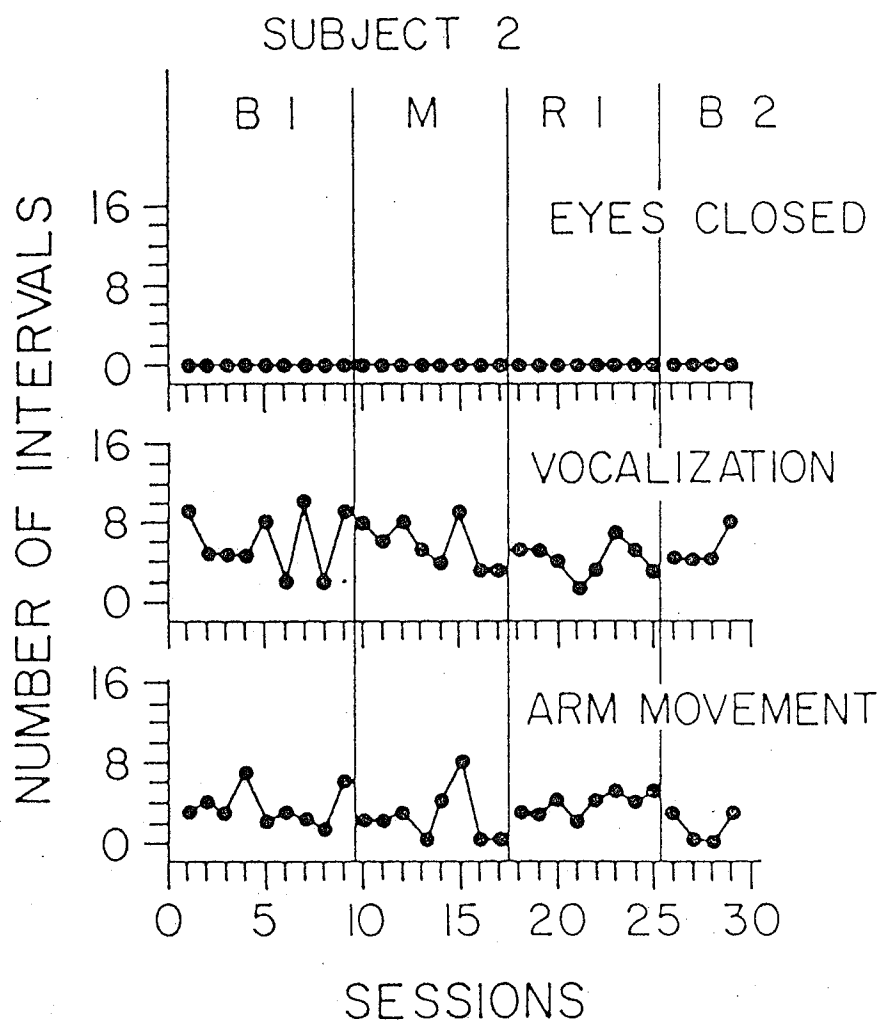


Figure 7. Number of one-minute intervals during which collateral responses occurred during Baseline 1 (B1), Music (M), Social Reinforcement (S), Chimes (C), Reversal 1 (R1) and Baseline 2 (B2).

Subject 3

Figure 6 shows rate of headturns and rate of reinforcement for each session for Subject 3. Number of headturns per minute ranged from .32 to 5.8 over the 10 Baseline 1 sessions, while number of reinforcements per minute ranged from .19 to 3.7. The next four sessions involved the presentation of country and western music. Number of headturns per minute ranged from .44 to 3.43 and number of reinforcements per minute ranged from .32 to 1.75. As can be seen in Figure 6, this rate was not consistently different from baseline performance. Social reinforcement was the next stimulus introduced for four sessions. Again, as Figure 6 indicates, the rate of responding was not different from Baseline 1 data. This stimulus yielded .38 to 2.25 headturns per minute, and .19 to 1.6 reinforcements per minute. The final auditory stimulus, chime tones, was introduced for four sessions. Responding increased during the first session but then fell to levels comparable to the social reinforcement condition. Rate of headturns over the four sessions with chime tones ranged from .29 to 3.45. The next condition, Reversal 1, was conducted for eight sessions and rate of headturning and reinforcement did not show a consistent change over these sessions. The range of headturns per minute in the Reversal 1 condition (0 to 2.5) was lower than the range during Baseline 1 (.32 to 5.8).

Baseline 2 data indicates that the experimenter's presence in the testing room did not affect the subject's response rate as response rates were comparable to those in the Reversal 1 phase. This baseline condition, lasting for four sessions, yielded results of .12 to 2.38 headturns per minute and .13 to 1.14 reinforcements per minute.

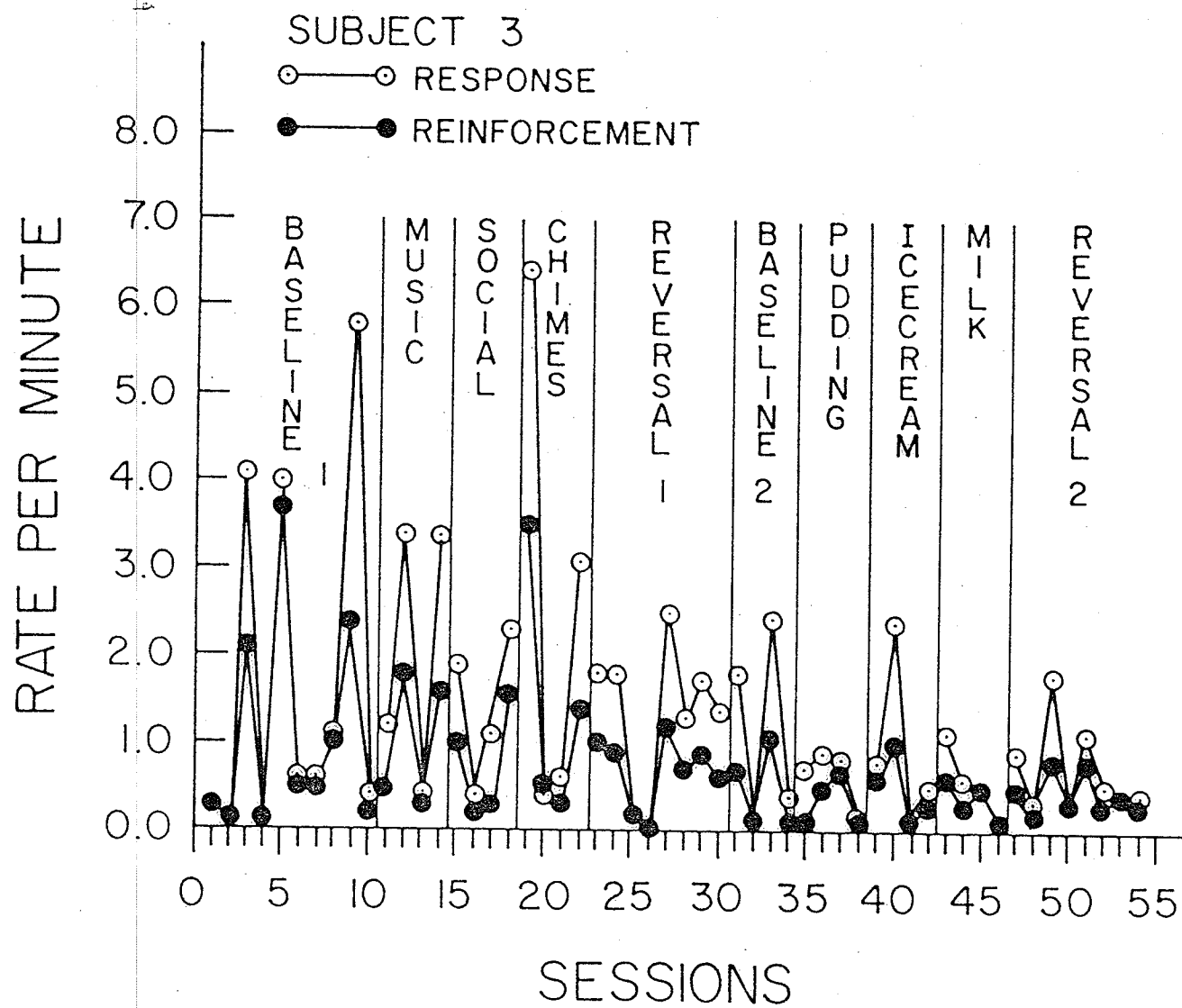


Figure 6. Rate of headturns and reinforcement per minute for Subject 3.

Chocolate pudding was the first appetitive stimulus introduced for the next four sessions. This stimulus produced .13 to .88 headturns per minute and from .06 to .88 reinforcements per minute. As Figure 6 shows, this was not consistently different from Baseline 2 performance. Contingent ice-cream resulted in an increase in response rate during the next two sessions; however, this increase was not maintained over the last two sessions and rates overall were similar to Baseline 2 rates. The final appetitive stimulus, sugar milk, also failed to result in an increase in response rate. Results with this stimulus ranged from .13 to 1.13 headturns per minute and from .06 to .60 reinforcements per minute. The final condition, Reversal 2, produced results of .25 to 1.8 headturns per minute and .19 to .81 reinforcements per minute over eight sessions.

Figure 7 shows the number of intervals during which each of the collateral responses were observed for each session to the end of Baseline 2 for Subject 3. For this subject, arm movements did not occur during any of the sessions. She vocalized during some sessions in each phase of the study and during every session of country and western music and social reinforcement. Her eyes were open during most sessions, notable exceptions were session 2 (16 intervals with eyes closed) and sessions 4, 17, and 23 (five or more intervals with eyes closed).

Subject 3 was not found to increase her rate of headturning when any of the three auditory or three appetitive stimuli were introduced.

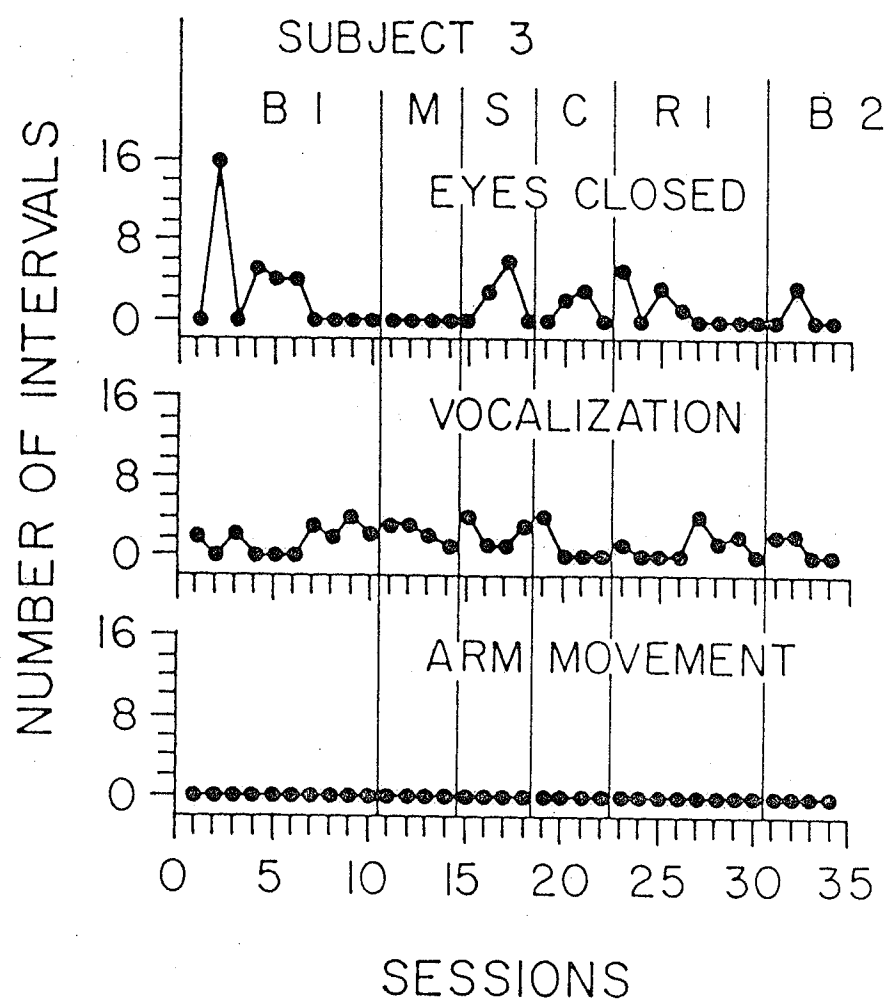


Figure 5 . Number of one-minute intervals during which collateral responses occurred during Baseline 1 (B1), Music (M), Social Reinforcement (S), Chimes (C), Reversal 1 (R1) and Baseline 2 (B2).

Discussion

Subject 1 did not increase her rate of headturning in any of the auditory stimulus conditions. However, during the appetitive stimulus condition utilizing chocolate pudding, her rate of headturning increased as compared with Baseline 2 and Reversal 2 performance. Chocolate pudding might have acted as a positive reinforcer for this Subject. A major problem in interpreting the data arises from the possibility that the pudding stimulus may have elicited headturning. Subject 1 continued to respond for the first three sessions of Reversal 3 before responding dropped to zero for the last five sessions. These results suggest that the increase in response rate during training was not due to an eliciting effect since responding continued in the absence of the stimulus during early reversal sessions.

Subject 2 was found to increase her rate of headturning to one auditory stimulus condition, country and western music. However, during the appetitive stimulus condition, her behavior could not be brought under reinforcement control. Again the eliciting effects of the stimulus may account for this apparent change in response rate. There is no clear evidence to refute this possibility since response rates did not decline gradually during Reversal 1 sessions.

Subject 3 was not found to increase her rate of headturning when any of the three auditory or three appetitive stimuli were introduced.

An eliciting effect rather than a contingency effect may have accounted for the results. To determine if this was in fact the case, response independent presentations of the stimulus, similar to the procedure used by Haskett and Hollar (1978), would be needed. In their ex-

periments, periods of response-dependent reinforcement and response-independent reinforcement were included within each session. If there is a contingency effect, results would show a definite and consistent decline in response rate indicating that responding was decreasing during response-independent components. However, if responding continued at the same levels during these components an eliciting effect of the stimulus would be implicated.

The results of this study support previous research showing that auditory and appetitive stimuli can be used with the NPMR population, since one auditory and one appetitive stimulus was found to control headturning. The more recent literature dealing with this subject population has focused on the use of sensory stimulation to the exclusion of appetitive stimuli (Bailey and Meyerson, 1969; Remington et al., 1977; Rice et al., 1967; Fehr et al., Note 1). The results from the present study suggest that a more profitable avenue of research with these subjects might be a return to exploring appetitive stimuli as well as sensory reinforcers since one of the subjects was found to increase the rate of the operant response when an appetitive stimulus was used but not when sensory stimuli were introduced.

The problems encountered in the present study using appetitive stimuli included some reported by other researchers. Consumables have been rejected by other researchers because delivery is not easily automated for liquids or spoon feeding. Rice et al. (1968) had difficulty using consumables with this population as did Fuller (1949) who used a syringe filled with the reinforcing liquid. In the present study it was difficult to spoon feed all three subjects, especially Subject 2

and Subject 3. These subjects were not accustomed to being spoon fed and Subjects 2 and 3 turned their heads away when the spoon was introduced into their mouths. Subjects 2 and 3 also tended to close their mouths when the appetitive reinforcement was delivered. Subject 1 who was found to increase her headturning response rate to chocolate pudding was never seen to close her mouth or turn away from the spoon. For Subject 2 and Subject 3, appetitive stimuli appeared to function as punishing stimuli as the rate of headturning during appetitive stimuli was somewhat lower than in Baseline 2 and Reversal 2. Rice et al. (1968) found that some consumables, especially candies, seemed to function as punishing stimuli.

The amount fed to the subject also may have contributed to the appetitive stimuli being aversive. It was felt by the experimenter, after the study had been completed, that a smaller amount of the stimulus might produce better results. Although only a $\frac{1}{4}$ of a teaspoon of the particular stimulus was used, Subject 2 and 3 spat most of it out. The amount given may have made feeding an aversive event for these two subjects. On the other hand, the tastes of the appetitive stimuli may have been aversive. However, with Subject 1, very little was actually not ingested. Once in her mouth she would grind her teeth together and only a very small amount ran out of her mouth onto a bib. Rice et al. (1968) found ice-cream to be a reinforcing stimulus but found that most of it was not ingested but ran out of the subject's mouth onto a crib sheet. A smaller amount may be all that is required for the subjects to taste the stimulus.

Satiation, a problem encountered by Rice et al. (1968), did not

appear to be a problem with Subject 1 who was responsive to chocolate pudding. Her response rates did not drop during these sessions and she continued to respond over the pudding training sessions.

In the present study it was sometimes difficult to dispense the appetitive stimulus by hand and record a reinforcement on the electro-mechanical equipment before a nonreinforced headturn had taken place. This problem, although it occurred only a few times, was found to have occurred for Subjects 2 and 3 who turned their head during reinforcement presentation. Future studies should avoid this problem so that a definite CRF schedule is maintained throughout the entire study and no nonreinforced responses occur. To accomplish this, a more direct means of feeding the subjects would be needed.

The inconvenience of delivering the food by spoon with these subjects is a problem which future studies could possibly overcome. Fuller (1949) was able to use a syringe and inject the sugar milk solution directly into his subject's mouth. Piper and MacKinnon (1969) used a permanently implanted cannula to deliver the reinforcing liquid. The subjects in the present study had their meals delivered through nasogastric tubes. Future studies could explore the possibility of feeding the subjects the different appetitive stimuli through their nasogastric tubes. Such procedures might be better than the procedure of spoon feeding used in the present study.

Rice and McDaniel (1966) reported the phenomenon of "spontaneous extinction". Here, for unknown reasons, a subject would respond at a high rate and then drop in response rate over a period of two or three sessions. This phenomenon has not been seen in subsequent studies (Rem-

ington et al., 1977), nor was it found in the present study.

Another issue which is of relevance to the researcher involved with this subject population is the great deal of time required to shape-up a desired response (Rice and McDaniel, 1966). In the present study shaping was not a problem, since all of the subjects were capable of some headturn movement.

A CRF schedule of reinforcement was employed in the present study. Rice et al. (1968) suggest that such a schedule be employed initially since it produces responding at a moderate, fairly constant rate. However, they suggest that researchers then shift to a fixed ratio schedule. The advantages of using a ratio schedule include an increased rate of responding and a delay of satiation. Before implementing a ratio schedule the subject must show a consistent response rate on a CRF schedule. It was not reasonable to implement such a schedule with any of the three subjects involved in the present study because Subject 1 had a very low response rate and Subject 2 was inconsistent in responding.

The automated delivery of auditory stimuli ensured immediate reinforcement of a response and headturns made during the six second stimulus presentation were not reinforced. Future studies might consider employing different types of music since, of the three different auditory stimuli introduced, only country and western music showed some evidence of being reinforcing. Neither social reinforcement nor chime tones produced changes in behavior. By using other forms of music, e.g. Blues, or sung nursery rhymes, more impressive results may be found. Remington et al. (1977) found such music reinforcing for three of their four

subjects.

It is very difficult to predict which stimuli will be effective for an NPMR subject. An efficient method for testing a large number of stimuli is required. In the present experiment each stimulus was employed for a four session test period but it is possible that more than four sessions may be necessary to adequately test a stimulus.

Other studies which have employed more test sessions have not found that the added sessions contributed to a different decision concerning the effectiveness of the stimulus. Haskett and Hollar (1978) included extra test sessions with one of their subjects and found no behavior change. In the present study, Subject 1 was given an extra session with country and western music but this did not result in a change in the evaluation of the stimulus.

Social reinforcement was chosen as one of the three auditory stimuli to be presented to the subjects. This particular auditory stimulus has never been used in any of the previous research. This stimulus was not effective for the NPMR subjects involved in this study.

Examination of the three collateral responses indicated that Subject 1 kept her eyes open during the auditory stimulus presentation conditions but not during the initial baseline condition. The auditory stimulus may have resulted in a change in behavioral state that persisted throughout the remaining sessions. For Subject 2 and Subject 3 there was no change in the three collateral responses examined during stimulus presentation conditions and Baseline conditions. These results agree with Haskett and Hollar (1978) who also found no clear relationship between collateral behavior and changes in stimulus condi-

tions.

Previous studies have not compared the effectiveness of appetitive and sensory stimuli within the same individuals. The present experiment employed a systematic method of testing different stimuli as potential positive reinforcers. This method of systematic testing allowed up to six different stimuli to be tested in a relatively efficient manner. Results indicated that one auditory stimulus, country and western music, and one appetitive stimulus, chocolate pudding, appear to function as positive reinforcers. The approach to studying potentially reinforcing stimuli employed in this study provides a useful means of identifying positive reinforcers for NPMR individuals. With such a method designed, implemented and tested here, future research can build and expand on this base.

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