An Analysis of Potential Adjunctive Behavior in Two Developmentally Disabled Subjects

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AN ANALYSIS OF POTENTIAL ADJUNCTIVE BEHAVIOR IN TWO DEVELOPMENTALLY DISABLED SUBJECTS

by

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AN ANALYSIS OF POTENTIAL ADJUNCTIVE BEHAVIOR
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Past research on adjunctive behavior in humans has generally not employed methods which are comparable to those included in studies of adjunctive behavior in nonhumans. Consequently, the results of these studies are often difficult to interpret. The present study examined locomotor movement and salient self-stimulatory behaviors in two developmentally disabled students exposed to four fixed-interval (FI) schedules of food delivery (FI 16-, 60-, 120-, and 240-sec). Results of this study were analyzed according to whether the seven defining characteristics of the prototype of adjunctive behavior, polydipsia, were present. Locomotor movement and nut manipulation evidenced several of the defining characteristics. Characteristics of self-stimulatory behaviors of both subjects were similar to those of schedule-induced polydipsia under some schedules but different under other schedules.
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Nancy K. Brhely
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CHAPTER I

INTRODUCTION

Since Falk's discovery of schedule-induced polydipsia in 1961, adjunctive behavior has been the focus of extensive experimentation. Falk found that when food deprived rats were allowed free access to water during intermittent schedules of food presentation they drank up to one-half of their body weights within a single session. Since then, further investigations have identified the intermittency of the food schedule as the inducing factor of unexpected excessive behavior. Other nonhuman subjects such as mice, pigeons, rhesus monkeys, and hamsters have been studied for evidence of the generality of adjunctive behavior. In addition, other behaviors such as air-licking, attack, wheel-running, pica, eating, and drug self-injection have been offered as adjunctive activities (for reviews see Falk, 1971; Roper, 1981; Staddon, 1977). Due to the somewhat weak and variable nature of some of these activities (e.g., wheel-running), schedule-induced polydipsia is still generally considered the prototype of adjunctive behavior (Roper, 1981).

Falk (1971) has defined adjunctive behavior as "behavior maintained at high probability by stimuli whose reinforcing properties in the situation are derived primarily as a function of schedule parameters governing the availability of another class of reinforcers" (p. 586). Yet even with a relatively clear and generally agreed upon definition of this phenomenon, researchers are
still exploring several explanations for schedule-induced behavior. In the face of this uncertainty, extending findings from the nonhuman laboratory to human behavior is bound to be difficult. As observed by Poppen (1982), "Extrapolating from the laboratory to other situations is a risky business in that the presence of many more variables and their interactions were likely to obscure the relationships observed under controlled conditions" (p. 128). Moreover, some of the factors that contribute to adjunctive behavior cannot be arranged with humans. For example, food deprivation plays an important role in engendering schedule-induced drinking, but for ethical and moral reasons, a strong food deprivation cannot be arranged in studies with humans.

Nevertheless, several investigators have attempted to use data from studies of adjunctive behavior exhibited by nonhumans in the laboratory to account for some behaviors of human subjects in their everyday environment. Falk (1971) himself has suggested that adjunctive behavior demonstrated in the laboratory is similar to the stereotyped responses shown by institutionalized mentally-retarded individuals. Behaviors such as movement, eating, drinking, grooming, nail-biting, and doodling have been offered as adjunctive activities engendered by inducing schedules found in classroom, home, office, and ward routines (Foster, 1978). If some of these activities are indeed adjunctive in nature, it would be to our benefit to identify them as such and alter the inducing schedules appropriately, instead of attempting to directly modify them by using medication or other consequences (Foster, 1978).
A number of studies have addressed the issue of schedule-induced human activities and purportedly have demonstrated adjunctive behavior in humans under intermittent schedules of reinforcement (e.g., Cantor, Smith, & Bryan, 1982; Kachanoff, Leveille, McLelland, & Wayner, 1973; Wallace & Singer, 1976). Although it is quite plausible that several human activities are adjunctive in nature, it is still questionable whether previous research has clearly demonstrated its existence in human subjects. When polydipsia is accepted as the prototype, because it is the most studied and robust of behaviors considered adjunctive, it is reasonable to expect other behaviors labeled as adjuncts to exhibit similar characteristics (Falk, 1971, 1981).

In order to demonstrate the similarities between certain human behaviors and polydipsia, the conditions of investigation should be similar. Several researchers have cited the need to equate the procedures used in human studies to those which have induced adjunctive behavior in nonhumans (Cherek, 1982; Fallon, Allen, & Butler, 1979; Porter, Brown, & Goldsmith, 1982; Wallace & Oei, 1981; Wallace, Sanson, & Singer, 1978). The majority of experiments with nonhumans involve the intermittent presentation of food reinforcement as the inducing stimulus. Wallace et al. (1978) attempted to satisfy this condition by intermittently presenting small sugar-coated chocolate candies to induce movement in human subjects. Following an extinction baseline session (no food), the total number of reinforcers were made available at the beginning of the session (ad
lib food condition). Food reinforcers were then presented on a fixed-interval 60-sec (FI 60-sec) schedule contingent upon key pressing. In general, results indicated that the presence of ad lib food increased movement scores when compared to the extinction session (no food), but there was no difference in behavior during ad lib food and FI 60-sec food conditions.

Wallace et al. (1978) concluded that human subjects exhibit adjunctive behavior on food delivery schedules as do other species. Yet, it has been suggested that a massed-reinforcer baseline must be combined with an extinction baseline in order to properly evaluate increases in the target behavior (Roper, 1981). The ad lib food condition (massed-reinforcer) in this study would have more appropriately been considered part of the baseline condition. Since the authors found no difference between the ad lib food conditions and intermittent schedule conditions, this study does not qualify as clear evidence of adjunctive behavior in humans.

Porter et al. (1982) addressed both the need for employing a conventional primary reinforcer and a massed-feeding or continuous reinforcement baseline when studying adjunctive behavior in humans. In their study, small candies were used to induce movement, drinking, and vocalizations in four children exposed to FI 30-sec and FI 60-sec schedules. All four subjects exhibited increased movement on FI schedules when compared to fixed-ratio 1 (FR 1) baseline conditions, but drinking and vocalizations were not as reliably induced. Porter et al. (1982) consider the FR 1 schedule employed in this study an "appropriate" baseline against which to evaluate changes in target
behaviors. Yet, according to Roper (1981), comparing behavior exhibited under an intermittent schedule to that displayed under an FR 1 baseline schedule has two problems: (1) it is impossible to equate both the number of reinforcers per session and session duration because the rate of reinforcement will be lower in the intermittent condition, and (2) FR 1 schedules allow the organism to engage in practically continuous consummatory behavior which leaves no time for any schedule-induced activity (other activities cannot compete with consummatory behavior).

In summary, it has been suggested that several human activities are adjunctive in nature, but evidence offered by previous research has not entirely substantiated this claim. Several investigators have identified the need to study human adjunctive behavior under conditions similar to those employed in the laboratory with nonhumans. In general, the present study was an attempt to extend the procedures used in nonhuman investigations of adjunctive behavior to human studies to determine if subjects exhibit adjunctive behavior having characteristics similar to that of schedule-induced polydipsia in nonhumans.

Previous studies have met some, but not all, of the necessary procedural conditions (e.g., appropriate baselines) and they have examined some, but not all, of the defining characteristics of adjunctive behavior as enumerated by Falk (1961, 1977, 1981). Schedule-induced polydipsia (SIP) is the most studied form of adjunctive behavior and its defining characteristics are as follows:
SIP (a) requires an intermittent inducing schedule to appear, (b) is persistent and excessive, (c) develops gradually, (d) appears in all (or almost all) members of a species exposed to appropriate conditions, (e) is bitonically related to interfood interval, (f) occurs immediately following delivery of each reinforcer, and (g) varies directly with level of food deprivation (Falk, 1971, 1977, 1981).

As noted previously, this final characteristic of schedule-induced polydipsia cannot ethically be examined with human subjects. Yet, there is the possibility that strong food deprivation is not crucial for the development of adjunctive behavior. Cantor and others have suggested that food deprivation may be sufficient for the development of adjunctive behavior, but not necessary for its appearance (Cantor, 1981; Cantor & Wilson, 1978; Cantor et al., 1982). In one study, Cantor (1981) found that satiated rats ate as much as 50-gm of wet mash in a 3-hr session when exposed to a FI 2-min schedule of brain stimulation. Similarly, satiated rats on a FI 1-min schedule of brain stimulation drank four times their normal intake of water. Cantor (1981) also reports that a human male subject in an "Eye-Hand Coordination Experiment" (tracking a spot of light with a hand-held stylus) ate a quarter of a pound of cashew nuts just prior to the session and this had no effect on his usual adjunctive behavior (eating, drinking, grooming, and fiddling). If one accepts these findings as adequate examples of adjunctive behavior, then perhaps applied researchers need not be as concerned with the lack of a deprivation condition as previously thought.
The present study examined movement (locomotor activity) in two mentally-retarded subjects exposed to various FI schedules of food presentation. In addition to movement other discrete, easily classified behaviors (e.g., clearly repeated instances of self-stimulation) were recorded as they emerged. Unlike previous studies, combined massed-reinforcer and extinction baselines were employed in this experiment. In addition, resulting data were analyzed in terms of their similarity to the defining characteristics of polydipsia.
CHAPTER II

METHOD

Subjects

Two male students from Croyden Avenue School, Kalamazoo, Michigan, served as subjects in this study. One subject was trainably mentally impaired and the other was severely multiply impaired (trainably mentally impaired, hearing impaired, and autistic impaired). They were 17 and 23 years old and exhibited receptive and expressive language skills in addition to normal ambulatory abilities. These subjects were selected for this experiment based on exhibition of self-stimulatory behavior, history of performing for edible reinforcement, ability to work on an individualized, solitary basis, and performance in seven screening sessions (see the Procedure section for criteria and details). Neither subject had participated in treatment programs to reduce their self-stimulatory behavior nor were they currently receiving any medication. Consent to participate in this study was obtained from the natural parents of one subject and from the foster parents of the other.

Setting

The experimental setting was a 4 x 2.4 m room with a concrete floor and no windows. The floor of the experimental room was divided into 30 x 30 cm squares with black electrical tape to form a grid from which the experimenter recorded the locomotor movement of
subjects during screening sessions only. The furniture in this room consisted of a table and an armless chair in which the subject was initially seated. A 132 x 91 x 46 cm black metal storage cabinet and a 76 x 47 x 75 cm silver metal cabinet on wheels were located behind the seated subject on the opposite wall. Adjacent to the two cabinets was a 110 x 115 cm wooden barricade which hid a video-camera tripod from view. The camera itself was covered by a white sheet so that only the lens was visible. The two cabinets and the wooden barricade limited the walking space to 3.4 x 2.4 m. A red and white cardboard box, 15 x 15 x 8 cm, was placed on the floor approximately 91 cm behind the subject near the wall to serve as a potential focus for adjunctive behavior.

Apparatus

A matching-to-sample task was displayed on a computer screen located on a shelf in front of the subject's table at eye level. A 49 x 23 x 8 cm wooden box with three 10 x 5 cm wooden response keys was bolted to the center of the table. Depression of the center key produced a three item display of simple geometric figures according to the FI schedule in effect. The figure to be matched appeared at the top of the screen first, with the choices appearing on the lower right and left half of the screen one second later. By depressing the right response key, the subject chose the right-most figure as the correct answer; the left-most figure was selected by depressing the left response key. Correct answers produced a rolling flash of light on the computer screen and activated the food dispenser (Davis
Scientific Instrument Universal Feeder, model #310) located on the shelf to the right of the computer screen and barricaded with wooden boards to prevent subject intrusion. The rolling flash of light was programmed for the benefit of the deaf student who was unable to detect the sound made by the dispenser when it was activated. Incorrect answers darkened the computer screen for approximately one second. The same display appeared again following this period until the subject emitted a correct response. Small, edible reinforcers were used in this study to remain consistent with the type of reinforcer employed in studies of polydipsia in nonhumans. A correct response resulted in the delivery of one piece of sweetened breakfast cereal (Trix cereal, General Mills, Inc.).

Two cameras were used to record the subjects' on-going behavior. A Panasonic TV camera (model WV 220P) equipped with a wide angle lens was mounted on top of the 2.1 m shelves in the left corner of the room giving the experimenter a view of the right three-quarters of the room. A RCA Color Video Camera (model CKC021), also equipped with a wide angle lens, was mounted on a tripod in the right corner of the room enabling the experimenter to view the left three-quarters of the room. The video camera was used to make video-tapes of all the sessions.

The experimenter recorded on-going behavior from outside the experimental room at a table supporting an IBM PC-Jr (128k memory, single 360k flexible disk drive), and two TV monitors. The experimenter used four keys of the computer keyboard to categorize
the subjects' behavior. These keys were trapped asynchronously and recorded to diskette as key type, key status (on or off for duration behaviors), and time depressed. The data from the response keybox in the experimental room were interfaced to the computer using the external input ports at the rear of the computer. When the subject made a correct response, a 0.5 second pulse was output on the cassette tape interface controller to activate the feeder. The time and key type (center, left, right) of the subject's responses were recorded without interrupting the information being keyed-in by the experimenter outside of the room. All times recorded during the sessions were that of the computer's timer which recorded seconds past midnight. Prior to any data reduction all data were printed for permanent files.

Dependent Variables

In the screening sessions, movement was initially defined as any step which resulted in the subject's foot crossing over a grid line onto the floor of a new section. This definition included instances in which the subject's foot, but not entire weight, was placed into a new section regardless of the location of the section in relation to the direction the subject was facing (e.g., stepping backwards, sideways, diagonally). This definition was later changed for the experimental sessions when it became apparent that subjects were engaging in other lower extremity movement while standing for which this definition was not sensitive (e.g., jumping). Locomotor movement was then defined as any time one or both of the subject's
feet broke and made contact with the floor during the times the subject was not seated at the table. This definition included walking, jumping, and shifting entire weight from one foot to the other.

Other discrete, repetitive behaviors identified during screening sessions were operationalized from the video-tapes of the last day of exploratory sessions (see Procedure) based on their salience and frequency. These self-stimulatory behaviors of the selected subjects were as follows:

Subject 7

Rocking: Movement of upper torso forward and backward of at least 10 degrees deviation from vertical body position while seated in the chair.

Hand configurations: Hand held rigidly, usually four to twelve inches in front of subject's face, with two or three fingers extended upwards and tensed while the other hand was curled into a fist and held near the subject's left ear.

Subjects 7 and 4

Vocalizations: Any vocal sound emitted by the subject was recorded from onset to offset. Characteristic vocalizations included but were not limited to elongated and repeated vowels, moaning, grunting, and full sentences.
Subject 4

Upper body stimulation: This in-seat behavior included several self-stimulatory movements which were topographically similar and appeared repeatedly as a group. The subject would bend his head downward into arms bent towards his face so that the outsides of his wrists were directly in front of his face while elbows were extended to the sides and he rapidly fluttered his hands back and forth. This category also included the slight variation in which the subject lowered head into folded arms and fluttered hands under armpits, or folded arms across chest and gripped sides of neck with hands while tensing, or simply repeatedly shook his head and fluttered his hands.

Nut manipulation: Subject lifted up a response key on the keybox and spun the nut attached to the screw underneath the key with his fingers.

Object manipulation: This category included touching the square cardboard box with hand(s), turning it over, opening it up, and holding it against any part of the body.

The rate of movement and duration of repetitive behaviors were recorded by the experimenter located in an adjacent room. By depressing an assigned key on the computer keyboard, the experimenter recorded an occurrence of movement and the time at which it occurred. By depressing other keys at the onset and offset of each targeted repetitive behavior, the experimenter recorded the duration of these behaviors and the time at which they occurred.
Procedure

Screening Sessions

Based on teacher recommendations, seven male subjects (severely mentally impaired, trainably mentally impaired, and severely multiply impaired) were observed in their respective classrooms and selected for screening based upon exhibition of self-stimulatory behavior, histories of performing for edible reinforcement, and normal ambulatory ability. Screening consisted of approximately five to seven daily 15-min sessions in which the subject was lead into the experimental room and seated at the table (response keybox and computer screen were not present). Each subject was informed that he was free to move about the room if he wished. As soon as the experimenter left the room, a fixed-time schedule was activated in which food was presented once every 90-sec independent of the subject's behavior (FT 90-sec). Rate of movement was recorded by the experimenter via two TV monitors and other salient, repetitive behaviors were noted.

Results indicated that the increase in rate of movement for these subjects ranged from 0% to 823% (three subjects emitted no locomotor activity). The subject demonstrating the greatest percent increase in rate of movement was selected for exploratory sessions. Two other subjects were also selected for exploratory sessions; they did not engage in any locomotor activity, but spent the majority of
the session engaging in salient self-stimulation. Those subjects who were not selected were difficult to contain in the experimental room.

**Exploratory Sessions**

Seven exploratory sessions were conducted with the three subjects selected in the screening sessions to formulate operational definitions of the discrete, repetitive behaviors identified during screening. Prior to the start of these 15-min sessions, a manipulable object (small cardboard box) was placed on the floor in the experimental room where it remained for the duration of the experiment. Exploratory sessions were conducted in the same manner as screening sessions, with the following changes: an FT 60-sec schedule was in effect, the computer screen and response keybox were positioned in front of the subject, and the duration of the repetitive behaviors identified during screening was recorded. It became obvious at this point that recording all targeted behaviors of a subject simultaneously was too complex an observation response for accurate recording. Therefore, movement and all repetitive behaviors except vocalizations were recorded during each session. Vocalizations were scored from a video-tape after the actual session was concluded.

**Training Sessions**

Following the exploratory phase, six training sessions were conducted with the subjects to familiarize them with the matching-to-sample task. They were trained to respond on the apparatus under a
continuous reinforcement (CRF) schedule which was gradually lengthened until the subjects were responding under an FI 16-sec schedule. No verbal instructions were given to the subjects. Subjects were trained through modeling and physical guidance. This aspect of the study was included to avoid the possibility of verbal instructions interfering with the development of the FI "scallop" pattern of responding (Poppen, 1982) which might in turn limit the development of adjunctive behaviors.

**Baseline Conditions**

Both massed-reinforcer and extinction baseline conditions were employed in this study. Each subject was randomly assigned to either three massed-reinforcer sessions followed by three extinction sessions or three extinction sessions followed by three massed-reinforcer sessions. In the massed-reinforcer baselines, the total amount of food which would later be presented intermittently under each FI schedule was placed in the food dispenser tray at the beginning of the session. The computer screen remained dark and the food dispenser was inoperative. The extinction baseline condition was identical to the massed-reinforcer condition except that no food was made available. All baseline sessions were terminated after 20 minutes.

**Experimental Design**

Experimental sessions lasting 20 min were conducted
independently for each subject five days a week at approximately the
same time each day. To determine the relation between the length of
the inter-reinforcement interval and amount of adjunctive behavior
induced, four fixed-interval schedules were examined: FI 16-, FI 60-, FI 120-, and FI 240-sec. These schedules are consistent with
those which have induced adjunctive behavior in humans in previous
studies. The fixed-interval schedules were to be presented in the
order listed above along with baseline conditions interspersed
between each FI value in an ABABABAB design. It became apparent
during the FI 16-sec sessions that subjects did not earn the amount
of reinforcers that they theoretically should have under this
schedule (75 reinforcers) and therefore did not match the number of
reinforcers presented during the previous massed-reinforcer sessions.
The order of conditions was then reversed to compensate for this
problem. That is, subjects were exposed to scheduled presentation of
reinforcers followed by baseline conditions in which the massed-
reinforcer sessions consisted of the average number of reinforcers
that a particular subject earned under the previous schedule (e.g.,
instead of receiving 75 reinforcers during the massed-reinforcer
segment of the FI 16-sec baseline condition, one subject received 30
reinforcers). The result was a ABABABABA design. Each FI schedule
remained in effect for 10 sessions.
CHAPTER III

RESULTS

During the FI 16-sec schedule, one of the subjects (Subject 5) failed to consistently perform the matching-to-sample task without considerable prompting from the experimenter. When this situation could not be remedied by further training sessions, Subject 5 was dropped from the experiment. The two subjects previously mentioned in the dependent variable section completed the entire study.

The behaviors identified during exploratory sessions generally remained stable throughout the experiment, therefore, no emergent behaviors were included in these results. However, Subject 4 developed an interesting pattern of behavior which was executed in conjunction with his locomotor movement. As Subject 4 walked around the room he manipulated some of the furniture in the room. He would pull the silver cabinet out from the corner, tilt it several times, open and close its door, or tip it over onto the floor, and return it to its original position in the corner. This sequence of behavior was repeated several times during the inter-reinforcement interval. It occurred reliably following Subject 4's departure from the response table and followed an exact stereotypic pattern each time. During the second half of the experiment Subject 4 added barricade dragging to this sequence. He would move the silver cabinet around a bit, then grasp the 118 x 115 cm wooden barricade under his arm, drag it along the floor in circles, then return both objects to their
original locations. Like cabinet manipulation, barricade dragging was emitted in a precise sequence. Because the rate of Subject 4's movement generally reflected the time he spent moving these objects and because of observer difficulty in recording these behaviors simultaneously, only movement was measured.

Interobserver Agreement

Interobserver agreement was calculated from video-tapes for each behavior of each subject with the exception of movement. Agreement could not be measured for movement because only the video-camera facing the subject's table produced permanent tapes. When a subject moved outside of the range of this camera, the primary experimenter could view movements on the second monitor, but no video-tapes for the second observer to view could be produced by this second camera system.

The second observer rescored 25% of the video-taped sessions: 10 sessions for Subject 7 and 12 sessions for Subject 4. Each taped session had to be viewed twice because vocalizations were scored separately from other self-stimulatory behaviors for observer ease and accuracy. Exact agreement was calculated from the two observers' scores of each self-stimulatory behavior by dividing the smaller percent of session duration by the larger duration and multiplying this figure by 100. The overall agreement for both subjects' behaviors was 89.0% with a range of 60.1% to 100.0%. Mean agreement for the self-stimulatory behaviors of Subject 4 was 91.0% and for Subject 7 it was 88.0%. The agreement for vocalizations was about
the same as the other behaviors with 89.1% agreement for Subject 4's vocalizations and 87.5% agreement for Subject 7's vocalizations.

Data Analysis

Figures 1 through 3 show the rate of movement and percent of session duration for the repetitive self-stimulatory behaviors of both subjects. Rate of movement was calculated by dividing the total number of locomotor movements by the total number of minutes in the session (20 min). The percentages were calculated by dividing the total duration of each behavior by the total session duration and multiplying by 100. Daily rates and percentages have been graphed to indicate the rate of development of these behaviors within each fixed-interval schedule.

Only Subject 4 engaged in locomotor movement during the experiment and Figure 1 shows his rate of movement under the four FI schedules. There was very little movement during the FI 16-sec sessions. Rates stabilized at zero during the second half of the schedule. In the FI 60-sec schedule, rates began at zero and increased sharply for the next three sessions where they remained between 42 and 25 movements per minute. Unlike during the FI 60-sec schedule, movement stabilized around 35 movements per minute at the beginning of the FI 120-sec schedule and dropped sharply in the final two sessions of the schedule. In the FI 240-sec schedule, movement was variable and lower than both FI 60-sec and FI 120-sec schedules with rates ranging between 5 and 25 movements per minute.
Figure 1. Rate of Movement for Daily Sessions Under Each FI Schedule Value (* Indicates Missing Data).
Figure 2 indicates the percent of session duration of Subject 4's self-stimulatory behaviors: vocalizations, nut manipulation, and upper body stimulation. Although Subject 4 did engage in some object manipulation, it was minimal and was not included in these results. Vocalizations were extremely variable across all four schedules, whereas nut manipulation and upper body stimulation were more stable. Although vocalizations initially increased in the FI 16-sec and FI 120-sec schedules and showed initial declines in the FI 60-sec and FI 240-sec schedules, no real patterns were evident within or across schedules. Unlike vocalizations, nut manipulation rose from 0% to a high of 60% during the FI 16-sec sessions and then declined sharply to around 5% where it stabilized for most of the FI 60-sec and FI 120-sec sessions. This was followed by slightly decreased yet stable percentages during the FI 240-sec sessions. Finally, upper body stimulation remained at low percentages throughout the four schedules with the exception of a sharp increase in the second FI 60-sec session and a smaller peak in the third FI 240-sec session.

Figure 3 shows the percent of session duration of Subject 7's self-stimulatory behaviors: vocalizations, hand configurations, and rocking. For all of these behaviors, the most variability was found in the FI 16-sec schedule. Like Subject 4, Subject 7's vocalizations were quite variable and exhibited a similar pattern of an initial increase in behavior during FI 16-sec and FI 120-sec schedules and a decrease in the initial sessions of the FI 60-sec and FI 240-sec schedules. Only during the 240-sec schedule did vocalizations appear to be generally increasing. Following variable FI 16-sec session
Figure 2. Percent of Session Duration for Three of Subject 4's Self-Stimulatory Behaviors Under Each FI Schedule Value (* Indicates Missing Data).

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Figure 3. Percent of Session Duration for Three of Subject 7's Self-Stimulatory Behaviors Under Each FI Schedule Value (* Indicates Missing Data).

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percentages, hand configurations developed in a jagged increase-decrease, increase-decrease pattern during the FI 60-sec schedule which was similarly repeated in the FI 120-sec and FI 240-sec sessions. This was a general increasing trend within the three schedules. In contrast, the percentages of rocking during FI 60-, 120-, 240-sec schedules increased initially for the first few days followed by a general decline as sessions continued within each schedule.

In order to determine the excessiveness of the data shown in Figures 1 through 3, the average rate or percent of session duration average of each behavior under each schedule was compared to the averages recorded during corresponding baselines. As indicated earlier, each baseline condition consisted of three days massed-reinforcer and three days extinction sessions to clarify whether baseline type made a difference when determining behavior excessiveness. Although some differences were found between percentage averages under these two baseline conditions, these differences were generally insignificant and showed no particular tendency towards one condition over the other. Consequently, baseline sessions were treated as a unit when compared to FI schedule sessions to obtain a percent change index of excessiveness.

Tables 1 and 2 represent the percent change of each behavior as conditions were switched from fixed-interval schedule to baseline sessions. Percent change was calculated by subtracting the baseline average from the FI schedule average, dividing this figure by the baseline average and multiplying by 100.
### Table 1

Percent Change Between FI Schedule Averages and Corresponding Baseline Averages for Subject 4

<table>
<thead>
<tr>
<th>Behavior</th>
<th>FI Schedule</th>
<th>Baseline Average</th>
<th>Schedule Average</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 sec</td>
<td>5.4</td>
<td>.7</td>
<td>(87.0)</td>
<td></td>
</tr>
<tr>
<td>60 sec</td>
<td>25.8</td>
<td>23.0</td>
<td>(10.9)</td>
<td></td>
</tr>
<tr>
<td>120 sec</td>
<td>8.6</td>
<td>29.6</td>
<td>244.2</td>
<td></td>
</tr>
<tr>
<td>240 sec</td>
<td>12.2</td>
<td>14.5</td>
<td>18.8</td>
<td></td>
</tr>
<tr>
<td>Nut Manipulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 sec</td>
<td>6.0</td>
<td>27.3</td>
<td>355.9</td>
<td></td>
</tr>
<tr>
<td>60 sec</td>
<td>4.8</td>
<td>5.9</td>
<td>24.2</td>
<td></td>
</tr>
<tr>
<td>120 sec</td>
<td>2.1</td>
<td>5.1</td>
<td>140.5</td>
<td></td>
</tr>
<tr>
<td>240 sec</td>
<td>1.9</td>
<td>3.0</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Upper Body Stimulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 sec</td>
<td>13.9</td>
<td>1.3</td>
<td>(90.4)</td>
<td></td>
</tr>
<tr>
<td>60 sec</td>
<td>.5</td>
<td>7.5</td>
<td>1,487.2</td>
<td></td>
</tr>
<tr>
<td>120 sec</td>
<td>5.3</td>
<td>2.0</td>
<td>(61.5)</td>
<td></td>
</tr>
<tr>
<td>240 sec</td>
<td>3.5</td>
<td>5.9</td>
<td>66.3</td>
<td></td>
</tr>
<tr>
<td>Vocals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 sec</td>
<td>26.6</td>
<td>37.6</td>
<td>41.5</td>
<td></td>
</tr>
<tr>
<td>60 sec</td>
<td>17.0</td>
<td>27.4</td>
<td>60.7</td>
<td></td>
</tr>
<tr>
<td>120 sec</td>
<td>24.4</td>
<td>34.0</td>
<td>39.6</td>
<td></td>
</tr>
<tr>
<td>240 sec</td>
<td>24.9</td>
<td>25.5</td>
<td>2.2</td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Parentheses indicate decreases in percentages.

Some behaviors showed large percent changes because their baseline averages and schedule averages were near the zero end of the
scale (e.g., upper body stimulation). These percentages are indicated in the table but were not weighted heavily in the analysis of excessiveness.

Table 2

Percent Change Between FI Schedule Averages and Corresponding Baseline Averages for Subject 7

<table>
<thead>
<tr>
<th>Behavior</th>
<th>FI Schedule</th>
<th>Baseline Average</th>
<th>Schedule Average</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Configuration</td>
<td>16 sec</td>
<td>54.7</td>
<td>26.7</td>
<td>(51.1)</td>
</tr>
<tr>
<td></td>
<td>60 sec</td>
<td>41.9</td>
<td>25.5</td>
<td>(39.1)</td>
</tr>
<tr>
<td></td>
<td>120 sec</td>
<td>34.8</td>
<td>26.9</td>
<td>(22.7)</td>
</tr>
<tr>
<td></td>
<td>240 sec</td>
<td>53.6</td>
<td>43.2</td>
<td>(19.4)</td>
</tr>
<tr>
<td>Rocking</td>
<td>16 sec</td>
<td>65.8</td>
<td>26.9</td>
<td>(59.2)</td>
</tr>
<tr>
<td></td>
<td>60 sec</td>
<td>59.5</td>
<td>45.8</td>
<td>(23.0)</td>
</tr>
<tr>
<td></td>
<td>120 sec</td>
<td>55.1</td>
<td>41.5</td>
<td>(24.6)</td>
</tr>
<tr>
<td></td>
<td>240 sec</td>
<td>56.7</td>
<td>58.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Vocals</td>
<td>16 sec</td>
<td>25.8</td>
<td>38.8</td>
<td>50.3</td>
</tr>
<tr>
<td></td>
<td>60 sec</td>
<td>50.9</td>
<td>26.8</td>
<td>(47.4)</td>
</tr>
<tr>
<td></td>
<td>120 sec</td>
<td>50.0</td>
<td>42.2</td>
<td>(15.6)</td>
</tr>
<tr>
<td></td>
<td>240 sec</td>
<td>46.6</td>
<td>48.4</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Note. Parentheses indicate decreases in percentages.

For the majority of comparisons there was an increase of schedule averages over baseline averages that ranged from 3.7% to 1,487.2%. These increases were most prevalent for Subject 4.
Subject 4's nut manipulation and vocalizations increased during every FI schedule manipulation. Movement decreased during FI 16-sec and FI 60-sec schedules then increased over baseline averages during FI 120-sec and FI 240-sec schedules. Upper body stimulation increased and decreased every other FI schedule when compared to corresponding baselines.

Subject 7's targeted behaviors showed more decreases in schedule averages than Subject 4's behaviors (Table 2). The percent changes for Subject 7 were not as large as those for Subject 4. Hand configurations decreased during every FI schedule when compared to baseline averages (19.4% to 51.1% decrease). Rocking showed a similar pattern except that it increased during the FI 240-sec schedule by 3.7%. Vocalizations increased by 50.3% during FI 16-sec sessions, but decreased during FI 60-sec and FI 120-sec schedules. There was a slight increase in vocalizations during the FI 240-sec schedule similar to that found with rocking. Overall, the only schedule which produced consistent increases in behavior averages over corresponding baseline averages for all behaviors was the FI 240-sec schedule for Subject 4 (Table 1).

The relation of each behavior to FI length was assessed. This information is indicated in Figures 4 through 6. Figure 4 shows Subject 4's mean rate of locomotor movement under each schedule value. Beginning at a low rate during the FI 16-sec schedule, movement increased over ten-fold in the FI 60-sec schedule and continued to increase in the FI 120-sec sessions. Movement then decreased by 50% during the FI 240-sec schedule.
Figure 4. Mean Rate of Movement Under Each FI Schedule Value.
Figure 5. Mean Percent of Session Duration of Subject 4's Self-Stimulatory Behaviors Under Each FI Schedule Value.

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Figure 6. Mean Percent of Session Duration of Subject 7's Self-Stimulatory Behaviors Under Each FI Schedule Value.
Subject 4's other recorded behaviors—vocalizations, upper body stimulation, nut manipulation—did not show a similar pattern (Figure 5). Both vocalizations and nut manipulation were the greatest during the FI 16-sec schedule. Vocalizations and upper body stimulation appeared to be unrelated to FI value. The relation between nut manipulation percentages and schedule values was unique. After reaching a mean of 28% in the FI 16-sec schedule, nut manipulation dropped to 5% during FI 60-sec sessions and remained there for the rest of the FI schedules. This pattern may be explained by the fact that Subject 4 consistently engaged in center key pressing then nut manipulation just before and immediately following reinforcement delivery. Although this sequence was repeated often in the FI 16-sec sessions, Subject 4 eventually fell into a pattern of center key press/nut manipulation which was repeated only twice before or immediately following reinforcement delivery. Subject 4 appeared to test if the center key was operative, and when it was not, he discontinued the center key press-nut manipulation sequence until several minutes had elapsed and the key again became operative.

The mean percent of session duration of Subject 7's vocalizations, hand configurations, and rocking for each FI schedule is shown in Figure 6. Unlike Subject 4 whose vocalizations were far more prevalent than his other behaviors, Subject 7 engaged in his three targeted behaviors about equally during all experimental sessions. All three behaviors reached their highest mean percentage in the FI 240-sec schedule. During the preceding schedules,
Subject 7's vocalizations were initially high in the FI 16-sec sessions followed by a drop in the mean percentage during the FI 60-sec sessions. At this point, vocalizations increased as the FI value increased.

Rocking was lowest in the FI 16-sec schedule. It alternately increased and decreased over the next three schedules like Subject 4's vocalizations and upper body stimulation, but instead of returning to similar levels each time, rocking showed a progressively increasing trend. Finally, hand configuration means indicate a pattern exactly the opposite of Subject 4's nut manipulation. Hand configurations remained near 25% for the FI 16-, 60-, and 120-sec schedules and then increased to a mean of 42% during the FI 240-sec sessions.

To determine the temporal distribution of the subjects' behavior each inter-reinforcement interval was divided into quarters. The first three quarters of each interval were of equal duration while the final quarter was left to vary depending upon how quickly the subject correctly completed the matching-to-sample task, thus satisfying the FI requirement (see Appendix for Programmed vs. Subject Response Schedules). Temporal distributions of each behavior for randomly selected sessions are indicated in Figures 7, 8, and 9. All behaviors were measured in terms of percent occurrence. The percent occurrence of movement was calculated by dividing the number of movements occurring in each different quarter by the total number of movements for that session and multiplying by 100. Similarly, the

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duration of each self-stimulatory behavior occurring in each quarter was divided by the total duration of that behavior for one session and multiplied by 100.

Because the final quarter of the interval varied in duration from the previous three quarters according to subject performance, it was possible that more behavior would occur in the fourth quarter solely due to its increased duration. Therefore, an absolute interval percentage was also calculated for the fourth quarters. For example, the FI 16-sec quarters of the interval all lasted 4 seconds and the excess time before the next reinforcement delivery was dropped. Each absolute fourth quarter percentage is indicated in the graphs by the symbol x.

Figure 7 shows the percent occurrence of movement in quarters of the interval for the four FI schedules. The temporal distribution of movement was generally the same across all schedules and did not differ from baseline distributions. There was very little movement immediately following reinforcement with roughly 10% to 20% occurring in the second and third quarters. As Figure 7 clearly indicates, the majority (60% to 100%) of movement occurred during the fourth quarter. The calculation of absolute equal intervals did not alter these data.

The temporal distributions of Subject 4's vocalizations, upper body stimulation, and nut manipulation are shown in Figure 8. Like movement, the majority of vocalizations occurred in the fourth quarter across all four schedules and did not differ from baseline distributions. The percent occurrence during the first three
Figure 7. Percent Occurrence of Movement in Quarters of the Interval for Randomly Selected Sessions.
Figure 8. Percent Occurrence of Subject 4's Self-Stimulatory Behaviors in Quarters of the Interval for Randomly Selected Sessions (x Indicates Absolute Fourth Quarter Calculations).
quarters was about equal. However, when absolute quarters were examined, all fourth quarter percentages dropped to levels consistent with the first three quarters.

The temporal distribution of upper body stimulation and nut manipulation appeared to change with schedule value. During the FI 16-sec schedule, the majority of these behaviors occurred in the final quarter. With the introduction of the FI 60-sec schedule, the greatest percentage of these behaviors occurred in the first quarter, with the exception of one session. This session was the first FI 60-sec session following the final FI 16-sec baseline session. Both upper body stimulation and nut manipulation continued the first quarter majority pattern throughout the FI 120-sec schedule while the distribution of the other three quarters also remained the same. These distributions became more variable for upper body stimulation during the FI 240-sec schedule, but nut manipulation distributions showed little change. Temporal distributions of baseline data for these behaviors were opposite those produced under the FI 60-sec and FI 120-sec schedules. The majority of both behaviors fell in the third or fourth baseline quarters. The distribution of upper body stimulation was almost equal across the quarters during FI 240-sec baseline sessions but nut manipulation continued to produce first quarter majority distributions during the final baseline sessions. The results of the absolute quarter calculations mainly affected the FI 16-sec schedule data. The majority of upper body stimulation and nut manipulation now tended to occur in the second quarter instead of the fourth.
Figure 9. Percent Occurrence of Subject 7's Self-Stimulatory Behaviors in Quarters of the Interval for Randomly Selected Sessions (x Indicates Absolute Fourth Quarter Calculations).
Temporal distribution of responding for Subject 7 is presented in Figure 9. Like Subject 4's vocalizations, the greatest percentage of Subject 7's vocalizations generally occurred in the fourth quarter. This was not different from baseline distributions. With the introduction of the FI 60-sec schedule, fourth quarter percentages were no longer as extreme resulting in flatter distributions which generally were repeated in the FI 120-sec and FI 240-sec schedules. Absolute quarter calculations for vocalizations lowered fourth quarter percentages so that the majority of occurrences often centered in the second and third quarters.

For Subject 7's hand configurations and rocking, the majority of behavior occurred in the fourth quarter during the FI 16-sec schedule. Both behaviors showed a tendency to shift to the first quarter of the interval in the FI 60-sec sessions. This tendency was more prominent for rocking during the FI 120-sec schedule. Baseline data showed opposite distributions with the majority of both behaviors occurring in the fourth quarters. The FI 240-sec data did not conform to any particular pattern. This was no different from baseline distributions for the FI 240-sec schedule. Absolute quarter calculations once again lowered several of the fourth quarter percentages so that the greatest percentage of hand configurations and rocking occurred in the first or second quarters for most FI sessions within and across schedules.
CHAPTER IV

DISCUSSION

The general purpose of this study was to analyze the behavior of two human subjects under conditions which were matched as closely as possible to those employed in nonhuman adjunctive behavior experiments. Food was used as the inducing stimulus, reinforcement was delivered on an intermittent schedule, and appropriate baselines (massed-reinforcer and extinction) were included to provide a valid comparison condition for developing behavior. These methodological details are significant because although several researchers have cited the need for including these procedures in human studies of adjunctive behavior, no study has as yet included all three.

The specific purpose of the present study was to analyze the behavior induced under fixed-interval schedules according to the defining features of the most studied form of adjunctive behavior—polydipsia. Previous researchers have compared their findings to only a few of these defining features. What follows is a discussion of the present study's results as they relate to the defining characteristics of adjunctive behavior as indicated by nonhuman studies of schedule-induced polydipsia.

Defining Characteristics

Intermittent Inducing Schedule

Fixed-interval schedules of food presentation were in effect
during all experimental sessions of this study, thus the requirement of an intermittent inducing schedule was met.

**Excessiveness and Persistence**

The most obvious characteristic which alerted researchers to the phenomenon of adjunctive behavior was the excessiveness of behavior which had nothing to do with the procurement of reinforcement. In early studies, rats whose drinking increased by 10 times were readily noticeable because of their distended stomachs. But as pointed out by Lasiter (1979), adjunctive behaviors noted in humans "appear less rigorous" than those observed in nonhumans (p. 239). Measures of excessiveness have generally not been included in previous adjunctive behavior research in humans. In the present study excessiveness was measured as percent increase of behavior under each FI schedule relative to the corresponding baseline level. As shown in Tables 1 and 2, there were both increases and decreases in targeted behaviors during different FI schedules. For those behaviors which show increases over baseline rates and percentages, the increases were often substantial (e.g., 50.3%, 60.7%, 244.2%). Subject 4 exhibited the largest schedule-induced increases in behaviors with nut manipulation and vocalizations increasing most and the most consistently. Without a specific criterion as to what constitutes excessiveness, it is difficult to label some of the other behaviors as excessive. These data indicate that some behaviors appeared excessive under certain schedules while not excessive under others. No pattern is readily apparent.
According to the defining characteristics of polydipsia, the behavior in question should be persistent as well as excessive. In earlier studies it has been difficult to determine persistence of a behavior because the majority of experiments did not include a sufficient number of sessions within or across schedules. In the present study, each FI value remained in effect for ten sessions before returning to baseline conditions making a total of 64 sessions. As indicated in Figures 1, 2, and 3, day-to-day rates and percentages were often variable. The best examples of behavior which increased above baseline levels and remained there for the majority of the sessions within a schedule are movement and nut manipulation of Subject 4. However, Kachanoff et al. (1973) reported that some habituation appeared to occur in schedule-induced pacing and drinking when each schedule was repeated for several sessions (3 sessions per schedule). A similar pattern was seen in Subject 7's rocking data (Figure 3) where percentages decreased as sessions continued within the FI 60-, 120-, and 240-sec schedules. It is possible that human induced behaviors do not remain as persistent as nonhuman induced behaviors.

**Gradual Development**

Research with nonhumans has indicated that schedule-induced polydipsia develops over the course of a few sessions (Hawkins, Schrot, Githens, & Everett, 1972; Reynierse & Spanier, 1968; Staddon & Ayres, 1975). An analysis of Figures 1, 2, and 3 indicates that
the best example of gradual development of behavior is movement under
the FI 60-sec schedule of Figure 1. Here, movement continued to
increase over the course of four sessions, and eventually stabilized
around a rate of 37 movements per minute. The other self-stimulatory
behaviors did not show this gradual development. In fact, several
behaviors peaked during the first or second session of a schedule and
dropped to lower levels as sessions continued (e.g., Subject 7's
vocalizations during FI 60-sec and FI 120-sec schedules, hand
configurations and rocking during the FI 240-sec schedule, and
Subject 4's upper body stimulation during FI 60-sec and FI 240-sec
schedules). Other researchers have reported similar results.
Wallace and Singer (1976) found that when four college students were
exposed to six consecutive FI 120-sec maze solving sessions following
baseline sessions of nonscheduled problem solving (lateral thinking
problems), they reached their maximum activity level for a specific
schedule in a single session. Similarly, Wallace and Oei (1981)
found that movement of eight body-weight reduced subjects exposed to
a fixed-time 1 minute food schedule reached an asymptote during the
first session.

Bitonic Relation

Another defining characteristic of polydipsia pertains to the
relation between the intermittency of delivery of the inducing
stimulus and the amount of drinking induced. Food-deprived rats
exposed to fixed-interval schedules of food presentation exhibit
polydipsia at FI 4-sec or FI 5-sec. The amount drunk continues to

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increase up to FI 2-min or 3-min, then it progressively decreases as FI values become larger. The effective range for excessive behavior in humans is not yet clear. In the present study, the only behavior which clearly exhibited the bitonic relation found in polydipsia studies was movement (Figure 4). Movement began at a low level during FI 16-sec sessions, greatly increased during FI 60-sec sessions, peaked during FI 120-sec sessions, and dropped off as the inter-reinforcement interval increased to 240-sec in the final schedule. The other self-stimulatory behaviors did not follow this pattern. Vocalizations were relatively high (38%) during FI 16-sec sessions, but in the subsequent FI 60-, 120-sec, and 240-sec schedules, mean percentages dropped and then continued in an increasing linear trend. Examining schedule values above 240-sec would perhaps clarify this developing vocalization pattern.

Temporal Distribution

In polydipsia studies, the majority of drinking occurred immediately following the delivery of reinforcement. Several of the self-stimulatory behaviors in Figures 8 and 9 reflect this characteristic, especially when the absolute fourth quarter data points are included. It is interesting to note that except for vocalizations, all self-stimulatory behaviors in Figures 8 and 9 show a tendency for maximum percentages to occur in the later quarters during the FI 16-sec schedules, but then occur mainly in the first quarter during the subsequent schedules. According to some studies
with humans (e.g., Kachanoff et al., 1973), adjunctive behavior peaks during FI 60-sec and FI 120-sec schedules. Perhaps it is during these schedules that the first quarter maximum behavior distributions emerge. It is also interesting to note that although movement exhibited a clear cut bitonic relation between schedule value and amount of behavior induced, it produced temporal patterns entirely opposite of polydipsia. It is noteworthy that temporal distributions for movement are almost the mirror image of upper body stimulation and nut manipulation for this same subject. While he was engaging in upper body stimulation and nut manipulation his movement scores were low, and while he was walking about the room, the scores of these other behaviors were low.

Generality

When polydipsia is induced in a particular member of a species, it generally can be engendered in all members of that species. A crude test of generality can be effected by comparing Subject 4's data to Subject 7's data. Overall, Subject 7's data showed more variability than Subject 4's results. Out of the three characteristics presented in Figures 1 through 9—rate of development, bitonic relation, and temporal distribution—temporal distribution in quarters of the interval indicated the greatest similarities between the two subjects' data, particularly when absolute fourth quarter intervals were included. There may be a problem with this type of blanket comparison considering that the generality of results found in nonhumans refers to only one
behavior—polydipsia. Hence, a more valid comparison of the present study's data might be between behaviors common to both subjects. Both subjects emitted vocalizations throughout the entire experiment. Rate of development graphs (Figures 2 and 3) show that both subjects' vocalizations were variable within all four FI schedules. Although vocalizations showed different patterns as the fixed-interval value increased in Figures 5 and 6, they were generally the most prevalent behavior for both subjects. Finally, the temporal distributions of both subjects' vocalizations were similar across all schedules when absolute fourth quarter calculations were included. The percent occurrence of vocalizations in each quarter varied less than 10% for both subjects. These relatively flat distributions were in contrast to the often steep slopes indicated in the other behaviors' distributions.

Deprivation

According to the polydipsia literature, the amount of induced drinking varies inversely with the relative body-weight of a food-deprived subject. As mentioned previously, a comparable deprivation condition cannot be ethically arranged in human studies. Some researchers have attempted mild deprivation conditions such as asking subjects not to eat for two hours prior to each experimental session, but this did not appear to have any effect on the subjects' subsequent induced activity (Wallace & Oei, 1981; Wallace et al., 1978). Due to scheduling difficulties, the subjects in the present
study participated in experimental sessions 1/2 to 1-1/2 hours following their lunch period. Yet, as suggested by Cantor and others (Cantor, 1981; Cantor & Wilson, 1978; Cantor et al., 1982), a deprivation condition might not be necessary for inducing adjunctive behavior. Like Cantor's (1981) male subject who ate a quarter of a pound of cashew nuts just prior to the experimental session, Subject 4 in the present experiment consumed five waffles and several servings of scrambled eggs immediately before his session. This was during the FI 120-sec schedule and it had no apparent effect on his induced behavior levels. Examples such as these suggest that deprivation conditions might not be a must for engendering adjunctive behavior in human subjects. On the other hand, the amount of activity induced in human subjects might be more excessive and follow the defining characteristics of schedule-induced polydipsia more closely if a feasible deprivation condition could be employed.

Summary

In summary, when the present data are analyzed relative to the seven defining characteristics of schedule-induced polydipsia, the prototype of adjunctive behavior:

(1) Nut manipulation of Subject 4 appeared excessive for all FI schedules compared to baseline means.

(2) The most persistent behaviors were movement and nut manipulation of Subject 4.

(3) Only movement of Subject 4 appeared to develop gradually within a single FI schedule.
Only movement of Subject 4 indicated a clear bitonic relation under the particular FI values examined.

Exposure to schedules which purportedly induced adjunctive behavior in humans in previous studies generally produced first quarter maximum occurrence distributions for upper body stimulation, nut manipulation, rocking, and hand configurations.

An analysis of generality of behavior patterns between the two subjects indicated greatest similarities in the temporal distributions for self-stimulatory behaviors across all schedules.

No deprivation condition could be arranged in the present study and its necessity is questionable.

Methodological Problems

Early in this experiment it became apparent that subjects were not under strict schedule control and their responding did not eventually come under the control of the exact schedule in effect. The subject response schedules were idiosyncratic to each participant, yet they generally increased from one schedule to the next in the same proportions as the programmed FI schedules values (See Appendix). Subject 7 performed according to FI 42-, 92-, 150-, and 300-sec schedules while Subject 4 responded under FI 40-, 150-, 300-, and 600-sec schedules. Subject 4 performed on schedules which were often twice as long as Subject 7's. This may account for the greater excessiveness of Subject 4's behaviors when compared to those of Subject 7. The differences in programmed FI schedule and subject
response schedule values make it difficult to determine the range of effective values for the emergence, peak, and decline of induced behaviors. This difference also creates problems when comparing the results of the present study to results of previous research in which FI schedule values were standard.

Another factor complicating the analysis of this study's data is that behaviors did not always return to baseline levels following exposure to FI schedules. Particularly for Subject 7, the percentages of vocalizations, rocking, and hand configurations appeared somewhat resistant to extinction during baseline conditions. Kachanoff et al. (1973) note that the reduction of induced drinking and pacing during extinction sessions was not as pronounced for those subjects having a long history in the experimental setting. Including screening, exploratory and training sessions, the subjects in the present study spent approximately 85 sessions in the experimental situation, which may have contributed to the observed metastability.

Future Research and Applications

An obvious direction for future research in the area of adjunctive behavior would involve systematic sets of studies which vary the FI schedule values over larger ranges of inter-reinforcement intervals. It appears from past research and the present study that the FI values at which behavior declines are longer than those previously examined. Schedule-induced polydipsia drops out at inter-reinforcement intervals of 4 to 5 minutes. Both Subject 4's movement
and Subject 7's vocalizations, hand configurations, and rocking peaked at subject response schedules (not programmed fixed-intervals) of 300-sec or 5-min schedules. The inclusion of long FI values would provide a clearer indication of the point at which human induced behavior tends to decline.

Some of the data in the present study suggest habituation of behaviors under certain schedules and baselines and some increasing or decreasing trends within different schedules. A logical follow-up study should include several more sessions under each condition to allow for stabilization of behavior or clear detection of behavior patterns. As noted earlier, the number of sessions conducted for separate schedules in previous studies has been severely limited.

Until we have an adequate understanding of the characteristics and variables which affect induced excessive behavior in humans, the utility and application of this knowledge is speculative. From what is already known about adjunctive behavior in nonhumans, situations such as academic group activities and workshop schedules would be primary candidates for inducing excessive behavior in humans. Casual observation of group activities (several students and one instructor) in a classroom at the institution in which this study was executed revealed that several students' self-stimulatory behavior increased in intensity and frequency immediately following social praise of edible reinforcement from the instructor. This increase often disrupted the instructor's subsequent attention to the next student and disturbed or excited nearby students. The instructor had been
interacting repeatedly with each student, one-by-one, in the same order—similar to an FI schedule. By switching to a variable-interval schedule of reinforcement, the increase in self-stimulatory behaviors might be avoided making it easier for both instructor and students to complete the lesson. In this manner, several students' inappropriate induced behaviors could be minimized without individual attention to each problem behavior. In classrooms where students greatly outnumber the instructors, changing the schedule of reinforcement could have a sizeable impact on classroom activities and learning.

Finally, the question still remains whether or not the behaviors exhibited by the subjects in this study are to be considered as adjunctive behaviors. Surely some of the behaviors showed several of the characteristics of schedule-induced polydipsia. On the other hand, some of the behaviors did not. More well-controlled, systematic experimentation is needed to answer the question of whether the seemingly excessive behavior observed in human studies is adjunctive in the same sense as schedule-induced polydipsia. Falk (1981), the researcher who first demonstrated schedule-induced polydipsia, acknowledged that the possibility of human behaviors being adjunctive in nature is reasonable. Still, we must not be unreasonable or overzealous in labeling as adjunctive all behaviors which appear excessive and persistent. By including appropriate methodological and analytical criterion in our research, we will be better equipped to interpret puzzling behavior.
Appendix

*Programmed FI Schedule vs. Subject Response Schedule*
## Programmed FI Schedule vs. Subject Response Schedule

<table>
<thead>
<tr>
<th>Programmed Schedule</th>
<th>Subject 7</th>
<th>Subject 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>FI 16 sec</td>
<td>FI 42 sec</td>
<td>FI 40 sec</td>
</tr>
<tr>
<td>FI 60 sec</td>
<td>FI 92 sec</td>
<td>FI 150 sec</td>
</tr>
<tr>
<td>FI 120 sec</td>
<td>FI 150 sec</td>
<td>FI 300 sec</td>
</tr>
<tr>
<td>FI 240 sec</td>
<td>FI 300 sec</td>
<td>FI 600 sec</td>
</tr>
</tbody>
</table>

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BIBLIOGRAPHY


