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BEHAVIORAL OBSERVATION OF FOOD-DEPRIVED HUMANS UNDER A FOOD-DELIVERY SCHEDULE

OBSERVACION CONDUCTUAL DE HUMANOS PRIVADOS DE COMIDA BAJO UN PROGRAMA DE ENTREGA DE COMIDA

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ABSTRACT

The objective of this study was to explore the behavior of food-deprived human subjects under a fixed-time (FT) schedule of food delivery. Three adult women following a ritual religious fast volunteered to participate. They were individually observed through a one-way mirror after a 13-hour period of food-deprivation. Three 20-min sessions in which the delivery of palatable pieces of food was manipulated were run: a massed-food session (Session 1, Day 1), a no-food session (Session 2, Day 2) and a FT 60-s session (Session 3, Day 2). Observed response categories included "drinking", "grooming", "moving", "quiet" and "vocalizing". No enhancement of drinking behavior in the FT session as compared to the other two conditions was observed. One of the subjects displayed enhanced grooming and vocalizing, although the increase was not localized soon after food consumption. It is concluded that although the present study does not provide enough evidence for a schedule induced effect, it contributes an original and potentially fruitful food deprivation procedure that can be used in future human studies.

Key words: polydipsia, schedule-induced human behavior, food deprivation, adjunctive behavior.

RESUMEN

El objetivo de este trabajo fue explorar la conducta de sujetos humanos privados de comida, bajo un programa de tiempo fijo (TF) de suministro de comida. Tres mujeres

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adultas que seguían un ayuno como parte de un ritual religioso, participaron como voluntarias. Después de un periodo de 13 horas de privación de comida, se observó a las mujeres de forma individual, a través de un espejo unidireccional. En tres sesiones de 20 minutos, se suministró comida de sabor agradable, de la siguiente forma: una sesión de comida-masiva (Sesión 1, Día 1), una sesión de "no-comida" (Sesión 2, Día 2) y una sesión donde estuvo en operación un programa TF 60-s (Sesión 3, Día, 2). Las categorías de respuesta observadas incluían: "beber", "acicalarse", "moverse", "en silencio" y "vocalizar". Durante la sesión donde estuvo en operación el programa TF, no se observó un aumento en la conducta de beber, en relación a las otras dos condiciones. Uno de los sujetos mostró un aumento en las conductas de acicalarse y de vocalizar; sin embargo, este incremento no sucedió inmediatamente después del consumo de la comida. Se concluyó que aunque el presente estudio no provee suficiente evidencia de un efecto inducido por el programa, sí ofrece un procedimiento de privación original y potencialmente productivo, que podrá ser usado en estudios futuros con humanos.

Palabras clave: polidipsia, conducta inducida por el programa en humanos, privación de comida, comportamiento adjuntivo.

The phenomenon of schedule-induced behavior has been widely investigated, since Falk (1961) observed the induction of excessive drinking in food deprived rats under a variable-interval schedule of reinforcement. After that, several studies reported the induction of other kinds of behavior in different species and under different schedules of reinforcement. For instance, there were reports of schedule-induced airstream licking in rats (Chillag & Mendelson, 1971), target attack in pigeons and monkeys (Flory, 1969; Hutchinson, Azrin, & Hunt, 1968), and wheel running in rats (Levitsky & Collier, 1968). The fact that several kinds of behavior had been induced under a variety of generating conditions and in different species led Falk (1971) to describe the general nature of schedule-induced behavior. Excessiveness and persistence of the induced behavior and its concentration on the low reinforcement probability portions of the schedule were defined as its main systematic features. Another frequent feature was the bitonic function relating behavioral strength (frequency, duration, or magnitude) to frequency of the intermittently delivered stimuli.

Falk's analysis (1971) of the generality of the scheduled-induced phenomenon prompted a number of investigations of different topographies of behavior: wood chewing in rats (Roper, Edwards, & Crossland, 1983), defecation in rats (Gimenes, Andronis, & Goldiamond, 1987), stereotyped motor patterns in pigeons (Staddon & Simmelhag, 1971), excessive eating in rats (Bellingham, Wayner, & Barone, 1979). Other species and strains also were investigated, as well as other motivational states: for example there were reports of schedule-induced polydipsia in wild rats (McCaffrey, Pavlik,

Hoppmann, & Allen, 1980), mice (Palfai, Kutscher, & Symons, 1971), hamsters (Wilson & Spencer, 1975), guinea pigs (Urbain, Poling, & Thompson, 1979), pigeons (Dale, 1979), gerbils (Porter & Bryant, 1978); and reports of target attack in wild pigeons (Yorburn & Cohen, 1979), nest building in hamsters (Diosdado, 1984), and wheel running in rats, hamsters and guinea pigs (Bryant & Porter, 1983).

Schedule-induced behavior also was demonstrated in humans. Experiments differ in many critical variables such as the stimuli for inducing behavior, the kind of control procedure, the number of experimental sessions, and interstimulus interval durations. Two basic procedures have been employed: a) conditioned or unconditioned stimuli such as food, tokens and money were delivered on an FT schedule or on a fixed-interval (FI) schedule requiring an arbitrary response; b) tokens or money were delivered on an FI or FT schedule requiring the subject's participation on a game. Children, moderately retarded adolescents and psychiatric patients were the subjects of experiments in which arbitrary responses were intermittently reinforced. For instance, Kachanoff, Leveille, McLelland, and Wayner (1973) reported increased walking behavior as compared to an extinction session in 5 out of 7 and increased drinking in 2 out of 5 psychiatric patients on FI schedules varying from 15 to 120 s in which automatically dispensed coins were the reinforcing stimuli. Porter, Brown, and Goldsmith (1982) observed increased drinking as compared to an FR 1 baseline in 3 out of 4 children key-pressing for candy on an FI 30-s schedule and in 2 of them when an FI 60-s schedule was employed. Using the same FR 1 control baseline, Granger, Porter, and Christoph (1984) reported increased drinking, motor responses and grooming in a pair of twins pressing a key on FI schedules of candy delivery. They observed a bitonic function with a peak at FI 90-s for drinking, but this behavior was equally distributed throughout the FI.

When subjects were human adults, some studies employed intermittent access to a game board as the reinforcer. For instance Wallace, Singer, Wayner, and Cook (1975), using as control a session in which subjects listened to a tape recording of a lively discussion on crime and violence, observed increased paper tearing and grooming in 7 college students playing poker on an FI 60-s schedule. Drinking and eating, however, were not affected. Seventeen college students were the subjects of Fallon, Allen, and Butler (1979), who reported increased drinking, eating, moving and grooming when the access to a backgammon game was scheduled on an FT 30-s schedule, as compared to a situation of free game access. These behavioral categories were equally distributed throughout the FT. Beer drinking by college students during a computer game was monitored by Doyle and Samson (1988), who observed increased drinking in a group exposed to an FI 90-s schedule, but not in one exposed to FI 30 s. A substantial increase in movement and a modest increase

in drinking during a backgammon game were reported by Allen and Butler (1990), while grooming was not affected. Movement distribution along the interplay interval was increasing and monotonically related to interval duration. Only drinking occurred soon after the playing response.

Taken together, the results of human studies show that, within limits, polydipsia and other kinds of schedule-induced behavior can be intensified under certain conditions. A salient omission in this literature is the study of schedule-induced behavior under a condition of food deprivation, because the best studied schedule-induced behavior in animals, which is polydipsia, results from intermittent food delivery to food deprived subjects. The strict animal model of schedule-induced polydipsia after food deprivation was tried with humans only once. Wallace and Oei (1981) compared subjects who had recently suffered an average 29% weight reduction to another group of stable weight subjects. Both groups were subjected to an FT 60-s schedule of food delivery in which they themselves controlled their food intake in response to an intermittent light signal, according to verbal instructions. They did not become polydipsic although they showed increased levels of activity. The authors also demonstrated that scheduled access to a maze task generated more adjunctive activity than the food delivery schedule. They concluded that weight reduction is not a prime variable in the induction of behavior in humans, and that schedule-induced polydipsia may be "as difficult to produce in humans as it is in pigeons" (p. 1029). They were cautious, however, in warning that their procedure did not involve controlled food deprivation, and as such could not be strictly compared to the usual animal laboratory deprivation condition.

One possible reason for avoiding food deprivation in humans is that it is difficult to achieve. The opportunity to study the effect of this variable on schedule-induced behavior in humans came from a Bahai community living in a Brazilian town that follows a 19-day ritual fast every year. The aim of this experiment was to observe drinking and other behaviors in fasting Bahai volunteers under conditions of intermittent food consumption.

METHOD

Subjects

Three adult women belonging to a Bahai middle-class religious community consented to be the subjects of this experiment, after being told it was a research project of interest to the university. They were not paid for their effort, but were offered free transportation to and from the university campus. The subjects were 27, 35 and 45 years old, and they were personally recruited

by one of the experimenters, who explained the procedure they would go through, in the event they agreed to participate in the experiment. At the time of the experiment, they were in the 18th and 19th days of their annual 19-day fast period, which consists of food and water abstinence for 13 hours every day. A complete meal may be taken before 6 am and after 7 pm. As a rule, they break their fast with juice, and then have their meal.

Apparatus

The experiment was conducted in a 7.7 x 4.2 m room. A table and a chair were located in the middle of the room. At the time the experiment started it was already dark outside. There were two windows in one of the walls; in order to keep the room cooled, the windows remained opened and curtains half opened during the experimental sessions, and a fan was permanently on. Outside the windows there was a desert garden. A one-way mirror was located on one of the walls perpendicular to the windows. Two water bottles with straws and a dish containing the selected food were on the table. A 60 W white light bulb was placed adjacent to the window, about 2.5 m from the table. Presentation of the light was remotely controlled by the experimenter through an extension cord going to the observation room.

Procedure

The experimental sessions were conducted between 7:30 pm and 9:30 pm. Before starting the experiment, subjects indicated their food preferences so as to determine the food to be delivered in the experimental sessions. As a result, white cheese was chosen and delivered in 1.5 x 1.5 cm 4 g pieces. They were offered water before each experimental session, so that an eventual schedule-induced effect could not be attributed to water deprivation. Three 20-min sessions were conducted over two days. Session 1 was conducted on Day 1 and consisted of a massed food session, in which 20 food pieces were placed in a bowl in front of the subject, who received the following instruction: *"You are going to participate in an experiment in which the effect of fasting on your behavior will be analyzed. Initially you will fill a questionnaire in which you will find questions on your mood at the moment. After that, you will remain inside the room for 20 min. You can eat a small food portion that is placed on the table. You should eat all the food as soon as I leave, and stay in the room until I return within 20 min. After that you will fill the questionnaire again."* At the top of the 40-item scale sheet they recorded the time of their last meal. The task took approximately five minutes, and was repeated before the two other sessions. Results on the mood scale were discarded. Sessions 2 and 3 were

conducted on Day 2, with a 10 min interval between them. The second session was a no-food session in which no food was presented. The instructions were as follows: *"You are going to stay in this room again for 20 min. You can do whatever you want during this time, but you can't leave the room."* The third session was an FT 60-s session, in which a dish containing 20 food pieces was placed on the table, and the subject received the following instruction: *"You will stay in this room again for 20 min. Every time the light on the corner turns on you should pick up a piece of cheese and eat it."* Lighting of the bulb followed an FT 60-s schedule; the interval started after food ingestion. After the experiment was completed, each subject was given a more precise description of the purpose of the experiment, specifying that the behavior inside the room had been recorded.

Observation was conducted through the one-way mirror by two researchers. One of them observed the behavior and dictated the category to the other, who recorded it. The raters had gone through a training procedure in which two observers and two note takers made approximately 20 hours of simultaneous recordings of 6-h food deprived students in the same experimental setting. They were considered ready to participate in the experiment when a 90% agreement was reached. The most frequent response categories observed in human experiments were selected for recording (Fallon et al., 1979; Porter et al., 1982). They were water drinking (D), grooming (G), moving (M), quiet (Q) and vocalizing (V). Drinking behavior was recorded every time the subject placed the straw in her mouth until she removed it. Any behavior directed towards the body was recorded as grooming. Any audible sound which could be detected by the experimenter was considered as vocalizing. Moving was recorded when motor responses excluding D, G and V were observed; movements as subtle as an eyeblink were not recorded. "Quiet" was registered when no activity could be detected following a 5-s period, except for eye blinking. At every second response categories codes were dictated by one trained observer to another, in a continuous recording.

Criteria for induction were the temporal distribution of the observed behaviors along the inter-stimuli intervals and the degree of increase relative to the baseline sessions. A 50% increase in the total frequency of a given behavior in relation to the control sessions, with a peak in the first third of the interval, would be considered a schedule effect.

RESULTS

All subjects declared having had their last meal before 6 am on the two days of the experiment. In spite of water deprivation, drinking before the

sessions began was negligible, varying between two and three short sips per session.

Figure 1 shows, for each subject, the proportional frequency of each behavior observed in the massed food, no-food and FT 60-s sessions. Drinking was extremely low in all three sessions. It can be seen that S1 exhibited a greater than 50% increase in grooming and vocalizing during the FT session. The other two subjects did not exhibit excessive increases of any recorded behavior, within the required criteria.

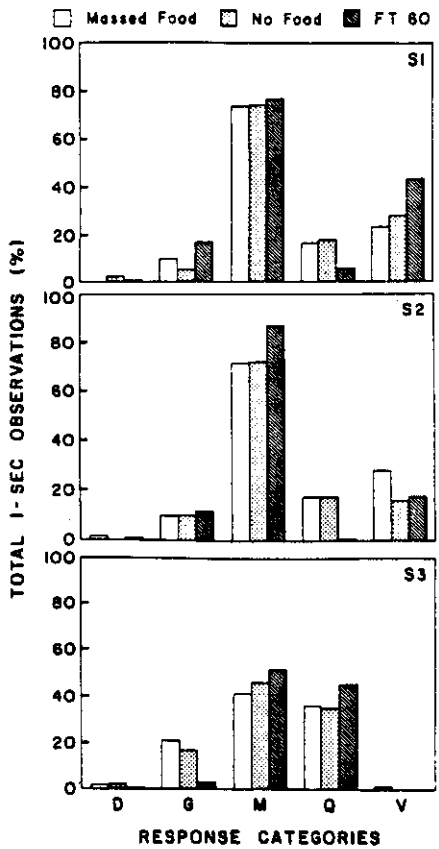

Figure 1. Frequency of behavioral responses exhibited by the three subjects S1, S2 and S3, expressed as percentage of the 1200 1-sec observations made in each session: massed food, absent food and FT 60 s (D = drinking; G = grooming; M = moving; Q = quiet; V = vocalizing).

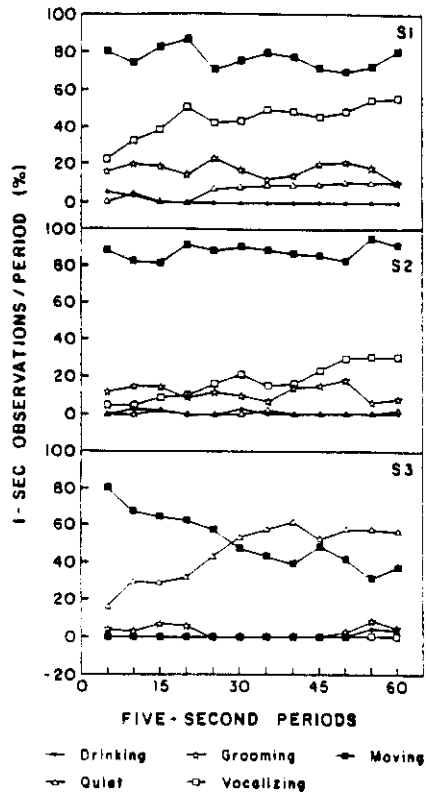

Figure 2. Percent temporal distributions of the observed behavioral responses within the 60-s intervals of the FT 60-s session. Observations were scored at every one second, and averaged for each successive 5-s period.

The temporal distribution of the observed behaviors during the inter-food intervals of the FT 60-s session is depicted in Figure 2. Category frequencies have been averaged over every 5 s of the interval. No evidence was found of a post-food peak in the distribution of any of the observed behaviors. Subjects 1 and 2 displayed a similar pattern, in spite of the excessive grooming and vocalizing shown by S1. For S1, moving and grooming were evenly distributed within the interval. Drinking was virtually absent. The "quiet" category appeared in slightly greater frequency after the first third of the interval, and vocalizing increased gradually as the interval elapsed. The behavioral patterns observed for S2 also were distributed evenly, except for

vocalizing, which showed a small and gradual increase over the interval. The low initial amount of vocalizing presented by these two subjects was probably due to incompatible mouth movements after food ingestion at the beginning of the interval. Subject 3 was distinguishable by her alternation of moving and quiet patterns. Her moving decreased progressively toward the end of the interval as the "quiet" pattern correspondingly increased. She presented an extremely low level of drinking, grooming and vocalizing.

DISCUSSION

There was no clear evidence of behavioral induction in the human subjects of the present study, in spite of the use of adequate controls and moderate food deprivation.

An important distinction between animal and human studies on schedule-induced behavior is that animals are studied under high levels of food deprivation, whereas humans are not food deprived. A single human study considered this variable, using as an indirect control of food deprivation the subjects' recent body-weight loss (Wallace & Oei, 1981). In the present study body-weight as an independent measure of food deprivation was not taken because the subjects were contacted when already on their 16th fasting day. However, the three women declared to be deeply committed to their religious obligations and appeared to be under close control from their social group. Besides, since they were not being paid or in any way coerced to take part in the experiment, one might reasonably assume that they were being honest. Thus, subjects in this experiment were undergoing a minimum of 13-hour food deprivation when they were placed on the intermittent schedule of food delivery, but no polydipsia was observed.

Another difference between animal and human studies can be found in the baseline procedures defined as a criterion against which behavioral enhancement under intermittent schedule is evaluated. In animal experiments the most common procedures are control sessions in which: a) the stimulus is delivered under an FR 1 schedule; b) there is a massive contingent or non-contingent stimulus delivery at the beginning of the session; and c) no stimulus is delivered ("extinction" session). In human experiments, on the other hand, subjects usually do not have access to the intermittently delivered stimuli during the control sessions, and they frequently are asked to perform tasks that are unrelated to the ones they will be doing when under the schedule (for instance, they may listen to a recording in the control session and play a game in the experimental session). Thus, the frequency of recorded behavior in control sessions cannot be considered a completely appropriate baseline measure. In

the present experiment two baseline procedures were employed: one extinction session and one session in which the same amount of food delivered on the intermittent schedule session was continuous and non-contingently provided. Thus, a parallel with two control procedures widely used in animal experiments was achieved.

Although food deprivation was effected in a voluntary way and adequate control sessions were used, some aspects of the procedure employed may have precluded the emergence of a clear induction effect. First, the 13-hour food deprivation procedure employed in the present study was closer to laboratory food deprivation in animals than the weight-reduction procedure, but well below the typical 22-23 hour animal level. A second point relates to the number of sessions required for polydipsia to develop. In rats, an average of 10 sessions must occur before polydipsia is observed clearly. In the present experiment only one schedule session was conducted, due to constraints in the subjects availability. Another difference between the typical animal procedure and the present one is the manner of stimulus presentation. Following Wallace and Oei's procedure, subjects themselves were allowed to control their food intake in response to an intermittent light signal, according to verbal instructions. Rats and other animals in schedule-induced experiments obviously do not have either the physical availability of food during the intervals or the self-restriction imposed by rules. However, human experiments in which excessive drinking has been reported did not rely on self-control, since they employed telegraph key pressing reinforced on an FI schedule of candy delivery (Porter et al., 1982; Granger et al., 1984). Another point to be considered is the interval value of the intermittent schedule. Schedule values used in human experiments are in the range of those used for animals, but the optimal intervals for generating schedule-induced behavior in humans have not been precisely determined, so it remains an open question as to whether different interval values of stimulus delivery would produce a clear induction effect in the present experiment.

The other question addressed by the present experiment was the induction of other patterns of behavior besides polydipsic drinking. Only one of the three subjects displayed excessive behavior in the form of intense movement and vocalizing. Even in this case, however, the excessive behavior did not follow the typical temporal pattern exhibited in schedule-induced polydipsia, in which peak frequency appears after stimulus delivery. Human studies using food as the scheduled stimulus usually produce some degree of increased motor activity in most subjects (Granger et al., 1984; Porter et al., 1982; Wallace & Oei, 1981; Wallace, Sanson, & Singer, 1978). However, subjects in this experiment repeatedly and spontaneously reported to be

exhausted because of their long fast, and that certainly did not facilitate the display of high levels of activity.

Although the present study does not provide enough evidence for a schedule-induced effect, it contributes an original food deprivation procedure that can be improved and fruitfully used in future human studies.

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