JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1985, 18, 237–248 NUMBER 3 (FALL 1985)

THE RELATIVE MOTIVATIONAL PROPERTIES OF SENSORY AND EDIBLE REINFORCERS IN TEACHING AUTISTIC CHILDREN

ARNOLD RINCOVER AND CRIGHTON D. NEWSOM

SURREY PLACE CENTRE, TORONTO, ONTARIO, CANADA AND
MUSCATATUCK TRAINING CENTER, BUTLERVILLE, INDIANA

We compared the effects of sensory and edible reinforcers on resistance to satiation in three autistic children while learning visual discrimination tasks. Within-subject designs were used to compare a single sensory reinforcer with a single edible reinforcer and to compare multiple sensory reinforcers with multiple edibles. Results indicated that multiple sensory reinforcers maintained responding over more trials than did multiple edible reinforcers; however, the use of single sensory reinforcers and single edibles resulted in about equal numbers of trials to satiation. Both multiple and single sensory reinforcers produced higher percentages of correct responses than edible reinforcers. The findings are discussed in terms of the advantages of sensory reinforcers in teaching autistic children.

DESCRIPTORS: sensory reinforcement, motivation, reinforcement, teaching, autistic children

One of the most difficult problems encountered in the treatment of autistic children is lack of motivation. These children do not typically show preference for social events, such as smiles, praise, gestures, or the closeness of others, which makes it difficult for the natural environment to shape and reinforce new behaviors. Furthermore, efforts to establish such generalized social reinforcers have met with little success (Lovaas, Freitag, Kinder, Rubenstein, Schaeffer, & Simmons, 1966; Lovaas, Schaeffer, & Simmons, 1965).

To overcome this problem, parents and teachers have been forced to rely on edible reinforcers (cf. Lovaas, Koegel, Simmons, & Long, 1973). Although many studies have shown that a wide range of skills can be established with edibles, the benefits are limited: Children quickly satiate on edible reinforcers, with the result that responding becomes inconsistent and learning is difficult to program.

Preparation of this manuscript was supported by Grant No. G007802084 from the U.S. Dept. of Education, and Grant No. 1090 from the Ontario Ministry of Health.

We acknowledge Ken Berry for his assistance in collecting the data, and the *JABA* reviewers for their helpful editorial comments.

Reprint requests should be sent to Arnold Rincover, Surrey Place Centre, 2 Surrey Place, Toronto, Ontario, Canada M5S 2C2.

Recent research suggests that there may be attractive alternatives to the use of food. Studies on self-stimulatory behavior, for example, suggest that these persistent stereotypic motor movements are maintained by the auditory, visual, or tactile sensory consequences they produce (Rincover, 1978; Rincover, Cook, Peoples, & Packard, 1979; Rincover & Devaney, 1982; Rincover, Newsome, & Carr, 1979). Because autistic children spend such a large proportion of their free time engaged in self-stimulation (Boer, 1968; Lovaas et al., 1965; Rimland, 1964), which continues for years unless specifically treated, the implication may be that sensory stimulation is a powerful and durable class of reinforcers. Furthermore, several studies (e.g., Bailey & Myerson, 1969; Fineman & Ferjo, 1969; Rice, McDaniel, Stallings, & Gatz, 1967; Rincover & Koegel, 1977; Rotholz & Luce, 1983) have shown that brief presentations of sensory events, such as vibration or music, can in fact serve as reinforcers in treating developmentally disabled children. In one study, when idiosyncratic sensory reinforcers (e.g., 5 s of music, strobe lights) were identified for each autistic child, thousands of bar presses were maintained by contingent presentations of the sensory event (Rincover, Newsom, Lovaas, & Koegel, 1977; Remington, Foxen, & Hogg, 1977). Furthermore, when satiation did occur, only a slight change in the sensory consequence (e.g., changing the music) served to reinstate the previous high level of responding. Results of these studies suggest that sensory events may be extremely powerful reinforcers for autistic children, and that programming a variety of sensory reinforcers may maintain responding indefinitely. If so, sensory reinforcement might be significantly more beneficial in motivating and teaching these children than edible reinforcers.

Although these studies suggest that sensory reinforcement may be a useful alternative to edibles, there is no experimental evidence comparing their satiation properties. There are, however, two studies that investigate initial preferences for different types of reinforcers. Ferrari and Harris (1981) compared the reinforcing effects of edibles, vibration, light flashes, music, and social praise on responding by autistic children in two types of tasks, button pressing and receptive object discriminations. They found that initial preferences among the reinforcers varied across children and across the dependent measures examined (rate per session, percent correct, and trials to criterion). Similarly, Rehagen and Thelen (1972) compared food, touch, and vibration as potential reinforcers for lever pressing with retarded children, and concluded that vibration was as effective as food with most children, whereas touch was relatively ineffective. The relative satiation properties of the stimuli used were not assessed in either study, however.

The purpose of our study was to compare the satiation properties of sensory and edible reinforcers. Comparisons were made when only a single reinforcer of each type was used and when a variety of sensories and edibles were used.

METHOD

Children

Three boys, diagnosed autistic by agencies not associated with this research, participated in this experiment. William and Edward, each 5 years of age, were students in our experimental classroom; Robert, age 6, attended a local center for developmentally disabled children during the day. Each child was tested with the Stanford Binet Intelligence Test or the Peabody Picture Vocabulary Test, and obtained an M.A. score below 2.5 years. All the children lived at home with their natural parents.

William was primarily echolalic but had a small repertoire of expressive speech; that is, he could expressively label simple objects (e.g., "water," "cracker"). His receptive language skills were minimal, as he responded correctly to only a few simple commands (e.g., "Hands quiet," "Sit down"). William was able to feed himself, assist with dressing, and was toilet trained, but his appropriate play skills were limited to tossing a ball back and forth and inserting pegs in a pegboard. In addition, William also displayed a great deal of self-stimulatory behavior; he would spend long periods of time gazing at his fingers while he was either flapping them back and forth or slowly bending each finger up and down.

Edward was also echolalic, and his repertoire of appropriate speech was limited to labeling a few objects (e.g., water, juice). He was toilet trained and could dress himself with adult assistance. His appropriate play skills consisted primarily of listening to music boxes, but he spent most of his free time engaged in one of several self-stimulatory activities, mainly flapping his fingers.

Robert was primarily mute, although he spontaneously produced a variety of vowel sounds. He showed no expressive language skills, including verbal imitation. He responded correctly to a few simple commands (e.g., "Stop that" and "Sit down"), but he could not feed or dress himself without assistance. He displayed no appropriate play skills and virtually all of his free time was spent in self-stimulation; he would rock back and forth on his toes, flap his hands and arms in front of his face, or vigorously clap his hands together.

The first three children for whom consents were obtained participated in this study. No consideration was given to reinforcer preferences during selection; in fact, all three children appeared to have a number of powerful sensory and edible reinforcers.

Setting

Sessions were conducted in our experimental classroom (for William and Edward) and at a developmental disabilities center (for Robert). William's and Edward's sessions were conducted in a classroom approximately 6.3 m wide and 9.5 m long. A child was seated at a table, approximately 1.3 m square, which faced a particle board partition (approximately 3 m high) dividing this corner of the room from the rest of the classroom. The experimenter sat at the table to the left of the child. At the developmental disabilities center, the sessions were conducted in a therapy room (4.5 m × 4.5 m), with the child seated at a round table (1.2 m in diameter) situated in the middle of the room. The experimenter sat directly across the table from the child. The room was free from other furnishings and equipment except for a one-way mirror connecting the treatment room and an adjoining observation room.

General Procedures

Two-choice visual discrimination tasks were used throughout the experiment. On every trial, the experimenter placed two 0.25-m × 0.25-m stimulus cards on the table directly in front of the child and instructed him to "Touch the (e.g., blue)." The position (left/right) of the cards on the table was varied in a predetermined random order. If the child touched the correct card, he received either edibles or sensory stimuli, depending on the experimental phase. If the child touched the incorrect card, the experimenter said "No" and briefly removed the cards for 5 s before beginning the next trial. When the child reached criterion, two blocks of 10 trials with 90% correct responding or better, a new task of relatively equal difficulty was introduced. The same task was used across reinforcement conditions unless and until it was learned. A session was terminated when the child either (a) made no response after the verbal instruction on 50% (or more) of the trials in two consecutive blocks of 10 trials or (b) when 300 trials had been completed. Thus, the session could be terminated by the cessation of responding or by the maintenance of responding over a 300-trial period.

Training Stimuli

Tasks were selected on the basis of each student's individual level of development. Tasks that were currently being used in the child's classroom, that had not been acquired yet, and that were deemed most difficult for the child, were selected. Visual discriminations involving colors or letters of the alphabet were used with each child. The training stimuli for Robert consisted of two 0.25-m × 0.25-m cards; one was completely covered with red construction paper, the other with blue. The blue card was the S+ (correct) stimulus; the red card was the S− (incorrect) stimulus. Because Robert never reached criterion on this initial discrimination, no other training stimuli were used with him.

Nine sets of training cards were used with William. These were the following letter discriminations: B-D, E-F, C-F, L-I, Y-X, O-Q, V-W, R-P, N-M. These 0.2-m letters were stenciled in black magic marker on white cards. The child was trained on a discrimination until he reached criterion, then the next discrimination was immediately introduced. When the last discrimination (N-M) was mastered, the experimenter reintroduced the first training task (B-D), except that now the child was instructed to select the "B" (previously the S−) card. Similarly, the remainder of the discriminations were retaught using the former S− as the S+ stimulus.

Edward was trained on both color and letter tasks. Color tasks included red-blue, yellow-green, and brown-black; letter tasks were the same as those described for William.

Selection of Food and Sensory Reinforcers

A preliminary list of potential food and sensory reinforcers was constructed for each child after both a consultation with teachers and caretakers who knew the child well and a 2-hr observation of the child by the therapist. Approximately 10 potential edible and sensory reinforcers were identified for each child. The reinforcing properties of these stimuli were then assessed by using each as a consequence for correct responding on simple motor tasks (e.g., "Touch your nose"). Stimuli that the child seemed to enjoy (e.g., smiling, reaching), maintained responding for at least 50 trials, were easily administered by the therapist, and were highly rated by the teacher, were selected for use in this study. The final list for each child contained five different edibles and five different kinds of sensory stimulation that were deemed the most preferred from each list. A child participated in the study approximately 1 month after the reinforcer list was compiled.

For William, the five edibles used as reinforcers were pieces of chocolate chip cookies, potato chips, miniature marshmallows, M & M candies and Apple Jacks cereal. The sensory stimuli used as reinforcers for William were tickling, hand clapping (the child clapping the therapist's hands together), rope-twirling (performed by the therapist as the child watched), a drum cadence performed on the table with sticks by the therapist, and finger tapping on the table by the therapist (approximately two taps per second). The edibles used with Robert were potato chips, cheese-flavored crackers, M & M candies, candy-covered popcorn and Froot Loops cereal. The sensory stimuli used with Robert were tickling, rubbing a piece of furry cloth, blowing bubbles, arm caressing and hair stroking. The edibles used with Edward were Froot Loops, potato chips, grapes, M & M candies, and cheese-flavored crackers; the sensory events were singing (the therapist sang with Edward), 5 s of music from a music box, a jack-in-the-box, tickling, and caressing his neck.

Single-Food vs. Single-Sensory Sessions

The initial phase of this study was designed to compare the effects of using a single sensory versus a single edible reinforcer during training. One session using a single type of food was conducted with William, followed by one session with a single sensory; three different food sessions were conducted with Edward and Robert before three individual sensory sessions were initiated. All of Robert's sessions were conducted first, then Edward's, and finally William's.

For each child, the particular sensory (5-s presentation) or edible reinforcer used in a given session was randomly selected. With the exception of the type of reinforcer, the sessions in the "single-food" and the "single-sensory" conditions were identical.

Multiple-Food vs. Multiple-Sensory Sessions

These sessions were designed to assess the relative effects of using a variety of edibles vs. sensory events on the durability of responding and learning. Sessions were conducted in the same manner as those described earlier, with the exception that multiple food reinforcers were now employed in the "food" sessions and multiple sensory events were used in the "sensory" conditions. A reversal design was used for each child, with each experimental phase representing a single session. Robert and Edward each received two food (A) sessions and two sensory (B) sessions. Robert received a food session first in an ABAB design, whereas Edward received a sensory session first in a BABA design. William received three sessions, two food sessions and one sensory session, in ABA order.

Multiple-food sessions were conducted using the five previously tested foods to reinforce correct responses. Whenever the child made a correct response, he was given a small piece of one of his five foods. Food items were alternated on each correct response such that the same food was delivered after every fifth correct response. Similarly, multiple-sensory sessions were conducted using 5 s of the five previously tested sensory events as reinforcers for correct responses. A different sensory event was used to reinforce each correct response so that every fifth response was reinforced by the same sensory event.

Recording and Reliability

The child's response was recorded on every trial by the experimenter on precoded data sheets. Each trial was scored as correct, incorrect, or no response. A "correct" trial was recorded if the child touched (only) the correct card within 10 s of the experimenter's verbal instruction. An "incorrect" response was recorded if the child touched the incorrect card or touched both cards. A "no response"

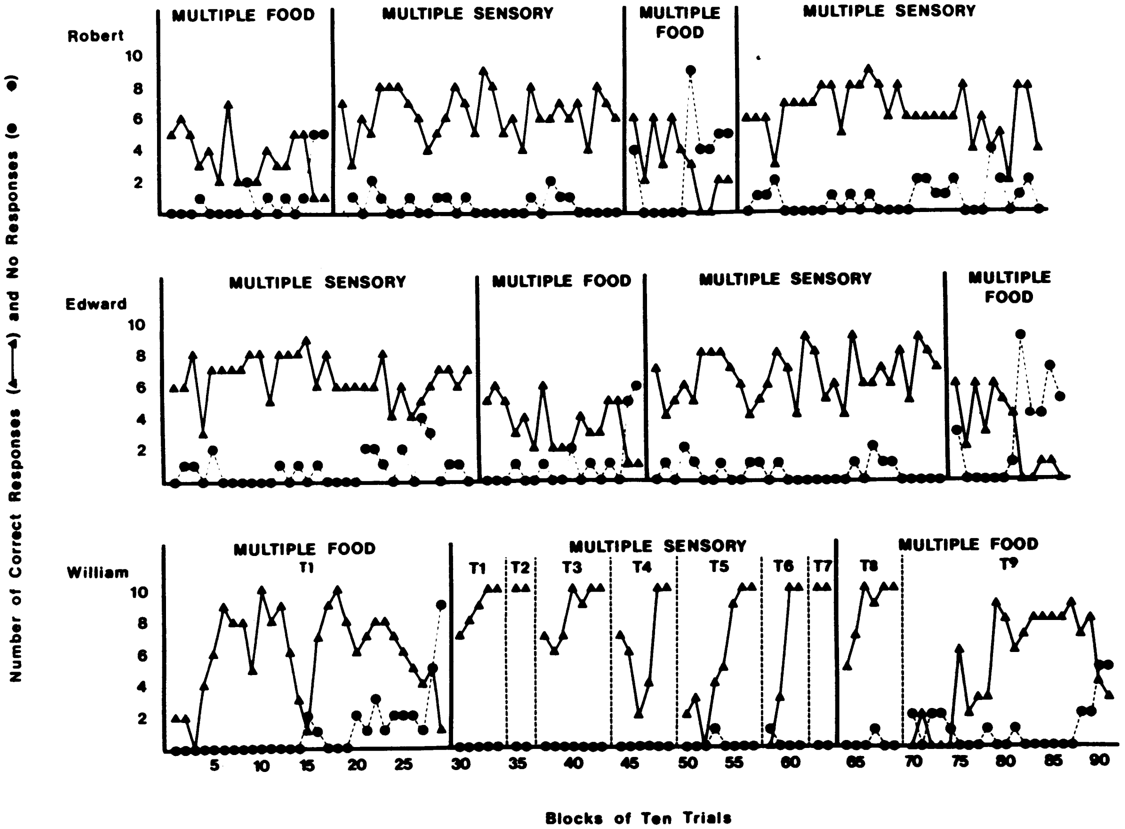


Figure 1. Both the number of correct responses and the number of trials where the child made no response are shown for each block of 10 trials. Rates of responding are shown for all three children under two motivational conditions—when multiple food reinforcers are used vs. when multiple sensory reinforcers are used. Several different tasks were used for William (T1, T2, T3, etc.).

was recorded if the child failed to touch either card within 10 s of the instruction.

At least one reliability session was conducted during each experimental phase for each child (for at least one-third of the single-food vs. single-sensory data, and one-half of the multiple-food vs. multiple-sensory data). Trained undergraduate observers, naive to the experimental hypotheses, were used to obtain reliability measures. Each observer scored his data sheets independently; the experimenter's data sheets were not in view. During William's and Edward's sessions, the observer sat adjacent to the table, with a clear view of the child's responding. During Robert's sessions, the observer had an unobstructed view of the child and the stimulus materials through the one-way mirror, and an intercom system allowed the observer to hear the experimental session.

Experimenter-observer agreement was calculated on a trial-by-trial basis by dividing the number of agreements by the total number of trials in that session. An agreement was defined as the same response recorded for any given trial. Interobserver reliability was at or above 96% for all sessions. Scored separately, reliability was above 90% for "correct responses," "incorrect responses," and "no responses."

RESULTS

The results are organized to answer three questions. First, did multiple sensory reinforcers produce more responding (i.e., resistance to satiation) and higher percentages of correct responses than did multiple edible reinforcers? Second, did a single sensory reinforcer produce more responding and higher percentages of correct responding than a single edible reinforcer? Finally, did the use of variety (i.e., multiple reinforcers), when compared to a single reinforcer, increase motivation, and to a greater degree for sensory than for edible reinforcers?

Multiple-Food vs. Multiple-Sensory Sessions

Robert's data, presented at the top of Figure 1, show that responding was maintained much longer in the sensory sessions than in the food sessions. In the first food session, Robert responded for 170 trials before satiation; in the second food session, he responded for only 110 trials. In contrast, the first sensory session maintained responding for 300 trials without evidence of satiation (either a decline in correct responding or an increase in the frequency of "no responses"); the second sensory session maintained responding for 320 trials. The amount of correct responding observed during the two conditions also favored the sensory reinforcers: In the food sessions, the mean percentages of correct responding were 34.7% for Session 1 and 30% for Session 3, whereas the mean percentages of correct responding were about twice as great in the sensory sessions, 65.3% for Session 2 and 63.4% for Session 4.

The results for Edward, shown in the middle graph of Figure 1, are similar. In each of the two sensory sessions, responding was maintained over 300 trials while the rate of "no responses" remained low; responding in the two food conditions was clearly less durable, as Edward responded for 170 trials in the first food condition and only 120 trials in the second. Each sensory session also produced more correct responding than either food session: The mean percentage of correct responding in the food sessions was 33.5%; the mean percentage of correct responding in the sensory sessions was 65.1%.

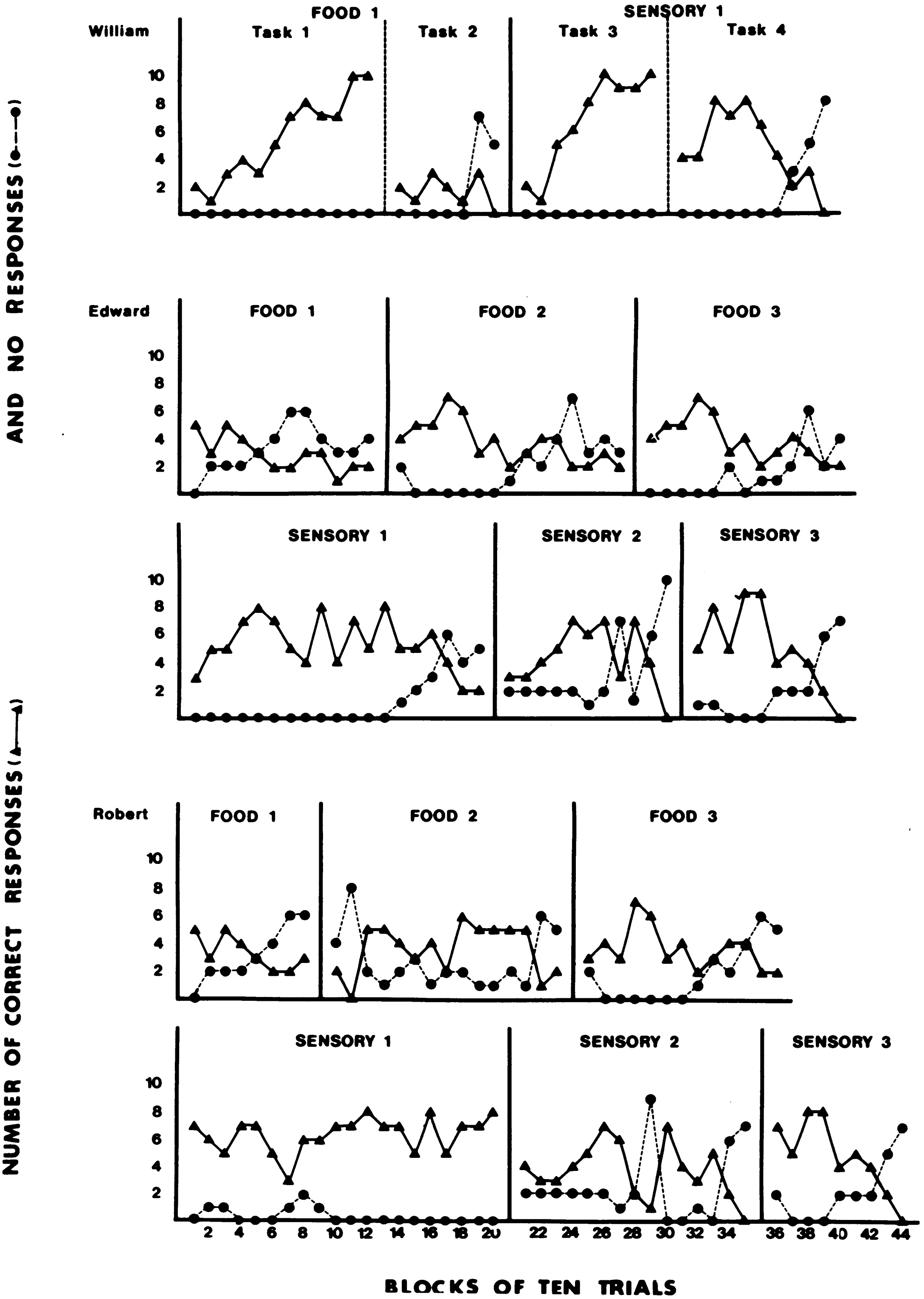
Similar results were obtained for William, as shown in the bottom portion of Figure 1. In the initial food session, William satiated after 290 trials, and he did not master any task during this session. When sensory events were used to reinforce correct responses in the next session, William responded for 340 trials with no evidence of satiation. The percentage of "no responses" never surpassed 10%. Interestingly, William learned seven different tasks (Tasks 1–7) during this session, including the one he had been previously unable to learn with food. When five foods were again used to reinforce correct responses, William learned only one task (Task 8) and satiated on the edible reinforcers after 280 trials. Again percentage of correct responding was higher in the sensory reinforcement condition, averaging 73.2%, than in the food reinforcer conditions, averaging 56.4%.

Single-Food vs. Single-Sensory Sessions

William received one single-food and one single-sensory session, as shown in Figure 2. In the food session, he provided 178 responses (correct plus incorrect), before satiation occurred. Similarly, in the sensory session, he responded for 174 trials before satiating. In addition, the rate and pattern of "no responses" across the food and sensory conditions are remarkably similar; in both conditions, the rate of "no responses" remained at zero until the end of the session, when it rose dramatically, indicating that the child had satiated on the reinforcer. Finally, no difference in amount of learning was seen across the two experimental conditions—William mastered one task during the food session and one during the sensory session—although a slight difference in percentage of correct responding was obtained in favor of the sensory session, 56%

→

Figure 2. Both the number of correct responses and the number of trials where the child made no response are shown for each block of 10 trials. Rates of responding are shown for all three children under two motivational conditions—when a single food reinforcer is used vs. when a single sensory reinforcer is used. One food (Food 1) and one sensory reinforcer (Sensory 1) were used for William, and three foods and three sensories were singly used for Edward and Robert.


William
FOOD 1
SENSORY 1
Task 1
Task 2
Task 3
Task 4
Edward
FOOD 1
FOOD 2
FOOD 3
SENSORY 1
SENSORY 2
SENSORY 3
Robert
FOOD 1
FOOD 2
FOOD 3
SENSORY 1
SENSORY 2
SENSORY 3
NUMBER OF CORRECT RESPONSES AND NO RESPONSES
BLOCKS OF TEN TRIALS

vs. 35%. [It should be noted that 20 extra trials (i.e., after criterion was met on the task) were inadvertently conducted for Task 3 in the sensory condition, which inflates the percentage of correct responding. If we exclude those 20 trials in our calculations, however, the percentage of correct responding is 51% in the sensory condition, still somewhat higher than the (35%) found for the food condition. Similarly, some extra trials were often conducted after a child met criterion (either 300 trials or 50% no responses), during sensory and food conditions, in Figures 1 and 2. These extra trials had no effect on the results and were simply to ensure that our criterion, which was fairly arbitrary, truly depicted the trend in responding.]

The data for Robert and Edward are similar. Robert averaged 84 responses before satiation (range: 55–107) during food sessions and 126 responses (range: 70–194) during the sensory sessions. The percentage of correct responding was slightly higher in the sensory sessions (52% vs. 36%). Robert did not master any tasks in either the sensory or the food sessions. Edward averaged 105 responses (range: 81–121) during the three food sessions, and 107 responses per session (range: 73–169) during the three sensory sessions. Thus, the individual food and sensory events proved to be about equal in the amount of responding each maintained. Edward did not master any of the experimental tasks, yet a small difference in the percentage of correct responding maintained by the two types of consequences was obtained, 50% vs. 36%, in favor of the sensory events.

Single-Reinforcer vs. Multiple-Reinforcer Sessions

When compared to single food sessions, the use of multiple edible reinforcers produced significantly greater responding only in William. William responded for 190 trials in the single-food sessions (Figure 2) and averaged 285 trials in the multiple-food sessions (Figure 1). On the other hand, Robert averaged 120 trials in the single-food sessions and 140 trials in the multiple-food sessions; Edward averaged 133 trials in the single-food sessions and 145 trials in the multiple-food sessions.

When single-sensory sessions were compared with multiple-sensory sessions, however, a substantial increase in responding was found across all three children. William responded for 190 trials in the single-sensory sessions before satiation occurred, yet responded for 340 trials in the multiple-sensory sessions with no evidence of satiation. Robert averaged 147 trials in the single-sensory sessions and 310 trials in the multiple-sensory sessions, and Edward averaged 133 trials in the single-sensory sessions and 315 trials in the multiple-sensory sessions.

For all three children, the introduction of variety had a greater impact on responding in the sensory sessions than when edibles were used. That is, the increase in responding was greater when multiple sensories were introduced (mean increase: 165 trials) than when multiple foods were introduced (mean increase: 42 trials).

DISCUSSION

This study was designed to compare the motivational properties of sensory and edible reinforcers for autistic children. The power of sensory events to maintain responding was found to be substantially greater than food when a variety of reinforcers was used. However, food and sensory reinforcers were found to be roughly equal in their ability to maintain responding when only one of each type of reinforcer was used.

Although the differential effect of multiple food versus sensory reinforcers is clear from these data, this study does not determine what variables account for the differences found. It might be argued that some of the sensory reinforcers used, such as singing, tickling, and stroking, were more powerful because they also contained social reinforcers (i.e., smiling, more eye contact, and attention). However, this argument would predict greater responding in the single-sensory sessions than in the single-food sessions, and this result did not occur.

Further, the autistic children studied, like most, were generally unresponsive to social reinforcers alone, according both to their teachers' reports and our own informal observations. It therefore seems unlikely that the purely "social" components of some of the sensory reinforcers were functional variables.

We also recognize that food ingestion has sensory components, along with providing nutrients and reducing hunger. Indeed, it is quite likely that the power of food to function as a reinforcer derives primarily from its sensory qualities (taste, smell, texture), particularly in treatment settings where the edibles used as reinforcers are selected specifically for the attractiveness of their flavors to the clients. Although our distinction between "food" and "sensory" reinforcers may therefore seem arbitrary, we believe the distinction is important for two reasons. First, as shown in this study, sensory reinforcers exhibit greater resistance to satiation than edibles when multiple consequences are scheduled. This difference in satiation characteristics under conditions of varied presentation justifies a distinction between sensory and food reinforcers for both theoretical and clinical purposes. Second, the simple need for clear communication argues for the maintenance of the commonsense distinction between foods and events such as music, toys, tickling, and the like.

Although we are unaware of any previous studies systematically comparing the satiation properties of sensory vs. edible reinforcers, there are several bodies of literature related to the question of single vs. multiple reinforcers. Many studies addressing stimulus variation, curiosity, and novelty document the positive effects of reinforcer change on motivation (e.g., Berlyne, 1960; Fowler, 1965; Glanzer, 1958). The majority of this research focuses on sensory stimuli and is supported by our data on single vs. multiple sensory reinforcers.

Recent studies on the effects of varying edible reinforcers also reveal findings relevant to ours. Egel (1980) found that the scheduling of multiple edible reinforcers produced more bar press responses and faster responding than single edible reinforcers in 10 autistic children. Of greater relevance to our study, Egel (1981) found that multiple edibles produced more responses and higher percentages of correct responding and on-task behavior than single edibles in classroom discrimination tasks with three autistic children. In our study, two children showed only marginal increases in responding in multiple- as opposed to single-food sessions; only one (William) showed a large increase. The basic difference in the two sets of findings may be attributable to fewer responses in the single-food condition in Egel's (1981) subjects (range: 8–64) than in ours (range: 80–190). This difference may in turn be due to Egel's use of a more restrictive satiation criterion than ours (viz., three no-response trials vs. 50% no-response trials in two blocks of 10 trials), to the use of three teacher-nominated edibles as reinforcers instead of five empirically validated edibles, or to subject, task, or other procedural differences. Finally, Litt and Schreibman (1981) found that multiple edibles produced faster acquisition of receptive object labels than single, "salient" (i.e., highly preferred) edibles in five autistic children. In the study reported here, only one child (William) showed a higher percentage of correct responding in the multiple-food condition than in the single-food condition. Litt and Schreibman did not examine reinforcer durability, and numerous procedural differences preclude a more detailed comparison of their findings with ours.

These data have several implications for treatment. Of primary significance is the finding that children may work longer and learn more when multiple-sensory events are used. In fact, some of the multiple-sensory sessions lasted over 2 hr without breaks, tantrums, or other "escape" behavior in the children studied. Such lengthy, intensive sessions are rarely possible when food is used; in fact, traditional treatment "lore" holds that short sessions with frequent breaks are necessary in teaching autistic and other developmentally disabled children. Further, the children in this study appeared to actively enjoy the sensory sessions in spite of their length. For example, one child, Edward, maintained good eye contact, laughed and played with the therapist in the sensory condition, but did none of this in the food session.

There are also external constraints on the use of edible reinforcers that do not apply to sensory consequences. Current legal and ethical standards limit the degree to which clients may be food deprived. Typically, institutionalized children noncontingently receive three full meals and two snacks each day. Although granting the humanitarian merits of this requirement, treatment based solely on contingent food delivery will clearly not be maximally effective. Fewer problems exist when sensory events are used in treatment: Even when satiation on a sensory consequence does occur, varying multiple consequences or modifying a single consequence (Rincover et al., 1977) can be sufficient to recover a high rate of responding.

The therapist's use of food may also have some undesirable side effects not found for sensory stimuli. When clients already receive adequate nourishment outside of treatment, therapists frequently use preferred but non-nutritious candies, cookies, and other highly sugared foods. This practice may lead to undesired weight gain and a greater incidence of dental cavities unless regular dietary management, exercise, and toothbrushing programs are in place.

An additional benefit of the use of sensory reinforcers is that it may promote greater interaction between the child and the environment. Many sensory events that can be used as reinforcers require participation or at least attention by the child, rather than passive acceptance of food. Because the behavioral repertoires of these children are generally extremely restricted, any increase in environmental interaction seems worthwhile. Such interaction may provide the basis for building appropriate play (Eason, White, & Newsom, 1982; Favell, McGimsey, & Schell, 1982; Rincover et al., 1979), social behavior, and social reinforcers. In line with this, we should note that many behaviors provide "natural" sensory consequences (for example, turning on a tape recorder). Perhaps it would be efficacious to teach these behaviors and their associated consequences during the initial stages of treatment with autistic children, as a way of bringing them in contact with the available reinforcers in the world around them. Recent data (e.g., Koegel & Williams, 1980) showing faster acquisition for behaviors reinforced by natural events are consistent with this view.

In our study, higher percentages of correct responding were observed in the sensory reinforcement sessions than in the food sessions. This result was found with all the children and occurred in both single- and multiple-reinforcer conditions. Although this could in part be due to an order effect in the single-reinforcer comparison, an order effect is not supported in the multiple-reinforcer comparison. It may be that the "attention-facilitation" effects of sensory reinforcers include the enhancement of attention to the objects used in discrimination tasks. Further research examining this possibility seems warranted, particularly in light of the severe attention problems evidenced by many autistic and retarded children (e.g., Altman & Krupshaw, 1982; Foxx, 1977; Lovaas, Koegel, & Schreibman, 1979; Mullins & Rincover, in press; Zeaman & House, 1979).

Finally, sensory reinforcement may have wider applicability than edible reinforcement. Some autistic children, both in our own experience and in the published literature, are unmotivated by food even when they have been food deprived (e.g., Fineman & Ferjo, 1969). Obviously, treatment based solely on the use of food consequences will be ineffective with this subgroup. All autistic children, however, seem to show preference for sensory events of one kind or another. The child who cares nothing for music, for example, may work long periods to view a kaleidoscope, to be tickled and stroked, or to engage in scheduled opportunities for self-stimulation (Devany & Rincover, 1979; Rincover et al., 1977). This apparent universality of the applicability of sensory reinforcement is supported by studies demonstrating sensory reinforcement effects with decorticate humans (Deiker & Bruno, 1976), neonates (Siqueland, 1968), and animals (Kish, 1966) and suggests that the capacity to be reinforced by sensory stimulation may be a basic feature of human and animal life.

REFERENCES

Altman, K., & Krupshaw, R. (1982). Increasing eye contact by head holding. *Analysis and Intervention in Developmental Disabilities,* **2,** 319–327.

Bailey, J., & Meyerson, L. (1969). Vibration as a reinforcer with a profoundly retarded child. *Journal of Applied Behavior Analysis,* **1,** 91–97.

Berlyne, D. E. (1960). *Conflict, arousal, and curiousity.* New York: McGraw-Hill.

Boer, A. P. (1968). Application of a simple recording system to the analysis of free-play behavior in autistic children. *Journal of Applied Behavior Analysis,* **1,** 335–340.

Deiker, T., & Bruno, R. (1976). Sensory reinforcement of eyeblink rate in a decorticate human. *American Journal of Mental Deficiency,* **80,** 665–667.

Devany, J., & Rincover, A. (1979, November). Experimental analysis of ethical issues: I. Using self-stimulation as a reinforcer with developmentally disabled children. Paper presented at the meeting of the Association for Advancement of Behavior Therapy, San Francisco, CA.

Eason, L., White, M., & Newsom, C. (1982). Generalized reduction of self-stimulatory behavior: An effect of teaching appropriate play to autistic children. *Analysis and Intervention in Developmental Disabilities,* **2,** 157–169.

Egel, A. L. (1980). The effects of constant vs. varied reinforcer presentation on responding by autistic children. *Journal of Experimental Child Psychology,* **30,** 455–463.

Egel, A. L. (1981). Reinforcer variation: Implications for motivating developmentally disabled children. *Journal of Applied Behavior Analysis,* **14,** 345–350.

Favell, J., McGimsey, J., & Schell, R. (1982). Treatment of self-injury by providing alternate sensory activities. *Analysis and Intervention in Developmental Disabilities,* **2,** 83–104.

Ferrari, M., & Harris, S. (1981). The limits and motivation potential of sensory stimuli as reinforcers for autistic children. *Journal of Applied Behavior Analysis,* **14,** 339–343.

Fineman, K. R., & Ferjo, J. (1969). Establishing and increasing verbalizations in a deaf schizophrenic child through the use of contingent visual reinforcement. *Perceptual and Motor Skills,* **29,** 647–652.

Fowler, H. (1965). *Curiosity and exploratory behavior.* New York: Macmillan.

Foxx, R. M. (1977). Attention training: The use of overcorrection avoidance to increase the eye contact of autistic and retarded children. *Journal of Applied Behavior Analysis,* **10,** 489–499.

Glanzer, M. (1958). Curiosity, exploratory drive, and stimulus satiation. *Psychological Bulletin,* **55,** 302–315.

Kish, G. B. (1966). Studies of sensory reinforcement. In W. K. Honig (Ed.), *Operant behavior: Areas of research and application* (pp. 109–159). New York: Appleton-Century-Crofts.

Koegel, R. L., & Williams, J. A. (1980). Direct vs. indirect response-reinforcer relationships in teaching autistic children. *Journal of Abnormal Child Psychology,* **8,** 537–547.

Litt, M. D., & Schreibman, L. (1981). Stimulus-specific reinforcement in the acquisition of receptive labels by autistic children. *Analysis and Intervention in Developmental Disabilities,* **1,** 171–186.

Lovaas, O. I., Freitag, G., Kinder, M. I., Rubenstein, B. D., Schaeffer, B., & Simmons, J. Q. (1966). Establishment of social reinforcers in two schizophrenic children on the basis of food. *Journal of Experimental Child Psychology,* **4,** 109–125.

Lovaas, O. I., Koegel, R. L., & Schreibman, L. (1979). Stimulus overselectivity in autism: A review of research. *Psychological Bulletin,* **86,** 1236–1254.

Lovaas, O. I., Koegel, R. L., Simmons, J. Q., & Long, J. S. (1973). Some generalization and follow-up measures on autistic children in behavior therapy. *Journal of Applied Behavior Analysis,* **6,** 131–165.

Lovaas, O. I., Schaeffer, B., & Simmons, J. Q. (1965). Experimental studies in childhood schizophrenia: Building social behavior by use of electric shock. *Journal of Experimental Studies in Personality,* **1,** 99–109.

Mullins, M., & Rincover, A. (in press). Comparing autistic and normal children along the dimensions of reinforcement maximization, stimulus sampling, and responsiveness to extinction. *Journal of Experimental Child Psychology.*

Rehagen, N., & Thelen, M. (1972). Vibration as a positive reinforcer for retarded children. *Journal of Abnormal Psychology,* **80,** 162–167.

Remington, R., Foxen, T. & Hogg, J. (1977). Auditory reinforcement in profoundly retarded multiply-handicapped children. *American Journal of Mental Deficiency,* **82,** 299–304.

Rice, H., McDaniel, M., Stallings, V., & Gatz, M. (1967). Operant behavior in vegetative patients, II. *Psychological Record,* **17,** 449–460.

Rimland, B. (1964). *Infantile autism.* New York: Appleton-Century Crofts.

Rincover, A. (1978). Sensory extinction: A procedure for eliminating self-stimulatory behavior in autistic and retarded children. *Journal of Abnormal Child Psychology,* **6,** 695–701.

Rincover, A., Cook, R., Peoples, A., & Packard, D. (1979). Sensory extinction and sensory reinforcement principles for programming multiple adaptive behavior change. *Journal of Applied Behavior Analysis,* **12,** 221–233.

Rincover, A., & Devany, J. (1982). The application of sensory extinction principles to self-injury in developmentally disabled children. *Analysis and Intervention in Developmental Disabilities,* **2**, 67–81.

Rincover, A., & Koegel, R. L. (1977). Treatment of psychotic children in a classroom environment: II. Individualized instruction in a group. *Journal of Abnormal Child Psychology,* **5**, 123–136.

Rincover, A., Newsom, C. D., & Carr, E. G. (1979). Using sensory extinction procedures in the treatment of compulsive-like behavior of developmentally disabled children. *Journal of Consulting and Clinical Psychology,* **47**, 695–701.

Rincover, A., Newsom, C. D., Lovaas, O. I., & Koegel, R. L. (1977). Some motivational properties of sensory reinforcement with psychotic children. *Journal of Experimental Child Psychology,* **24**, 312–323.

Rotholz, D. A., and Luce, S. C. (1983). Alternative reinforcement strategies for the reduction of self-stimulatory behavior in autistic youth. *Education and Treatment of Children,* **6**, 363–377.

Siqueland, E. R. (1968). Reinforcement patterns and extinction in human newborns. *Journal of Experimental Child Psychology,* **6**, 431–442.

Zeaman, D., & House, B. J. (1979). A review of attention theory. In N. R. Ellis (Ed.), *Handbook of mental deficiency, psychological theory and research* (pp. 131–159). Hillsdale, NJ: Lawrence Erlbaum.

Received May 21, 1984
Final acceptance May 13, 1985