COMPARISON OF SENSORY AND EDIBLE REINFORCERS

By

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To my wonderful family, Anthony, Deborah, and Christopher

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Previous research has shown that individuals with developmental disabilities generally prefer edible items over leisure items. Other research has reported that "sensory" (leisure) items facilitate acquisition and maintenance of behavior better than do edible items for individuals with autism. Although these findings seem contradictory, the data are not comparable because studies on preference were conducted with subjects without autism, whereas data on performance were collected for subjects with autism. The current study examined preference and performance of children with and without autism using sensory and edible reinforcers. Results showed that edibles were more preferred (Experiment 1) and resulted in higher rates of responding under maintenance conditions (Experiment 3) in subjects with and without autism. Edible and sensory items resulted in equal rates of response acquisition (Experiment 2) for both samples and for subjects with different patterns of preference.

CHAPTER 1
INTRODUCTION

Identifying reinforcers for adaptive behavior is an important step in developing effective behavioral interventions for individuals with disabilities who often have deficits in the areas of language, self-care, academic, and social skills. Decisions regarding the type of reinforcer used may be influenced by a number of variables, including the availability, practicality, and, most important, efficacy of the reinforcer. Basic research has revealed that the efficacy of particular events as reinforcers largely depends on individual conditioning histories and present levels of deprivation, both of which suggest an individualized approach to the selection of reinforcers. Such an approach commonly is accomplished in applied settings through stimulus preference assessments (Pace, Ivancic, Edwards, Iwata, & Page, 1985), which are used to predict the value of various stimuli as reinforcers for an individual.

Pace et al. (1985) evaluated subjects' physical approach to various beverages (e.g., coffee), sensory items (e.g., lights), odors (e.g., dried hibiscus), foods (graham cracker), and social events (e.g., hugs). Items that were approached the most (at least 8 of 10 presentations) by each subject were considered high-preference items and were shown to maintain a higher level of adaptive responding than items approached least (less than 5 of 10 presentations). Results also revealed between-subject differences in preference for specific stimuli. These results were replicated across different assessment formats (e.g., multiple-stimulus and duration-based formats); the majority of outcomes from preference assessment research have supported the idiosyncratic nature of preference between subjects (e.g., DeLeon & Iwata, 1996) and within subjects across time (Hanley, Iwata, & Roscoe, 2006). Nevertheless, certain broad classes of stimuli (e.g., social, edible, leisure) have proven generally effective as reinforcers across a large number of behaviors

and subjects, and thus several studies (e.g., Rincover & Newsom, 1985) have sought to compare stimulus classes with respect to reinforcer efficacy and durability.

Reinforcer Classes

Reinforcers have been categorized in behavioral research along a variety of dimensions, including the delivering agent (social, nonsocial), contingency (positive, negative), conditioning history (primary, secondary), and stimulus form (attention, item, activity). Most research on acquisition has been conducted using social positive reinforcement (attention, tangible items, and activities). In the first-reported application of operant conditioning with a human, Fuller (1949) delivered a sugar-milk solution contingent on the arm movements of an adolescent male labeled "vegetative." Subsequent research established the effectiveness of edible reinforcers for a variety of adaptive behaviors, such as communication (Barton, 1970), daily living skills (Wolf, Risley, & Mees, 1964), and compliance (Whitman, Zakaras, & Chardos, 1971). For example, Whitman et al. used cereal, chocolate, and diet soda as reinforcers for the completion of single-step instructions in two children with profound disabilities who were reported by their teachers as unwilling to follow vocal instructions. Physical guidance was used initially to ensure contact with the reinforcer but was later faded from training. Results showed a marked increase in compliance with instructions used during training as well as generalization to novel instructions that were not used during training for both subjects.

Sensory stimulation—in the form of vibration, light, and sound—also has been shown to reinforce simple arbitrary responses (e.g., lever pressing) in animals (e.g., Kish, 1955; Kish & Baron, 1962) and humans (Bailey & Meyerson, 1969; Fehr, 1979). Some of the earliest studies to apply sensory reinforcers to socially meaningful behavior were conducted by Rice and colleagues (Rice & McDaniel, 1966; Rice, McDaniel, & Stallings, 1967) and involved increasing the motor behaviors of "vegetative" patients. Subsequent research showed that sensory stimuli

could be used to establish more complex behaviors, such as vocal behavior (Fineman, 1968; Fineman & Ferjo, 1969) and conditional discriminations (Rincover & Newsom, 1985).

Comparison of Sensory and Edible Reinforcers

Direct comparisons of the effects of sensory and edible reinforcers on response acquisition (Ferrari & Harris, 1981; Rehagen & Thelen, 1972; Rincover & Newsom, 1985) have shown somewhat inconsistent results. Rehagen and Thelen compared rates of button pressing in 20 individuals with moderate to severe disabilities who received 10-s access to either sensory (vibrating massager) or edible (sugared cereal) stimuli on a continuous schedule of reinforcement. The effects of each reinforcer class were evaluated in a group design, with 10 subjects assigned to the sensory group and 10 to the edible group. Results showed no significant difference in response rates across groups, indicating relatively equal efficacy across edible and sensory reinforcers. However, the group design did not permit a direct, within-subject comparison of the effects of each reinforcer, which is problematic if certain individuals are prone to greater reinforcer sensitivity by reinforcer type. In addition, no individual data were reported, so the extent to which group means were representative of responding by individuals is unknown.

Ferrari and Harris (1981) observed individual differences in the effectiveness of edible (fruit, candy, and cereal) and sensory (music, strobe lights, and vibrating massager) reinforcers in 4 children with autism. A within-subject design was used and consisted of two phases, which differed with respect to task difficulty. In phase 1, subjects touched a clown's nose to receive reinforcers (single sensory and edible items were alternated across sessions) on a fixed ratio (FR) 6 schedule of reinforcement. In phase 2, the experimenters trained a two-choice object discrimination using continuous reinforcement. One reinforcer type was used to train an initial set of discriminations and, following mastery with the initial set, the second reinforcer type was

used to train a second set of discriminations. Phase 1 results showed overall higher levels of responding for vibrating items in two subjects and for edible items in the remaining two subjects. Phase 2 results were the same, with vibration (two subjects) and edibles (two subjects) resulting in faster acquisition and better maintenance of the trained discrimination. The authors also noted that no difference in satiation effects was observed across stimulus classes, although data were not presented on this measure.

Rincover and Newsom (1985) also compared the effects of edible items (various snacks) and sensory items or events (auditory, visual, and tactile stimulation) on the outcomes of discrimination training in three children with autism. Four conditions were included, each involving the repeated presentation of a two-choice visual discrimination task. The same edible item was delivered contingent on each correct response in the *Single Edible* condition, whereas different edible items were rotated as reinforcers in the *Multiple Edible* condition; the *Single Sensory* and *Multiple Sensory* conditions were identical except that sensory items were used. Accuracy of responding was measured by calculating the percentage of trials with a correct response within 10 s of task presentation. Durability of responding was measured by counting the number of trials completed before meeting a satiation criterion or until a 300-trial cap was met. Responding on the discrimination task was more accurate and more durable for all subjects when the consequences for correct responses were multiple sensory items, as compared to multiple edible items. Only small differences in favor of sensory items were obtained when single sensory items were compared to single edible items: Single sensory items resulted in slightly higher accuracy but no better durability compared to single edible items.

Results from more recent studies on the assessment of preference (Bojak & Carr, 1999; DeLeon, Iwata, & Roscoe, 1997), however, indicate that edible items are generally preferred to

leisure items in individuals with intellectual disabilities. DeLeon et al. conducted a multiple-stimulus-without-replacement (MSWO) preference assessment (DeLeon & Iwata, 1996) for edible items alone and leisure items alone with 14 individuals with moderate to profound mental retardation. The authors subsequently included the most-highly preferred items from each class in a combined preference assessment. Twelve of their subjects showed a pronounced preference for the edible items over leisure items. Bojak and Carr replicated this general finding in four adults with severe mental retardation. The authors additionally attempted to alter the establishing operation for edibles by conducting combined MSWO assessments immediately following meals. Resulting preferences were not changed by this manipulation (i.e., preferences remained in favor of edible items), indicating a general resistance to satiation effects for edible items. No comparable manipulation was conducted for leisure items. It should be noted that the leisure items in these studies primarily included auditory, tactile, visual, or olfactory features, and thus, these items should be considered comparable to the "sensory" items used in previous research. Given the lack of distinguishing features between items labeled "sensory" and "leisure" in previous research, both classes of items will be referenced by the more commonly used term, "leisure" items.

In summary, although results of some studies have shown that edibles are generally preferred (Bojak & Carr, 1999; DeLeon, et al., 1997), results of others (Rincover & Newsom, 1985) suggest that leisure items may be more effective reinforcers. Several possible explanations exist for these seemingly discrepant results. First, edible items may be preferred, but also may be more prone to satiation relative to leisure items. Satiation was unlikely to occur during the brief preference assessments conducted by Bojak and Carr and by DeLeon et al., so it is unclear whether the highly preferred edible items would have maintained responding longer than the

less-preferred leisure items when used over extended periods of time. Second, results of the Rincover and Newsom study may have reflected subject characteristics. The authors did not compare preference between reinforcer classes, so perhaps subjects in that study happened to prefer leisure over edible reinforcers. In addition, all subjects in the Rincover and Newsom study were diagnosed with autism, whereas subjects in the studies conducted by Bojak and Carr and by DeLeon et al. were not.

Several authors have noted that sensory stimuli might be particularly potent and durable reinforcers for individuals with autism because these individuals frequently engage in stereotypic behaviors that persist throughout the day (e.g., Ferrari & Harris, 1981). Early accounts suggested that these particularly rigid and repetitive forms of behavior were likely maintained by the sensory stimulation produced as a direct result of the behavior; this hypothesis was bolstered by evidence that stereotypy decreased when the resulting sensory consequences were removed (e.g., "sensory extinction"; Rincover, Cook, Peoples, & Packard, 1979). In addition, a large proportion of studies in which functional analyses were conducted of stereotypy have shown that the behavior typically is not maintained by social reinforcement (Hanley, Iwata, & McCord, 2003), adding further evidence that stereotypy produces automatic reinforcement in the form of sensory stimulation. The use of sensory events has been broadly recommended as an important component of treatment for individuals with autism (e.g., “sensory integration” therapy); however, evidence in support of this recommendation is largely anecdotal and has little empirical basis (Rogers & Ozonoff, 2005).

The purpose of the current studies was to extend research on preference, efficacy, and durability of leisure and edible items as reinforcers for individuals with and without autism. In Experiment 1, we replicated the procedures of DeLeon et al. (1997) to compare preference for

leisure and edible items. Experiment 2 was a comparison of the effects of leisure and edible reinforcement on the acquisition of a 6-step response chain. We compared the effects of leisure and edible reinforcement on the maintenance of a simple motor response in Experiment 3.

CHAPTER 2
EXPERIMENT 1: PREFERENCE FOR LEISURE AND EDIBLE ITEMS

Method

Subjects, Setting, and Materials

Twelve individuals diagnosed with autism or an intellectual disability participated in one or more studies. All subjects attended a special education school approximately 7 hrs a day at the time of participation. Table 2-1 contains specific information about the subjects' ages, diagnoses, and participation. A diagnosis of autism or of a specific intellectual disability (e.g., Down Syndrome) was listed in the subjects' medical records and was made by a qualified physician. A diagnosis of intellectual disability (not otherwise specified) was listed as the primary exceptionality in the subjects' individualized education plan (IEP) and was provided by a physician or school psychologist. All assessments took place in a research room located close to the subjects' typical classroom. No more than one assessment was conducted per day.

Preference for 16 stimuli was assessed for each subject. Eight edible items were selected arbitrarily from a list that included sweet, salty, and sour snacks similar (but not identical) to those typically used during acquisition training in the school. All edible items were bite-sized and able to be consumed easily within 15 s. Examples included candies (sweet and sour), crackers, cereals, pretzels, peanuts, and pickles. Eight leisure items were selected based on recommendations from an on-site occupational therapist and included a sample of visual, auditory, and tactile stimuli. The sensory function was a prominent feature of each leisure item sampled. Inclusion of a specific edible or leisure item in any individual assessment was based upon consumption (edible) or interaction (leisure) with the item during a brief pre-experimental exposure. Informal interviews with the subjects' teachers and caregivers indicated that the items were not being used on a daily basis in the classroom or the home settings.

Response Measurement and Interobserver Agreement

The primary dependent measure for all preference assessments was selection, defined as approach or physical contact with an item. Data were summarized by dividing the number of times an item was selected by the number of times that item was available as a choice. Items were then ranked based on these selection percentages. The highest percentage was given a rank of 1 and the lowest a rank of 8. If two items had identical selection percentages, they were ranked equally by calculating the mean of the two ranks.

Reliability was assessed by having a second observer simultaneously but independently observe 81.7% (range, 40% to 100%) of trials across subjects. Observers' records were compared on a trial-by-trial basis, and an agreement was scored if both observers listed the same item selected for a given trial. Trials with agreement were divided by total trials, and the resulting quotient was multiplied by 100. The mean agreement across subjects was 100% for leisure and edible assessments and 98.8% (range, 92.5% to 100%) for combined assessments.

Procedures

Preference assessments were conducted using a multiple stimulus without replacement (MSWO) format, similar to that described by DeLeon and Iwata (1996). Prior to the first trial of each assessment, the subject was given an opportunity to sample the items to be used in the assessment. An array of eight items then was presented in front of the subject. The *Edible-only* assessment included all eight edible items; the *Leisure-only* assessment included all eight leisure items. On the first trial, the experimenter prompted the subject to "pick your favorite." Selection of an item resulted in access to that item for 15 s, removal of that item from the array, rotation of the remaining items, and a subsequent prompt to "pick your favorite" from the remaining items. This procedure continued until all items were selected. Attempts to select more than one item at the same time were blocked, and the array was represented with an instruction to "pick *one.*"

The *Edible-only* and *Leisure-only* assessments were conducted five times each. The top four ranked edible items (HPE) and the top four ranked leisure items (HPL) from these assessments subsequently were presented in a *Combined* array of edible and leisure items, which also was presented five times. This procedure resulted in 15 assessments per subject.

Results and Discussion

Table 2-2 shows rankings for the HPE and HPL items in *Combined* preference assessments for the 12 subjects (Wes, Billy, Nick, Martin, Dan, Carl, Ken, Mark, Elliot, Cade, Caleb, and Henry) who participated. All edible items were ranked higher than all leisure items in the combined assessment for 8 subjects (66.7%); these subjects showed an exclusive preference for edible over leisure items. Edible items were ranked higher than all but one leisure item in the combined assessments for 2 additional subjects (16.7%). These subjects showed a general, albeit not exclusive, preference for edible items over leisure items. Rankings for the remaining two subjects (Caleb and Henry) showed mixed preference for edible and leisure items.

Figure 2-1 shows selection percentages for the same top-four ranked edible and leisure items in the *Leisure only*, *Edible only*, and *Combined* assessments. Logged percentages are displayed because the equation used to derive selection percentages results in a negatively accelerating decrease in percentage for later selections from the array (i.e., if items consistently were selected 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, and 8th across all 5 assessments, percentages equaled 100%, 50%, 30%, 25%, 20%, 16.7%, 14.3%, and 12.5%, respectively). All 48 leisure items shown in Figure 2-1 were selected on a lower percentage of trials in the *Combined* assessment relative to the *Leisure* assessment. This was true for all subjects, despite differences in the relative rankings of leisure and edible items in the *Combined* assessment.

By contrast, only 21 of the 48 edible items (43.8%) shown in Figure 2-1 were selected on a lower percentage of trials in the *Combined* assessment relative to the *Edible only* assessment.

The remaining 27 edible items (56.2%) were selected on a higher percentage of trials. Decreases in the percentages of individual items indicate either a consistent decrease in their preference ranking or a general decrease in the consistency of rankings. Thus, although some variability in individual preferences may have been introduced in the *Combined* assessment (decreases in percentages for some leisure and some edible items), this was more frequently accounted for by changes in the rankings within each class as opposed to across classes.

These results replicate those reported by DeLeon et al. (1997) and by Bojak and Carr (1999) in that most subjects, 9 of 12, showed an exclusive preference for edible items. This extends the results of previous comparisons in that the general effect was shown in subjects with autism as well as subjects with intellectual disabilities.

Preference for edible items may be particularly strong because these items represent primary sources of reinforcement with an extensive phylogenic and ontogenic history. Leisure items generally are considered secondary reinforcers, though some evidence exists to suggest that sensory stimulation represents a primary source of reinforcement (Kish, 1966). Kish first proposed the class of "sensory" stimuli as a primary source of reinforcement, noting that sensory stimuli showed similar patterns of satiation and habituation as did primary reinforcers and that sensory reinforcers showed generality across species. Nevertheless, given that the sensory reinforcers in the current study could only be obtained through engagement with leisure items, this source of stimulation may have been more effortful to obtain than that of edibles.

Perhaps a stronger establishing operation for edible items exists because meals are scheduled at specific points in the day, and generally are restricted to three, whereas all other sources of sensory stimulation (visual, auditory, tactile) are continuously experienced throughout the day. Although we did not attempt to control for background levels of food consumption or sensory

stimulation, we did ensure that all items used in the preference assessments were unavailable to the subjects outside of experimental sessions.

In the current study, stimuli were selected so that a range of sensations was sampled (e.g., sweet, salty, and sour foods as well as tactile, visual, and auditory toys) and so that stimuli were unique to the experimental setting. Thus, item selection was not based on reports from the subjects' caregivers, which may have precluded inclusion of specific (perhaps very highly preferred) items. Although the procedure used in the current study provided a more even distribution across sensory modalities, it may have limited the generality of preference outcomes for subjects with highly idiosyncratic preference (e.g., a specific toy to which subject has access at home).

Table 2-1. Subject characteristics.

Subject	Age	Diagnosis	Experiment
Ken	5	Autism spectrum disorder (ASD)	1, 2, 3
Elliot	7	Autism	1
Henry	12	ASD	1, 2, 3
Dan	16	ASD	1, 3
Caleb	17	ASD	1, 2, 3
Mark	18	ASD	1
Carl	20	ASD	1
Martin	10	Intellectual disability (ID)	1
Billy	12	Dandy Walker syndrome	1, 3
Wes	19	Down Syndrome, Klinefelter Syndrome	1
Nick	20	ID	1, 2, 3
Cade	22	ID, Attention deficit hyperactivity disorder, Microcephaly	1

Table 2-2. Rankings for the HPE and HPL items in the combined assessments.

Subject	Highly-Preferred Edible (HPE) items	Highly-Preferred Leisure (HPL) items
Nick	1, 2, 3, 4	5, 6, 7, 8
Billy	1, 2, 3, 4	5, 6, 7, 8
Wes	1, 2, 3, 4	5, 6, 7, 8
Martin	1, 2, 3, 4	5, 6, 7, 8
Dan	1, 2, 3, 4	5, 6, 7, 8
Carl	1, 2, 3, 4	5, 6, 7, 8
Ken	1, 2, 3, 4	5, 6, 7, 8
Mark	1, 2, 3, 4	5, 6.5, 6.5, 8
Elliot	1, 2, 3, 5	4, 6, 7.5, 7.5
Cade	2, 3, 4.5, 4.5	1, 6, 7, 8
Caleb	1, 3, 5, 6	2, 4, 7, 8
Henry	2, 3, 7, 8	1, 4, 5, 6

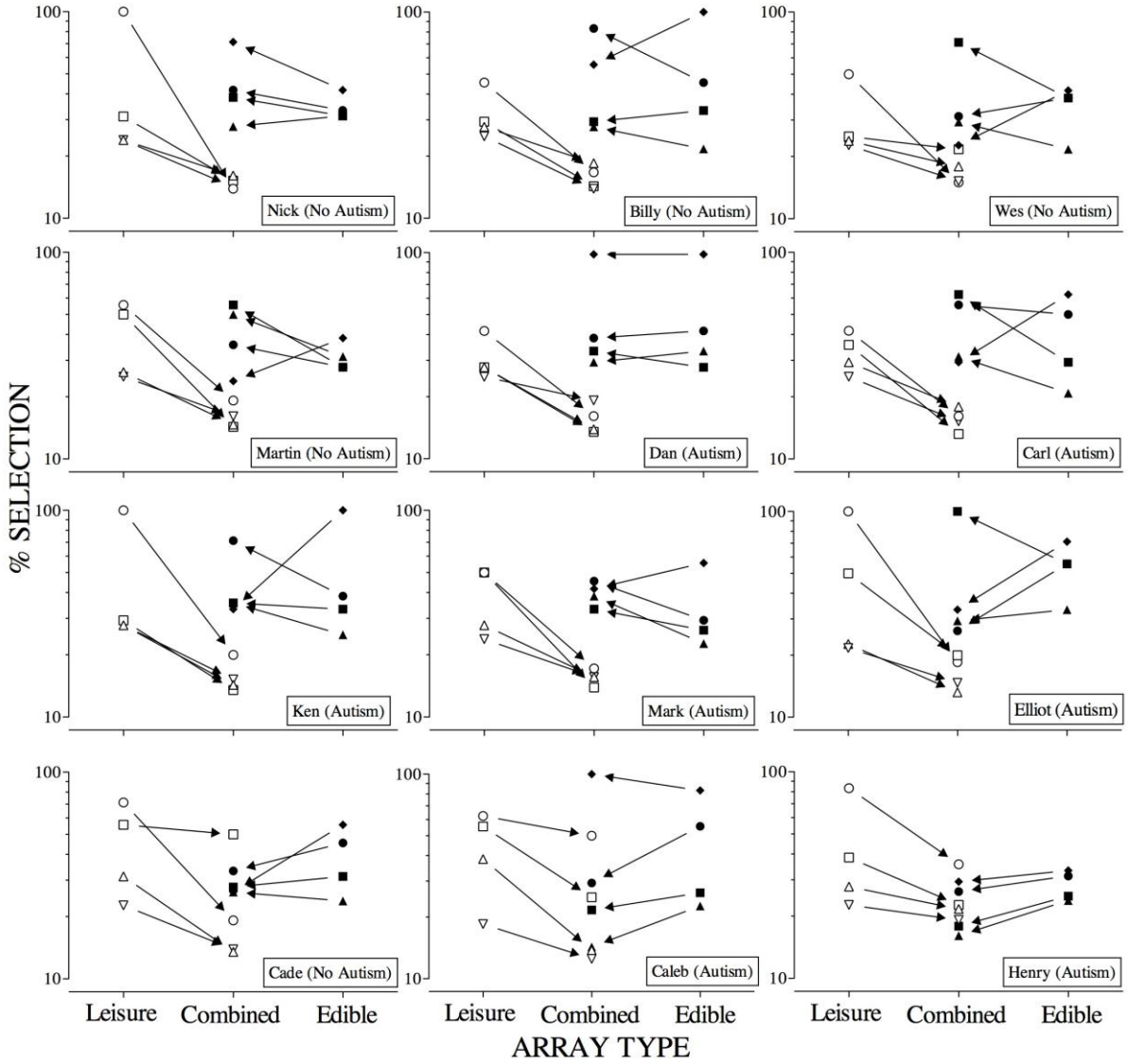

Figure 2-1. Selection percentages for the HPE and HPL items in the Edible-only, Leisure-only, and Combined assessments.

CHAPTER 3
EXPERIMENT 2: ACQUISITION OF RESPONDING FOR EDIBLE AND LEISURE ITEMS

Method

Subjects, Setting, and Materials

Four individuals from Experiment 1 (Caleb, Henry, Nick, and Ken) participated in Experiment 2. These individuals were selected for participation because they represented two different patterns of preference (exclusive preference for edibles and mixed preference) and two different diagnoses (autism and intellectual disability). This study was conducted in the same therapy room as that used in Experiment 1. Sessions were conducted one to two times per day, three to five days per week.

Prior to the experiment, four block (Lego®) structures were constructed, each including one baseboard and five blocks of four different colors and shapes. A six-step task analysis for each structure specified the order and the position in which the baseboard and blocks were to be arranged in the structure. The first step consisted of pulling the baseboard out from the group of unstructured blocks and placing it directly in front of the subject. Steps two through six each involved picking up and placing one block in a specific location. This task was selected for use in Experiment 2 because it seemed to share properties with many adaptive chains, yet it allowed for multiple variations that could be equated in difficulty.

Several criteria were established to ensure that each structure was equally difficult. First, each structure contained the same number of materials. Second, each completed structure had three vertical levels. Third, a “difficulty score” was calculated for each structure based on several criteria. The experimenter initially placed all five blocks in a vertical column; this starting position was equal to zero points. Each subsequent offset (left, right, forward, or backward movement) or rotation from the starting position added one point to the difficulty score. Each

structure was created to have a difficulty score of 5 points. In addition, the two blocks that were identical in shape and color always were positioned in parallel in the final structure. The materials necessary to complete one Lego® structure, plus a model of a completed Lego® structure, were available to the subjects during training.

The four high-preferred edible (HPE) stimuli and the four high-preferred leisure stimuli (HPL) from the *Combined* preference assessments of Experiment 1 were rotated across correct trials in the *Edible* and *Leisure* conditions, respectively. A picture board showing the edible and leisure stimuli to be used as reinforcers was visible to the subject during the respective sessions.

Procedures

The experimenter used forward chaining and most-to-least prompting to train the 6-step task analysis in a manner identical to that described by Libby, Weiss, Bancroft, and Ahearn (2008). Each session consisted of one probe trial followed by 10 training trials. Each trial commenced with the prompt, "Let's build a structure." The experimenter did not use prompting, reinforcement, or blocking during the probe trial. A probe trial was completed when the subject made an error or when 15 s elapsed with no responding. The experimenter ended the probe trial by removing the materials.

A forward chaining procedure was used during training trials. Each step was taught in a sequential order, beginning with step one. A subject progressed to the next step of the task analysis following two consecutive correct independent responses on a given step (step mastery criterion). A subject was retrained on a previously mastered step following two consecutive errors on the previously mastered step.

A most-to-least manual guidance procedure with a delay feature also was used during training trials (see Table 3-1 for a prompt hierarchy). Training of a step always began with immediate hand-over-hand guidance. Manual guidance subsequently was decreased by one level

following two consecutive correct prompted responses at the designated prompt level. The less intrusive prompts (forearm, upper arm, elbow) all were preceded by a 2 second delay, during which independent correct responses (or errors) could occur. Manual guidance was increased by one level if the subject emitted two consecutive errors at the designated prompt level. An error was defined as placing (or attempting to place) a material in the wrong position or in the wrong order, or allowing 15 s to elapse without making contact with any materials. Errors always resulted in immediate hand-over-hand guidance during the trial in which the error was made.

Reinforcers were delivered contingent on each correct, prompted or independent, response during training. During the *Edible* condition, correct responding on a training step resulted in the delivery of praise and 15-s access to a single edible item. During the *Leisure* condition, correct responding on a training step resulted in the delivery of praise and 15-s access to a single leisure item. Following reinforcer deliveries, the experimenter demonstrated all steps required to build the structure prior to initiating the next training trial.

The effects of edible and leisure items on response accuracy were compared using a multielement design, in which *Edible* and *Leisure* conditions were alternated across sessions. Two structures were taught simultaneously—one structure under each condition. When the subject independently completed all six steps of a structure across two consecutive trials (structure mastery criterion), two new structures were introduced, one structure under each condition. If a structure was mastered in one condition but not in the other, training continued with both structures until the mastery criterion was met for both structures.

Response Measurement and Interobserver Agreement

Trained observers recorded dependent variables with a paper and pencil. The level of prompting (hand-over-hand, forearm, upper arm, light touch/shadow, or independent [no

prompt]) required to complete each training step was recorded on every trial. Data were summarized as the number of steps performed independently in each session.

A second independent observer collected the same data for a mean of 58.5% of the sessions (range, 42.3% to 70%) for each subject. Interobserver agreement was calculated on a trial-by-trial basis. An agreement was scored if both observers recorded the same prompt level required on the same training step for a given trial. A disagreement was scored if observers recorded different prompt levels or different training steps for a given trial. The total number of agreements was divided by the total number of trials (11 per session), and the quotient was multiplied by 100. The mean percentage agreement across subjects was 97.7% (range, 80% to 100%).

Results and Discussion

Figure 3-1 shows the number of steps mastered across sessions in the *Leisure* and *Edible* conditions for Caleb, Henry, Nick, and Ken. Three subjects (Caleb, Henry, and Nick) showed similar rates of acquisition across leisure and edible conditions; that is, the same number of sessions was required to master each structure in both conditions for each subject. Caleb mastered both sets of structures in four sessions (40 trials) each. Henry mastered the first set of structures in 6 sessions (60 trials) and the second set in 3 sessions (30 trials). Nick mastered the first set of structures in 7 sessions (70 trials). For the second set of structures, Nick mastered the structure in the *Edible* condition slightly faster (5 sessions; 50 trials) than the structure in the *Leisure* condition (7 sessions; 70 trials).

Ken showed a more variable pattern of acquisition: He mastered the first set of structures faster under *Leisure* conditions (6 sessions compared to 15 sessions under *Edible* conditions), but mastered the second set of structures faster under *Edible* conditions (2 sessions compared to 6 sessions under *Leisure* conditions). The difference in relative speed of acquisition across sets

may have reflected Ken's general tendency to build on the right of the structure. For both structures that were mastered more slowly, Step 3 of the task analysis resulted in the most errors (84.2% of errors on probe trials), and this step involved placing a Lego® on the left of the structure. By contrast, for the structures mastered faster, Step 3 involved placing a Lego® on the right of a structure and relatively fewer errors were made (42.8% of errors on probe trials). Nevertheless, the potential inability of each reinforcer class to override Ken's existing bias towards the right of the structure provides further evidence that neither reinforcer class was significantly more effective than the other.

Thus, despite initial differences in relative preference for leisure and edible items, all subjects showed no difference in the absolute efficacy of reinforcers when used during acquisition of a response chain. This result is congruous with previous research showing that differences in relative preference were not predictive of differences in absolute efficacy of reinforcers (Roscoe, Iwata, & Kahng, 1999). Likewise, DeLeon et al. (1997) showed that leisure items that had been displaced by edibles in a combined preference assessment were nonetheless effective reinforcers for adaptive behavior; however, rates of responding for less-preferred leisure items were never compared to those for more-preferred edible items. Thus, results of the current experiment extend the findings of DeLeon et al. by including a direct comparison between reinforcer classes. Our results are perhaps not surprising given that all items used in the current experiment were first confirmed to be highly preferred during the single-class (*Leisure*-only and *Edible*-only) preference assessments of Experiment 1.

The current results might also suggest that the instructional procedure (most-to-least physical guidance and praise) was sufficiently effective to mask any difference in reinforcer effectiveness. Inclusion of a condition in which no leisure or edible reinforcers were delivered following

correct responses would have allowed for an evaluation of the necessity of these reinforcers in the acquisition of the chain. Future research should include such a condition to control for the influence of instructional components (i.e., guidance) and non-targeted reinforcers (i.e., praise) on correct responding. Despite the absence of a control condition, the current results suggest that no difference existed between reinforcer classes when used in combination with what many would consider standard instructional techniques.

Table 3-1. Most-to-least prompt hierarchy

Prompt Level	Prompt Type
1	Hand-over-hand guidance
2	2-s delay, forearm guidance
3	2-s delay, upper arm guidance
4	2-s delay, light touch of elbow

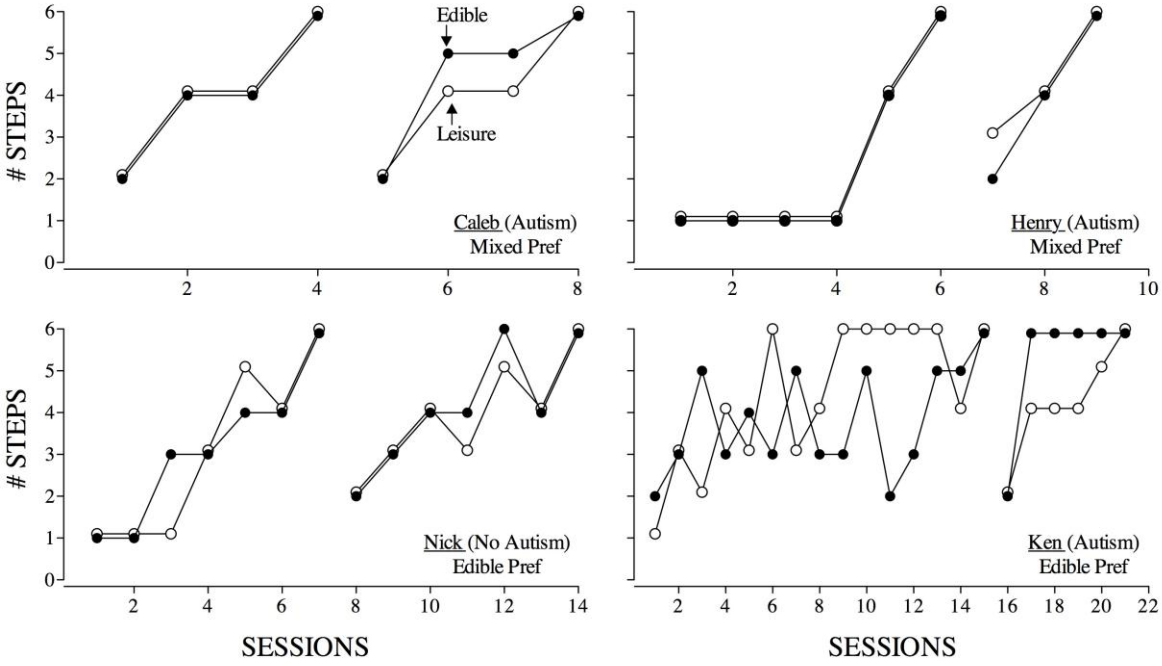

Figure 3-1. Number of steps mastered under Leisure and Edible conditions.

CHAPTER 4
EXPERIMENT 3: MAINTENANCE OF RESPONDING FOR EDIBLE AND LEISURE ITEMS

Method

Subjects, Setting, and Materials

Six individuals (Ken, Nick, Dan, Billy, Caleb, Henry) participated in Experiment 3. These individuals were representative of different diagnoses (Table 2-1) and different patterns of preference (see Experiment 1 results). Sessions were conducted in the same location as previously described, one to six times per day, three to five days per week. The stimuli necessary to complete a simple target response were present throughout all conditions. Reinforcers were the same HPE and HPL items used in Experiment 1.

Response Measurement and Interobserver Agreement

A simple and arbitrary response, such as pressing a button or putting a chip in a bank, was selected as a target response for each subject to expedite training and focus on maintenance. Target responses for each subject are listed in Table 4-1.

Observers recorded the frequency of target responses on a handheld PDA and summarized responses as a rate. Each delivery and removal of a reinforcer also was recorded and was used to calculate the total duration of reinforcer deliveries. These durations were subtracted from the total session time prior to calculating the rate of responding. Interaction with leisure items was scored as a duration measure commencing when a subject's hand or fingers made contact with a leisure item for at least 3 s and terminating when a subject's hand and fingers did not make contact with a leisure item for at least 3 s. Data on interaction were summarized as a percentage by dividing the number of seconds of interaction by the total number of seconds presented (15 s for each reinforcement interval) and multiplying by 100. Consumption of edible items was scored when a subject placed the item in his or her mouth and was summarized as the percentage

of edible items consumed. Percent of interaction and consumption was above 95% across all sessions and for all subjects, so these data were not graphed.

A second observer recorded data on 52.7% of sessions. To calculate interobserver agreement, sessions were divided into 10-s intervals, and observers' records were compared on an interval-by-interval basis. Interobserver agreement on target responses and consumption (edible condition only) was calculated by dividing the smaller number of responses by the larger number of responses in each interval, summing those quotients, and dividing the sum by the total number of intervals. Scores were converted to percentages by multiplying by 100. Interobserver agreement on reinforcer interaction (leisure condition only) was scored by dividing the smaller duration of interaction by the larger and multiplying by 100. The mean agreement across subjects was 90.4% (range, 70.6% to 100%) for target responses.

Procedures

Baseline

During baseline, target stimuli were present throughout the session, but no reinforcers or feedback were delivered. Baseline was conducted until a steady, low or zero rate of target responding was observed.

Schedule training

In order to equate reinforcer access time across leisure and edible conditions, subjects were trained to respond to a fixed ratio (FR) 10 schedule of reinforcement, and reinforcer delivery time was equal to 15 s across maintenance conditions (see below).

During schedule training, the experimenter was seated at a table across from the subject. Target stimuli were placed in front of the subject; one type of reinforcer (edible or leisure, depending on the condition) was located behind the target stimuli, visible to the subject. The experimenter modeled the target response (e.g., put a chip in the bank) and then prompted the

subject to engage in the target response ("Now you do it"). Initially, a reinforcer (edible or leisure item) was delivered contingent on each target response (FR1). The schedule requirement subsequently was increased to FR3, FR5, and FR10 following two consecutive reinforcer deliveries at a given schedule ratio. Verbal, model, and physical prompts were used as necessary to assist in schedule thinning, but only unprompted target responses resulted in an increase in the subsequent schedule requirement. Following training with one reinforcer type (e.g., edible), training occurred with the other reinforcer type (e.g., leisure). Training on each reinforcer type was terminated when the subject completed two consecutive FR10 schedule requirements without experimenter prompts.

Maintenance

In the *Edible* condition, completion of 10 target responses resulted in 15-s access to a single edible item. In the *Leisure* condition, completion of 10 target responses resulted in 15-s access to a single leisure item. The four HPE and four HPL items were rotated across schedule completions. The materials necessary to engage in a target response were restricted during all reinforcer access periods. If an edible was consumed before the time period elapsed (which occurred in nearly every access period across all subjects), an empty plate remained in front of the subject for the remainder of the 15 s.

The comparison was conducted initially using a multielement design, in which reinforcer conditions were alternated across sessions. Each session was 5 min in duration, and four or six sessions were conducted per day. The multielement design served as a starting point because it provided a rapid way to compare responding across reinforcer conditions. If a clear difference within subjects and a consistent difference across subjects emerged, there would be no need for a lengthier comparison. However, if no difference in response rates was observed across conditions in the multielement design, a reversal design was implemented to more closely

approximate conditions of repeated exposure to each reinforcer class. Each session was 15-min in duration, and two or three sessions of each condition were conducted daily.

Results and Discussion

Figure 4-1 shows the rate of target responding across *Baseline, Leisure Maintenance,* and *Edible Maintenance* conditions of Experiment 3. All subjects showed little to no responding in baseline, when no consequences were programmed for responding. Following baseline, all subjects showed rapid acquisition of the target response during *Training* (not depicted on graph).

All subjects except Ken showed little difference between response rates in the *Leisure* and *Edible Maintenance* conditions when session length was short (5 min) and when reinforcer conditions were alternated across sessions. Ken engaged in a mean of 22.3 (range; 7.4 to 34.8) responses per minute during *Leisure* conditions and 39.4 (range; 28.2 to 54.1) responses per minute during *Edible* conditions; thus, edible reinforcers nearly doubled Ken's rate of responding compared to leisure reinforcers.

When *Leisure* and *Edible* conditions were increased to 15 min and alternated in a reversal design, all remaining subjects except one (Nick) showed higher rates of responding under *Edible* conditions. Nick engaged in a mean of 4.4 (range, 3.8 to 5.6) responses per minute under *Leisure* conditions as compared to 4.1 (range, 3.4 to 4.5) responses per minute under *Edible* conditions. Dan engaged in decreasing rates of responding during the first *Leisure* condition and increasing rates during the first *Edible* condition; however, these results were not replicated in the second *Leisure* and *Edible* conditions, and no further replications were permitted because Dan abruptly left the school at which the experiment took place. Billy, Caleb, and Henry all showed some evidence of satiation (decreasing rates across successive sessions) during one or both *Leisure* conditions, but higher and more stable rates of responding during the *Edible* conditions, indicating that edible items were more durable reinforcers for these subjects.

Nonetheless, leisure reinforcers resulted in relatively equal levels of maintenance compared to edibles for most subjects when session length was short and when these reinforcers were alternated across sessions. These results are similar to those reported by Roscoe et al. (1999), in which high-preference and low-preference reinforcers resulted in similar levels of responding when presented under a single schedule of reinforcement. Results of the current study, however, provide a weaker demonstration of this effect because all reinforcers initially were identified as highly preferred in a single-class MSWO assessment. Perhaps a more interesting finding was that responding across the multielement phase showed no decrements for any subject. That is, when reinforcers were alternated across sessions, responding was relatively stable over time. Alternating preferred reinforcers in this manner is perhaps an ideal strategy in promoting the durability of a response when short sessions are an option.

More evidence of satiation was detected when session length was increased and repeated exposure to the same reinforcer class was programmed using a reversal design. Even given these manipulations, however, decreases in response rates were only shown during 5 of the 16 total phases conducted across subjects. Perhaps the lack of satiation shown in the current analysis was a function of the rotation of four edible and four leisure items across reinforcer deliveries. Previous research has shown that the presentation of varied reinforcers results in better response maintenance than the presentation of a single reinforcer (Egel, 1981). The presentation of varied reinforcers in the current study was an attempt to replicate the conditions under which Rincover and Newsom (1985) showed important differences in the effectiveness of leisure and edible items. Nevertheless, the current analysis did not replicate these differences but instead showed the opposite effect. When differences in the durability of reinforcers were obtained, they favored edible items over leisure items.

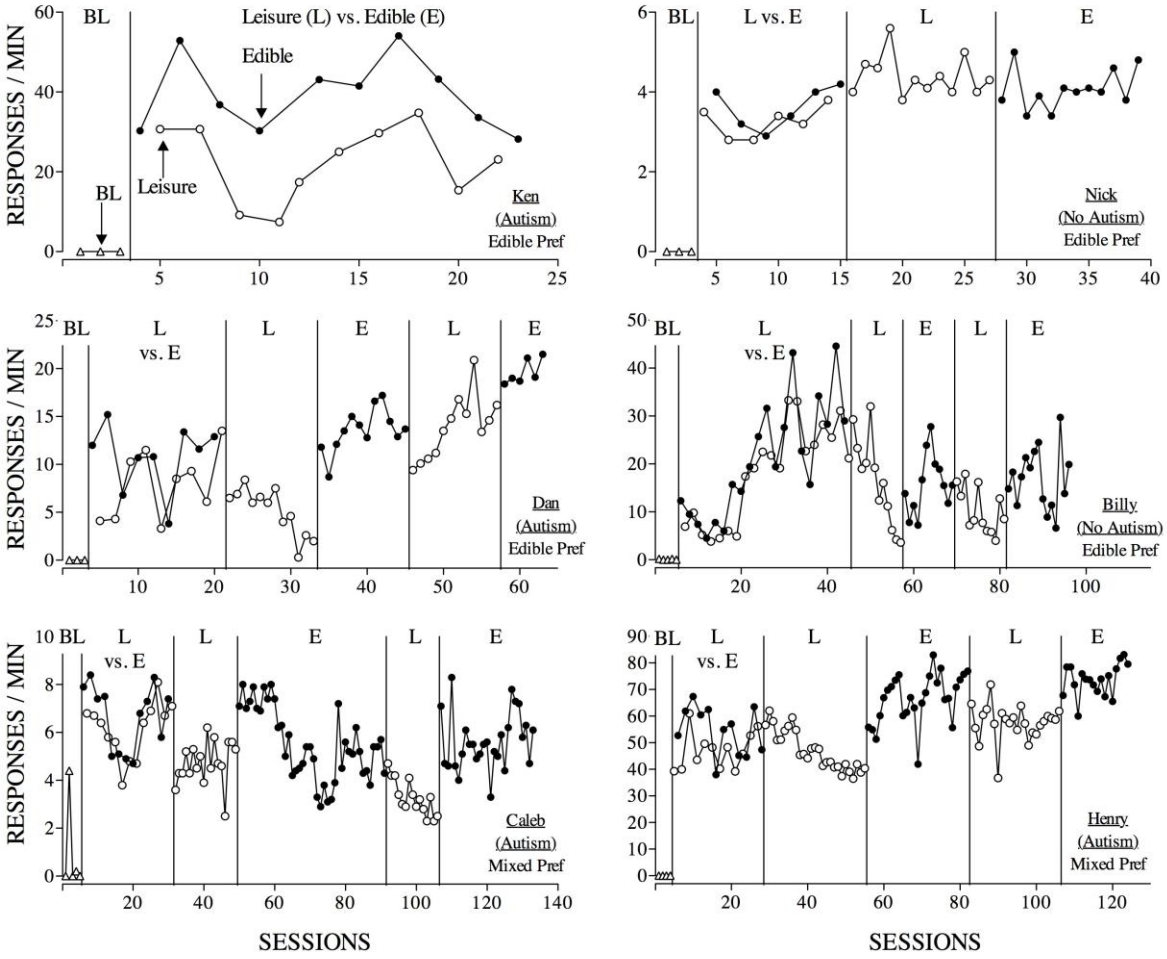

Figure 4-1. Rate of target responding across Baseline, Leisure, and Edible conditions.

CHAPTER 5
GENERAL DISCUSSION

Our results showed no evidence in either subject sample favoring sensory leisure items in three different contexts: preference, acquisition, and maintenance. Thus, these results directly contradicted the findings of Rincover and Newsom (1985). In addition, the majority of subjects showed exclusive preference (Experiment 1) and more durable maintenance (Experiment 3) for edible items compared to leisure items. Edible items, however, did not have an advantage when used to reinforce correct responding during acquisition of a behavioral chain (Experiment 2).

Although consuming edible items is an entirely sensory event, the current results support the distinction between leisure and edible reinforcers in that general disparities in preference and performance were shown across reinforcer classes. However, it may be important to consider the features of leisure and edible reinforcers that could contribute to such disparities. In the current study, leisure items were presented to the subject and removed 15 s later. Two features of this arrangement may have biased results in favor of edible stimuli.

First, a larger magnitude of reinforcement was perhaps accessed during leisure conditions because the sensory event (i.e., engagement with the leisure item) typically occupied the entire 15-s reinforcer access period. Edible stimuli, by contrast, typically were consumed within the first 3-5 s. The potential disparities in magnitude of reinforcement may have contributed to the results of Experiment 3: Satiation effects were perhaps more evident in the leisure condition due to an overall larger magnitude of sensory stimulation per reinforcer delivery compared to the edible condition. This hypothesis could be tested by yoking reinforcer access in the leisure condition to that observed in the edible condition. However, if the items included in the leisure condition did in fact provide a larger magnitude of reinforcement compared to items included in the edible condition, results of the preference assessments in Study 1 should have favored leisure

items. Given that our results showed the opposite effect, it remains unclear whether a difference in magnitude of reinforcement is an important feature of leisure and edible comparisons. It might be interesting to examine whether increases in the magnitude of sensory (leisure) reinforcement could produce a shift in preference for leisure over edible stimuli.

A second distinctive feature of the leisure stimuli used in the current study was the necessity of their removal from the subject's possession. In other words, every reinforcer delivery was accompanied by its subsequent removal (following 15-s access) to allow for the continuation of the preference assessment (Experiment 1), training (Experiment 2), or free operant responding (Experiment 3). Although no subjects engaged in problem behaviors when reinforcers were removed, some subjects engaged in behaviors (e.g., clasping the items more tightly, holding the items under the table) suggesting that reinforcer removal may have had some aversive characteristics (cf. Roane, Vollmer, Ringdahl, & Marcus, 1998). Edible items, by contrast, were naturally consumed and digested, and thus were never physically removed by the therapist. A component analysis of this feature of leisure and edible items might be conducted in future research. Sensory events might be delivered in a more direct manner (e.g., flashing lights on a screen), without leisure items as their vehicle, so that the removal of a toy is not required. Alternatively, edible items might be delivered in a more lingering manner (e.g., licking a lollipop), requiring therapist removal. Either of these manipulations would allow for a more thorough analysis of the effect of reinforcer removal on subject preference and performance.

The findings reported by Rincover and Newsom (1985), which suggested the superiority of sensory leisure items and events for autistic children, remain unexplained. In addition, it is yet unclear how the results of that study may be reconciled with the outcomes of studies on the assessment of preference showing that individuals with disabilities generally prefer edibles. We

attempted to test three hypotheses regarding this discrepancy. First, we determined whether highly preferred edibles were more prone to satiation than less preferred leisure items. Our results showed contrary evidence, in that edibles maintained responding better than did leisure items for the majority of subjects. Although we did not attempt to control for establishing operations, the amount of noncontingent reinforcement (edible or leisure) available to our subjects throughout their typical day perhaps differed from that experienced by the subjects in the study conducted by Rincover and Newsom. That is, perhaps satiation occurred more quickly with leisure items in the current study because our subjects were in classrooms enriched with multiple sources of sensory stimulation (frequent leisure activities and academic periods). Environmental enrichment has become an important component of services for individuals with disabilities over the past three decades, so perhaps the environment experienced by our subjects contained more of these sources of noncontingent leisure activity as compared to the environment experienced by the subjects in the study conducted by Rincover and Newsom.

Second, we sought to test the hypothesis that the results of the study conducted by Rincover and Newsom (1985) were influenced by subject preferences (i.e., subjects in that study happened to prefer leisure items). However, none of the subjects who participated in Experiment 1 showed this pattern of preference, and so whether or not subjects showing this pattern also would show more accurate and durable responding for leisure items remains unknown.

Finally, we included individuals both with and without autism in the current studies to determine whether subject diagnosis influenced the preference for, or effectiveness of, leisure and edible items. We found no noticeable differences between the outcomes for students with versus without autism across all analyses. However, other subject characteristics that were not measured in the current studies may have influenced the results obtained by Rincover and

Newsom (1985). For example, Rincover and Newsom noted that each of their subjects engaged in high levels of stereotypic behavior, though no data were presented on stereotypy. Although some of our subjects (Caleb, Elliot, Carl, Mark, Martin, Dan, and Billy) engaged in stereotypy, all did so at low to moderate levels.

Several possible modifications to the current procedures may have made a replication of Rincover and Newsom (1985) more tenable. First, the edible items selected for inclusion in the *Combined* assessment of Experiment 1 could have been those selected on the fewest percentage of trials during the *Edible-only* assessment (i.e., low-preference edibles) as opposed to the largest percentage of trials (i.e., high-preference edibles). This manipulation would have made it more likely that the high-preference leisure items would have retained higher rankings during the *Combined* assessments, and thus, this manipulation may have resulted in overall preference for leisure over edible items. Given this outcome, a comparison of highly-preferred leisure and less-preferred edible items during acquisition and maintenance could have been accomplished. Results in favor of leisure items also may have been obtained by selecting subjects with highly idiosyncratic and rigid leisure preferences (e.g., those who have a favorite toy with them at all times) and by including those items in the assessments of Experiment 1. It should be noted, however, that either of these strategies would have biased results in favor of leisure items.

Despite our inability to reconcile the findings of previous research (Bojak & Carr, 1999; DeLeon et al., 1997; Rincover & Newsom, 1985), the current study provides implications for effective practice. Edible items represent a generally preferred class of reinforcers that maintain responding somewhat longer than do leisure items. These advantages provide evidence in favor of including edible items in acquisition training. One additional advantage of edible reinforcers is that they are delivered more easily and efficiently, which may have an overall beneficial effect

on training in the long run. Some researchers (e.g., Ferrari & Harris, 1981; Rincover & Newsom) have emphasized the relative benefits of leisure stimuli in behavioral training, stating that leisure stimuli are more natural reinforcers, less deleterious to health, and require more active engagement. However, the cost of using less preferred and less durable leisure reinforcers should be considered in light of these proposed benefits. If behavioral acquisition is an important goal, and if gains are expected to be maintained over a long period of time, edible items should be included in preliminary preference assessments. Nevertheless, leisure items may be preferred for use with individuals with strict dietary restrictions or for settings in which a budget does not allow for the continued purchase of edibles. Results of these studies showed that leisure items, although not generally as preferred as edibles, were equally effective reinforcers for response acquisition (when paired with most-to-least guidance and praise) and maintained responding as well as edibles when session length was short. Thus, the inclusion of leisure items in training programs is only encouraged when the use of edibles is not convenient.

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BIOGRAPHICAL SKETCH

Tara Fahmie initially studied behavior analysis at the University of Florida (UF), where she received her B.S. in psychology in 2006. She obtained a master's degree in applied behavioral science from the University of Kansas the subsequent year under the supervision of Dr. Gregory Hanley. Upon graduation, she entered the applied behavior analysis PhD program at UF under the supervision of Dr. Brian Iwata. While at UF, she participated in a variety of clinical services, including the provision of behavior services to adults with Prader-Willi Syndrome at the ARC of Alachua. Tara also was involved in several research projects on the assessment and treatment of behavior disorders, skill acquisition, and the prevention of problem behavior. She has been a teaching assistant and an instructor for introductory and advanced undergraduate courses in applied behavior analysis at UF. Following graduation, Tara intends to pursue an academic and research career in applied behavior analysis.