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Evaluating preference for reinforcers under varying schedule requirements in children with developmental disabilities

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EVALUATING PREFERENCE FOR REINFORCERS UNDER VARYING SCHEDULE REQUIREMENTS IN CHILDREN WITH DEVELOPMENTAL DISABILITIES

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ABSTRACT

Previous research has shown that preference for concurrently available reinforcers can be influenced by the reinforcement schedule (DeLeon, Neidert, Anders, & Rodriguez-Catter, 2001; Tustin, 1994). However, limited research has been conducted on specific variables that may influence preference under various schedule requirements. The present study evaluated the influence of task preference, schedule, and quality of reinforcement on choice between either an arbitrary reinforcer or a functional reinforcer. Five participants diagnosed with Autism participated in the study. In the first phase, we evaluated the effects of task preference and schedule of reinforcement on choice between a 30-s break and a high preference food item. The results indicated that the food item was preferred over the break, regardless of the preference level of the task and schedule of reinforcement. In the second phase of the study, the parameters of the break were manipulated and toys and/or attention were added to the break. Only one participant showed preference for the enriched break during Phase 2. In the third phase of the study, we evaluated preference for a medium and/or low preference food item versus the enriched break. Three of the four participants in this phase showed preference for the break over the lower preference food item.

INTRODUCTION

Children with developmental disabilities typically have deficits in communication, social interaction, self-care, and cognitive skills. In addition, these children may engage in inappropriate behavior to gain access to reinforcement, especially if they are unable to ask for reinforcement in appropriate ways (i.e., because of language deficits). Inappropriate behavior may be maintained by a variety of reinforcing consequences. For example, children may tantrum to escape from completing tasks, hit others to get attention, cry to gain access to toys or food, or self-injure to access sensory stimulation (e.g., visual stimulation). A variety of assessment procedures may be conducted to identify the reinforcers that maintain problem behavior. Once the reinforcers maintaining problem behavior are identified, function-based treatments can be implemented to reduce levels of problem behavior.

The purpose of the introduction is to provide a brief overview of assessment techniques and function-based treatments for problem behavior. Research on choice between tasks, reinforcers, and treatments will be summarized, followed by a description of three conceptual approaches for predicting response allocation in choice situations. Basic and applied research findings related to these conceptual approaches will be described. Last, research on arbitrary versus functional reinforcement will be presented, followed by the purpose of the present study.

Functional Assessment

The purpose of a functional assessment is to identify potential antecedents and consequences that influence problem behavior. Three different types of assessment methods have been developed. First, an indirect assessment can be conducted which involves interviewing parents about problem behavior and the conditions under which it occurs (Durand & Crimmins, 1988). Second, a descriptive (correlational) analysis may be conducted which involves observing the child in naturalistic settings to identify commonly occurring antecedents and consequences related to problem behavior (Lalli, Browder, Mace, & Brown, 1993). Third, a functional (experimental) analysis of problem behavior may be conducted by directly manipulating the antecedents and consequences surrounding behavior in order to identify potential variables that maintain problem behavior (Iwata et al, 1982/1994).

In applied research, a functional analysis of problem behavior, based on procedures described by Iwata et al., 1982/1994, is the assessment approach that is most commonly used to determine whether behavior is maintained by access to social positive reinforcement (i.e., attention, toys, or food), social negative reinforcement (i.e., escape from demands), or automatic reinforcement (i.e., sensory stimulation).

A functional analysis of problem behavior usually includes five specific conditions (i.e., attention, escape, play, no interaction, and tangible) that alternate rapidly in a multielement design. In the attention condition, the child is given low preference toys and told to play while the therapist does work. When the child engages in a target behavior (e.g., hitting), verbal reprimands are provided for 20 s. This condition assesses whether problem behavior is maintained by access to adult attention. During the escape condition, the child is issued demands (i.e., academic demands). If the child engages in problem behavior during this condition, the therapist removes all demands and provides a 20-s break from the task. This condition assesses whether problem behavior is maintained by escape from demands. In the no interaction condition, no toys are provided and the therapist does not interact with the child. If target behavior occurs, the therapist ignores the behavior. This condition assesses whether problem behavior is maintained by automatic reinforcement. In the tangible condition, the child is given pre-session access to highly preferred toys for a brief amount of time. When the session begins, toys are removed. If the child engages in the target behavior, the child is given access to the toys for 20 s. This condition tests whether problem behavior is maintained by access to tangible items. In the play condition, highly preferred toys are provided and the therapist provides attention continuously. No demands are placed on the child. This condition serves as a control for the other four conditions.

Previous research has examined the frequency with which particular types of reinforcement maintain problem behavior in individual with developmental disabilities. Iwata et al. (1994) examined the results of 152 functional analyses and found that self-injurious behavior (SIB) was sensitive to social negative reinforcement for 38.1% of individuals, social positive reinforcement for 26.3% of individuals, automatic reinforcement for 25.7% of individuals, and multiply controlled for 5.3% of individuals. Because the maintaining reinforcers are idiosyncratic across individuals, it is important to conduct assessments with individual children.

Treatments based on functional analysis results have been shown to be more effective than treatments that are arbitrarily chosen (Carr & Durand, 1985; Iwata, Pace, Cowdery, & Miltenberger, 1994). As described in the next section, three types of function-based treatments are commonly used, including antecedent manipulations, extinction, and differential reinforcement.

Commonly Used Treatments

Antecedent Manipulations. Antecedent manipulations involve alterations to the environment before the behavior occurs to decrease the likelihood of behavior. These treatment procedures include demand fading (Pace, Iwata, Cowdery, Andree, & McIntyre, 1993), high-probability request procedures (Mace & Belfiore, 1990), and noncontingent reinforcement (Coleman & Holmes, 1998). For example, Coleman and Holmes evaluated the effectiveness of noncontingent escape (NCE) with three children with speech delays who exhibited problem behavior maintained by escape from demands. Brief breaks were provided on a fixed-time schedule and problem behavior no longer produced escape from demands (i.e., was on extinction). Results showed that NCE decreased problem behavior and increased compliance.

Extinction. The second type of function-based treatment is extinction. Extinction involves withholding the reinforcer for the problem behavior. For example, if problem behavior is maintained by attention, attention would no longer be provided immediately following occurrences of problem behavior. Problem behavior will then decrease, although extinction bursts can occur and temporarily cause higher rates of behavior immediately after implementation of the extinction procedure (Goh & Iwata, 1994; Iwata, Pace, Kalsher, Cowdery, & Caltaldo, 1990). Commonly, extinction is combined with other treatment procedures, such as differential reinforcement.

Differential Reinforcement. The third type of function-based treatment is differential reinforcement. Reinforcement is delivered for the absence of problem behavior (differential reinforcement of other behavior; DRO) or for an alternative response (differential reinforcement of alternative behavior; DRA), while problem behavior is no longer reinforced. DRO has been evaluated with a variety of types of problem behavior including disruption (Kodak, Miltenberger, and Romaniuk, 2003; Marcus & Vollmer, 1995), SIB (Roberts, Mace, and Daggett, 1995), pica (Kahng, Boscoe, and Byrne, 2003), and aggression and tantrums (Marcus & Vollmer, 1996). DRO requires the absence of the target behavior for a specific time period in order to gain access to the reinforcer. If the target behavior occurs during the time interval, the interval is reset. Kodak et al. (2003) evaluated DRO for two participants diagnosed with autism. Both participants engaged in problem behavior maintained by escape from demands. DRO led to near-zero levels of problem behavior and increased compliance with academic tasks.

DRA requires the participant to engage in a functionally equivalent alternative response (e.g., hand raising) to gain access to the reinforcer. A variety of studies have evaluated the effectiveness of DRA with children with developmental disabilities (Lalli et al., 1999; Piazza, Moes, and Fisher, 1996; Ringdahl et al., 2002, Vollmer, Iwata, Smith, and Rodgers, 1992; Vollmer, Roane, Ringdahl, and Marcus, 1999). For example, Piazza et al. (1996) treated escape-maintained destructive behavior with a differential reinforcement package including DRA, escape extinction, and demand fading. The participant received a break from the task for complying with demands. Treatment led to increased compliance and near-zero levels of destructive behavior.

In most of the treatment procedures described above, the functional reinforcer (i.e., the reinforcer maintaining problem behavior) was provided as part of the intervention. However, there are occasions when reinforcers that are functionally related to problem behavior may not be the most preferred form of reinforcement. For example, Golonka et al. (2000) examined the effects of providing either a break alone (negative reinforcement) or a break to an enriched environment (negative reinforcement plus positive reinforcement) on problem behavior maintained by escape from demands. Although the aberrant behavior was escape-maintained, reinforcement with the break alone did not decrease problem behavior as effectively as the enriched break. In addition, when participants were allowed to choose between the break alone and the enriched break, both participants chose the enriched break more often. Therefore, it may be important to evaluate choice in order to maximize the effectiveness of treatment.

Choice

Recently, investigators have begun to examine how providing choice during treatment can help enhance the effectiveness of intervention. Choice has been evaluated under a variety of conditions. First, choice between items in a preference assessment has been used to identify reinforcers that may be incorporated into subsequent treatments (Fisher et al., 1992). Preference assessments may be conducted in a variety of ways. For example, Pace, Ivancic, Edwards, Iwata, and Page (1985) presented single items to participants with moderate to severe mental retardation and measured the percentage of times the participant approached each item. Items that were approached more than 80% of trials were considered to be highly preferred. Fisher et al. (1992) compared the Pace et al. (1985) method to a paired-choice assessment method. In the paired-choice method, each item was paired once with every other item. The participant was presented with two items and asked to pick one item. The paired-choice method resulted in more differentiation between items. In addition, the paired-choice method was better able to identify items that functioned as effective reinforcers. In a study by Vollmer, Marcus, and LeBlanc (1994), a preference assessment was used to identify items that may function as reinforcers for children whose hand mouthing was maintained by automatic reinforcement. Results showed that treatments with empirically derived reinforcers were more effective than those with arbitrarily selected reinforcers.

Second, research has examined how opportunities to choose tasks or reinforcers can be an effective treatment component itself. For example, in Romaniuk, Miltenberger, and Conyers (2002), participants with problem behavior maintained by either attention or escape were allowed to choose between academic tasks. Results showed substantial reductions in problem behavior when choice was given to children with escape-maintained behavior but not when choice was given to children with attention-maintained behavior. Providing choice between academic tasks may reduce the aversiveness of the tasks and decrease the likelihood that children with escape-maintained behavior will engage in inappropriate behavior in order to escape the task.

Third, treatment choice has been explored to identify the form of treatment that is most preferred by individuals with developmental disabilities (Hanley, Piazza, Fisher, Contrucci, & Maglieri 1997). Identifying preference in this manner can be important because many people with developmental disabilities are unable to give informed consent to treatment. Hanley et al. evaluated individual's preference for treatment with functional communication training (FCT) or NCR after both procedures were found to reduce levels of problem behavior maintained by attention. All participants showed preference for FCT over NCR by consistently choosing a response that was associated with this treatment.

Last, choice among various types of reinforcers has been evaluated to determine how schedules of reinforcement interact with preference (DeLeon, Iwata, Goh, and Worsdell, 1997; Tustin, 1994). During a typical preference assessment, potential reinforcers are evaluated under a low response requirement (i.e., selecting or reaching for a stimulus). However, when increasing tasks demands are required in experimental or academic settings, preference for various reinforcers may change depending on the amount of work required to gain access to the reinforcer. As discussed in more detail below, Tustin (1994) and DeLeon et al. (1997) found that preference for reinforcers may shift from one reinforcer to another when schedules of reinforcement are thinned. As discussed in the next sections, choice or preference for reinforcers can be explained via three basic conceptual approaches. These include the matching law, substitutability, and behavioral economics.

Matching Law

The matching law states that choice among alternatives is related to the rate of reinforcement for each alternative (Hernstein, 1961). Various mathematical equations based on the matching law have been developed to predict how organisms will allocate responding among concurrently available reinforcers (McDowell, 1989). Typically, choice behavior has been studied in the laboratory with non-humans using concurrent variable or fixed interval reinforcement schedules. For example, Hernstein (1961) measured frequency of responding in pigeons when responses on two keys were reinforced on variable-interval (VI) schedules. Results showed that the proportion of responses allocated to a particular key matched the proportion of reinforcement provided for responding on that key.

The generalized matching law subsequently was developed to predict responding under single operant situations and when other parameters of reinforcement (e.g., magnitude, delay, quality) are unequal across competing response options (Hernstein, 1970, 1974). However, the matching law may be limited when making predictions about choice among qualitatively different reinforcers. This limitation, as well as alternative theories better suited for predicting choice in this situation, will be discussed in more detail following a description of applied studies on matching theory.

Applied Studies on Matching Theory. Current research on the matching law has been extended to clinical populations. These studies have shown that (a) additional procedures may be needed to produce matching as predicted by the matching law (Mace, Neef, Shade, & Mauro, 1994), (b) the matching law may not account for variations in choice between qualitatively different reinforcers (Neef, Mace, Shea, & Shade, 1992), and (c) various parameters of reinforcement (e.g., rate, quality, immediacy) may interact to influence choice in idiosyncratic ways (Neef, Shade, & Miller, 1994).

For example, Mace et al. (1994) evaluated the use of the matching law to predict response allocation among concurrently available math problems with children enrolled in special education programs. When increases or decreases in the schedule were introduced, the participants tended to continue to allocate the same amount of responding to each task that they had under previous schedules of reinforcement. That is, there was consistent preference for a particular response alternative, regardless of the reinforcement rate associated with that response. A variety of procedures were introduced to improve sensitivity to schedule changes. First, changeover delays were implemented, which required a fixed amount of time to elapse after the participant switched to a different set of math problems until reinforcement could be obtained. Second, timers were added which indicated how much time was left in the reinforcement interval for each stack of math problems. Third, the experimenter modeled how to maximize reinforcement by alternating between the stacks of math problems. Fourth, a 15-s limited-hold interval was added, which encouraged schedule switching. The 15-s limited hold procedure involved a short period during which a reinforcer was still available under the interval schedule. Results showed that the addition of timers, changeover delays, and limited holds were required to produce patters of responding that were predicted by the matching law. The authors stated that the findings suggest limitations in the matching law's ability to account for human choice in natural environments, where these additional procedures may not be present.

Additional factors may influence the matching law's ability to predict choice between concurrent operants, such as interactions between the quality and rate of reinforcement. Neef et al. (1992) evaluated how reinforcer quality and rate influenced responding among concurrently available tasks associated with reinforcers that were either equal or unequal in quality. Children with severe emotional disturbance or behavioral disorders and learning difficulties were required to choose between two stacks of math problems, each associated with a different reinforcer. The quality of the reinforcer was determined based on participant's rankings of 10 items. High quality reinforcers were the top five ranked items while lower quality reinforcers were the bottom five ranked items. Results showed that the matching law predicted time allocation to math problems when the quality of the reinforcer was equal for both alternatives. However, when the reinforcers were unequal in quality, the matching law did not predict choice among alternatives.

An additional evaluation of the interaction among rate of reinforcement, quality of reinforcement, delay of reinforcement, and response effort was conducted by Neef et al., (1994). The authors evaluated preference for either high quality (nickels, or items from Store A) or low quality (program money or items from Store B) reinforcers when response effort was high (acquisition math problems) versus low (review math problems), when reinforcement was delivered immediately (at the end of the session) versus delayed (the next day), and when the rate of reinforcement was high (VI 60 s) versus low (VI 90 s). All variations of the four dimensions of reinforcement were presented with each other during sessions to evaluate how the dimensions interacted to affect choice between math problems. Six participants with serious emotional disturbance were required to choose between two sets of math problems. Results indicated that choice for three participants was influenced by the interaction between quality and immediacy of reinforcement, choice for two participants was influenced by an interaction between quality and rate of reinforcement, and one participant's choice was influenced by the quality of reinforcement only. The authors suggested that the dimensions of reinforcement that influence choice may be idiosyncratic. In addition, the effects of various dimensions of reinforcement appeared to interact with other aspects of reinforcement. Such dimensions will typically vary in the natural environment, and the matching law will need to account for response allocation across these dimensions in order to be applicable to humans.

As discussed in the next section, the matching law may be limited when attempting to explain choice between qualitatively different reinforcers because the law is based on the assumption that reinforcers are "substitutable" (Green & Freed, 1993). Theories of substitutability have attempted to account for how qualitatively different reinforcers interact to affect choice.

Substitutability

Substitutability refers to the extent to which the consumption of two reinforcers is influenced by their interaction with each other and the price of each reinforcer (i.e., the reinforcement schedule or response effort required to obtain a reinforcer). Highly substitutable reinforcers are those that are readily traded for one another when the price of one reinforcer increases. Usually, substitutable reinforcers are similar in purpose (Green and Freed, 1993). For example, if peanuts and pretzels were substitutable reinforcers, the consumption of peanuts would decrease and the consumption of pretzels would increase when the price of peanuts was increased. However, reinforcers may not always be substitutes. Reinforcers may be complimentary (e.g., a bagel and cream cheese) or independent (e.g., and orange and a baseball). Complimentary reinforcers are items that are consumed jointly. If the price of one reinforcer was decreased, consumption of that reinforcer and the complimentary reinforcer would increase. Alternatively, for reinforcers that are independent, a change in the price of one reinforcer would not alter the consumption of the other (Green & Freed, 1993). Basic studies on substitutability have attempted to identify the conditions under which two items may be substitutes.

Basic Studies on Substitutability. Laboratory studies on substitutability with both humans and nonhumans have shown that changes in the consumption of reinforcers are independent of preference for particular items (Rachlin et al., 1976). For example, Kagel et al. (1975) compared consumption of either root beer or a Tom Collins mix in rats. Initially, the rats consumed more root beer when both drinks were available on equal reinforcement schedules. When the price of root beer was doubled and the price of Tom Collins was divided in half by changing the reinforcement schedule, the rats increased consumption of the Tom Collins drink and decreased consumption of root beer. These results indicated that root beer and Tom Collins were substitutable reinforcers.

Extending substitutability theory to humans in a laboratory setting has shown interesting results. Bernstein and Ebbesen (1978) conducted a baseline of interaction with various activities (e.g., sewing, art) when adults were asked to live in an isolated lab for a short period of time. The item that the participants interacted with the most was then restricted below baseline levels and was provided contingent on doing another activity. Substitutability was evaluated by examining whether increasing the price of one activity (i.e., requiring engagement with another activity to access the restricted activity) would result in decreased consumption of that activity and increased consumption of other substitutable activities. The authors predicted that baseline levels of preference would predict substitutability. However, the participants did not redistribute their time across activities proportionally to the time distribution for activities during baseline. Time was allocated to one or two other activities instead of distributing time across various activities. Results show that various substitutable reinforcers may not be related in ways that are obvious to experimenters (Green & Freed, 1993) and manipulating the price of two reinforcers is imperative for assessing whether two items are substitutes.

<u>Applied Studies on Substitutability</u>. Substitutability has implications for reinforcer choice with humans in natural environments; however, substitutability has

rarely been directly investigated with clinical populations or problems. When problem behavior produces one type of reinforcement (e.g., automatic reinforcement), examining the substitutability of other reinforcers (e.g., attention) may be helpful when attempting to reduce problem behavior. The only applied study to date directly evaluating substitutability was conducted by Shore, Iwata, DeLeon, Kahng, and Smith (1997). The authors examined the extent to which self-injurious behavior (SIB) and object manipulation produced substitutable reinforcers. Participants engaged in SIB that appeared to be maintained by automatic reinforcement. In the first experiment, placing highly preferred objects in the participants' hands nearly eliminated engagement in SIB (i.e., the participants showed a preference for the reinforcer produced by object manipulation over the automatic reinforcement produced by SIB). In the third experiment, the authors manipulated the response effort required to gain access to the highly preferred objects. Objects were attached to a string, and the distance between the participant and the string was systematically increased. Results showed that as the distance of the string increased, participants engaged in SIB more than object manipulation. That is, as the price of the object increased, consumption of the object decreased and consumption of SIB increased. Relatively small increases in response effort led to preference for engaging in SIB. In addition, when the authors examined the effectiveness of providing the object contingent on an absence of SIB (i.e., DRO), treatment was unsuccessful in reducing SIB. Results of Shore et al. (1997) indicate that the substitutability of two items may be extremely sensitive to changes in response effort.

Research findings on reinforcer substitutability have important implications for the treatment of potentially life-threatening SIB and other behavior disorders. One implication is that it may be desirable to identify substitutable reinforcers if the maintaining reinforcer cannot be withheld. However, the effort required to gain access to substitutable reinforcers (e.g., a toy) must be less than that required to gain access to reinforcers that maintain problem behavior. More research on the substitutability of reinforcers during treatment is needed.

Results from studies on substitutability may have implications for social policies as well. For example, methadone treatment is recommended for people who have addictions to heroin. However, methadone and heroin may not be substitutable because methadone does not produce euphoria to the extent that heroin does. In addition, there is a social component to using heroin that may be complimentary to drug use. If the complimentary reinforcer (i.e., socializing with other drug users) is not a component in methadone use, this also limits the substitutability of the two drugs (Hursh, 1991). If the two drugs are not substitutable, consumption of heroin should not be affected by the availability of methadone treatment. Therefore, an understanding of the concept of substitutability may help reveal why methadone treatment can be ineffective. More research will be necessary to indicate what variables can be manipulated in order to make methadone use and heroin use more substitutable.

There are potential limitations to applying substitutability theory in ecological settings. Studies of substitutability require that two reinforcers be different in price in order to investigate whether one reinforcer will be substitutable for the alternative (more expensive) reinforcer. More specifically, the only way to determine if a reinforcer is substitutable for another reinforcer is to directly manipulate the price of the other reinforcer. Therefore, substitutability theory doesn't make predictions about choice between qualitatively different reinforcers that are available on equal schedules of reinforcement.

Behavioral Economics

Due to the potential constraints of substitutability theory, a third approach to understanding choice among reinforcers involves the concept of behavioral economics. In behavioral economics, the behavior of an organism can be understood by considering supply and demand (Hursh, 1980). The supply of the reinforcer will be determined by how many opportunities the organism will have to access the reinforcer during the experiment. The demand represents how much of the reinforcer the organism will consume at a certain price. A schedule represents the "price" of the reinforcer because a certain number of responses are required to gain access to the reinforcer. Supply and demand will be influenced by whether the experimenter uses an open or closed economy (Hursh, 1980). In an open economy, the daily consumption of a commodity (i.e., food) is controlled by the experimenter and is not limited to experimental sessions. Alternatively, in a closed economy, no extra food is provided outside of experimental sessions or for a predetermined period of time. Hursh (1980) states that most animals and humans live in environments that closely approximate closed economies.

As discussed next, basic studies on behavioral economics have examined the conditions under which consumption of qualitatively different reinforcers is influenced by closed economies, demand elasticity, and schedules of reinforcement.

Basic Studies on Behavioral Economics. Studies examining behavior under closed economies with nonhuman participants have shown that the value of a reinforcer may vary depending on the price of the reinforcer (Hursh and Natelson, 1981) or on the demand elasticity of a reinforcer (Lea and Roper, 1977). For example, Hursh and Natelson examined lever pressing in rats on equal VI schedules. Each lever provided access to a qualitatively different reinforcer. One lever led to electrical brain stimulation while the other lever led to food pellets. Results showed that, as the schedule increased for both reinforcers, the rate of lever pressing for brain stimulation decreased while the rate of lever pressing for food increased. Hursh (1980) suggested that this finding is related to differences in importance among reinforcers. The value of a reinforcer may be low when its price is high.

However, the relationship between the value of the reinforcer and its price is determined by the "elasticity" of the demand for the reinforcer. Demand for various reinforcers may be either elastic or inelastic. If the demand for a reinforcer is elastic, consumption of the reinforcer is influenced by increases or decreases in the price of the reinforcer. If the demand for a reinforcer is inelastic, consumption is not affected by changes in the price of the reinforcer. For example, results of the study by Hursh and Natelson (1981) described above indicated that the demand for electrical brain stimulation was elastic, whereas demand for food was inelastic.

Lea and Roper (1977) examined the elasticity of mixed diet pellets and sucrose pellets when another food source was and was not simultaneously available. The demand elasticity of mixed diet pellets depended on the type of food that was concurrently available. When mixed diet pellets and sucrose pellets were concurrently available, the rats increased consumption of sucrose pellets and decreased consumption of mixed diet pellets as the schedules were increased. When mixed diet pellets were paired with no other source of food, demand for mixed diet pellets was inelastic. Therefore, demand for important reinforcers (i.e., high calorie food for hungry rats) may be inelastic under certain conditions. However, the elasticity of items that are essential to the survival of an organism (i.e., food) may be different than the elasticity of reinforcers that are not essential but are preferred (i.e., a highly preferred toy). Demand and choice between non-essential reinforcers has rarely been evaluated with clinical populations, as described in the next section.

<u>Applied Studies on Behavioral Economics</u>. Few applied studies have evaluated behavioral economic principles and reinforcer choice. In a notable exception, Tustin (1994) examined preference for two reinforcers under increasing schedule requirements. Participants made a choice between reinforcers by pushing buttons on a joystick that was attached to a computer. One participant's results were especially relevant to the discussion of behavioral economics principles. The participant could choose between a constant color on the computer screen versus a combination of visual stimuli involving changing colors and patters and auditory stimuli consisting of musical tones. At lower schedules, the participant chose the constant color more often. However, as the schedule requirements increased for both reinforcers, the participant chose the combination of visual and auditory stimuli more often. Preference for one reinforcer at a lower schedule was not maintained at higher schedules. As the price of the constant color reinforcer increased, demand for that reinforcer decreased.

A replication and extension of this study was conducted by DeLeon, Iwata, Goh, and Worsdell (1997). The authors extended the Tustin (1994) study by evaluating preference for both similar and dissimilar reinforcers under increasing fixed-ratio (FR) schedule requirements with two participants. Similar reinforcers consisted of two food items, while dissimilar reinforcers consisted of one leisure item and one food item. Participants could gain access to the reinforcers by pushing two microswitches, each of which was associated with one of the reinforcers during that session. When dissimilar reinforcers were available concurrently, preference for the two reinforcers remained unchanged across all schedule requirements for both participants. However, when similar reinforcers (two food items) were available concurrently, preference changed as the schedule increased. Under the low schedule (i.e., FR 1), participants did not appear to prefer one food item over the other. A preference for one food item only emerged after the schedule requirement was increased equally for both reinforcers.

Results of DeLeon et al. (1997) may have important implications for the accuracy of preference assessments, which typically evaluate items under rich schedules of reinforcement (i.e., FR 1) for compliance to relatively low effort demands (i.e., “pick one”). Both food items used in the study were identified as highly and equally preferred during a preference assessment. However, when the schedule of reinforcement was thinned from FR 1 to FR 5, both participants started to prefer one food item over the other. More research is needed to evaluate whether preference for various items differs depending on the reinforcement schedule.

In particular, further research is needed because results of the studies by Tustin (1994) and DeLeon et al. (1997) may have limited generality to clinical problems. Arbitrary reinforcers (i.e., sensory stimuli; food) and arbitrary responses (button presses; microswitch presses) were examined rather than more clinically relevant reinforcers and responses. As described above, a functional analysis typically is conducted to identify the reinforcers that maintain problem behavior. As part of treatment, these functional reinforcer(s) are delivered for the absence of problem behavior (i.e., DRO), contingent on an alternative behavior (i.e., DRA), or on a fixed-time schedule that is independent of behavior (i.e., NCR). The assumption is these reinforcers will be more effective in treating problem behavior and increasing adaptive behavior than arbitrary reinforcers (i.e., reinforcers that are not functionally related to problem behavior). However, as discussed in the next section, results of some studies indicate that arbitrary reinforcers may be equal to or more effective than functional reinforcers when treating problem behavior.

Arbitrary versus Functional Reinforcers

Studies examining the use of arbitrary versus functional reinforcers have shown that treatment with arbitrary reinforcers may be more effective than treatment with functional reinforcers. For example, a study by Lalli et al. (1999) is most relevant to the current discussion. In this study, the effects of positive and negative reinforcement on problem behavior and compliance were examined with children who engaged in problem behavior maintained by escape from demands. Treatment consisted of providing either negative reinforcement (i.e., a break from the task) or an arbitrary reinforcer (i.e., a food item) for compliance or after a fixed period of time had elapsed, while problem behavior either produced access to a functional reinforcer or was exposed to extinction. Treatment with the arbitrary reinforcer was associated with larger reductions in problem behavior and more compliance relative to treatment with the functional reinforcer, even when problem behavior continued to be reinforced. Therefore, the participants chose the food item over escape during treatment by complying with tasks to gain access to food rather than by engaging in problem behavior that would have resulted in a break. However, the authors attempted to thin the schedule of reinforcement for compliance with only two participants. Rates of problem behavior increased and compliance slightly decreased for one participant when the schedule requirement was gradually increased to FR 60, even though problem behavior was on extinction. The schedule of reinforcement for the other participant was only thinned to FR 20. Therefore, it may be difficult to extend the findings of this study to natural environments, where schedules of reinforcement are typically thin (i.e., similar to FR 60). More research is needed to evaluate whether providing arbitrary reinforcers for compliance would maintain high levels of compliance and low levels of problem behavior when reinforcement is delivered intermittently.

In Lalli et al. (1999), when both problem behavior and compliance resulted in escape from demands under the same reinforcement schedule (i.e., FR 1), participants spent more time complying with demands than engaging in problem behavior. Relative to problem behavior, compliance may have required less response effort to gain access to reinforcement. When the food reinforcer was introduced for compliance, participants also allocated responding to compliance, which produced access to an arbitrary (but presumably higher quality) reinforcer. When the price of the arbitrary reinforcer was increased (i.e., when the schedule of reinforcement for compliance was thinned to FR 60), the participant allocated responding to the lower priced reinforcer (i.e., a break), even though it was a lower quality reinforcer. Consistent with substitutability theory, these results suggest that a break was substitutable for food. When the price of the food became high, consumption of the food decreased and consumption of the break increased. Therefore, the value of positive and negative reinforcement may be influenced by the schedule requirement.

In future studies, the same type and amount of behavior should result in either the arbitrary or functional reinforcer to control for other variables that may influence choice (i.e., response effort). The only study on choice between functional versus arbitrary reinforcers to hold response effort constant was conducted by DeLeon, Neidert, Anders, and Rodriguez-Catter (2001). The authors examined choice between positive and negative reinforcement with a child who engaged in problem behavior maintained by escape. The participant was required to complete a number of tasks (based on the schedule requirement) in order to choose between either positive (i.e., a food item) or negative (i.e., a break) reinforcement. During treatment, problem behavior no longer produced a break. The participant chose the food item more often than the break under the low schedule requirements. However, when the schedule requirement reached FR 10, problem behavior increased and preference switched to negative reinforcement. When the results were replicated at FR 10, choice varied between positive and negative reinforcement.

Behavioral economics theory is most relevant to results of DeLeon et al. (2001) because the price of both the break and food item was increased systematically. When the price was increased to FR 10, the demand for the food item decreased and the demand for the break increased. These results indicated that the demand for food was elastic because it was easily influenced by changes in price. When the price of the food became too high, the participant stopped consuming the food item.

Results of DeLeon et al. (2001) have important implications for the use of arbitrary and functional reinforcers during treatment. For example, results of previous research indicating that arbitrary reinforcers may be more effective in reducing problem behavior than functional reinforcers may be inaccurate when schedules of reinforcement are thinned (e.g., FR 60). Preference for arbitrary reinforcers may only occur up to a certain schedule value, at which point the price of reinforcement may become too high. Therefore, it may be necessary to offer choice between both arbitrary and functional reinforcers when it is unclear whether preference will change in relation to the amount of work required to gain access to reinforcement.

Nevertheless, only one individual participated in DeLeon et al. (2001). Thus, more research is warranted to evaluate choice between functional and arbitrary reinforcers under increasing schedule requirements within a behavioral economics framework.

Purpose

The purpose of the present study was to replicate and extend previous applied studies on reinforcement choice and behavioral economics theory by examining how preference for either an arbitrary or functional reinforcer is influenced by schedule requirements (i.e., price) within the context of treating problem behavior. There has been limited research on how price influences choice between arbitrary and functional reinforcers. Additional research is needed to examine the effects of preference for qualitatively different reinforcers when schedule requirements increase. Traditional preference assessments may only identify items that will function as reinforcers under relatively rich schedules of reinforcement. When providing treatment in the natural environment, practitioners and teachers often deliver reinforcers on relatively thin schedules. Previous research has shown that arbitrary reinforcers can be effective in reducing problem behavior and maintaining high levels of compliance (e.g., Lalli et al., 1999). However, it remains unclear whether intermittently delivered arbitrary reinforcers would continue to maintain acceptable levels of appropriate behavior. Identifying the point at which preference switches for arbitrary versus functional reinforcers is important in order to make treatment recommendations to teachers.

Preference for various reinforcers under increasing schedule requirements was evaluated with children whose problem behavior was maintained by escape from demands. In the first phase, a replication and extension of the DeLeon et al. (2001) study was conducted by evaluating choice between qualitatively different reinforcers when reinforcers were provided contingent on compliance with either high preference or low preference tasks. Task preference was evaluated to determine if choice between reinforcers also would be influenced by the preference level of the task. For example, participants may be more likely to choose the break over the food item when working on low preference tasks because the value of the break as a reinforcer may increase under this condition. Previous research has not explicitly evaluated choice between various reinforcers when tasks vary in preference level. Results may help educators identify the most appropriate reinforcers to offer students, given the preference level of the required tasks.

In Phase 1, we expected that participants would show a preference for the food item over the break at low schedule requirements (i.e., FR 1 to FR 5) based on previous research in this area (DeLeon et al., 2001; Lalli et al, 1999). However, as indicated by the results of DeLeon et al., preference for a food item was expected to shift as the schedule was thinned (e.g., to FR 10 or FR 20). Furthermore, we hypothesized that preference would shift to the break at lower schedule requirements when participants were working on low preference tasks than when participants were working on high preference tasks because the low preference task would increase the value of the break.

Because participants continued to show preference for the food item over the break, regardless of the schedule or task in Phase 1, aspects of the break were manipulated in the second phase of the study to further evaluate preference when the quality of the break was manipulated. In the natural environment, a break from demands is likely to be combined with access to toys or attention from adults or peers. Therefore, it seemed important to evaluate whether a more naturalistic form of escape would alter preference for an arbitrary reinforcer (food) versus a functional reinforcer (escape). Furthermore, some educators may feel uncomfortable providing food as reinforcers to children in class. Thus, it seemed important to identify the conditions under which the break would be preferred, regardless of the schedule requirement.

Attention and toys were added to the break to evaluate whether preference would shift from the food item to the break. Previous research has shown that children with escape-maintained behavior may prefer escape to an enriched environment (i.e., a break with toys) over escape alone (Golonka et al., 2000). It was hypothesized that participants would show preference for the break over the food item when additional positive reinforcers were combined with the negative reinforcer (break). However, preference for the break may depend on whether attention only, toys only, or both attention and toys are included in the break. We hypothesized that participants would prefer the break when both attention and toys were included due to previous research findings indicating a preference for multiple types of reinforcement (Piazza et al., 1997).

In Phase 2, only one participant (i.e., Larry) showed a preference for the break over the food when the quality of the break was manipulated. We hypothesized that preference for the enriched break was displaced by the availability of a highly preferred food item. DeLeon, Iwata, & Roscoe (1997) found that food items displaced preference for leisure items in the paired-choice preference assessment. However, teachers often do not use food reinforcers that have been identified as highly preferred via systematic preference assessments. For this reason, it is likely that food reinforcers delivered for task compliance in the classroom are frequently of lower quality than those used during Phases 1 and 2. Thus, in Phase 3, we evaluated whether choice for the food item over the break would depend on the preference level of the food item. We hypothesized that participants would show a preference for the break over a lower-ranked food item from the preference assessment.

METHOD

Participants, Settings, and Materials

Five children, aged 4 to 8 years, participated in the study. Participants were diagnosed with developmental disabilities and/or Autism and were referred for the treatment of inappropriate behavior (i.e., destruction, aggression, SIB) that interfered with task completion. Larry was a six-year old boy diagnosed with Autism. Larry's problem behavior included aggression (i.e., scratching), disruption (i.e., throwing task materials), and inappropriate vocalizations (i.e., screaming). Casey was a seven-year-old boy diagnosed with Autism and moderate mental retardation. Casey engaged in aggression (i.e., hitting) and self-injurious behavior (i.e., hand biting and head and body hitting). Mary was a nine-year-old girl diagnosed with Autism and visual impairment. Mary's problem behavior included self-injurious behavior (i.e., arm biting), inappropriate vocalizations (i.e., whining and saying "no"), and mouthing (putting instructional materials in mouth and pulling on them with teeth). Sam was a four-year-old boy diagnosed with Autism. Sam displayed aggression (i.e., hitting, hair pulling, and pushing) and disruption (i.e., spitting, flopping, and throwing task materials). Scott was a four-year-old boy diagnosed with Autism. Scott displayed aggression (i.e., pinching), disruption (i.e., throwing task materials), and inappropriate vocalizations (i.e., saying "no"). All of the children were reported to have some visual discrimination skills. A functional analysis was conducted prior to the study to identify the variable(s) maintaining problem behavior. Only participants whose problem behavior was maintained by escape from demands were included in the study.

All assessment and treatment sessions were conducted in an unused room at the participant's school or in therapy rooms at a university-based early intervention program for children with Autism. The rooms contained a desk and chair, chairs for data collectors, and any relevant session materials. The therapist and data collectors were present during all sessions.

Dependent Measures

Data on inappropriate behavior, compliance, and reinforcer choice were collected during all assessment and treatment sessions. Inappropriate behavior included aggression (i.e., hitting, pushing, scratching, pinching, and pulling hair) disruption (i.e., throwing materials, flopping, crying, and spitting), self-injury (i.e., hand biting, arm biting, and head and body hitting), and inappropriate vocalizations (i.e., whining, screaming, and saying "no"). Compliance was defined as completing a demand within 5 s of a verbal or model prompt. Reinforcer choice was defined as pointing to or touching one of two coupons or items associated with the reinforcer after a verbal prompt. Observers were previously trained undergraduate and graduate students. All data were collected on laptops using real time recording. The frequency of inappropriate behavior was collected and converted to rate by dividing the number of times the behavior occurred by the number of minutes in a session. Each instance of compliance was scored and converted to a percentage of trials by dividing the number of instances the participant complied with a demand by the total number of demand trials per session. Reinforcer choice was expressed as a percentage by dividing the number of times the reinforcer was chosen by the number of opportunities to choose a reinforcer per session. Interobserver agreement was calculated for problem behavior, compliance, and choice by dividing the occurrence agreements by the occurrence agreement plus disagreements and multiplying by 100%. A second independent observer collected data during 44% of sessions for Casey, 53% of sessions for Larry, 36% of sessions for Sam, 47% of sessions for Mary, and 54% of sessions for Scott. Interobserver agreement for Casey's aggression, SIB, compliance, and choice between reinforcers was 93% (range, 76% to 100%), 87% (range, 58% to 100%), 99% (range, 94% to 100%), and 99% (range, 80% to 100%), respectively. Agreement for Larry's aggression, disruption, inappropriate vocalizations, compliance, and choice between reinforcers was 95% (range, 71% to 100%), 91% (range, 63% to 100%), 88% (range, 44% to 100%), 99% (range, 95% to 100%), and 98% (60% to 100%), respectively. Agreement for Sam's aggression, disruption, compliance, and choice between reinforcers was 92% (range, 34% to 100%), 96% (range, 33% to 100%), 99% (range, 96% to 100%), and 99% (range, 60% to 100%), respectively. Agreement for Mary's SIB, inappropriate vocalization, mouthing, compliance, and choice between reinforcers was 98% (range, 0% to 100%), 100%, 99% (range, 90% to 100%), and 97% (range, 0% to 100%), respectively. Agreement for Scott's aggression, disruption, compliance, and choice between reinforcers was 98% (range, 0% to 100%), 94% (range, 0% to 100%), 99% (range, 90% to 100%), and 99% (range, 60% to 100%), respectively.

General Procedures

Preference Assessment. A preference assessment was conducted to identify preferred tangible items, food items, and tasks based on procedures described by Fisher et al. (1992). Tangible and food items were assessed prior to the functional analysis because some of the items were incorporated into the functional analysis conditions. Tasks were assessed following the functional analysis but prior to baseline. Tangible items were assessed separately from food items and involved pairing each item once with every other item and asking the participant to choose one of the items. If both items were approached, the therapist blocked the choice, re-presented the items, and said, "Pick one." When one item was chosen, the participant was allowed to consume the food item or interact with the tangible item for 20 s. Each item was paired once with every other item. Relative preference for each item was determined by dividing the number of times the item was chosen by the number of times the item was presented and multiplying by 100%. These percentages were then used to rank the items from most to least preferred. Tangible and food items identified during the preference assessment were included in specific conditions of the functional analysis and in Phase 2 and 3 of the study. Highly preferred food items (i.e., the top two items identified in the preference assessment) were used in Phase 1 and 2 of the study.

Additional preference assessment procedures were conducted throughout the study with various participants. A multiple stimulus without replacement (MSWO) preference assessment was conducted daily with Sam following Phase 1 because it appeared that his preference for various food items may have changed (i.e., he was refusing to eat certain food items prior to the study when discrimination probes were conducted). In addition, a paired-choice preference assessment with healthy food items was conducted with Sam during Phase 3 to identify a low preference healthy food item. The additional preference assessment was conducted with healthy items because the initial preference assessment contained all unhealthy food items. Teachers and parents may be more likely to use healthy foods as reinforcers (e.g., raisins). Therefore, we wanted to assess the value of items that may be more likely to be used in the classroom or at home. An MSWO preference assessment was conducted daily with Larry to identify highly preferred food items to use during all phases after his parents placed him on a fairly restrictive diet. Larry would eat very few of the items that were permitted under his new diet, and his mother reported that he consumed large amounts of some items each day. Because we were concerned that Larry might become satiated on some of these items, a daily MSWO was conducted to ensure that a high preference food item was used during the sessions. An MSWO in Phase 1 was conducted daily after Scott coughed while eating a piece of popcorn and would no longer consume popcorn (which had previously been identified as a highly preferred food item). In addition, another paired-choice preference assessment was conducted prior to Phase 3 to identify a low preference food item that would be used during this phase. The additional preference assessment was conducted to determine Scott's current preference ranking of various food items.

A task preference assessment was also conducted with each participant using tasks that were delivered during the demand condition of the functional analysis (see further description below). The participants were required to complete each task once prior to the preference assessment. The therapist presented relevant materials for each of the two tasks, and the participant was told to "Pick one." When one task material was chosen, the participant was required to perform the task two times. Praise was provided for compliance. Preference for tasks was calculated as a percentage of trials chosen, using procedures described above for the tangible and food preference assessments. The task that the participant chose most often was designated the high preference task; the task that was chosen least often was designated the low preference task. High and low preference tasks were used in Phase 1.

Functional Analysis. A functional analysis of problem behavior was conducted to identify potential participants. Functional analysis conditions included attention, demand, tangible, play, food, and no interaction. Sessions were alternated in a multielement design using procedures described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994). Sessions were 10 min. During the attention condition, low preference tangibles were provided and the therapist told the participant that he/she could play with the toys while the therapist did work. Contingent on the target behavior, the therapist provided 20 s of attention in the form of reprimands and statements of concern. During the demand condition, task materials were present and the therapist issued verbal instructions. A three-step prompt procedure (verbal, gestural, physical) was used if the participant did not comply with the demand. Contingent on the target behavior, the therapist removed the task materials and turned away from the participant for 20 s. In the tangible condition, the participant had 2 min of pre-session access to highly preferred tangible items. The therapist removed the items at the beginning of the session and returned the items for 20 s contingent on target behavior. In the no interaction condition, the therapist was present in the room but did not interact with the participant at any point during the session. No tangible items were provided and the therapist did not provide any consequences for target behavior. During the play condition, highly preferred tangible items were available and the therapist provided attention at least once every 30 s. If target behaviors occurred, the therapist did not provide any consequences for the behavior. A food condition was included to determine if access to food was a functional reinforcer for problem behavior (i.e., to test the assumption that food was an arbitrary reinforcer for problem behavior). The food condition was evaluated in a pairwise comparison with food and toy play conditions. The food condition was similar to the tangible condition. Participants were given pre-session access to a highly preferred food. Food was removed at the beginning of the session and returned for 20 s contingent on target behavior. The pairwise comparison of food and toy play conditions was conducted following the choice analysis with Scott. Additional assessment procedures were conducted with certain participants to clarify functional analysis results. A pairwise comparison was conducted with Sam following the initial functional analysis to help clarify the environmental variables that were maintaining problem behavior. Tangible and control conditions were alternated in the pairwise comparison. A pairwise comparison was also conducted with Scott to identify whether problem behavior was maintained by escape from demands. Parent and teacher report indicated problem behavior frequently occurred when demands were placed on Scott. However, during the initial functional analysis, problem behavior did not occur in the demand condition. Therefore, demand and control conditions were alternated in the pairwise comparison.

Discrimination Training. Prior to baseline, the participant was taught to discriminate between two coupons (Sam, Scott, and Larry) or two three-dimensional items (Mary and Casey) and to touch the coupons or items to obtain the designated reinforcer. Coupons were used for participants whose teachers reported that they could discriminate among different pictures. Items were used for participants who did not reportedly possess such discrimination skills. Coupons were made of a 3 in. X 3 in. piece of paper. The break coupon showed a picture of a chair and said the word “break” above the picture. The food coupon had a picture of a food item and said the word “snack” above the picture. If three-dimensional items were used, one item represented the break (e.g., a timer) and the other item represented the snack (e.g., a bag of food). First, the therapist physically guided the participant to choose one coupon or item and delivered the consequence associated with the coupon or item (i.e., either a 30 s break from discrimination training or a small piece of food). After physically guiding the participant to pick each coupon or item a minimum of five times, the therapist required the participant to comply with one instruction (e.g., string one bead) and then permitted the participant to choose between the two coupons or items. This procedure occurred a minimum of three times. The therapist then asked the child to point to or say the coupon or item associated with either a break or food item. If the child could accurately perform this activity twice for each coupon or item, discrimination training was completed. If the participant did not accurately discriminate between the coupons, discrimination training was conducted with items in place of the coupons, and training continued until the criteria above are met. Prior to each day's sessions, the therapist forced a choice for each coupon or item one time and repeated the last step of discrimination training to ensure that the participant's choice behavior remained under discriminative control of the two coupons or items.

Experimental Design

High preference and low preference tasks were alternated in a multielement design during Phase 1. The effects of the schedule on reinforcer choice were evaluated in a reversal design in Phase 1. During Phase 2, the parameters of the break were manipulated using a reversal design. In Phase 3, the quality of the food item was manipulated and preference was evaluated using a reversal design.

Phase 1-Procedures

The purpose of Phase 1 was to evaluate preference for reinforcers under increasing schedule requirements with high versus low preference tasks. Two tasks with different levels of preference (the most and least preferred tasks identified via the task preference assessment) were alternated in a multielement design. During all sessions, the experimenter presented instructional trials using a graduated three-step prompting procedure (verbal, model, physical prompts). No programmed consequences were provided for inappropriate behavior (i.e., problem behavior was exposed to extinction).

Baseline (No Reinforcement). Sessions with the most and least preferred tasks were conducted a minimum of five times each. No programmed consequences were provided for compliance. Five trials were conducted during each session. The purpose of baseline was to evaluate levels of compliance and problem behavior in the absence of reinforcement for appropriate behavior.

Reinforcer Choice. All procedures were the same as in baseline but reinforcement was provided for task compliance. The participant had the opportunity to choose between two reinforcers contingent on task compliance following a verbal or model prompt. The number of times the participant had to complete the task to gain access to reinforcement was gradually increased on a fixed ratio (FR) schedule beginning with FR 1. Each session ended when the participant had received five opportunities to choose between reinforcers.

When the participant had complied with the required number of demands (depending on the schedule), the therapist placed both coupons/items on the table at equal distances from the participant. The therapist said, “Pick one.” If the participant chose the snack coupon/item, he/she was given a small piece of a highly preferred food. The next demand began immediately after delivery of the food item so that the positive reinforcer was not confounded with a break from the task. If the participant chose the break coupon/item, the therapist turned away from the participant and provided a 30-s break from task demands.

When reinforcer choice remained stable for at least 3 sessions under FR 1, the schedule was increase to FR 2. Reinforcer choice was considered stable if it varied by 20% or less from one session to the next. The schedule continued to be doubled if choice remained stable for at least three consecutive sessions under each schedule value until preference appeared to change (e.g., switched from the food item to the break) or until the schedule reached FR 40. If preference changed at or before the schedule reached FR 40, FR 2 and the highest schedule requirement for that participant was replicated.

<u>Phase 2-Procedure</u>

All of the participants participated in Phase 2 because results of Phase 1 generally indicated a preference for the food item under relatively thin reinforcement schedules (e.g., FR 20 or FR 40). The purpose of Phase 2 was to evaluate whether preference would change if the break contained access to other positive reinforcers. Because the parameters of the break were manipulated, the conditions most likely to increase the value of the break were conducted. Thus, the low preference task and the thinnest schedule under which the food reinforcer was consistently preferred over the break was used. All other procedures were identical to those in Phase 1.

<u>Baseline</u>. Data from the last phase in Phase 1 (i.e., when the highest schedule requirement reached by the participant was replicated) served as the baseline data for

Phase 2, with two exceptions. First, an additional baseline was conducted with Sam when a change in setting occurred following Phase 1, which was conducted in Sam's school setting. During the summer, Sam attended a university-based early intervention program for child with autism. Thus, we conducted the baseline for Phase 2 in the new setting. Second, a relatively rich schedule (FR 5) was chosen as the baseline schedule for Scott because reinforcer choice in Phase 1 was somewhat variable even under rich schedules of reinforcement (e.g., the replication of FR 2). Thus, a baseline phase with this schedule was implemented during Phase 2.

Reinforcer Choice. Either highly preferred tangible items (i.e., toys), therapist attention, or both were systematically combined with the break. Highly preferred tangible items were the two toys that were chosen most often during the pre-study preference assessment. First, both tangibles and attention were added to the break to determine if preference for the food reinforcer would shift to the break. Whenever the break was selected, the therapist removed the task materials, provided the two most highly preferred toys, and delivered attention (i.e., conversation) for 30 s. If the participant chose the break coupon/item more than he/she did in Phase 1, the separate effects of attention and tangibles during the break were evaluated to identify the variable(s) (attention, tangibles, or both) responsible for the change in preference. That is, the break was combined with 30 s of attention only (i.e., tangibles were no longer provided). If reinforcer choice remained unchanged, the break was combined with the tangibles only. This evaluation was followed by a reversal to the break only (i.e., baseline) and replication of the break plus the relevant variables (i.e., either attention or tangibles, or both). Other manipulations were conducted for Scott because the enriched break was introduced under a relative rich schedule of reinforcement (e.g., FR 5), and he did not show a change in preference from the food to the break. The schedules under which Scott consistently showed a preference for the food item in Phase 1 were replicated to determine if preference would shift to the enriched break under thinner schedule values.

Phase 3-Procedure

Four of the five participants (i.e., Sam, Scott, Casey, and Mary) participated in Phase 3 because they continued to show preference for the food item over the enriched break in Phase 2. Therefore, we wanted to evaluate whether preference would change when the quality of the food item was manipulated.

Baseline. Data from the last phase in Phase 2 (when the participant could choose between the high preference food item and the enriched break) served as the baseline data for Phase 3, with the exception of Mary, who was the first to participate in Phase 3. We hypothesized that a lower preference food item would lead to a complete switch in preference to the enriched break even when a more dense schedule of reinforcement was in place (e.g., FR 10). Therefore, we began Phase 3 under the FR 10 schedule with Mary only. When her preference did not change, the same reinforcement schedules that had been implemented in Phase 2 were used for the remaining participants.

Reinforcer choice. A medium and/or low preference food item was compared to the enriched break (i.e., break with access to two highly preferred toys and adult attention). The outcome of the pre-treatment food preference assessment was examined to identify the lowest ranked food item that the participant would consume. We only selected items that the participant would consume to increase the likelihood that the food would function as a reinforcer. In addition, it is unlikely that parents or teacher would use food items that the participants would not consume. A medium preference food item (i.e., food item ranked in the middle of the items in the food preference assessment) was also evaluated with Mary only. If participants chose the enriched break more often than during baseline, a reversal to the high preference food item was implemented. Following the reversal, the low preference food item was reinstated to replicate the change in preference. Mary continued to show a preference for the medium and low preference foods under the initial schedule value (i.e., FR 10). Thus, the schedule was increased to FR 20 and finally FR 40 to evaluate whether preference for the low or medium preference foods would vary as a function of the schedule.

The procedures conducted in Phase 3 were modified for Sam after a change in preference from the low preference food to the break was not replicated (i.e., Sam chose the low preference food over the break). An additional preference assessment was conducted to identify a food item that was less preferred than the current food item. The least preferred food item that Sam would consume was evaluated as the second low preference food item. We also hypothesized that the enriched break may have acquired some aversive properties during the course of the study (e.g., Sam began to push the toys away and wouldn't talk with the therapist during the break). Therefore, choice between the second low preference food item and a non-enriched break (i.e., a 30 s break with no toys and attention) was evaluated.

RESULTS

The results of the study will be presented in the order in which the procedures were conducted. Results of the preference assessments (Figures 1 to 17) and functional analyses (Figures 18 to 22) will be presented for each participant first, followed by the results for each dependent variable during Phases 1, 2, and 3. Data on reinforcer choice in Phase 1, 2, and 3 will be presented for every participant (Figures 22 to 31), followed by data on problem behavior (Figures 33 to 41) and compliance (Figures 42 to 51) during Phase 1, 2, and 3.

Preference Assessment

Figures 1, 2 and 3 show the results of the paired-choice preference assessments conducted with Casey. Only three food items were evaluated in the food preference assessment because he would eat only a limited number of food items. The three items evaluated were rice chex, a small piece of a peanut sandwich, and a piece of a ginger cookie. Results of the food preference assessment showed that the ginger cookie was most preferred (see Figure 1). Casey's toy preference assessment identified a Bumble Ball and disco ball as most preferred (see Figure 2). The task preference assessment identified putting pieces in a puzzle as Casey's most preferred task and matching letters as his least preferred task (see Figure 3).

Figures 4 and 5 show the outcome of Larry's preference assessments. As noted earlier, an MSWO food preference assessment was conducted daily to identify the highest preferred item from those that were permitted on Larry's gluten-free, casein-free diet. The food items included in the MSWO were a grape, carob chip, vanilla pudding, raisin, and a carob cookie. Larry commonly chose the carob chip and vanilla pudding as

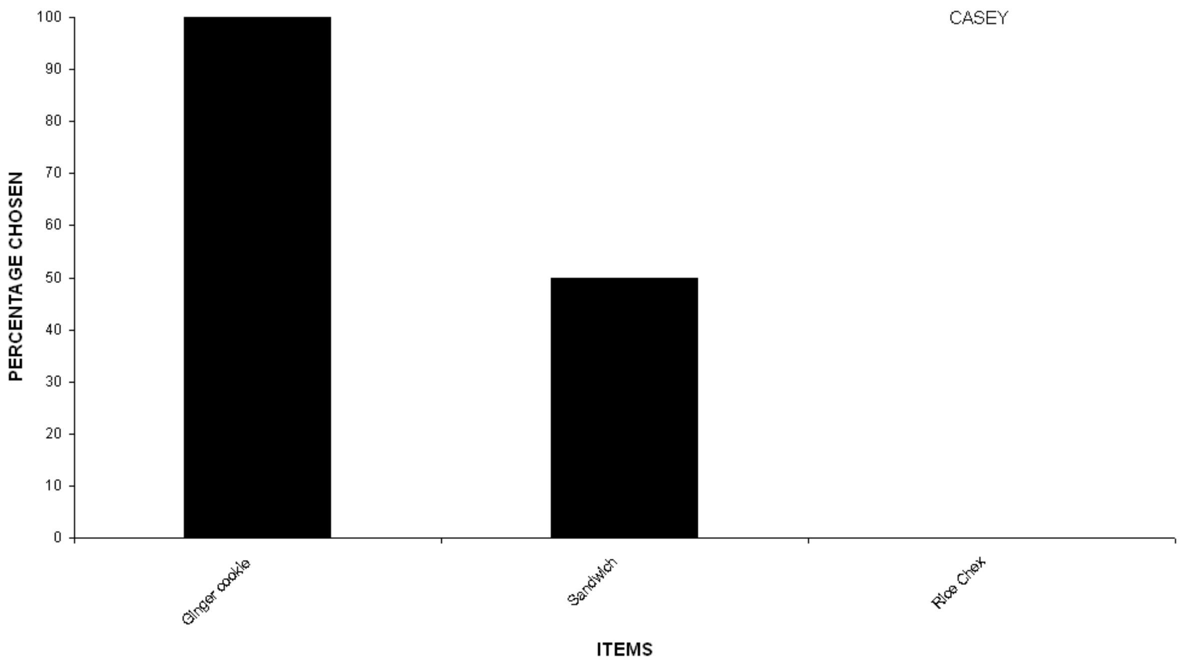

Figure 1. Casey’s paired-choice preference assessment for food items.

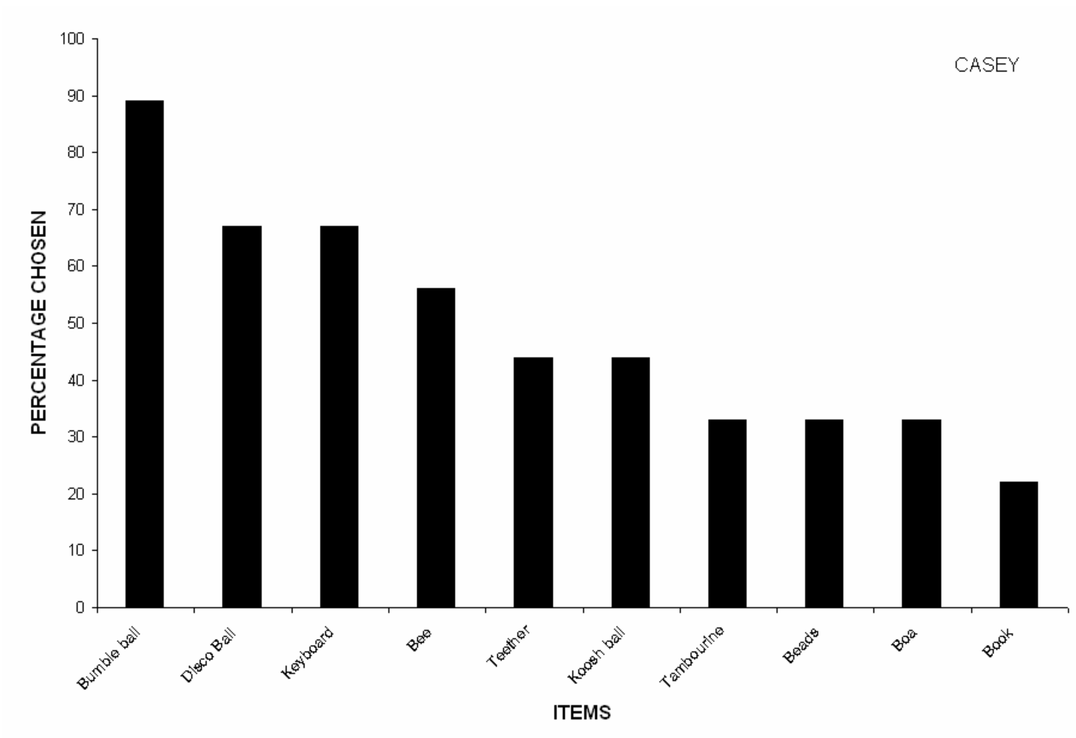

Figure 2. Casey’s paired-choice preference assessment for toys.

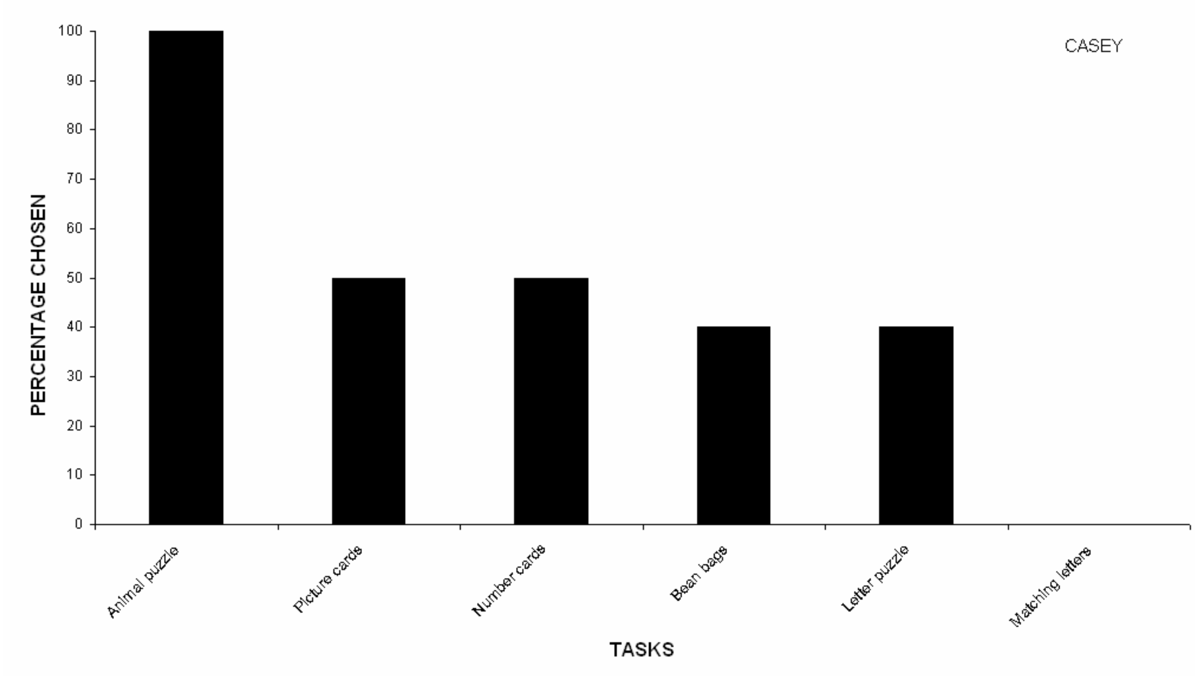

Figure 3. Casey’s paired-choice preference assessment for tasks.

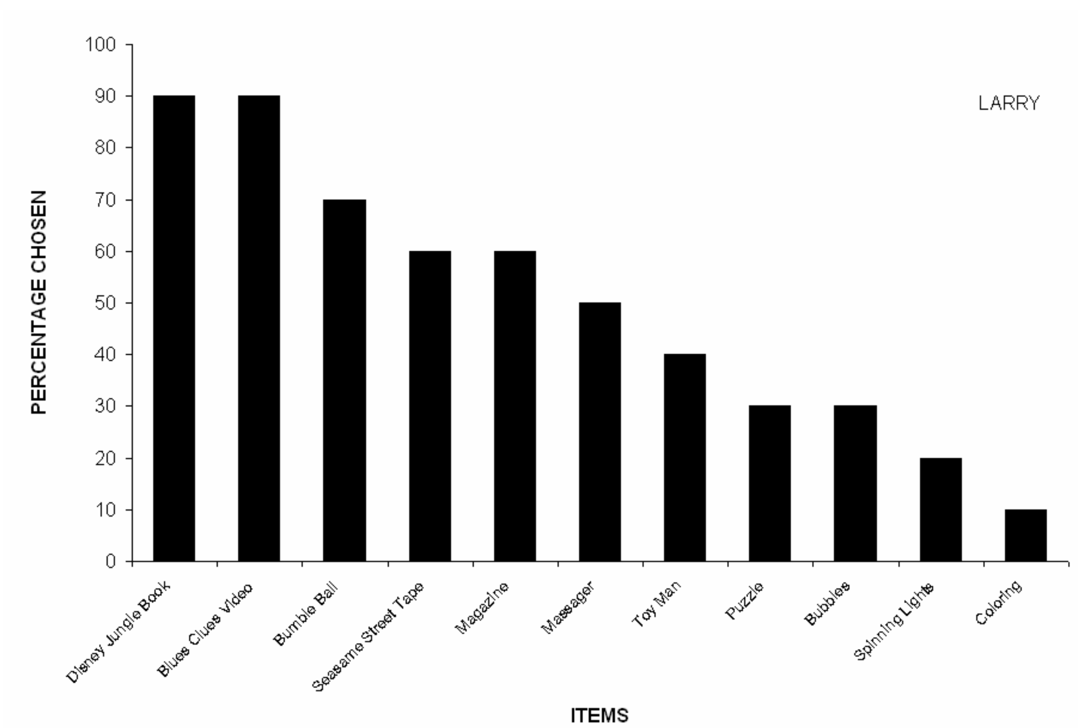

Figure 4. Larry’s paired-choice preference assessment for toys.

the first two choices during the MSWO. Results of Larry's toy preference assessment identified a Disney™ book and Blue's Clues™ video as most preferred (see Figure 4). Results of the task preference assessment showed that receptively identifying colored bears was Larry's most preferred task and stringing beads was the least preferred task (see Figure 5).

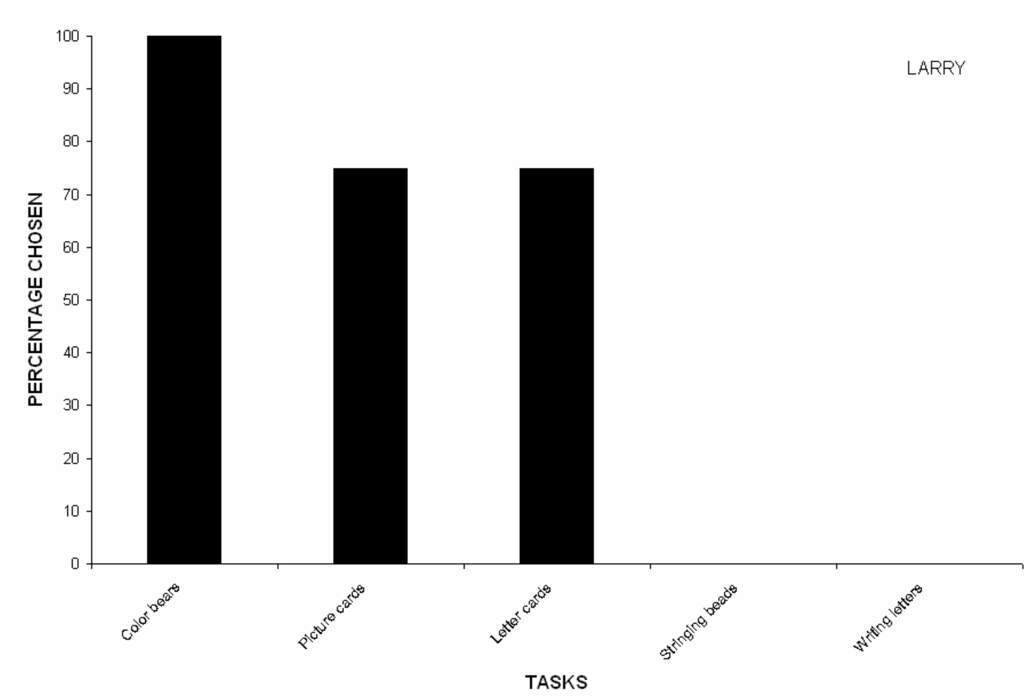

Figure 5. Larry's paired-choice preference assessment for tasks.

Figures 6, 7, 8, and 9 show the results of Sam's preference assessments. Sam's food preference assessment identified Fruit Gushers™ and Fruit Loops™ as most preferred (see Figure 6). Another food preference assessment was conducted after the first phase of the study was completed because it appeared that his food preferences may have changed. As noted in the Method section, Sam stopped eating the Fruit Gusher ™ during the discrimination training probes that were conducted prior to daily sessions. An

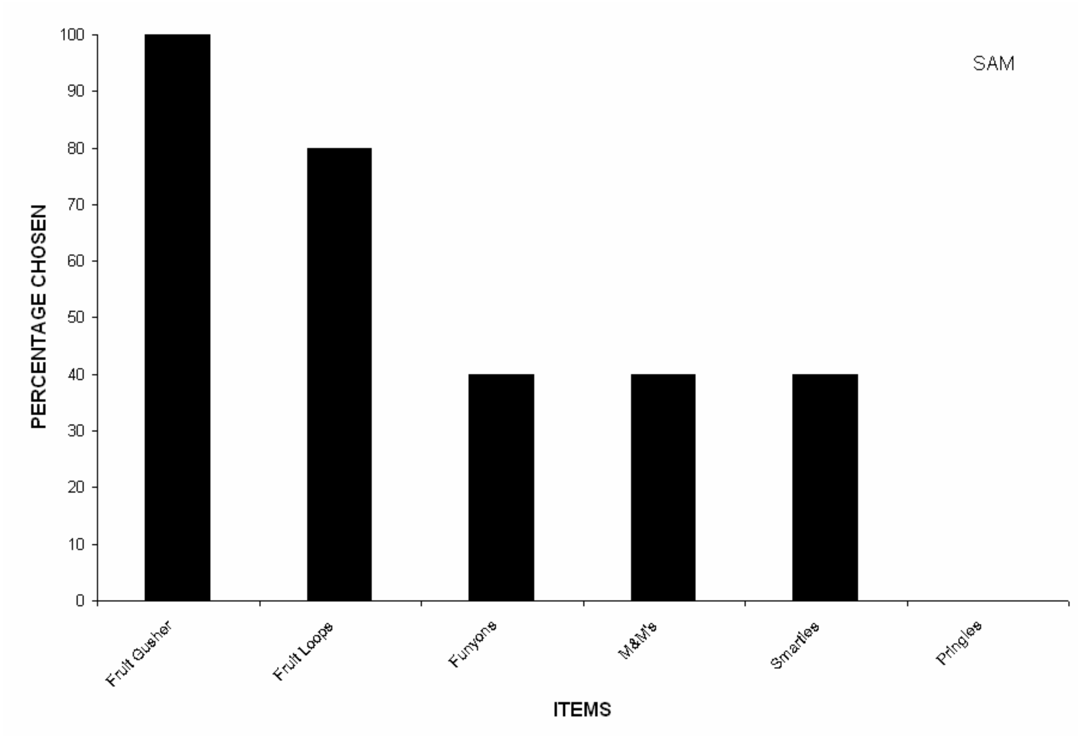

Figure 6. Sam's paired-choice preference assessment for food items.

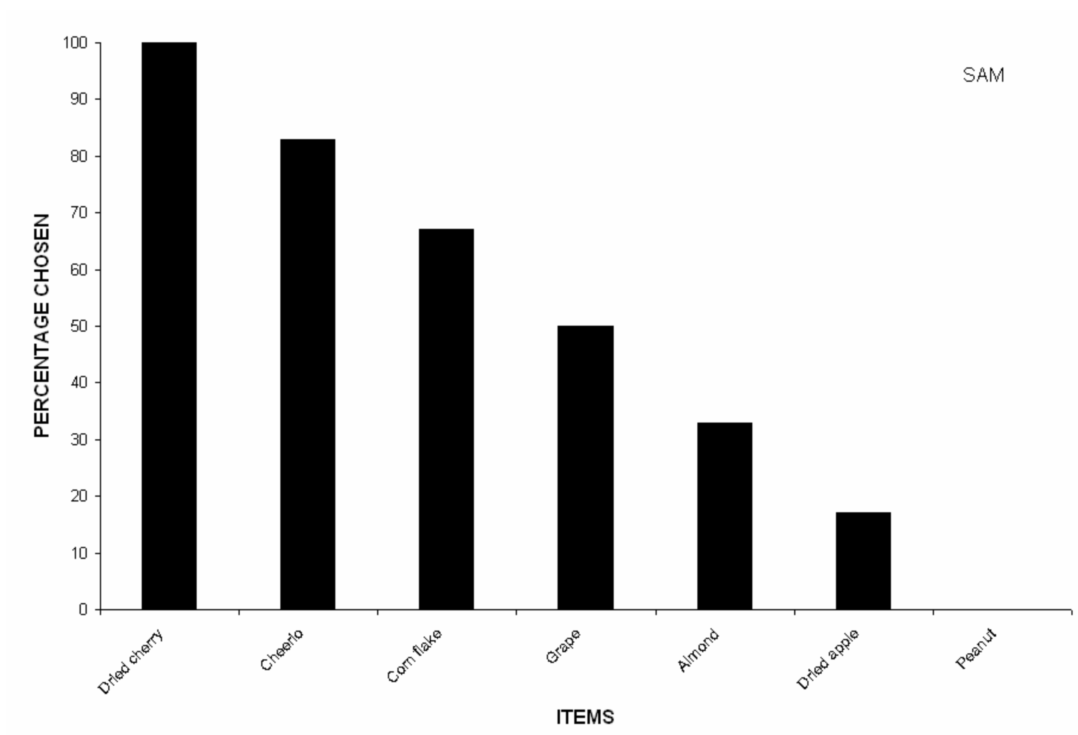

Figure 7. Sam's paired-choice preference assessment for healthy food items.

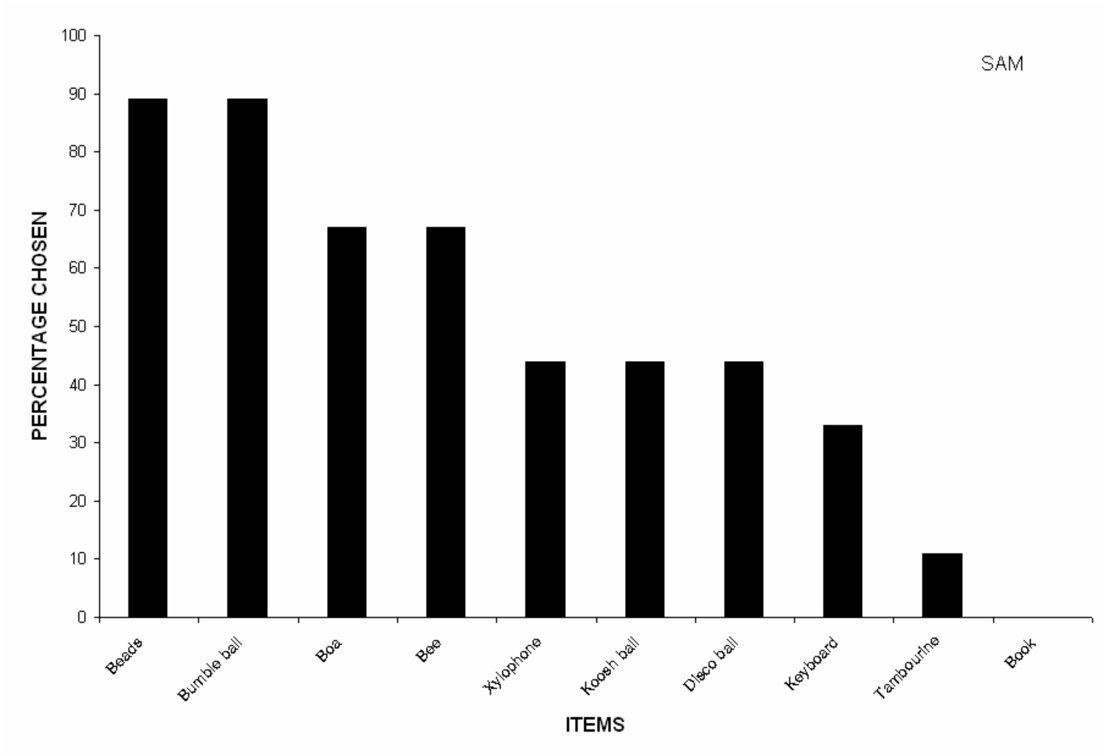

Figure 8. Sam’s paired-choice preference assessment for toys.

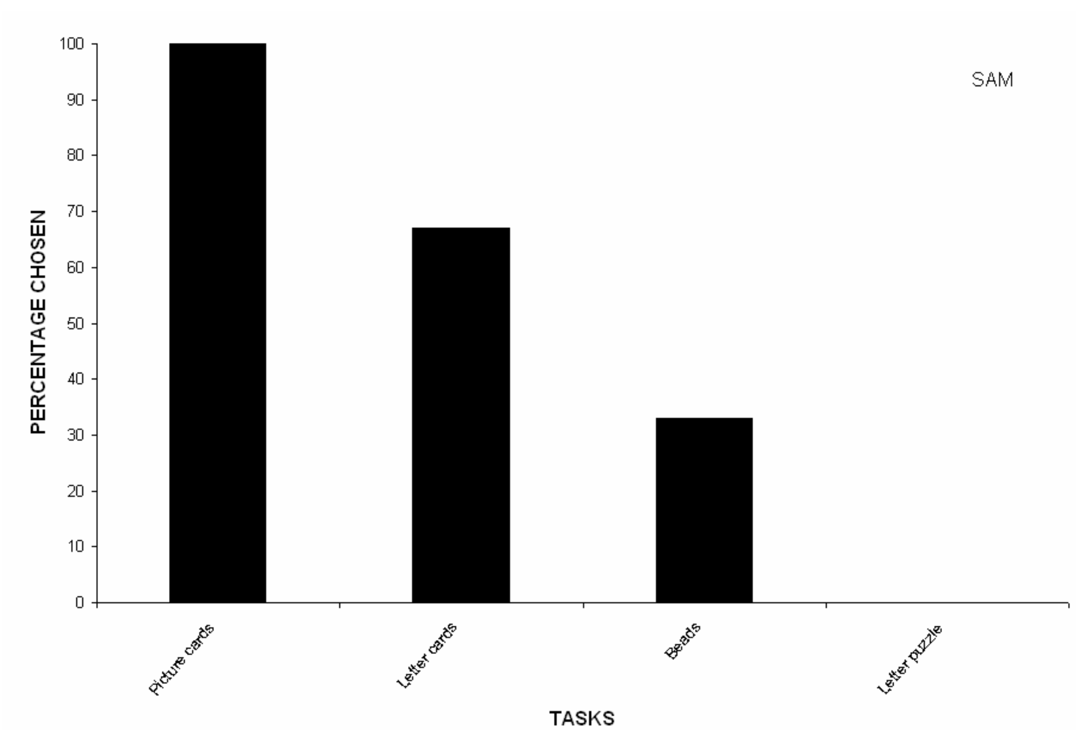

Figure 9. Sam’s paired-choice preference assessment for tasks.

MSWO was conducted prior to each day's sessions to ensure that the food items were highly preferred. The MSWO included one additional items not evaluated during the initial food preference assessment (i.e., Gummy Bears). Results of the daily MSWO showed that Pringles™ were always the most preferred food item, followed by gummy bears. As described in the Method section, an additional paired-choice food preference assessment was conducted with Sam following the introduction of the first low preference food item in Phase 3 (see Figure 7). Dried apples were identified as the lowest ranked food item that Sam would consume. The toy preference assessment conducted with Sam showed that Mardi Gras beads and a Bumble Ball™ were most preferred (see Figure 8). Sam's task preference assessment indicated that receptively identifying animals was his most preferred task and a letter puzzle was his least preferred task (see Figure 9).

Results of Mary's preference assessments are shown in Figures 10, 11, and 12. Results of the food preference assessment showed fruit snacks were most preferred and strawberry juice was least preferred (see Figure 10). Mary's toy preference assessment identified a squishy ball and Mardi Gras beads as most preferred (see Figure 11). Results of Mary's task preference assessment showed that Playdoh™ was her most preferred task and shape puzzle was her least preferred task (see Figure 12). However, when demands were presented with the Playdoh™, Mary would play with the Playdoh™ instead of engaging in the demand. Therefore, the second highest ranked task (stringing beads) was used as the high preference task in Phase 1.

Figures 13, 14, 15, and 16 show the results of Scott's preference assessments. Scott's food preference assessment indicated popcorn and M&M's™ were his most

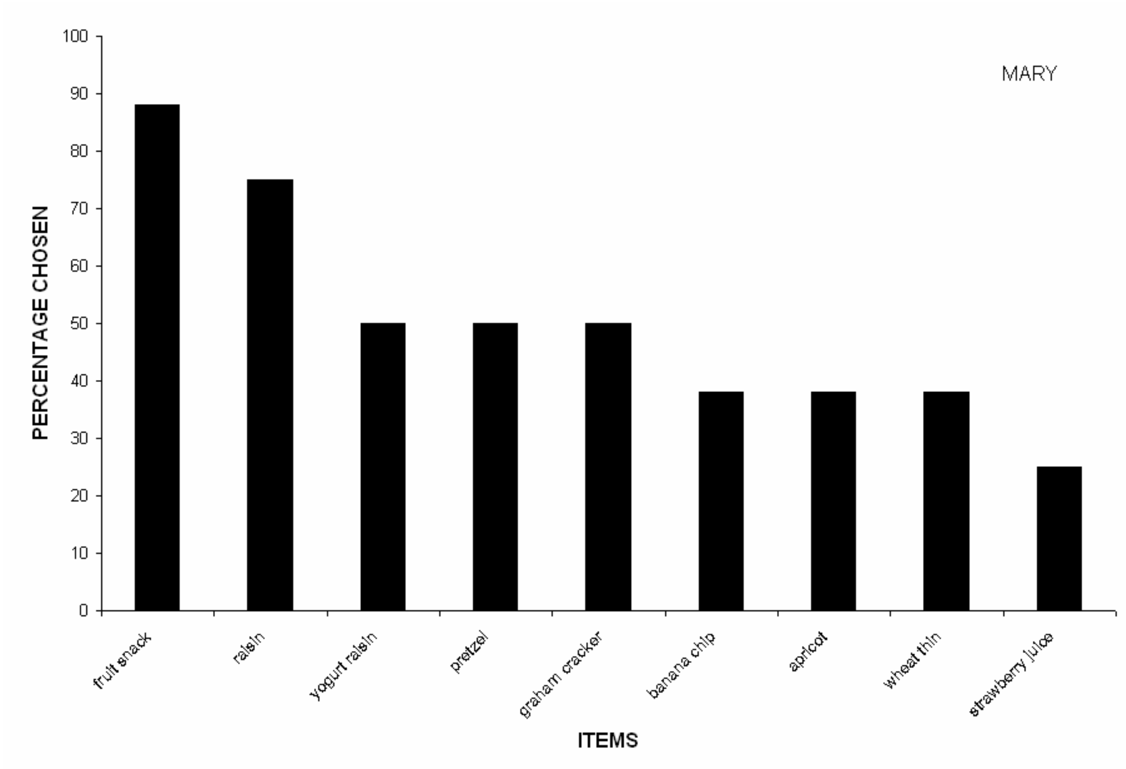

Figure 10. Mary's paired-choice preference assessment for food items.

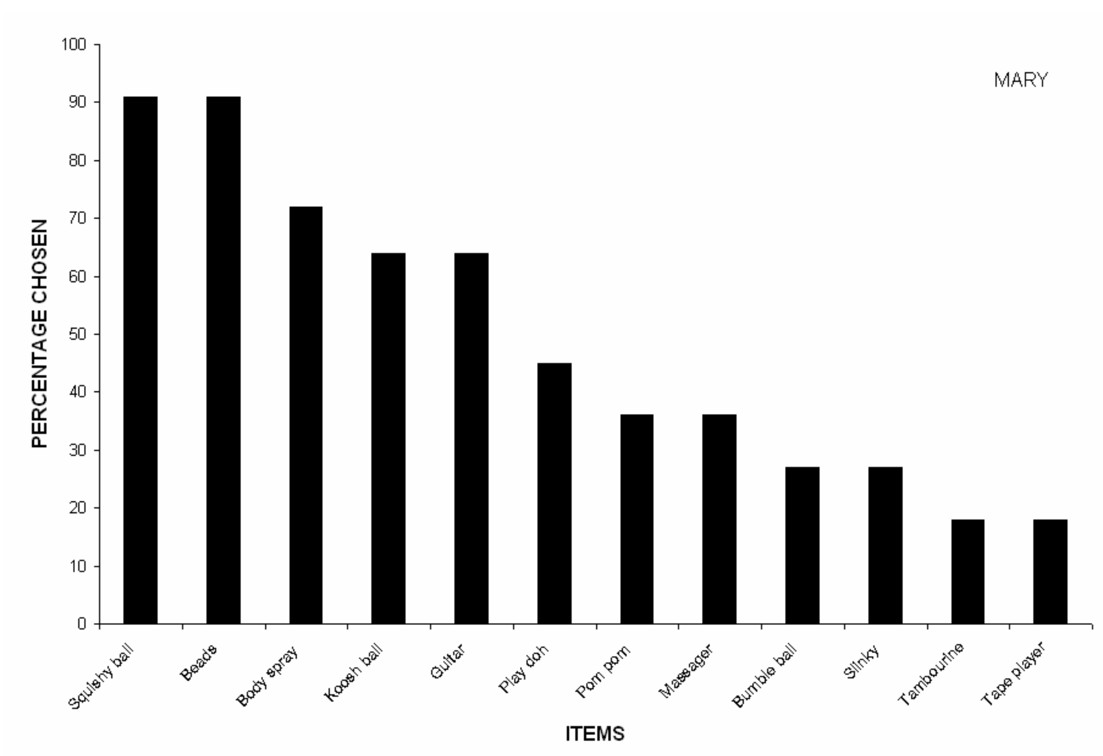

Figure 11. Mary's paired-choice preference assessment for toys.

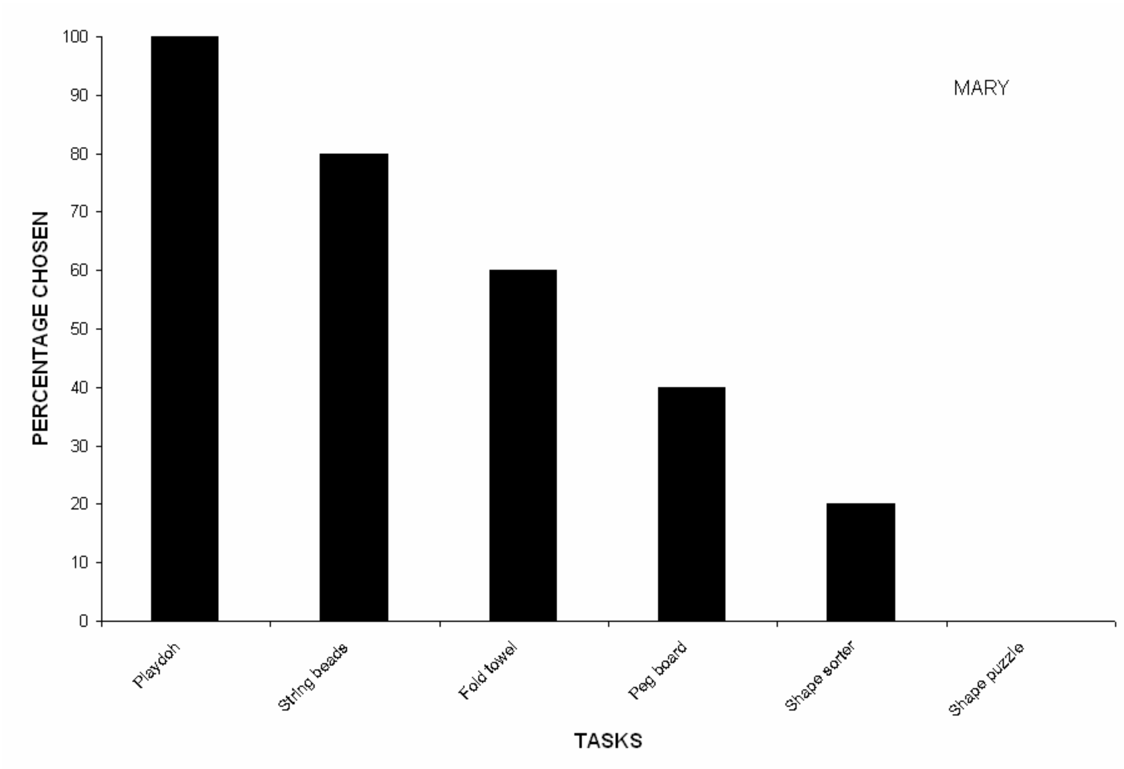

Figure 12. Mary's paired-choice preference assessment for tasks.

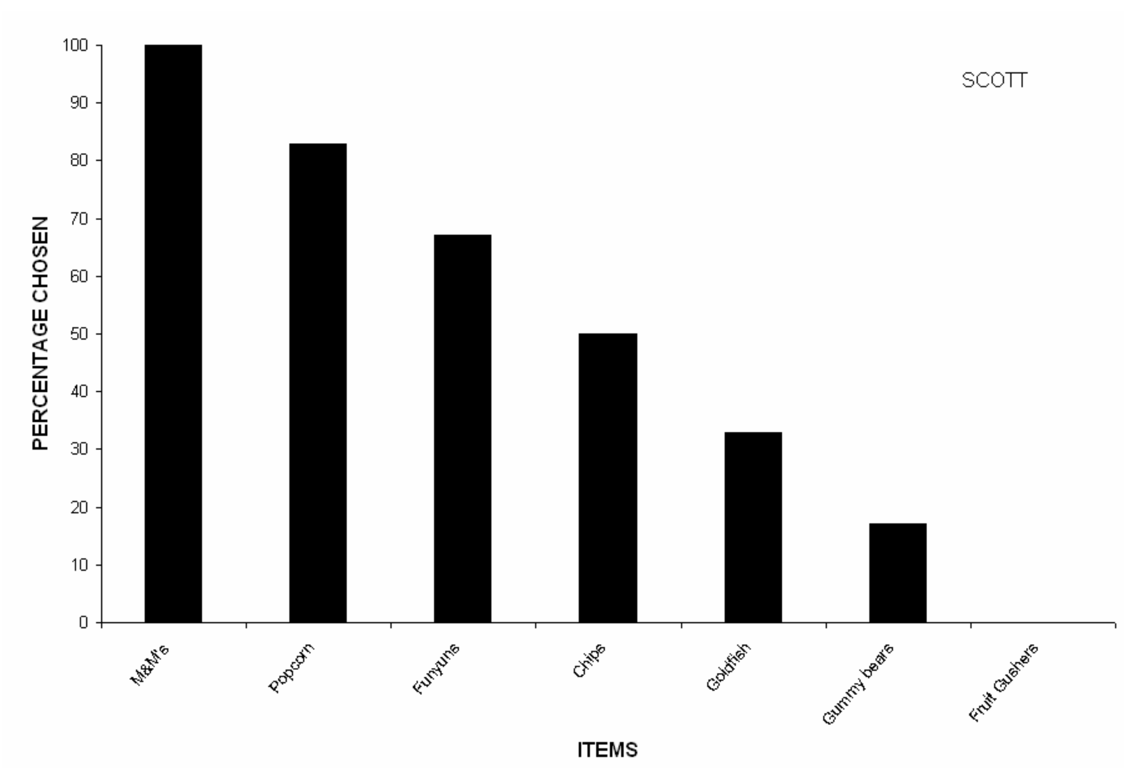

Figure 13. Scott's paired-choice preference assessment for food items.

preferred food items (see Figure 13). As noted earlier, an MSWO was conducted prior to sessions each day after Scott coughed while eating a piece of popcorn and would not consume popcorn from that point on. M&M's™ were consistently selected each day. In addition, another paired-choice food preference assessment was conducted with Scott prior to Phase 3 to identify an item that would be used as the low preference food item during this phase. The preference assessment identified dried apples as the lowest ranked food item that Scott would consume (see Figure 14). A light-up snake and play tools were identified as his most preferred toys (see Figure 15). Results of Scott's task preference assessment indicated that putting pegs in a peg board was his most preferred task and receptively identifying opposites was his least preferred task (see Figure 16).

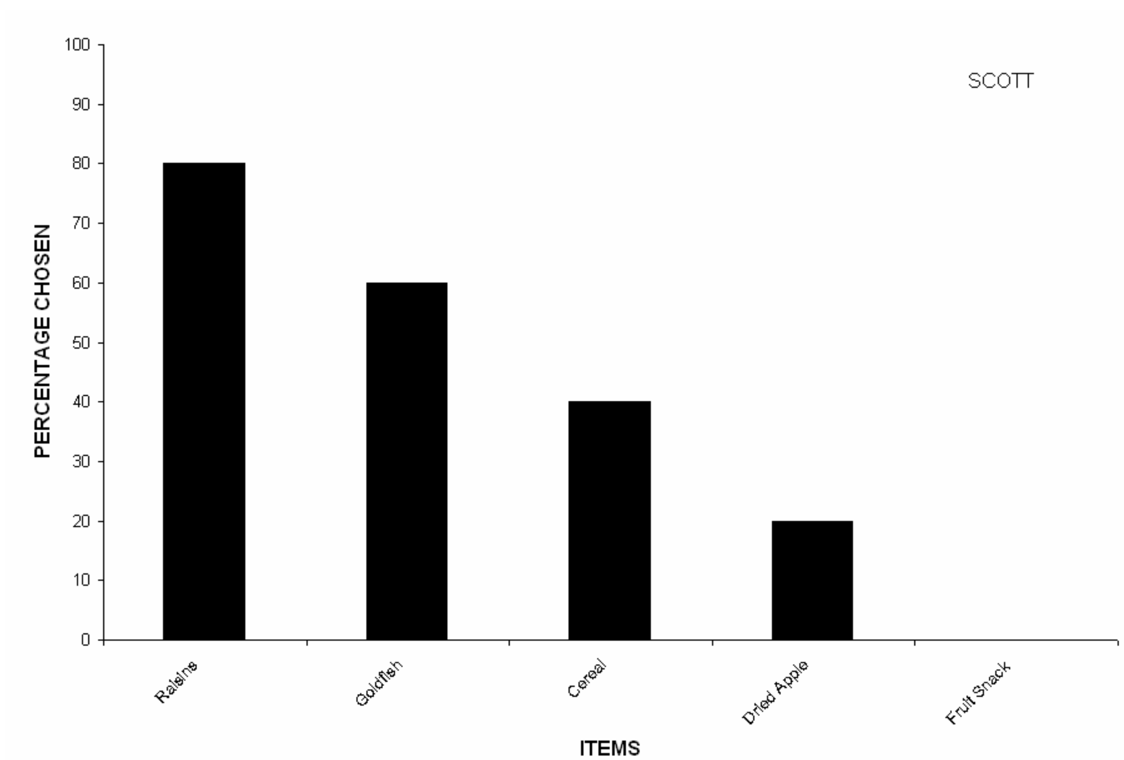

Figure 14. Scott's paired-choice preference assessment for healthy foods.

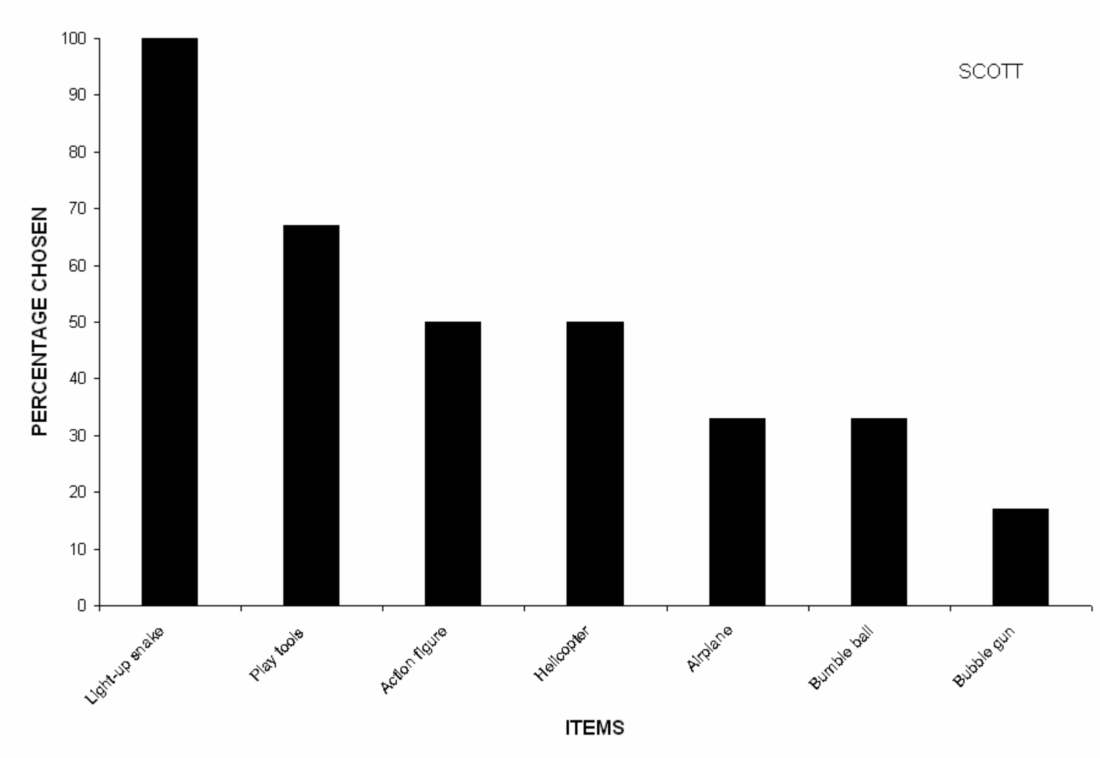

Figure 15. Scott's paired-choice preference assessment for toys.

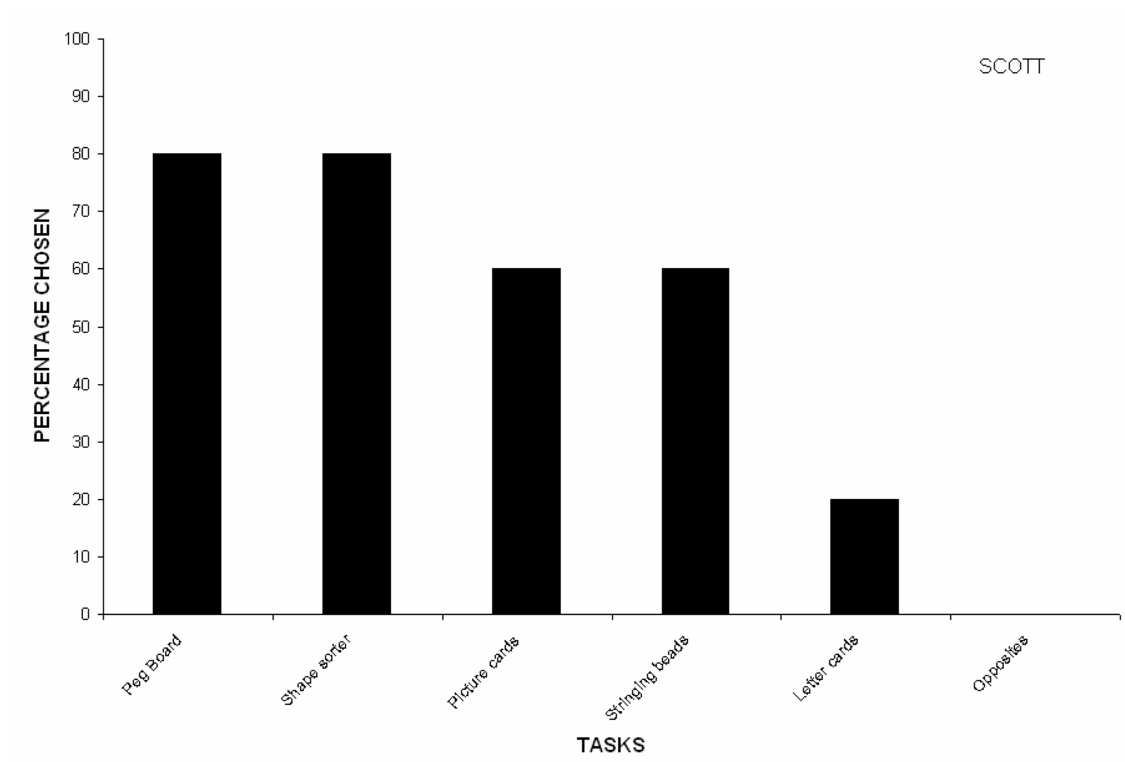

Figure 16. Scott's paired-choice preference assessment for tasks.

Functional Analysis

Figure 17 shows the results of Casey's functional analysis and pairwise comparison. Functional analysis results suggested that problem behavior was maintained by negative reinforcement in the form of escape from demands (demand, *M* = 1.6 responses per minute; social attention, *M* = .3; no interaction, *M* = .5; toy play, *M* = .9; tangibles, *M* = .5). Problem behavior was undifferentiated and variable until the last four sessions of each condition, at which point rates of problem behavior were higher in the demand condition than in the toy play and no interaction conditions. In addition, across all sessions of the functional analysis, problem behavior was consistently higher during the demand condition than in the no interaction condition. It should be noted that the attention and tangible conditions were discontinued mid-way through the assessment after very little problem behavior occurred for multiple sessions. In addition, the no interaction condition was introduced to determine whether Casey's problem behavior was maintained by automatic reinforcement. Results of the pairwise comparison of toy play and food conditions indicated that problem behavior was not maintained by access to food (food, *M* = .5 responses per minutes; toy play, *M* = 1.3).

Results of Larry's functional analysis and pairwise comparison are shown in Figure 18. Larry exhibited the highest rates of problem behavior during the tangible and demand conditions of the functional analysis, suggesting that his problem behavior was maintained by access to tangible items and escape from demands (tangibles, *M* = 5.3 responses per minute; demand, *M* = 2.1; toy play, *M* = 0; social attention, *M* = .8). Results of the pairwise comparison of food and toy play conditions indicated that problem behavior was not maintained by access to food (food, *M* = 0; toy play, *M* = 0).

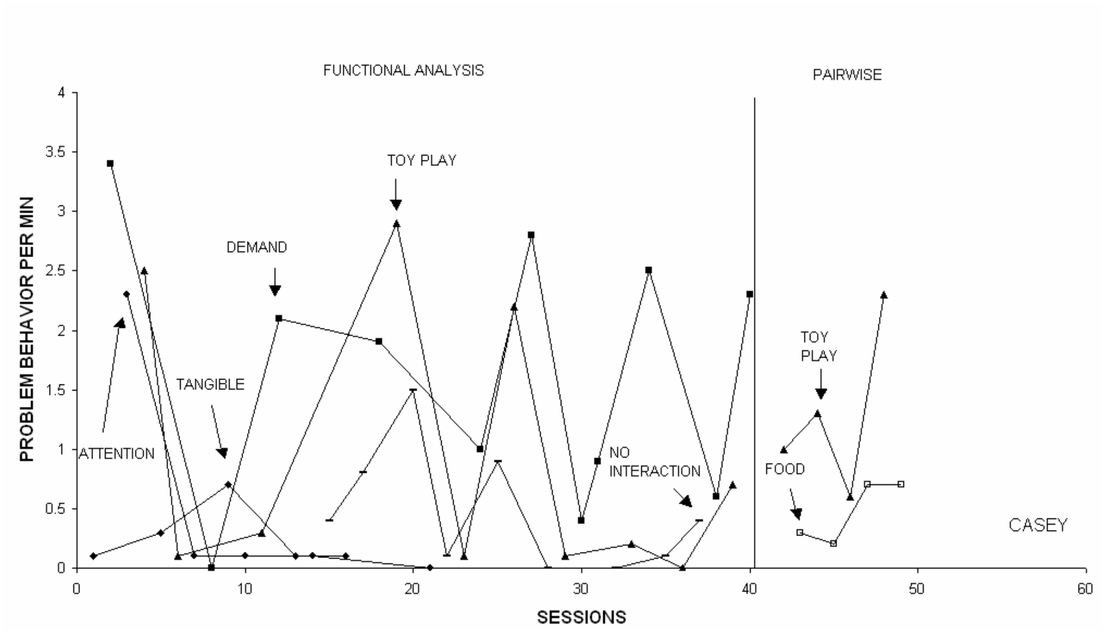

Figure 17. Results of Casey's functional analysis and pairwise comparison.

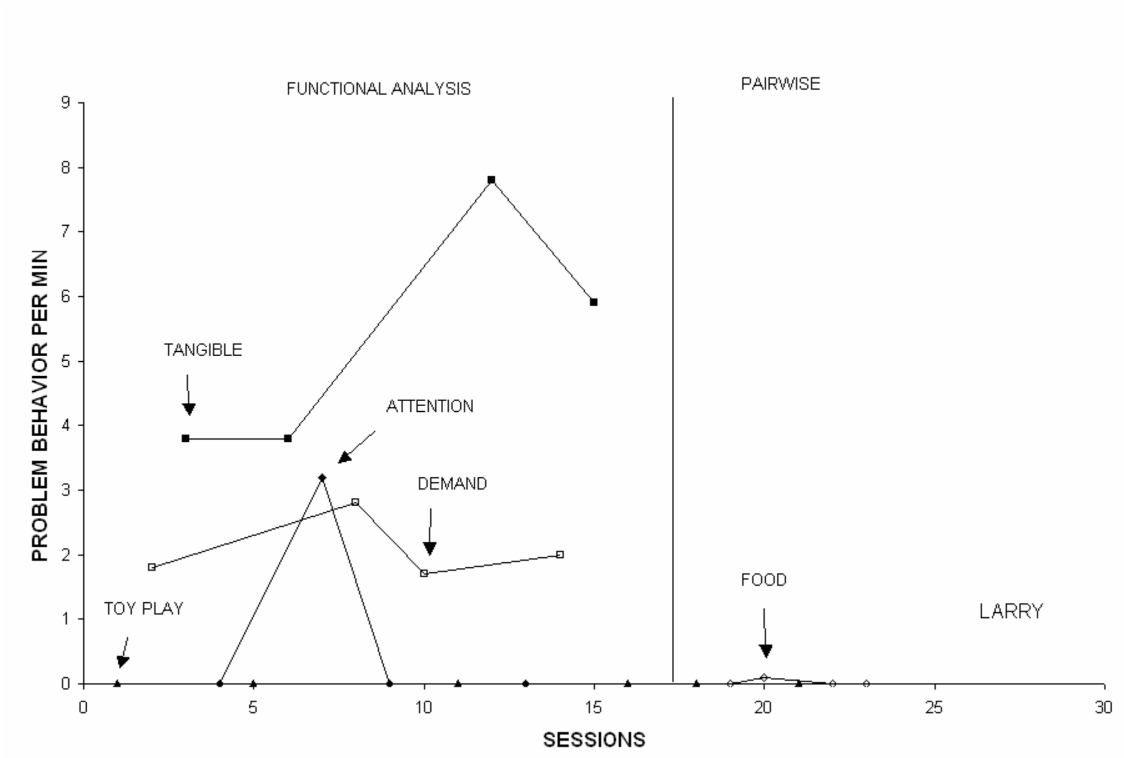

Figure 18. Results of Larry's functional analysis and pairwise comparison.

Figure 19 shows Sam's functional analysis and pairwise comparison. Results of Sam's functional analysis suggested that his problem behavior was maintained by positive reinforcement in the form of access to adult attention and negative reinforcement in the form of escape from demands (social attention, *M* = 2.1 responses per minute; demand, *M* = .9; toy play, *M* = .1; tangibles, *M* = .4). Higher rates of problem behavior began to occur during the last two sessions of the tangible condition. To assess whether behavior may have been maintained by access to toys, a pairwise comparison was conducted with the tangible and toy play conditions. Results of the pairwise assessment indicated that problem behavior was also maintained by positive reinforcement in the form of access to toys (tangibles, *M* = .9; toy play, *M* = 0). A pairwise comparison of the food and toy play conditions was also conducted to evaluate whether problem behavior was maintained by access to food. Results indicated that problem behavior was not maintained by access to food items (food, *M* = 0; toy play, *M* = 0).

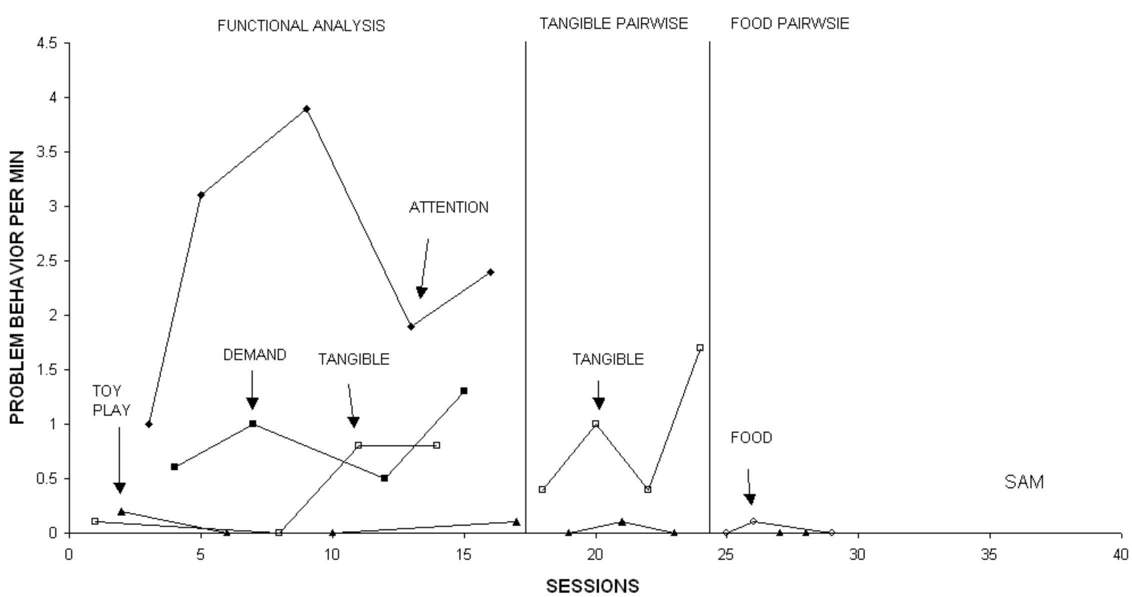

Figure 19. Sam's functional analysis and tangible and food pairwise comparison results.

Results of Mary's assessment procedures are shown in Figure 20. Mary's functional analysis results indicate problem behavior was maintained by negative reinforcement in the form of escape from demands (demands, *M* = 1.9 responses per min; toy play, *M* = 0; attention, *M* = 0, no interaction, *M* = 0). The pairwise comparison of food and toy play conditions suggested problem behavior was not maintained by access to food items (food, *M* = 0 responses per min; toy play, *M* = 0).

Figure 21 shows the results of Scott's functional analysis and pairwise comparison. In the first phase of the functional analysis, Scott displayed the highest rates of problem behavior in the tangible condition, suggesting that problem behavior was maintained by positive reinforcement in the form of access to toys (tangibles, *M* = 1.3; demand, *M* = 0 responses per minute; attention, *M* = 1; toy play, *M* = .2;). Problem behavior also was somewhat elevated during the attention condition, increasing to high levels during the final attention session. Due to the nature of the problem behavior during this session (i.e., severe aggression), additional attention sessions were not conducted. Because parent reports and previous observations in the classroom suggested that problem behavior may have been maintained by escape from demands, additional sessions with demand and toy play conditions were conducted to further evaluate this potential function. Results of the pairwise comparison suggested problem behavior was maintained by negative reinforcement in the form of escape from demands (demand, *M* = 1.9 responses per minute; toy play, *M* = .1). An additional pairwise comparison was conducted with toy play and food conditions following the choice analysis to assess whether problem behavior was maintained by access to food. Results of the pairwise

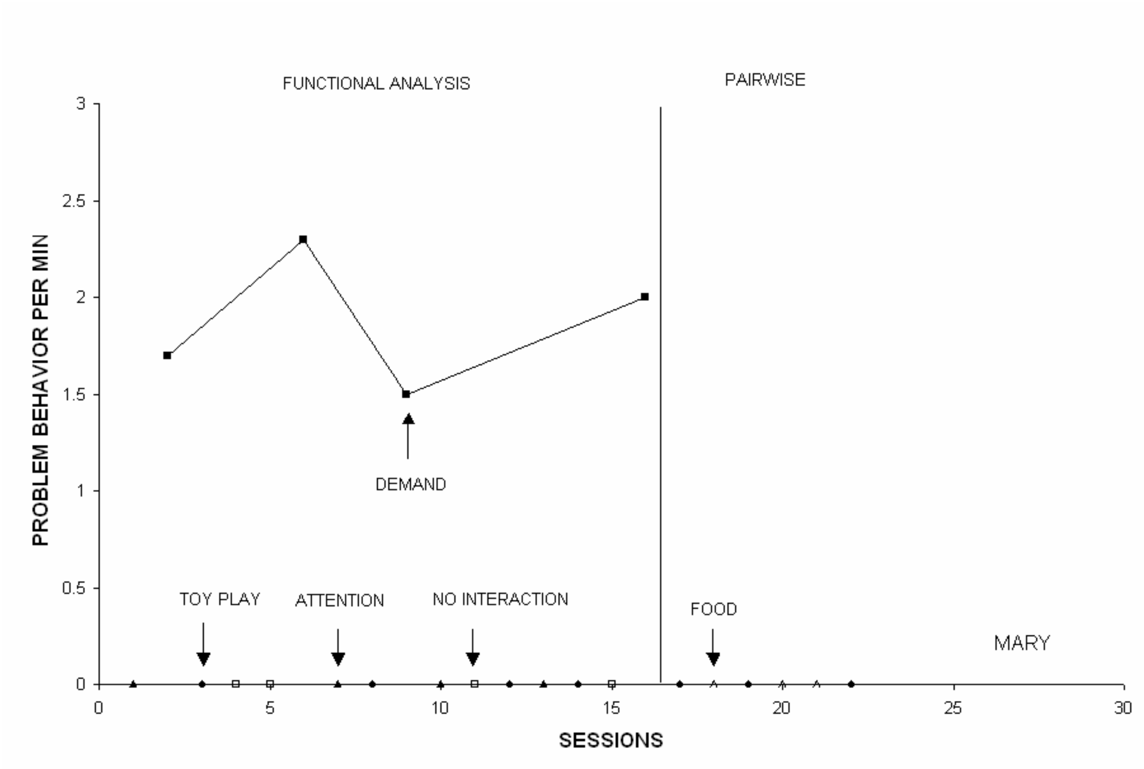

Figure 20. Mary's functional analysis and pairwise comparison results.

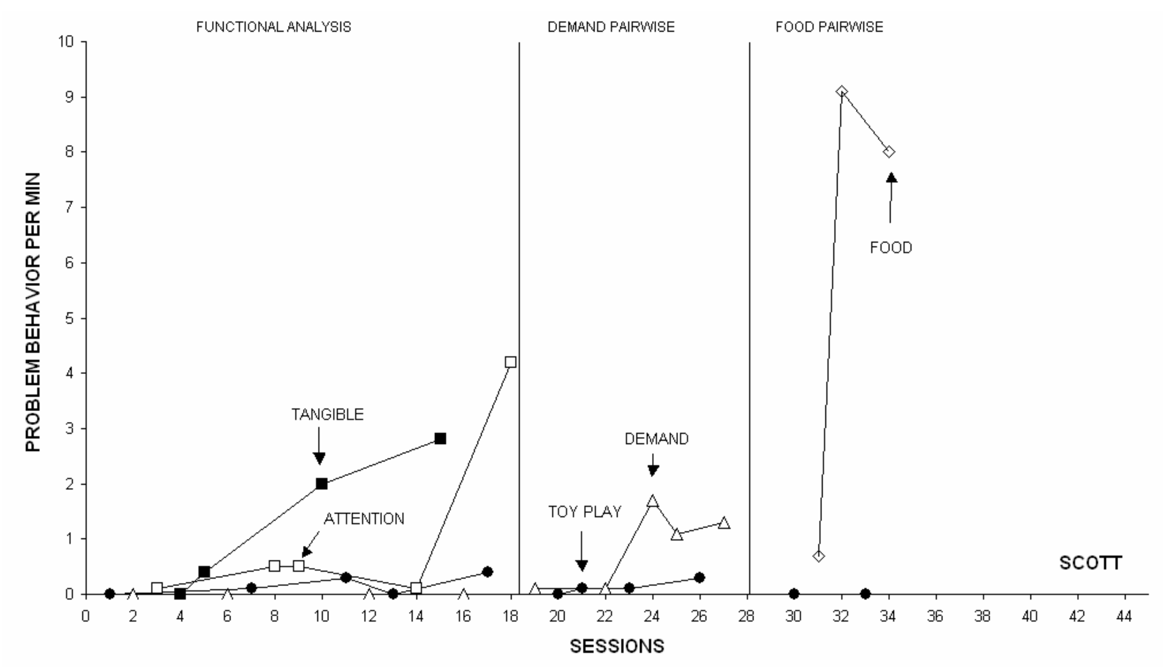

Figure 21. Scott's functional analysis and demand and food pairwise comparison results.

comparison indicated problem behavior was sensitive to food reinforcement (food, *M* = 5.7 responses per minute; toy play, *M* = 0).

Phase 1-3

The primary dependent variable was reinforcer choice, which is depicted for each participant in Figures 22 to 31. Two secondary dependent variables (i.e., problem behavior and compliance) were included because previous research findings indicate that these responses also may be influenced by reinforcement schedule (De Leon et al., 2001). Problem behavior is displayed for each participant in Figures 32 to 40. Compliance is displayed in Figures 41 to 50. The following abbreviations appear in the figures: High (Break) which represents the high preference task where the break was chosen; High (Food) which represents the high preference task where the food was chosen; Low (Break) which represents the low preference task where the break was chosen; Low (Food) which represents the low preference task where the food was chosen; EB represents enriched break; Lo P Food, Med P Food, and Hi P Food represents phases where low preference, medium preference, or high preference food was available, respectively; Hi P Task and Lo P Task represent the high and low preference tasks.

Choice. Figures 22 and 23 show the results of Casey's choice between reinforcers in each phase. Initially, Casey exclusively selected the food over the break under relatively rich schedules of reinforcement (i.e., FR 1, FR 2, and FR 5) in Phase 1 for both the high and low preference tasks (see Figure 22). Preference became somewhat variable under the FR 20 schedule, although Casey continued to show preference for the food item. When the schedule was increased to FR 40, preference became highly variable for both tasks. During a reversal to the FR 2 schedule, preference was less variable than it

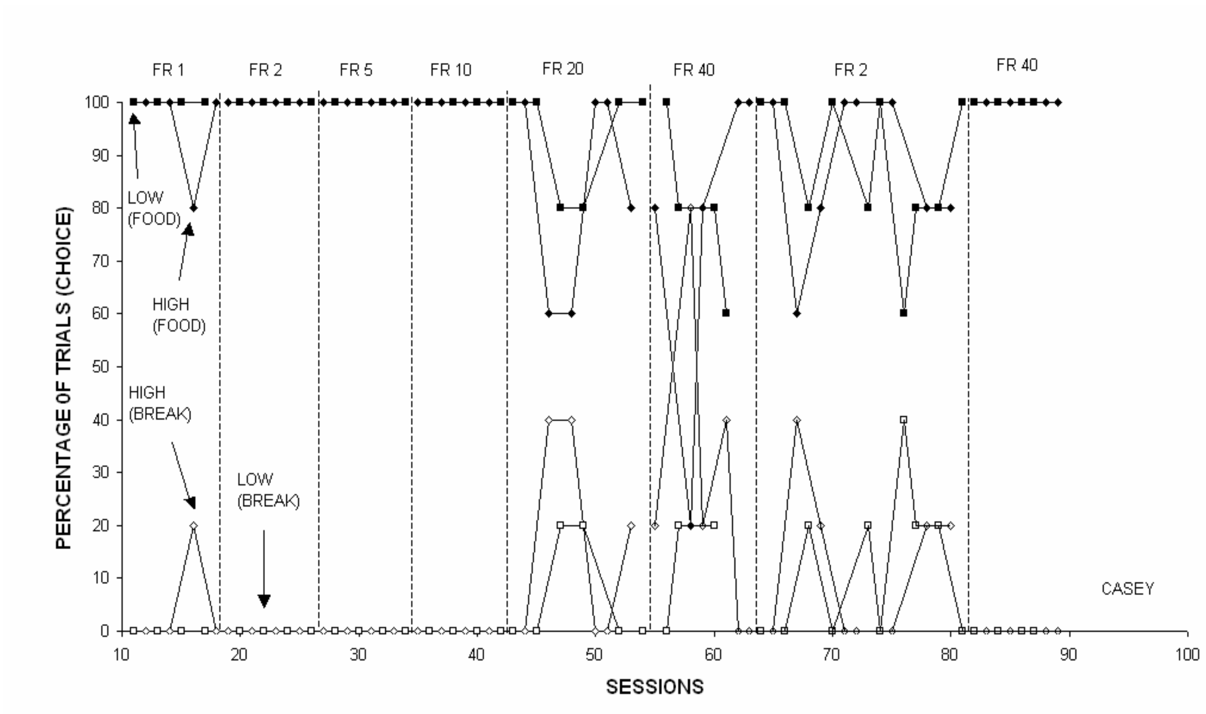

Figure 22. Phase 1 of Casey's choice between reinforcers.

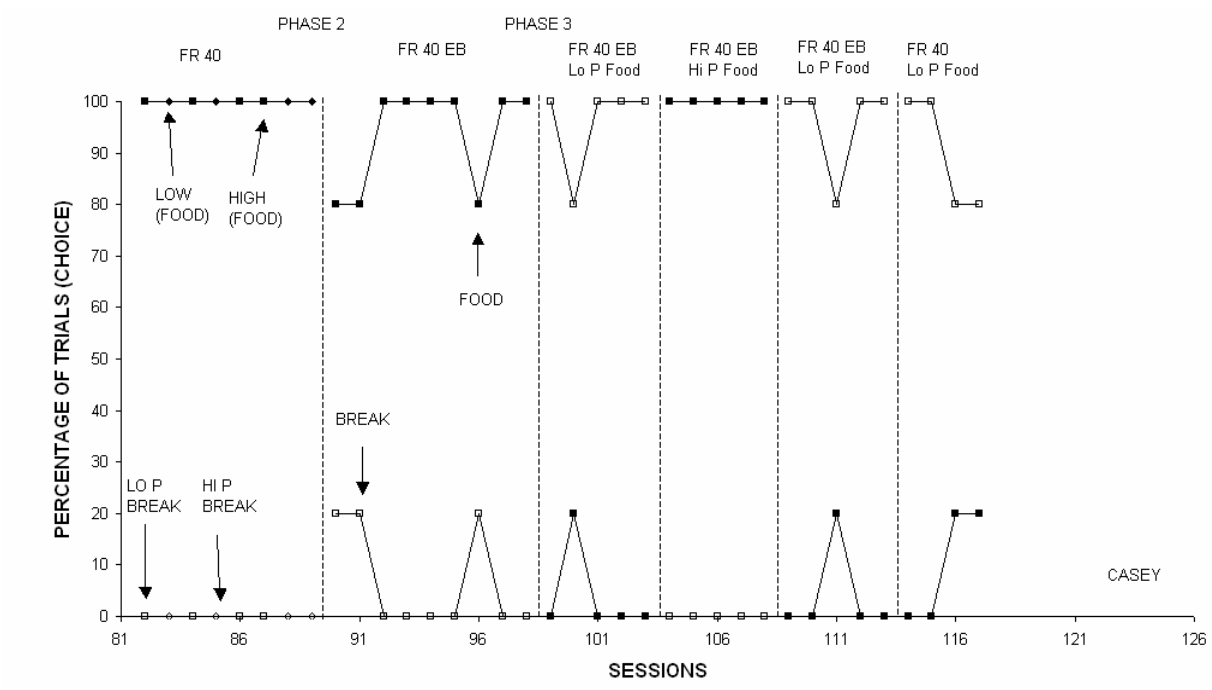

Figure 23. Phase 2 and 3 of Casey's choice between reinforcers.

had been in the previous FR 40 schedule. This schedule was no longer associated with exclusive preference for the food as it had been previously. Interestingly, Casey did select the food item exclusively when the FR 40 schedule was replicated. Thus, overall results suggest that Casey showed a strong preference for the food over the break, even under the highest schedule requirements.

The last FR 40 condition in Phase 1 served as the baseline for Phase 2. When attention and highly preferred toys were added to the break during Phase 2 (i.e., the enriched break), Casey continued to show preference for the food item (see Figure 23). Therefore, it was unnecessary to evaluate the individual components of the enriched break.

The baseline for Phase 3 was the FR 40-enriched break condition conducted during Phase 2. When the enriched break was available concurrently with a lower preference food item (i.e., rice chex). Casey showed a switch in preference to the enriched break (see Figure 23). A reversal back to a choice between the enriched break and the high preference food item under FR 40 resulted in a switch back to preference for the food item. When the lower preference food was re-introduced, preference switched back to the enriched break. Finally, Casey continued to show a preference for the break when the lower preference food and a non-enriched break (i.e., a break only) were available concurrently. Overall, Casey continued to show preference for the food item over the break until a lower preference food item was provided.

Results for Larry are shown in Figures 24 and 25. He showed a clear and stable preference for the food item when working on the high preference task in Phase 1 (see Figure 24). Preference for food was somewhat more variable when Larry was working

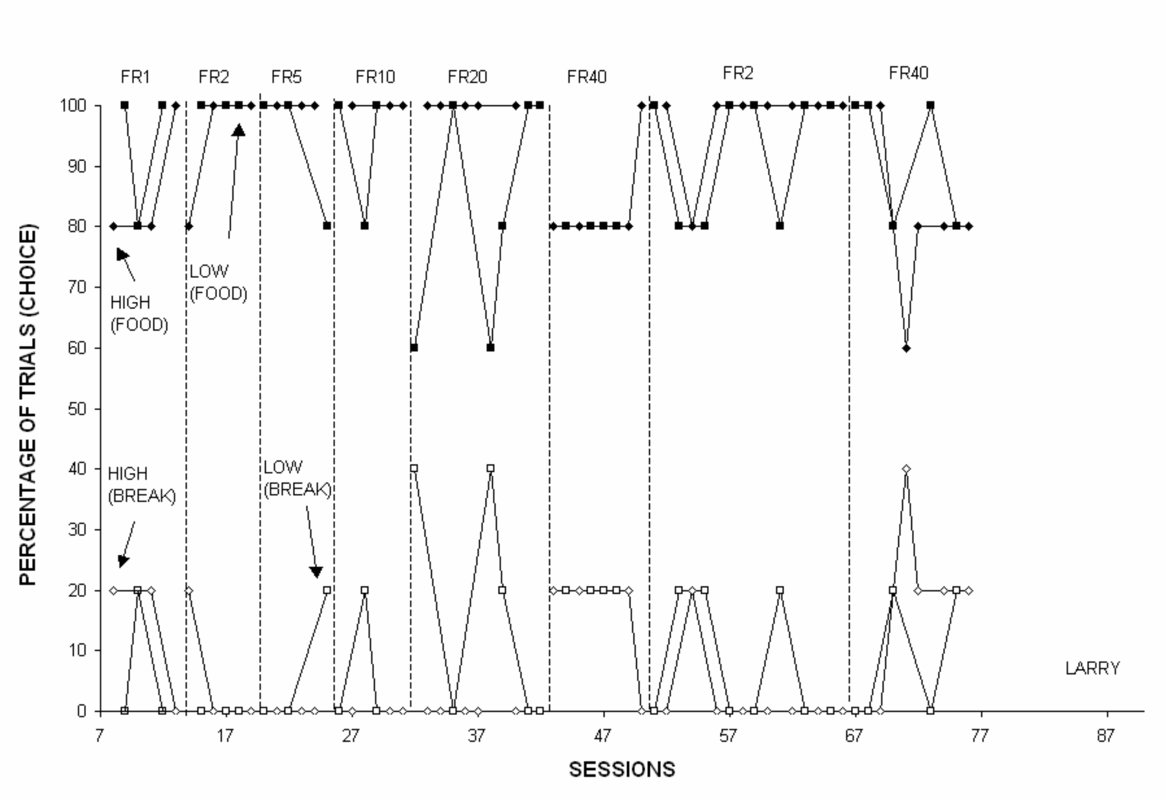

Figure 24. Phase 1 of Larry's choice between reinforcers.

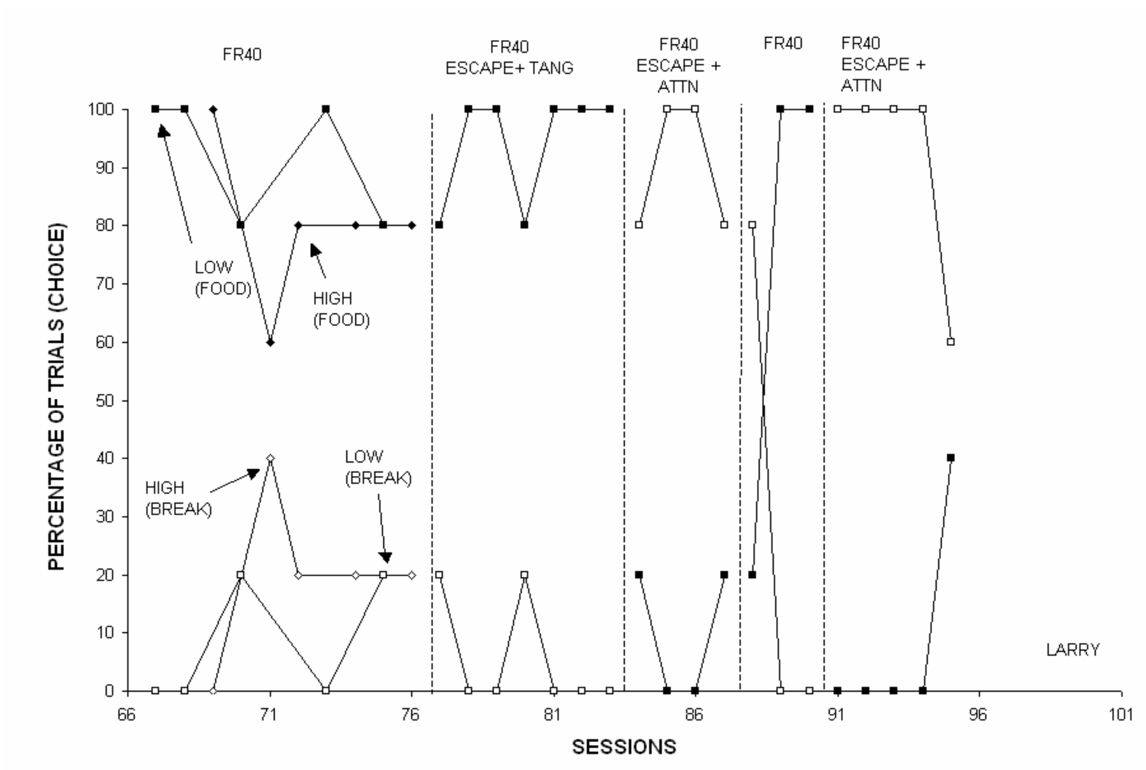

Figure 25. Phase 2 of Larry's choice between reinforcers.

on the low preference task. When the schedule was increased to FR 40, Larry continued to show preference for the food; however, choices were similar under both the high and low preference tasks. Although choice was more variable under the final FR 40 condition, Larry continued to show preference for the food item over the break.

When highly preferred tangibles (i.e., toys) were added to the break, Larry continued to show preference for the food (see Figure 25). When attention only was added to the break, Larry showed a preference for the break over the food. Following a reversal to the break only (i.e., no toys or attention were added), Larry switched back to choosing the food over the break, as in the previous FR 40 baseline. When the break plus attention was replicated, preference switched back to the break, replicating the previous break plus attention phase. To summarize, Larry preferred the food item to the break under thin schedules of reinforcement unless attention was delivered during the break.

Sam's choice data are shown in Figures 26 and 27. Sam showed a clear preference for the food item over the break until the schedule reached FR 20 in Phase 1 (see Figure 26). Under the FR 20 schedule, preference was variable and unstable. During several sessions, Sam preferred the break to the food item. After the reversal to the FR 2 schedule, Sam showed a preference for the food item to the break; however, he chose the break more often than he had under the initial FR 2 schedule. When the schedule was again increased to FR 20, preference was less variable than in the previous FR 20 phase, and Sam continued to prefer the food item to the break. Thus, the change in preference under the previous FR 20 schedule was not replicated. In fact, preference for the food item maintained even when the schedule was increased to FR 40.

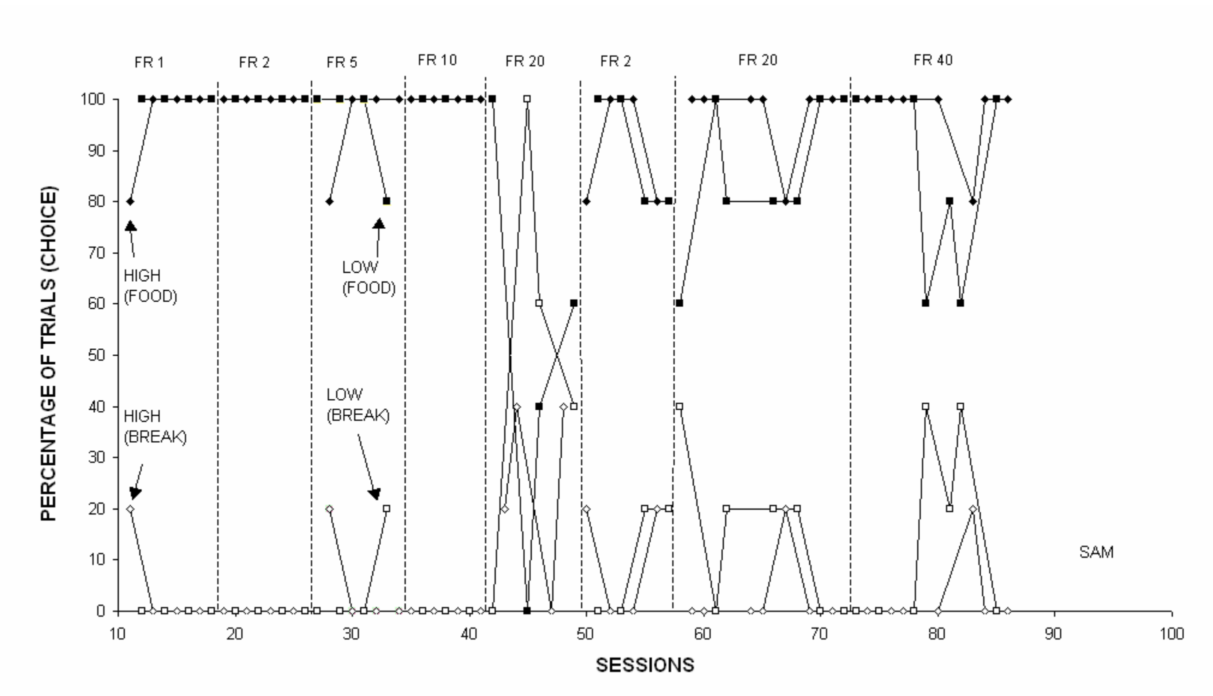

Figure 26. Phase 1 of Sam's choice between reinforcers.

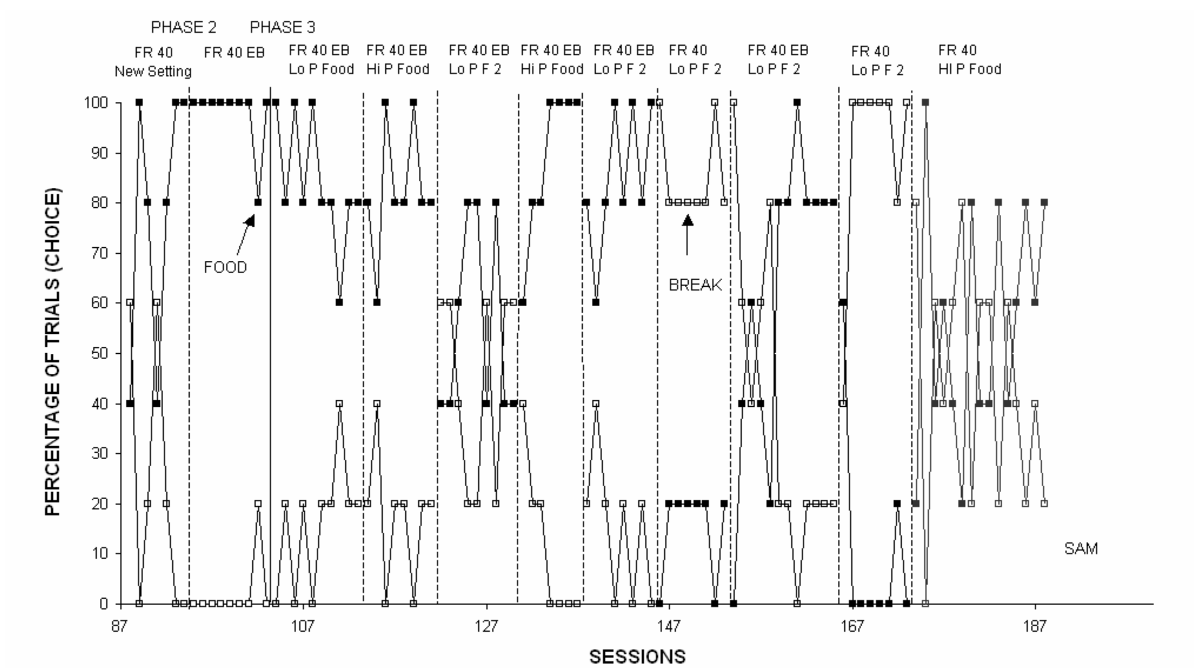

Figure 27. Phase 2 and 3 of Sam's choice between reinforcers.

Sam's choices for the food versus the break under FR 40 were somewhat more variable when this condition was conducted in a new setting as the baseline for Phase 2 (see Figure 27). However, he showed a consistent preference for the food item when he could choose between the food and an enriched break. The last condition in Phase 2, which indicated that Sam preferred the food item to the enriched break, served as a baseline for Phase 3. When the first low preference food item was introduced (i.e., ranch flavored Pringles) during Phase 3, preference was more variable than it had been during baseline (see Figure 27). However, Sam continued to show preference for the food item. This preference for the food remained during a reversal to the choice between the high preference food item and enriched break. When the second low preference food item (i.e., dried apple) was introduced into the evaluation, preference became more variable. Sam chose the enriched break more than the food item during some of the sessions. A reversal back to the high preference food item was associated with an increase in preference for food, which was chosen on 100% of the trials across the last four sessions. Nonetheless, Sam continued to choose the food over the enriched break when the second low preference food was re-introduced.

Anecdotal observations suggested that the enriched break may have acquired some aversive properties for Sam. He began to push the toys away and would not talk with the therapist during the break. Preference for the low preference food item versus a non-enriched break then was conducted to evaluate this hypothesis. Sam immediately showed a change in preference from the food item to the non-enriched break. A reversal to the low preference food item and enriched break resulted in a change in preference to the food item. When choice between the non-enriched break and low preference food was re-introduced, results replicated the previous similar phase. Finally, choice between the non-enriched break and high preference food was re-introduced. Sam did not show a consistent preference for either the high preference food or the break until the last few sessions, during which he chose the food somewhat more than the break.

Overall, Sam preferred the high preference food item to the break, regardless of the schedule requirement or preference level of the task. He also showed a preference for the low preference food item to the break if attention and tangibles were delivered during the break. However, he preferred the non-enriched break to the low preference food item.

Figures 28 and 29 show the results of Mary’s choice between reinforcers in each phase. Mary consistently showed a clear preference for the food item over the break regardless of the schedule of reinforcement in Phase 1 (see Figure 28). She selected the food on nearly 100% of trials during both the high and low preference tasks. Mary’s preference for the food persisted even when the enriched break was introduced and the schedule was increased from FR 20 to FR 40 in Phase 2 (see Figure 29). When Mary could choose between a low preference food (i.e., strawberry juice) and the enriched break under FR 10, she initially began to choose the break over the food on some trials (see Figure 29). However, exclusive preference for the food returned after the fifth session and maintained throughout the rest of the phase, despite the increase in schedule to FR 40. Overall, the preference level of the task, the schedule of reinforcement, the quality of the break, and the quality of the food item did not influence Mary’s preference for the food item.

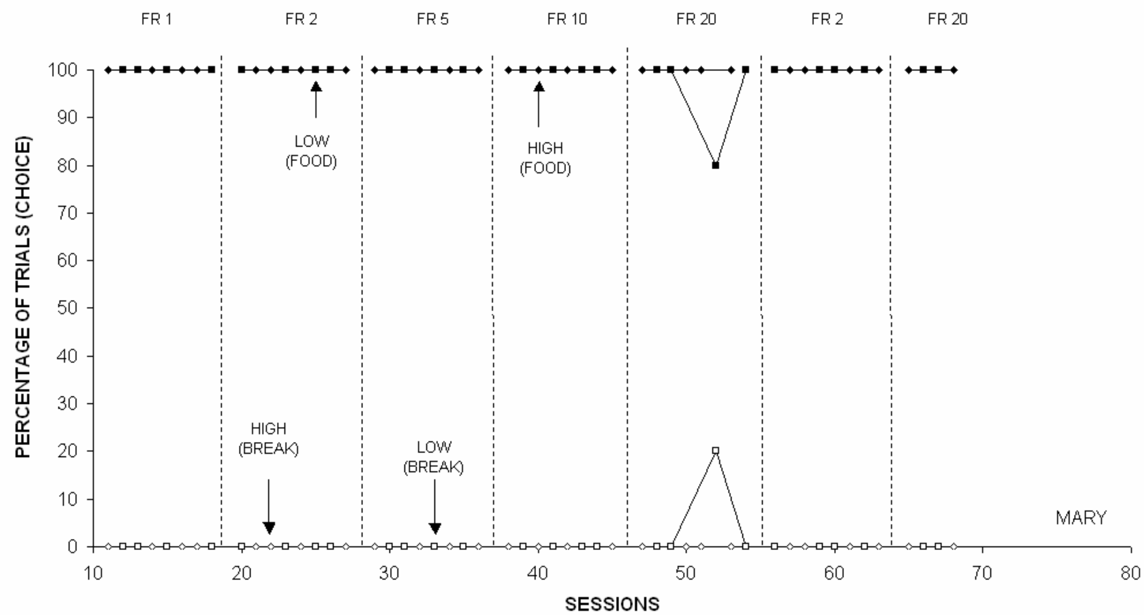

Figure 28. Phase 1 of Mary's choice between reinforcers.

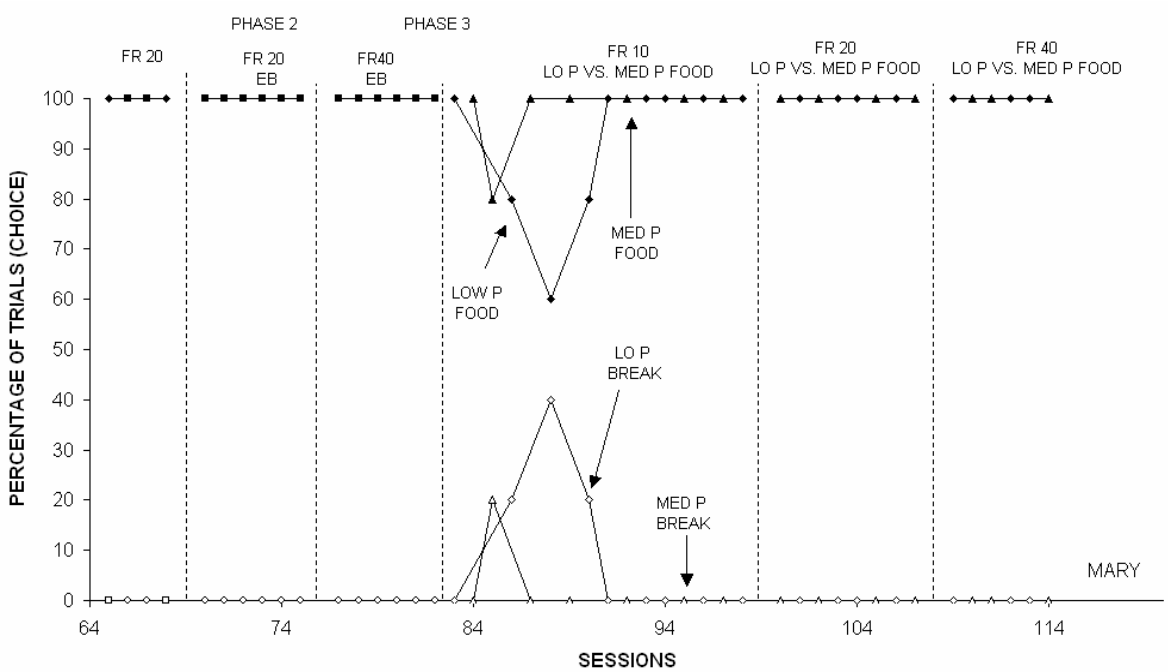

Figure 29. Phase 2 and 3 of Mary's choice between reinforcers.

Figures 30 and 31 show Scott's choice data. During Phase 1, Scott's preference for the food over the break was initially somewhat variable, but he consistently chose the food as the schedule was increased to FR 20 (see Figure 30). Preference became highly variable when the schedule was increased to FR 40. Although Scott chose the food item more than the break in the majority of sessions, he showed exclusive preference for the break during some of the sessions. Similar results were obtained for both the high and low preference tasks. This variability in choice initially persisted when the FR 2 schedule was reintroduced, but Scott showed exclusive preference for the food item across numerous consecutive sessions. During this phase, preference became variable again but did not switch over from the food to the break as often as in the previous FR 40 schedule. Prior to the re-introduction of the FR 40, Scott showed exclusive preference for the food. When the FR 40 schedule was replicated, preference was highly variable. He showed exclusive preference for either the food or the break during most sessions.

A relatively rich schedule (FR 5) was chosen as the baseline schedule for Phase 2 because preference was somewhat variable even under rich schedules of reinforcement (e.g., the replication of FR 2). Scott showed a preference for the food over the non-enriched break during baseline (see Figure 31). When the enriched break was introduced, Scott continued to show preference for the food even though choices were somewhat more variable than in baseline. The schedule was increased to FR 10 and 20 to evaluate whether preference would switch from the food to the enriched break under thinner schedules of reinforcement. Scott continued to choose the food over the break. When the low preference food item was introduced during Phase 3, preference switched from the food to the enriched break (see Figure 31). A reversal to the choice between a high

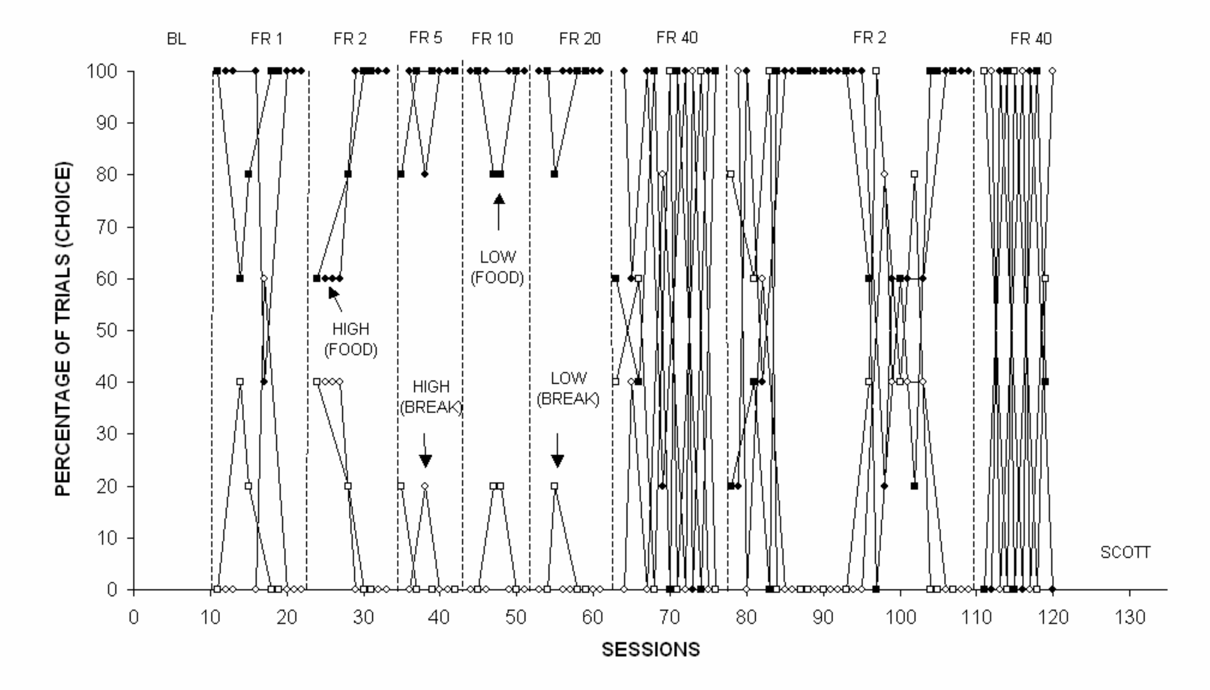

Figure 30. Phase 1 of Scott's choice between reinforcers.

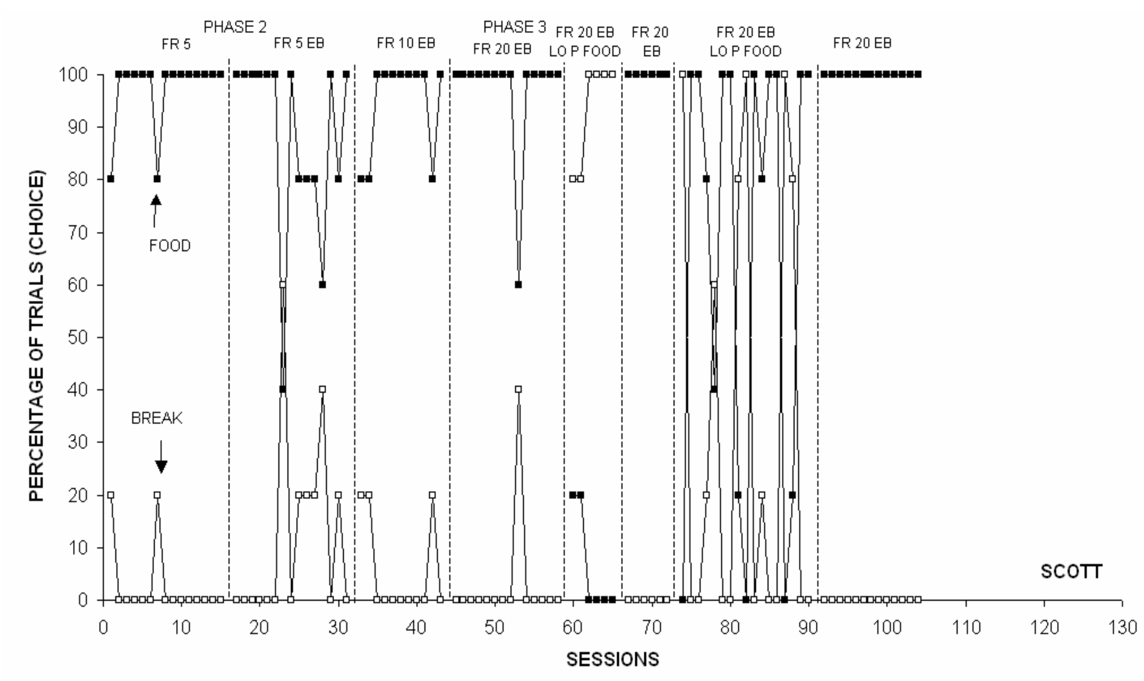

Figure 31. Phase 2 and 3 of Scott's choice between reinforcers.

preference food item and enriched break resulted in exclusive preference for food. When the low preference food item was re-introduced, Scott's choices were highly variable. He showed exclusive preference for the break in some sessions although he chose the food item more than the break in the majority of sessions. In the final phase, Scott showed exclusive preference for the food item over the enriched break when the high preference food was again introduced. To summarize, Scott showed a clear preference for the food item until the schedule reached FR 40 in Phase 1. Furthermore, he did not show a preference for the break when the enriched break was implemented. In Phase 3, he chose the break more often when the low preference food was substituted for the high preference food.

Problem Behavior. Figures 32 and 33 show Casey's rate of problem behavior during each phase. Casey did not engage in any problem behavior during baseline sessions (no reinforcement) in Phase 1 (see Figure 32). Casey's problem behavior remained relatively low under rich schedules of reinforcement (i.e., FR 1, FR 2, and FR 5) for both the high and low preference task during Phase 1. When the schedule reached FR 20 and FR 40, problem behavior occurred more frequently during both tasks. The reversal to the FR 2 schedule resulted in near zero rates of problem behavior for both high and low preference tasks. When the FR 40 schedule was replicated, rates of problem behavior were variable but not as high as during the previous FR 40 schedule. However, problem behavior increased and was variable when tangibles and toys were added to the break during the enriched FR 40 schedule and when the low preference food was introduced in Phase 3 (see Figure 33). Problem behavior remained variable during all conditions in Phase 3. Overall, Casey engaged in higher rates of problem behavior

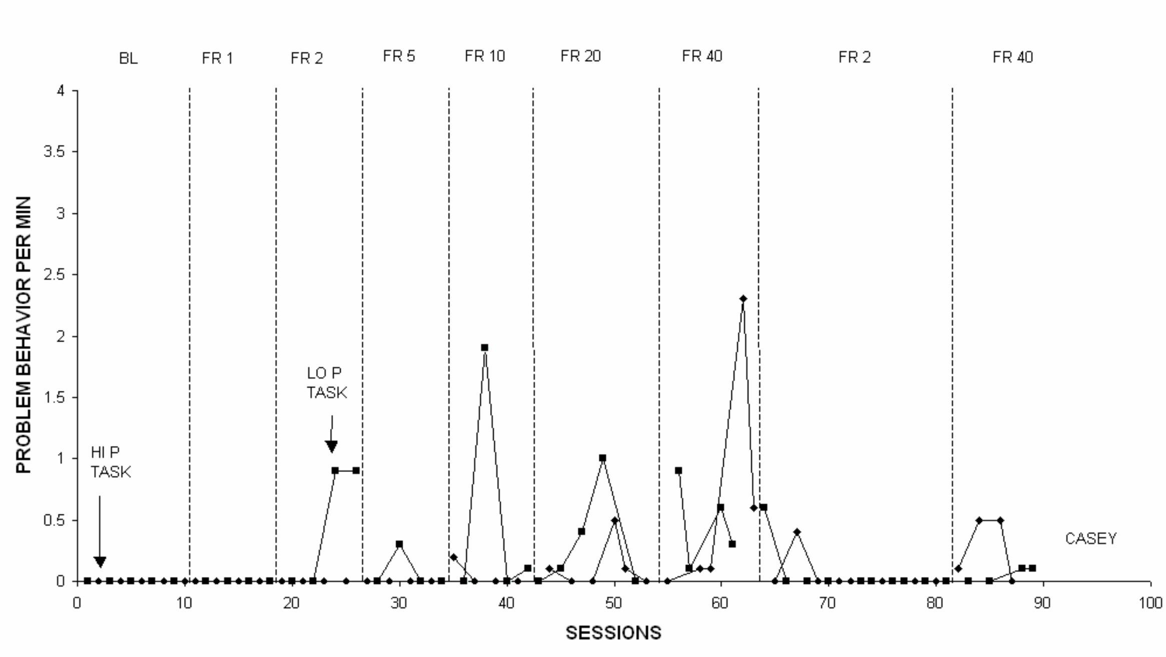

Figure 32. Casey's rate of problem behavior during Phase 1.

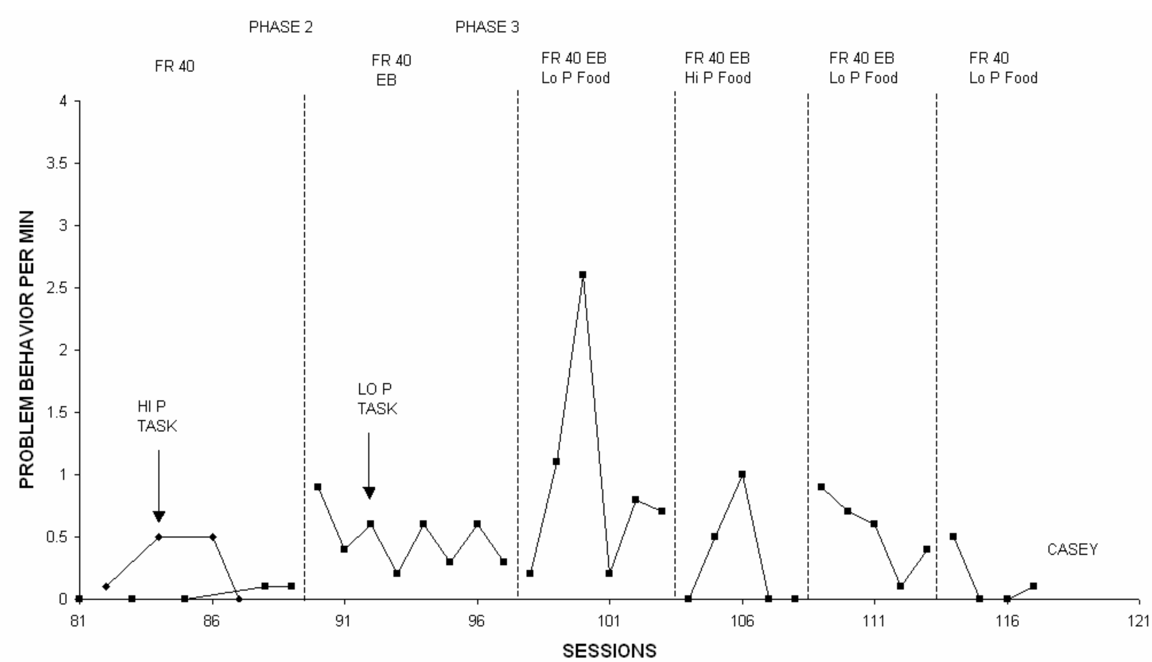

Figure 33. Casey's rate of problem behavior during Phase 2 and 3.

under thin schedules of reinforcement, although rates of problem behavior were variable both within and across conditions.

Larry's problem behavior is shown in Figures 34 and 35. Larry engaged in high rates of problem behavior when working on the low preference task during baseline sessions (no reinforcement) in Phase 1 (see Figure 34). Problem behavior did not occur during the high preference task. Following baseline, Larry occasionally engaged in high rates of problem behavior, but relatively little problem behavior occurred after the schedule was increased beyond FR 5. He displayed near zero rates of problem behavior during all conditions in Phase 2 (see Figure 35).

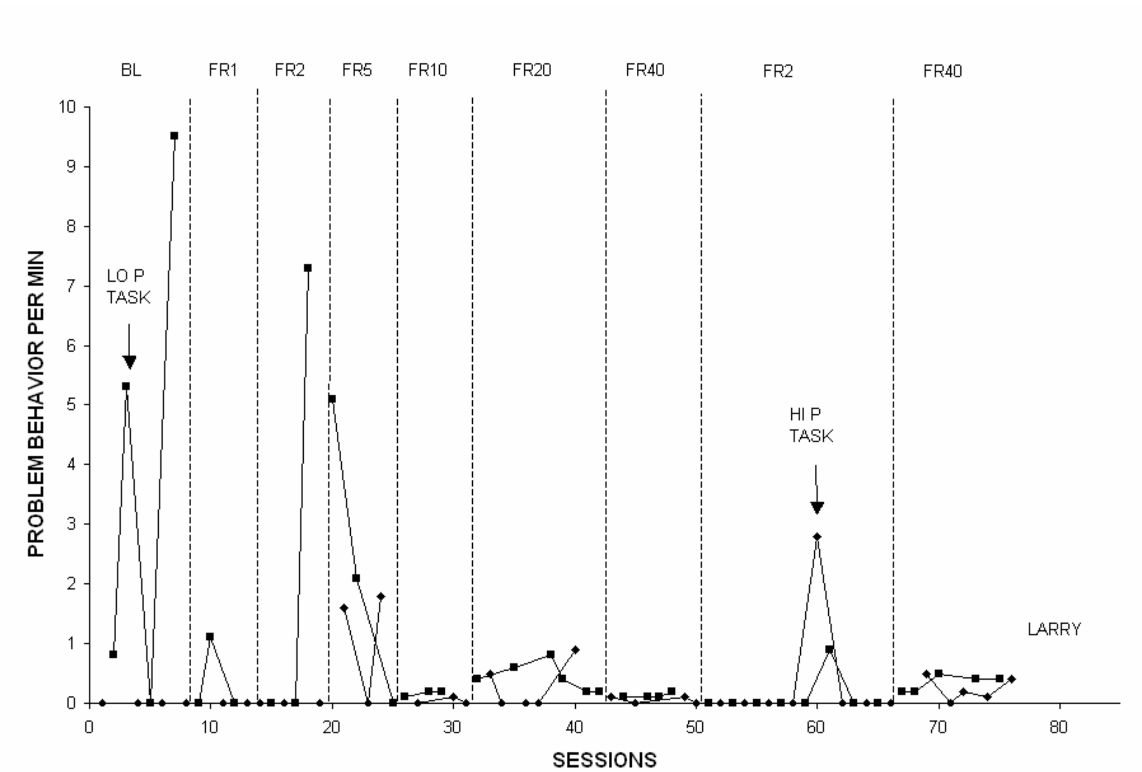

Figure 34. Larry's rate of problem behavior during Phase 1.

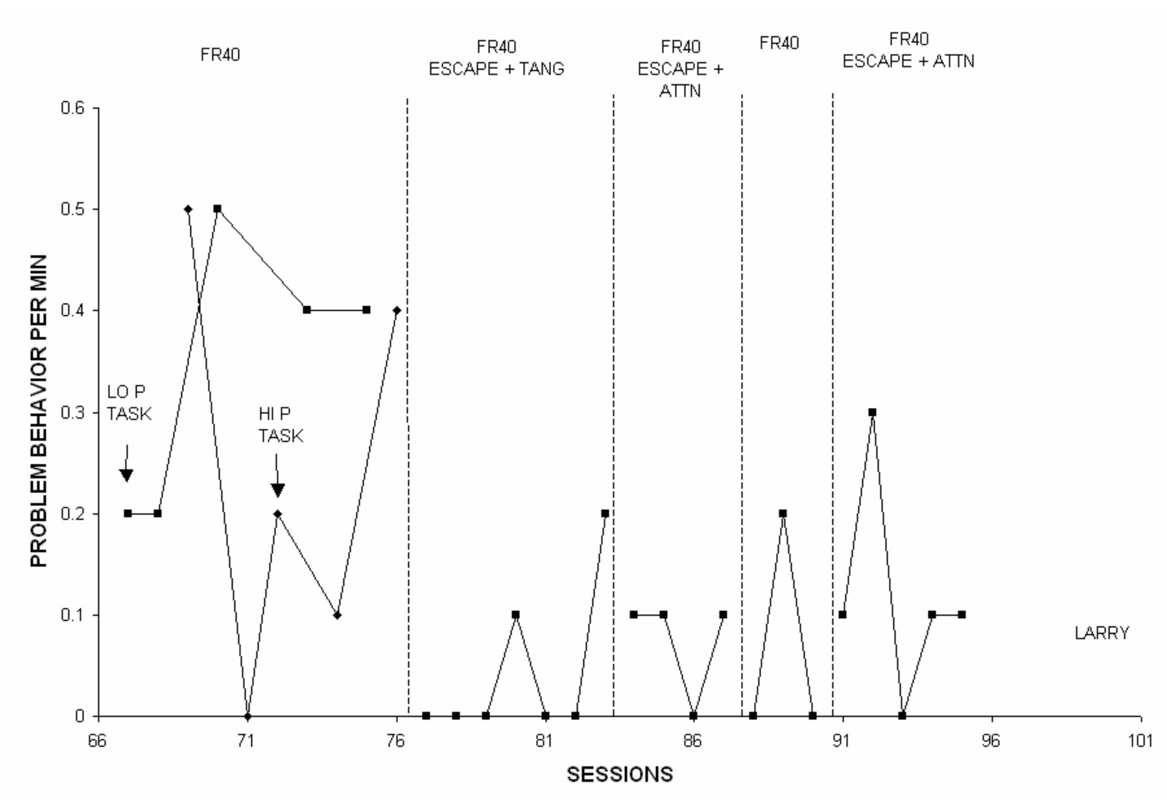

Figure 35. Larry's rate of problem behavior during Phase 2.

Figures 36 and 37 show Sam's rate of problem behavior during each phase. For Sam, no problem behavior occurred during the baseline (no reinforcement) or FR 1 schedule in Phase 1 (see Figure 36). However, when the schedule was increased to FR 2, problem behavior increased during both the high and low preference tasks. The frequency of his behavior generally decreased across the remaining conditions of Phase 1 and was slightly higher during the low preference task than during the high preference task under both the FR 10 and FR 20 schedules. After the reversal to FR 2 and re-introduction of FR 20, problem behavior increased and was variable during the low preference task while remaining low during the high preference task. When the schedule was increased to FR 40, problem behavior was variable and occurred more often during

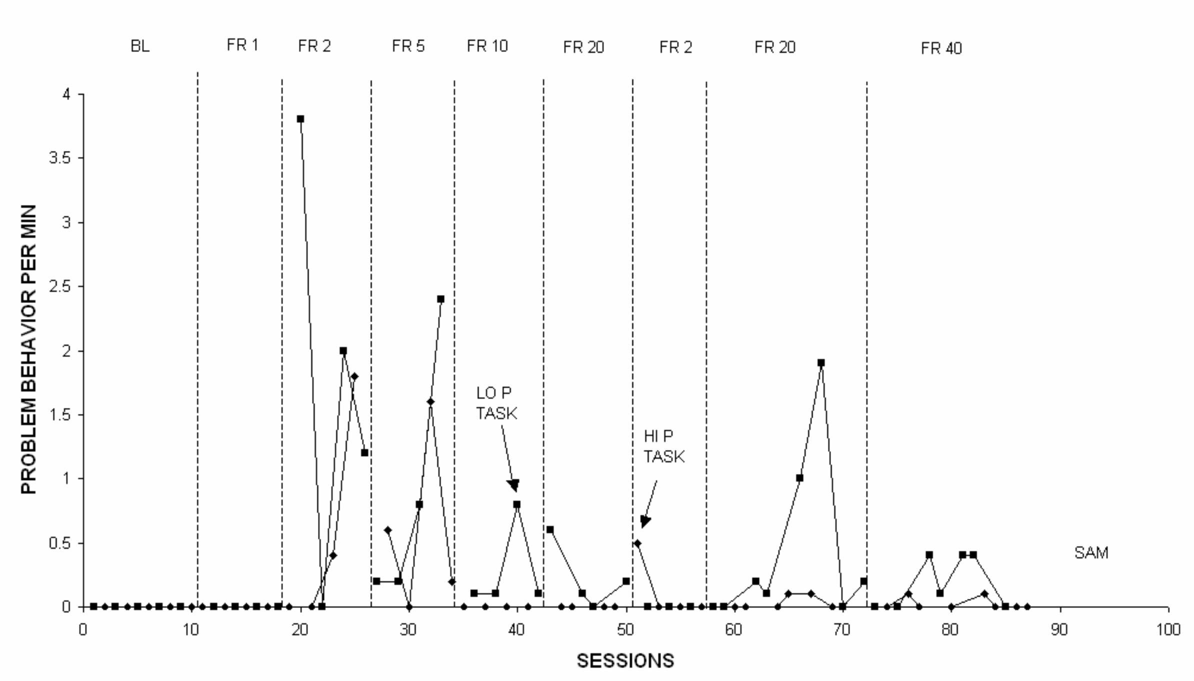

Figure 36. Sam's rate of problem behavior during Phase 1.

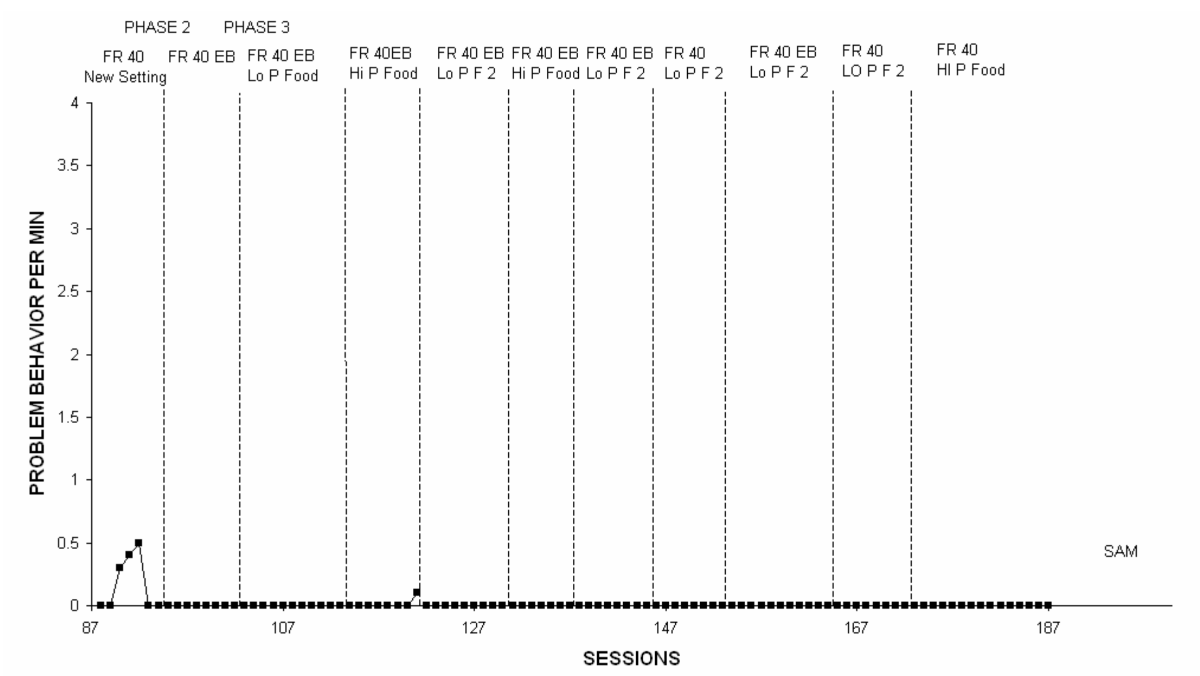

Figure 37. Sam's rate of problem behavior during Phase 2 and 3.

the low preference task. Very little problem behavior occurred during any of the conditions in Phases 2 or 3 (see Figure 37).

Figure 38 shows Mary's rate of problem behavior during each phase. Mary did not engage in any targeted problem behaviors during Phase 1 (see Figure 38). However, towards the end of the FR 5 schedule, Mary began engaging in a non-target problem behavior that had not occurred during the functional analysis, baseline, or previous sessions in Phase 1, and no data were collected on this behavior prior to FR 20. Mary began biting on the objects required to complete the task. For example, during bead stringing, which was the high preference task, Mary would place the foam bead in her mouth and bite down on it instead of stringing the bead. Object biting did not occur following the reversal to the FR 2 schedule and occurred occasionally during the replication of FR 20. Mary did not exhibit any problem behavior during Phase 2 and 3.

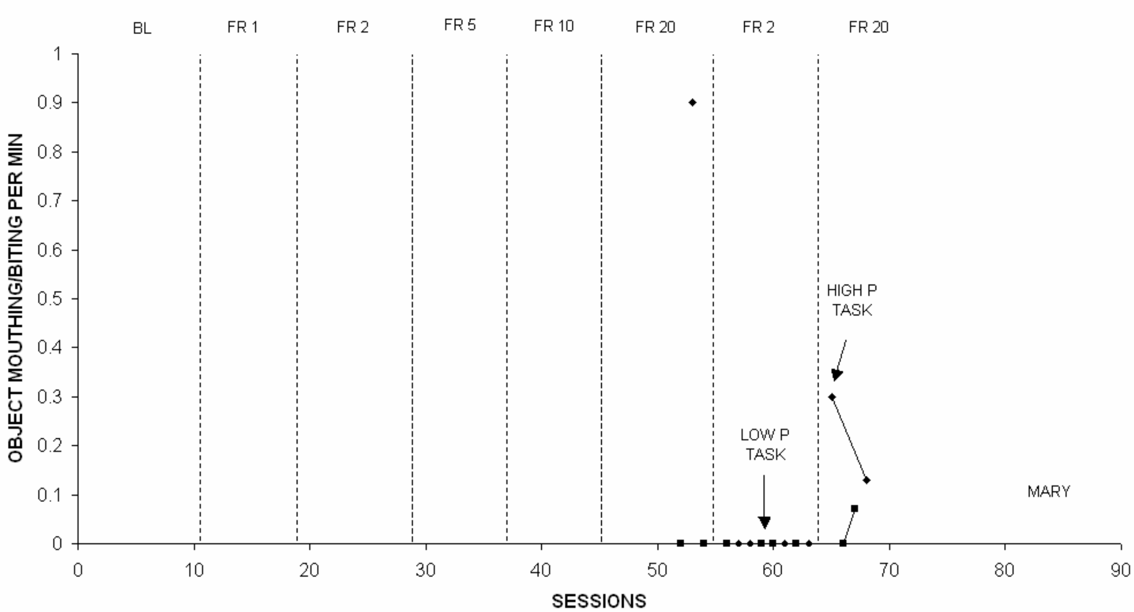

Figure 38. Mary's rate of problem behavior during Phase 1.

Figures 39 and 40 show Scott's rate of problem behavior during each phase. Scott displayed high rates of problem behavior during baseline, with higher rates of problem behavior occurring during the low preference task (see Figure 39). Problem behavior rapidly decreased once the FR 1 schedule was introduced, with occasional bursts of problem behavior under the FR 20 and FR 40 schedules. Problem behavior occurred during both the high and low preference tasks. During Phase 2 and 3, Scott sporadically exhibited low levels of problem behavior across conditions and phases (see Figure 40).

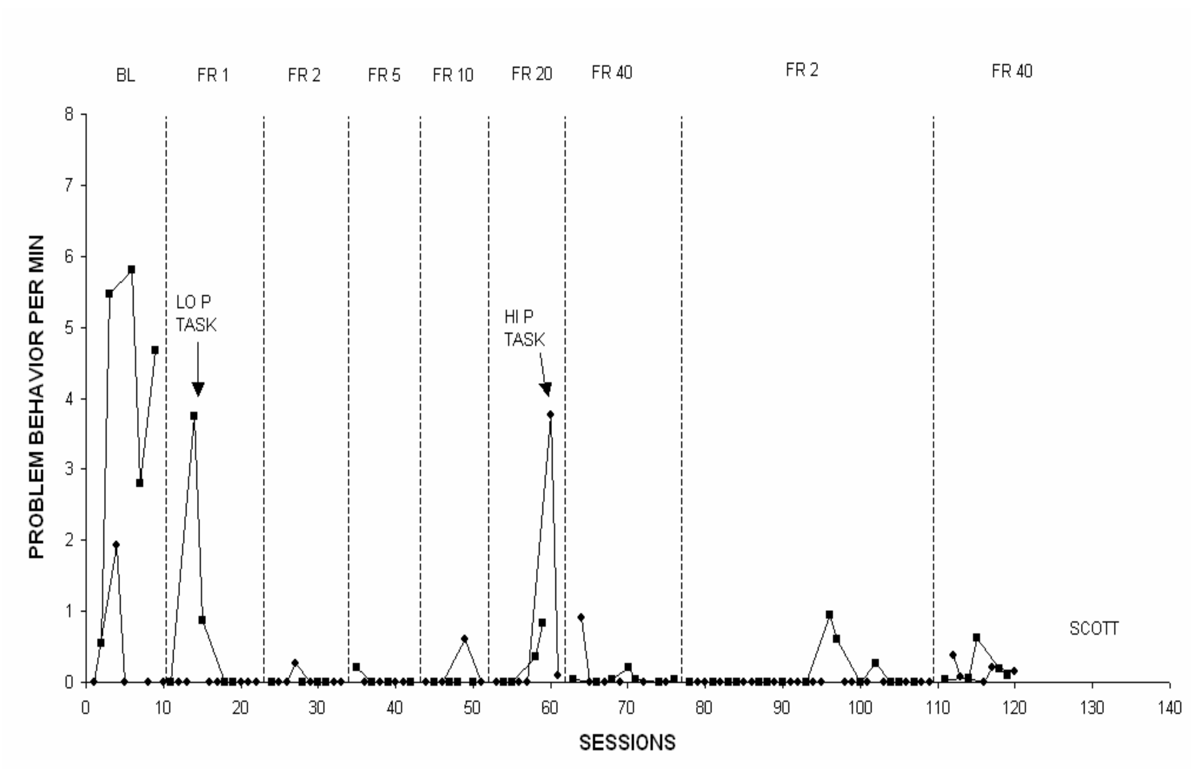

Figure 39. Scott's rate of problem behavior during Phase 1.

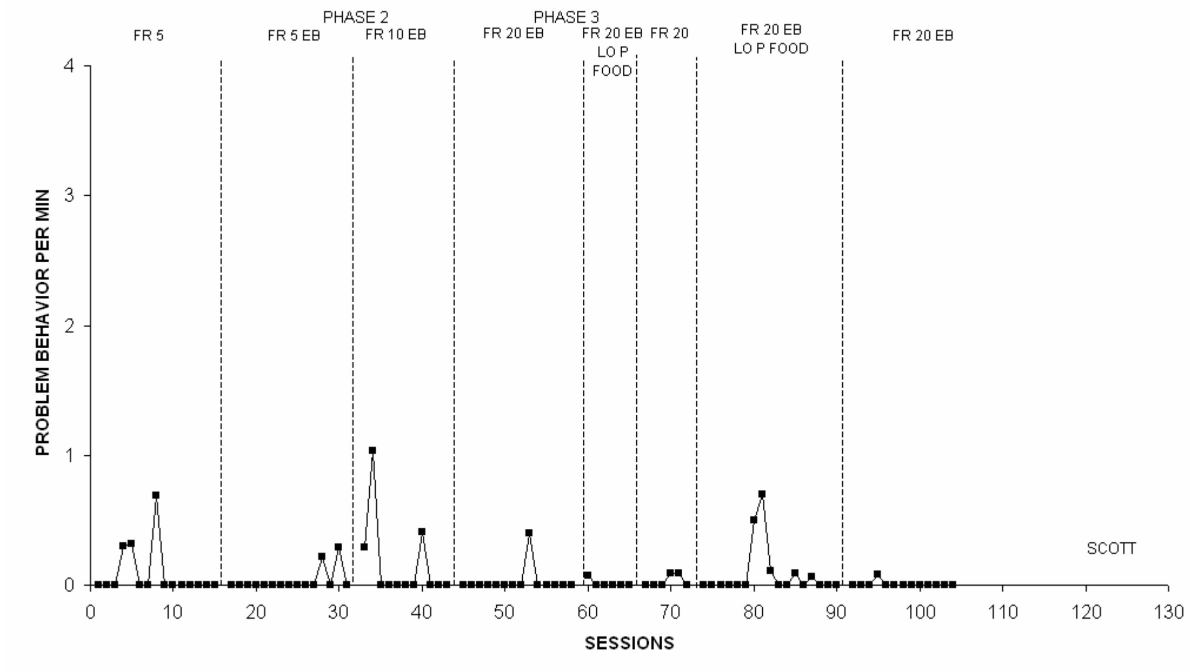

Figure 40. Scott’s rate of problem behavior during Phase 2 and 3.

To summarize, four participants had relatively low levels of problem behavior throughout the study following an initial decrease in behavior with the introduction of reinforcement in Phase 1. One participant (Casey) exhibited higher rates of problem behavior under thin schedules of reinforcement during all phases even though the behavior was on extinction.

Compliance. Figures 41 and 42 show Casey’s level of compliance during each phase. Casey complied to nearly 100% of the demands under both high and low preference tasks; however, compliance was slightly lower under the relatively thin reinforcement schedules (i.e., FR 20 and FR 40) during Phase 1 (see Figure 41). Compliance remained high throughout all of Phase 2 and 3 (see Figure 42).

Larry’s compliance is depicted in Figures 43 and 44. Larry had high but variable levels of compliance in baseline (no reinforcement) (see Figure 43). He complied with

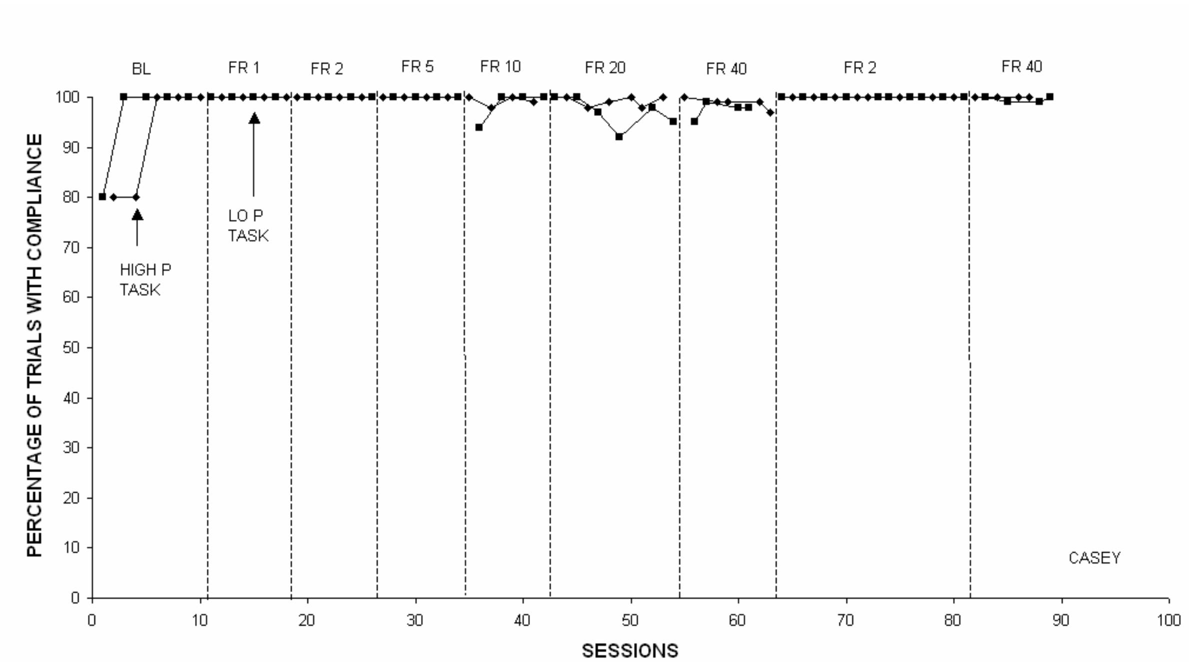

Figure 41. Casey's percentage of trials with compliance during Phase 1.

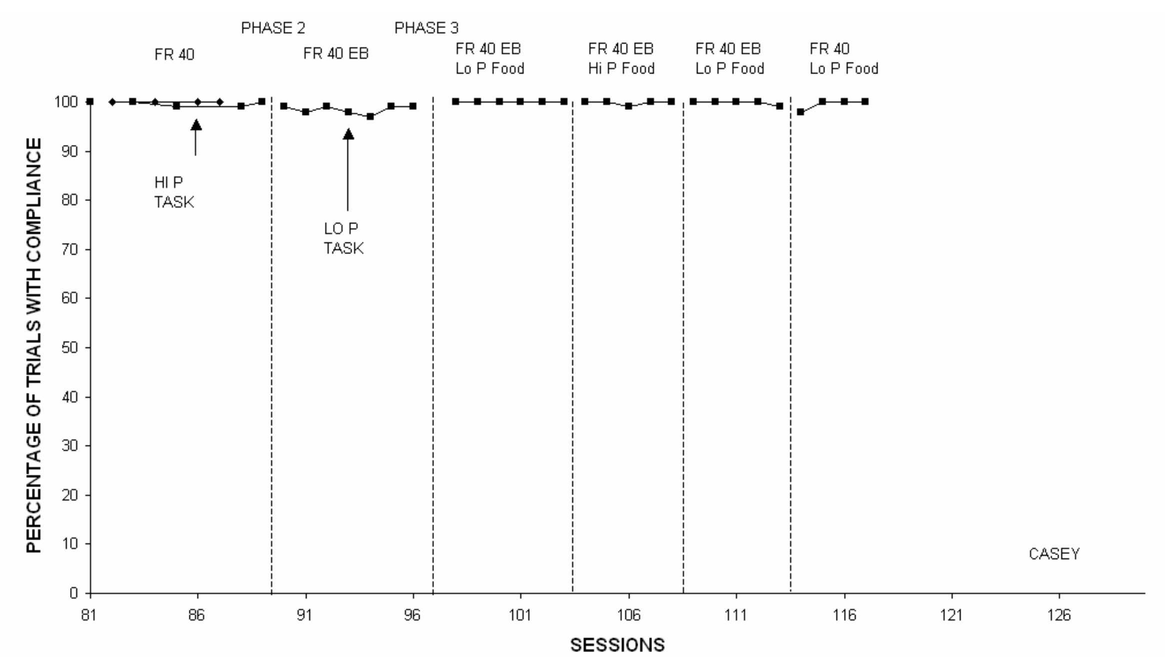

Figure 42. Casey's percentage of trials with compliance during Phase 2 and 3.

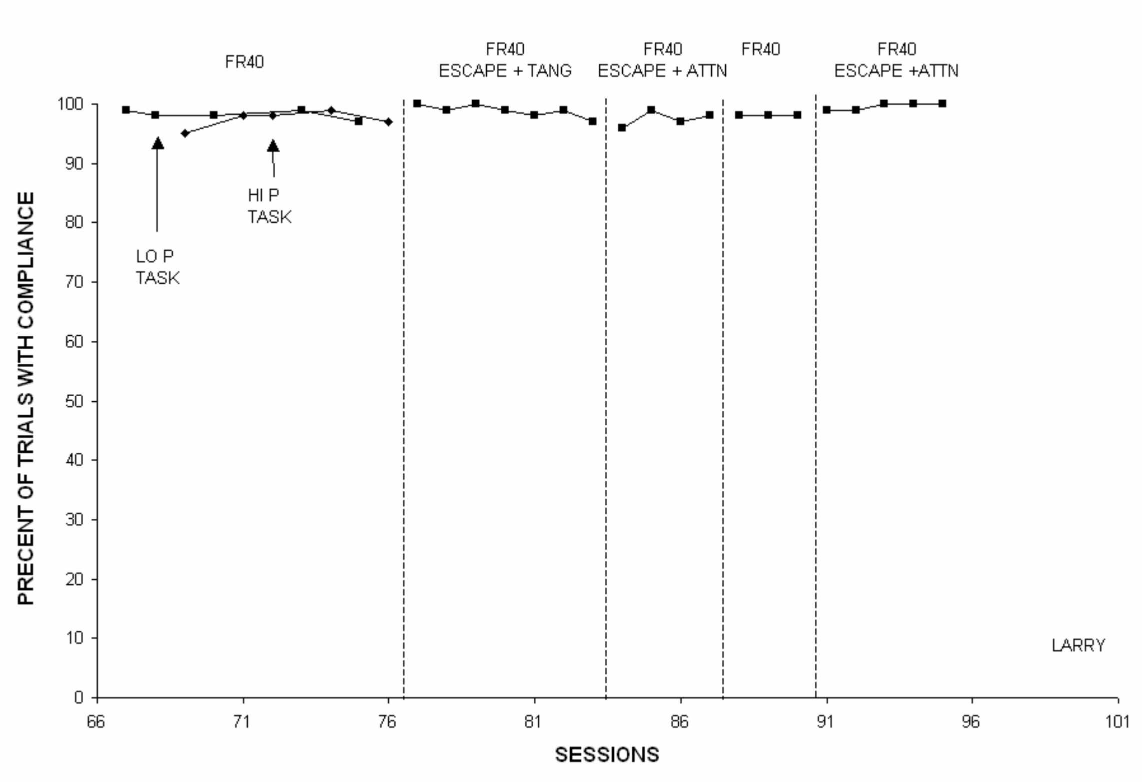

Figure 43. Larry's percentage of trials with compliance during Phase 1.

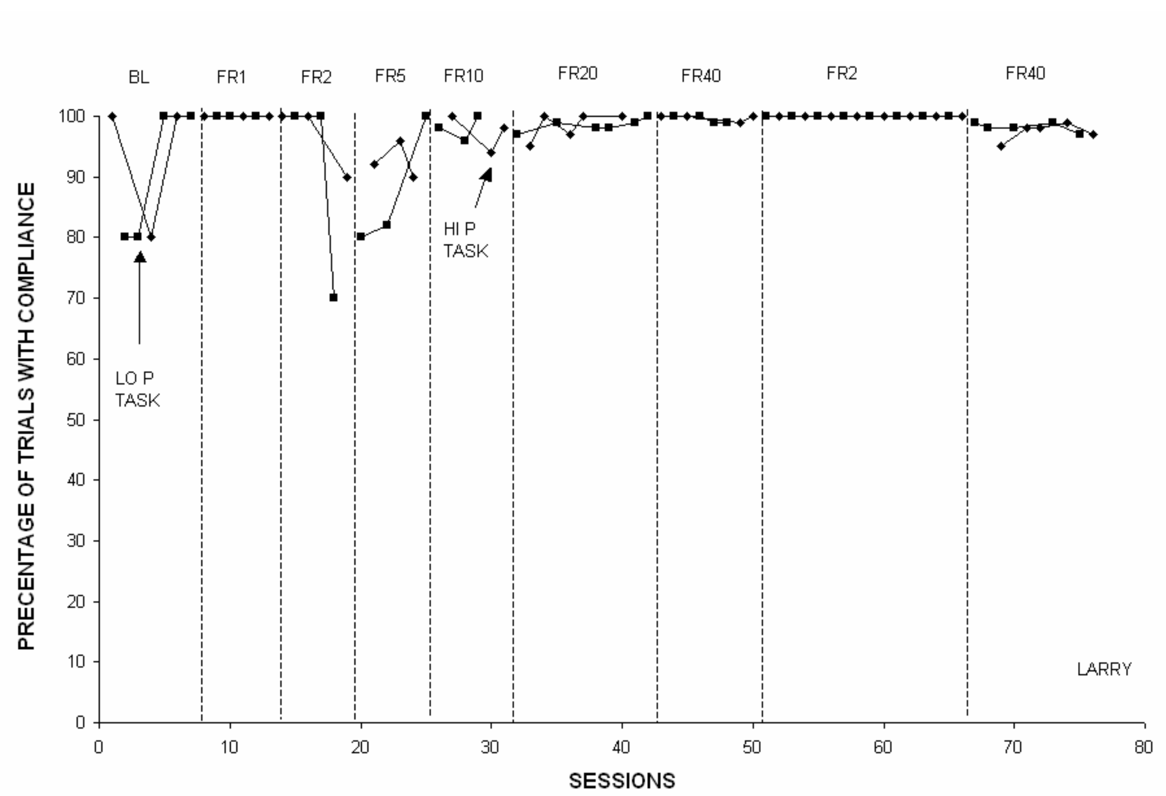

Figure 44. Larry's percentage of trials with compliance during Phase 2.

100% of demands during the FR 1 schedule. Compliance during the low preference task decreased near the end of the FR 2 schedule, and gradually increased across the FR 5 schedule. Compliance remained high throughout the remainder of Phase 1 during both the high and low preference task. Larry's compliance was nearly 100% during all conditions in Phase 2 (see Figure 44).

Figures 45 and 46 show level of compliance for Sam. Sam complied with every demand during baseline (no reinforcement) and under the FR 1 schedule (see Figure 45). Compliance decreased under the FR 2 schedule and was lower during the low preference task compared to the high preference task. Compliance gradually increased across sessions during Phase 1, but compliance was typically lower for the low preference task under both FR 10 and FR 20 schedules. A reversal to the FR 2 schedule resulted in high levels of compliance for both high and low preference tasks. Compliance remained relatively high during the replication of the FR 20 schedule and under the FR 40 schedule for both tasks. Sam had a higher level of compliance during the baseline conducted in the new setting for Phase 2 than he had in the previous FR 40 condition conducted in Phase 1 (see Figure 46). When the enriched break was implemented, compliance remained at nearly 100% across sessions. In addition, compliance occurred during 100% of trials throughout all of Phase 3.

Mary's compliance is shown in Figures 47 and 48. Following baseline (no reinforcement), Mary had high levels of compliance throughout Phase 1 (see Figure 47). Compliance was somewhat lower during the low preference task relative to the high preference task. Mary continued to exhibit high levels of compliance during Phase 2, even after the schedule was increased to FR 40 (see Figure 48).

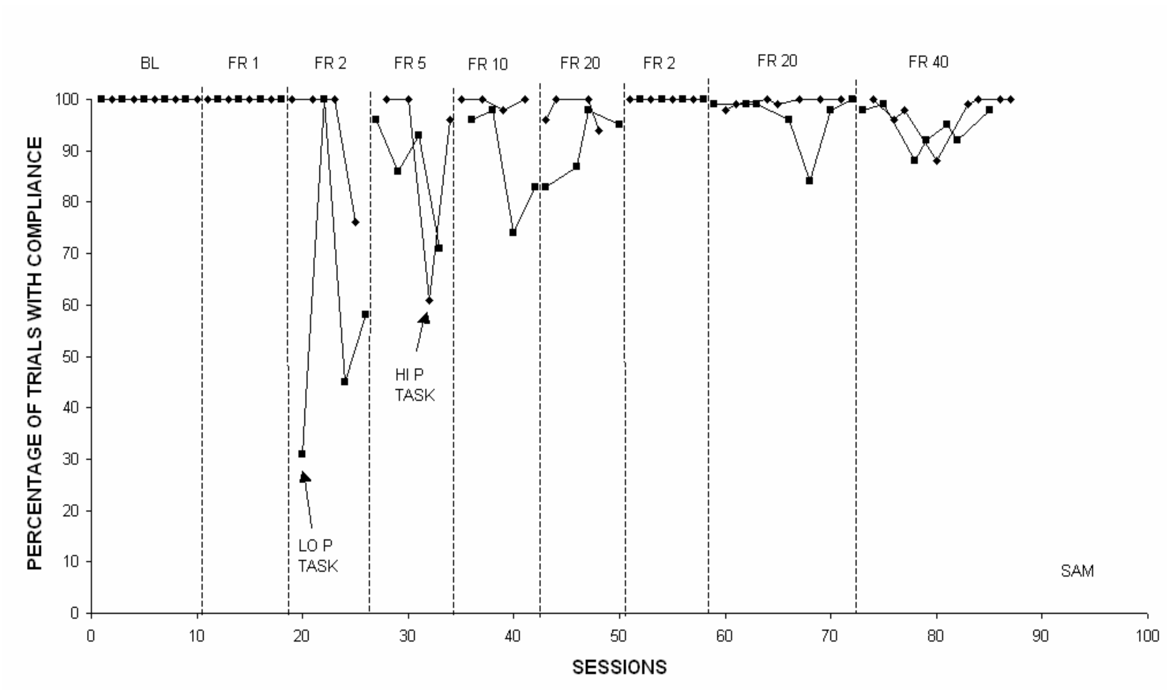

Figure 45. Sam's percentage of trials with compliance during Phase 1.

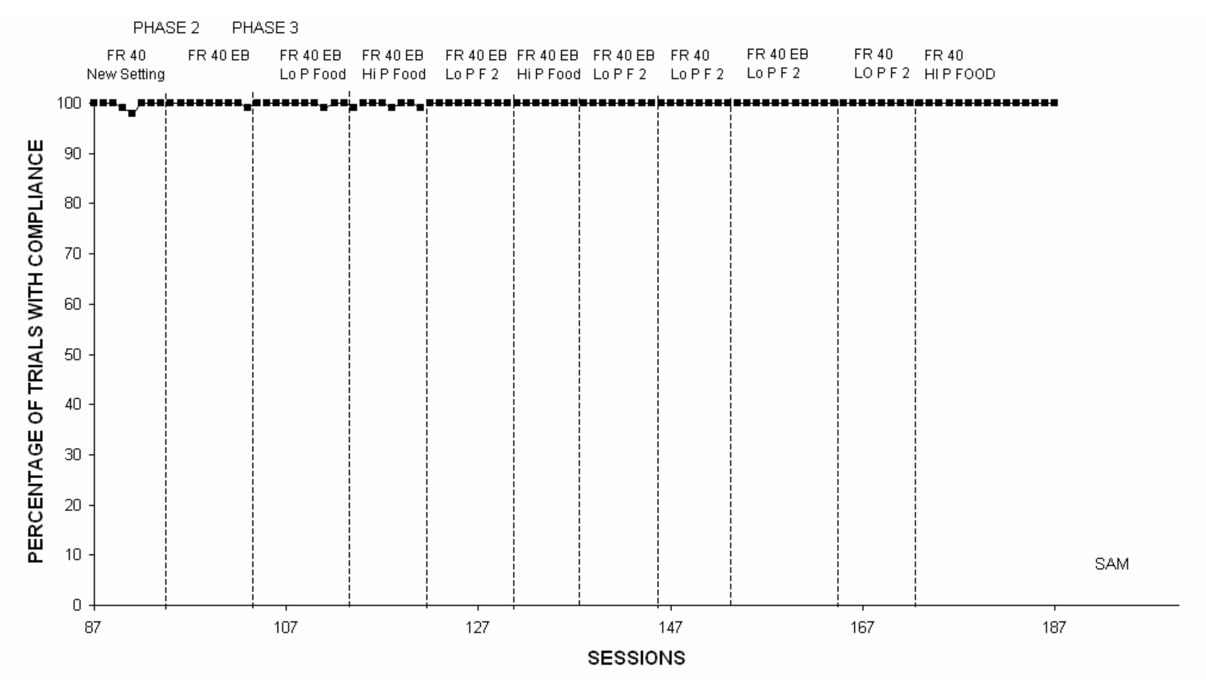

Figure 46. Sam's percentage of trials with compliance during Phase 2 and 3.

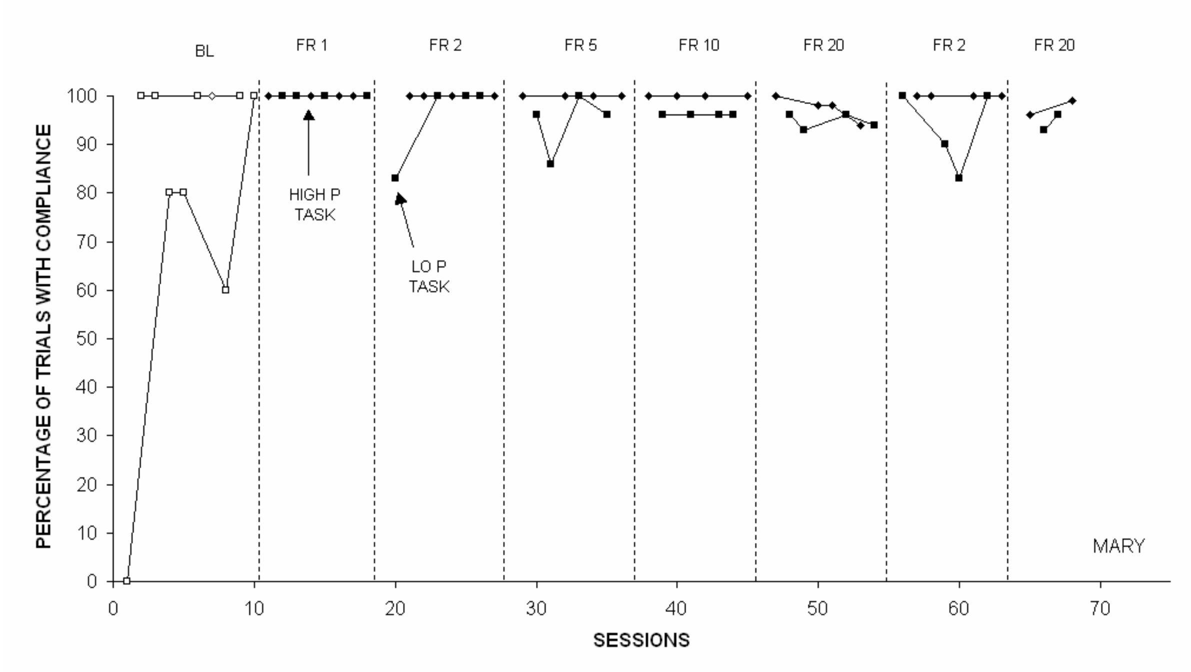

Figure 47. Mary's percentage of trials with compliance during Phase 1.

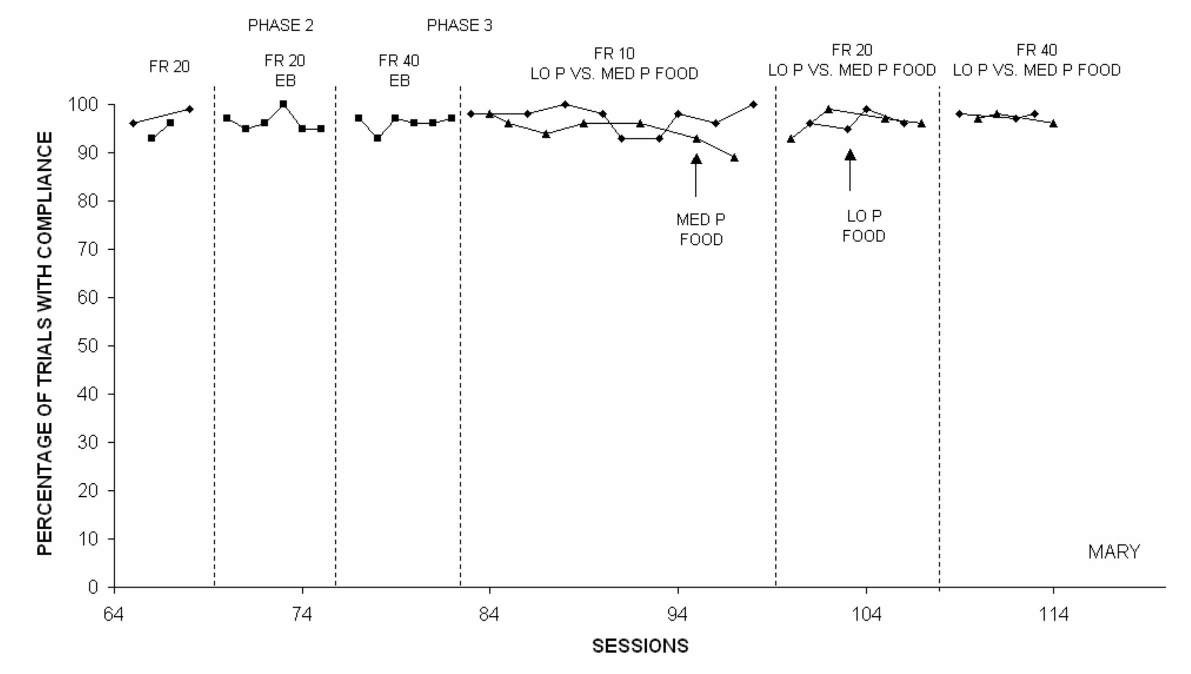

Figure 48. Mary's percentage of trials with compliance during Phase 2 and 3.

Scott's compliance is shown in Figures 49 and 50. For Scott, compliance was low during baseline (no reinforcement), especially for the low preference task (see Figure 49). Compliance increased to high levels with the introduction of reinforcement in Phase 1 and remained high across all the reinforcement schedules, with somewhat lower levels of compliance under FR 20 and FR 40. Levels of compliance were similar for the high and low preference tasks. During Phase 2 and 3, compliance remained at nearly 100% across conditions (see Figure 50).

To summarize, the participants' compliance increased with the introduction of reinforcement in Phase 1 and maintained at relatively high levels throughout all phases of the study with one exception.

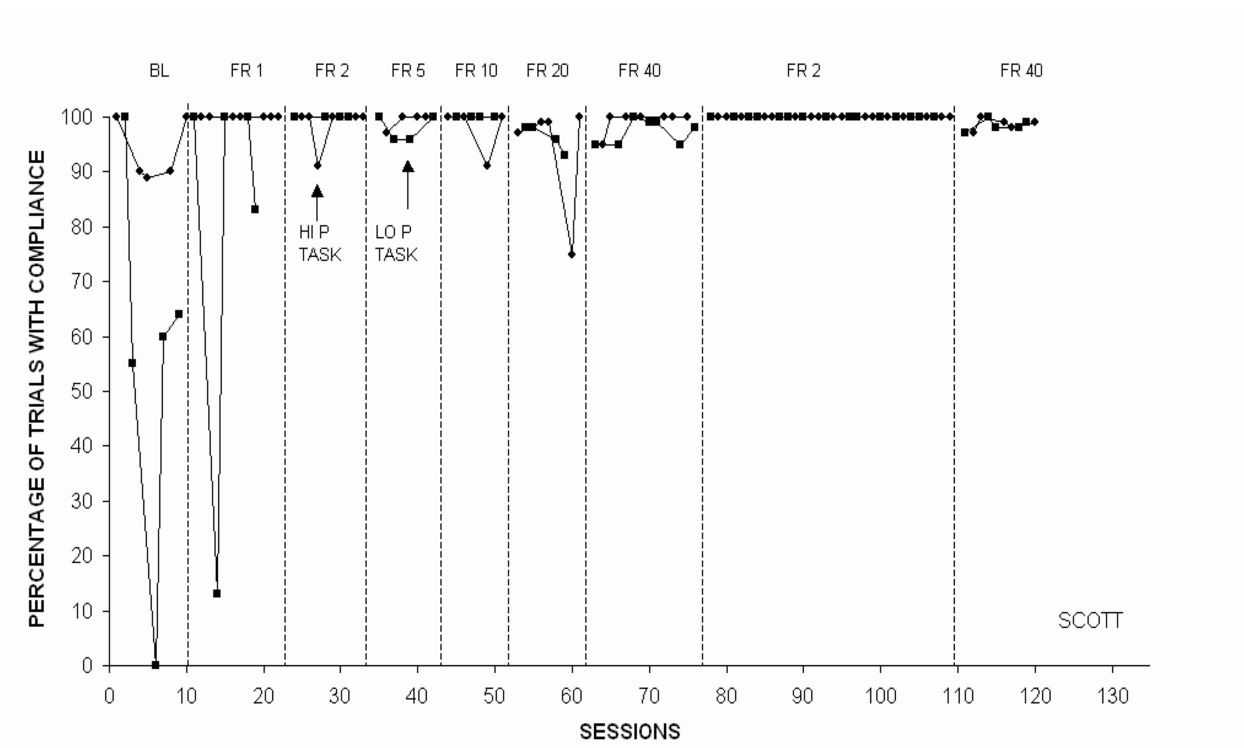

Figure 49. Scott's percentage of trials with compliance during Phase 1.

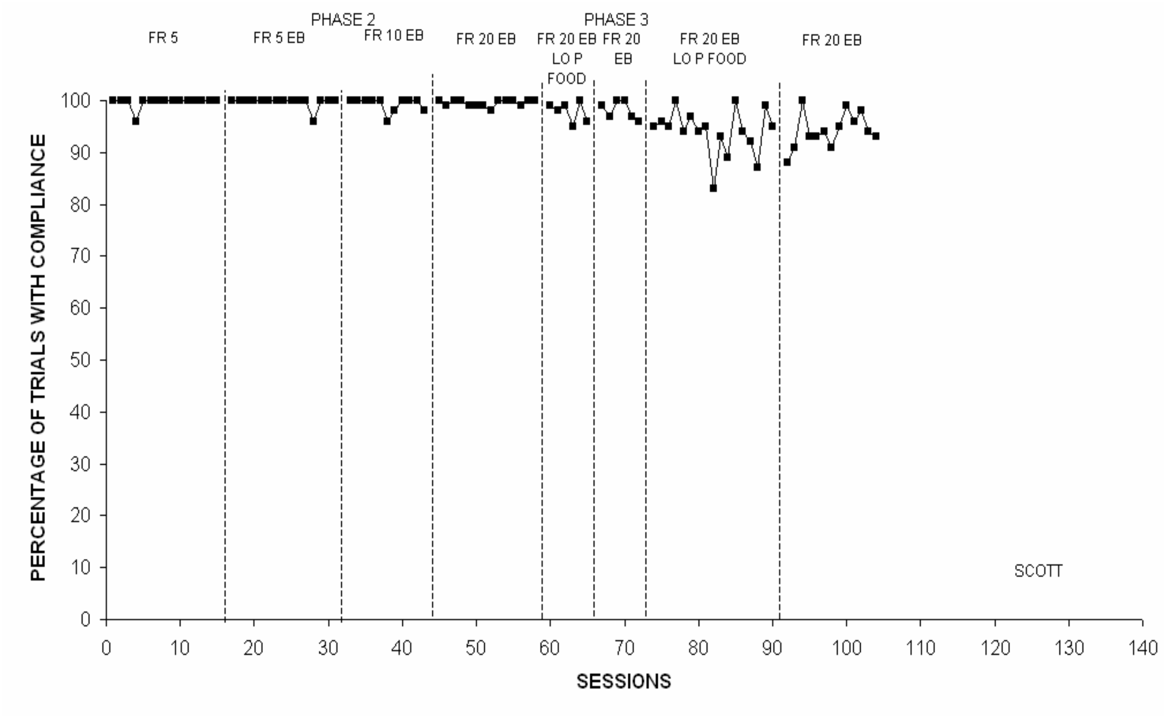

Figure 50. Scott's percentage of trials with compliance during Phase 2 and 3.

DISCUSSION

In the current investigation, 5 children with Autism displayed problem behavior that was maintained by escape from demands. In general, all but one child (Scott) showed a clear preference for an arbitrary reinforcer (i.e., food item) over a brief break from tasks, regardless of the reinforcement schedule. Four children (Scott, Mary, Casey, and Sam) continued to show preference for the food item even when attention and tangibles were available during the break (i.e., when the break was enriched). One child (Larry) displayed a change in preference when attention was available during the break. Of the four children who participated in Phase 3, three (Sam, Casey, and Scott) displayed a change in preference when the quality of the food item was manipulated. However, one participant (Mary) continued to choose the medium and lower preference food over the break, despite increases in the schedule to FR 20 and FR 40.

The current investigation adds to the literature on reinforcer choice and preference in several ways. First, previous studies comparing choice between positive and negative reinforcement did not specifically assess or manipulate the preference level of the task, an important EO for negative reinforcement (DeLeon et al, 2001). Results from the current investigation suggest that the preference level of the task may not necessarily affect preference for food over a break. It is possible that the food was such a potent reinforcer that the participants preferred the arbitrary reinforcer over the functional reinforcer regardless of the EO for the break. Another possible explanation was that the EO's associated with the two tasks were fairly similar. High and low preference tasks were identified via a task choice assessment. It was assumed that tasks chosen less frequently were more aversive to the participant than tasks chosen more frequently. A better method for identifying tasks that varied in level of aversiveness would have been to evaluate the amount of problem behavior and compliance associated with each task. It is also possible that a difference in reinforcer choice would have emerged across high and low preference tasks under thinner schedules of reinforcement. The schedule was increased to a maximum of FR 40 due to time constraints for conducting daily sessions with the participants. It should be noted that all tasks included in the assessment were those that had occasioned problem behavior during the functional analysis. Thus, the relevant EO should have been in effect.

Second, the present investigation is the only study to evaluate choice between an arbitrary reinforcer and multiple functional reinforcers. In previous investigations, participants could choose between a food item and a break alone (DeLeon et al., 2001; Lalli et al., 1999), although some children may prefer escape to an enriched environment over escape alone (Golanka et al., 2000). Furthermore, it is unlikely that attention or toys would be unavailable during work breaks in the natural environment. Therefore, evaluating preference for food versus a break alone may have limited the generality of previous research findings. Previous investigations also have shown that children may prefer multiple functional reinforcers (i.e., escape, attention, and toys) over a single functional reinforcer (i.e., escape only). For example, the participants in Piazza, Fisher, Hanley, Remick, Contrucci, and Aitken (1997) engaged in problem behavior maintained by positive reinforcement (i.e., tangibles, attention, or both) and negative reinforcement. The authors examined treatment when one, two, or three functional reinforcers (attention, tangibles, escape) were provided contingent on compliance with instructional tasks, while problem behavior continued to produce escape. Results showed that multiple functional reinforcers were required to produce rapid decreases in problem behavior and increases in compliance.

In the present study, three children (e.g., Sam, Scott, and Larry) engaged in problem behavior that was maintained by access to adult attention and/or tangibles in addition to escape from demands. Nevertheless, only one participant (Larry) shifted preference from the single arbitrary reinforcer to the break when attention and tangibles were added to the break during Phase 2. Interestingly, Larry preferred the break when attention was delivered during the break, even though results of his functional analysis indicated that problem behavior was maintained by tangible items but not by attention. One possible explanation for this finding is that the type of attention manipulated in the functional analysis (reprimands) did not function as a reinforcer for Larry. If the components of attention that are evaluated during a functional analysis (i.e., reprimands, statements of concern) are not reinforcing, the results may suggest that behavior is not sensitive to adult attention. However, other forms of attention (e.g., physical attention, praise, etc) may actually function as potent reinforcers. On the other hand, the functional analysis may indicate that reprimands are reinforcing even when praise is not a reinforcer for appropriate behavior. This may be relevant to the results for Sam and Scott.

In fact, results of Phase 3 for Sam indicated that attention may have become aversive because Sam chose the lower preference food item over the break only when the break was "enriched" with toys and attention. Adult attention may have become aversive over the course of the study because it was repeatedly paired with demands. It is also possible that Sam became satiated on therapist attention because attention was delivered continuously in the form of demands prior to the break, with praise and conversation delivered during the break. In fact, results for one participant in a study by Vollmer and Iwata (1991) suggested that attention might have switched from a reinforcing stimulus to an aversive stimulus after the individual was repeatedly exposed to 15 min of pre-session attention. The participant began running away from the therapist and threw items at the therapist who was attempting to deliver attention.

Larry and Scott may have continued to choose the food item over the enriched break because the toys available during the enriched break were not potent enough to effectively compete with the food reinforcers. These items were the highest ranked toys from a leisure-only preference assessment and some of the tangible items used as reinforcers during the tangible condition of the function analysis. However, as mentioned previously, DeLeon et al. (1997) found that food items completely displaced preference for leisure items during a stimulus preference assessment. That is, all of the food items included in the assessment were ranked above all of the leisure items. Thus, it is possible that the toys were relatively less preferred than the food items. In fact, the break was only preferred over the food item when a lower preference food item was introduced in Phase 3. This finding suggests that preference for the highest ranked toys and lower ranked food item may have been somewhat similar, resulting in some variability in preference for the food item for three of the four participants. The hypothesis that highly preferred food items displace preference for leisure items during a break should be evaluated in future research.

Third, the present investigation adds to the literature by replicating the DeLeon et al. (2001) study with multiple participants. DeLeon et al. found that one participant showed preference for the arbitrary reinforcer under dense schedules of reinforcement.

Under thin schedules of reinforcement (i.e., FR 10), preference switched to the break. However, the authors were unable to replicate the switch in preference. In the present investigation, although choice was somewhat more variable under the thinner reinforcement schedules for three participants (Sam, Casey, and Scott), all participants generally preferred the food to the break when a potent food item was identified via a systematic preference assessment and the break was not combined with other positive reinforcers. In addition, sequence effects may have influenced the results, a finding that was reported by DeLeon et al. (2001). In the present study, a change in the variability of choices under the thinner schedules (for Casey and Sam) was not replicated when the thin schedule was reintroduced later. A change in preference that occurred under an initial thin schedule also was not replicated in DeLeon et al. One possible explanation for these findings is that the establishing operation for the break decreased as a result of repeated exposure to the task under thin schedules of reinforcement. That is, the task may have become less aversive after the participant had been exposed to numerous instructional trials. If so, the break from the task may have become less valuable, decreasing the likelihood that the participant would choose the break over the food.

Fourth, the present study examined how behavioral economics principles can be applied to an evaluation of choice between various reinforcers. From an economics point of view, the results of the present study can be understood by considering the degree of demand elasticity of the reinforcers. As mentioned previously, demand elasticity is determined by changes in consumption of a reinforcer as the price of the reinforcer is manipulated. If the demand for a reinforcer is elastic, consumption of the reinforcer is influenced by increases or decreases in the price of the reinforcer. If the demand for a reinforcer is inelastic, consumption is not affected by changes in the price of the reinforcer. Hursh (1984) proposed four variables that influence demand elasticity: the nature of the commodity (essential versus nonessential), the species of the consumer, the availability of substitute reinforcers, and the type of economy (open versus closed). It may be especially important to consider the nature of the commodity. Food is an example of an essential commodity, whereas toys are probably nonessential commodities. Essential commodities usually have few substitutes. In the present study, participants may have continued to prefer the food item under thin schedules of reinforcement, even when other reinforcers were added to the break, because the food item was an essential commodity with few substitutes.

The type of economy also may have interacted with other variables to influence preference. Previous research on responding in open and closed economies indicates that the economy type can influence responding for various commodities. In particular, individuals may not engage in a response at the same rate in experimental sessions if the commodity is available outside of the session (an open economy) than if the commodity is only available during the session (a closed economy; Hursh, 1978). Furthermore, a study by Ladewig, Sorensen, Nielsen, and Matthews (2002) found that an item was less valuable during experimental session when the item was available one hour prior to the session than when the item was available either immediately after the session or multiple hours after the session. These results indicate that the demand elasticity of a commodity may increase if it is available prior to sessions. The participants in the present study typically had access to numerous breaks outside of experimental sessions, including a break immediately prior to the sessions. Thus, an increase in the demand elasticity of escape may explain the results of this study. Food items were also available outside of experimental sessions. However, it is unclear to what extent the participants had access to the food items that were used as reinforcers in the study outside of experimental sessions. With at least one participant (i.e., Casey), the high preference food item that was used in the study was not available outside of experimental sessions, according to his parents. Future studies evaluating choice between a food item and break under increasing schedule requirements in both an open and closed economy may help determine the extent to which choice and the demand elasticity of the reinforcers are influenced by the type of economy.

Fifth, results of the present study replicate and extend previous research on reinforcement variables and their influence on choice (Neef et al., 1992; 1994). Previous research has indicated that participants do not distribute responding equally when reinforcers are unequal in quality (Neef et al. 1992). Of the variables manipulated in the present investigation, the quality of the food reinforcer had the largest influence on choice. Neef et al (1994) also found that choices of six participants were influenced by the quality of the reinforcer. Moreover, the quality of the reinforcer interacted with other variables (i.e., immediacy of the reinforcer and rate of reinforcement) for five of the six participants in the Neef et al. study. However, in the present investigation, manipulating the preference level of the task, increasing the work schedule to gain access to the choice, and manipulating the quality of the break (e.g., including highly preferred toys and attention to the break) did not appear to influence choice between reinforcers. Thus, the demand for the food reinforcer was fairly stable across manipulations of other variables.

One limitation of the present study is that the schedule of reinforcement was not thinned past FR 40. Due to the participants' schedules, daily sessions were limited to 1-hour blocks of time. One session under the FR 40 schedule required approximately 45 minutes to complete for most participants. Thus, thinner schedules likely would have required session lengths that were prohibitive. Another limitation was the failure to replicate several of the findings within subjects. For example, the changes in choice under the thinner schedules in Phase 1 (for Sam and Casey) did not replicate when the schedules were reintroduced following a reversal to a rich schedule. In addition, in Phase 3, the change in preference from the food to the break did not replicate for one of the three participants (Scott).

These failures to replicate may indicate that uncontrolled variables were influencing the results. Alternatively, sequence effects may have been responsible. For example, as noted previously, the tasks may have become less aversive over time due to repeated exposure to instructional trials, altering the value of the break. In Phase 3, preference for the lower quality food items may have increased over time due to multiple exposures to the food item. These food items may have been ranked low during the preference assessment because the participant was relatively unfamiliar with these items. Prior to each day's sessions, participants were exposed to the consequences associated with each choice (i.e., were given one piece of the food item or a 30 s break). Therefore, even if the low quality food item was not chosen initially during Phase 3, participants were exposed to the food item each day. An MSWO assessment could have been conducted daily prior to sessions to determine whether the low quality food item continued to be the least preferred food item. As noted previously, DeLeon et al. (2001)

also did not replicate the change in preference that initially occurred the first time the schedule of reinforcement was thinned. When the thin schedule was reintroduced, preference was variable and the participant did not show exclusive preference for the break as in the initial FR 10 schedule. The results of both the DeLeon et al. study and the present investigation indicate that choice between reinforcers may be influenced by a number of possible variables (e.g., recent history with certain schedules, decreased aversiveness of the task). An examination of these variables was outside of the scope of the present study. Future research should investigate why preference for reinforcers under varying schedule requirements may fluctuate over time.

Another limitation of the study is that food appeared to be a functional reinforcer for one participant's problem behavior (Scott). Food was described as an arbitrary reinforcer throughout the paper because problem behavior was not sensitive to food reinforcement during the functional analysis for four of the five participants. Nevertheless, the results for Scott were similar to those for the other participants. Choice between the low preference food item and a break also was only compared under one schedule of reinforcement with three of the four participants (FR 20 with Scott, FR 40 with Casey, and FR 40 with Sam), and these schedules were relatively thin. Participants may have been less likely to choose the break over the low preference food under denser schedules of reinforcement. Future research should evaluate the potential interaction between reinforcer quality and schedule.

A final limitation is that the schedule of reinforcement was gradually thinned across Phase 1. This type of gradual schedule thinning is often used during treatment to maintain high levels of compliance and low levels of problem behavior while decreasing the frequency of reinforcement. However, choice between reinforcers may have been more sensitive to changes in the reinforcement schedule under a rapid schedule fade. For example, preference may have shifted to the break if the schedule had been increased from FR 1 to FR 20 or FR 40. Future research could evaluate this hypothesis by examining choice between reinforcers when the schedule of reinforcement for appropriate behavior is rapidly thinned.

Results of the present investigation have several implications for future research and clinical practice. The results of Phase 3 for Sam indicated that attention in the form of praise might have been aversive, despite the finding that problem behavior was maintained by access to adult attention during the functional analysis. Future research should investigate the extent to which various forms of attention are differentially reinforcing. In addition, future research is needed to evaluate the conditions under which various forms of attention may actually become aversive during treatment (e.g., when praise is repeatedly paired with demands).

The relative potency of food as a reinforcer in this study has a number of implications for the use of reinforcement in applied settings. Teachers and parents should consider using food reinforcers if it is difficult to find alternative items that function as potent reinforcers. Nevertheless, food should be paired with other types of naturalistic reinforcers (e.g., praise). To prevent satiation, a variety of highly preferred food items should be provided. However, functional reinforcers also should be available, especially following meals and periodically throughout the day, so that participants do not become satiated on food reinforcers.

The results of the present investigation also showed that high levels of compliance and low levels of problem behavior maintained under thin schedules of reinforcement. Therefore, teachers may be able to provide highly preferred food items on relatively thin schedules, even when children exhibit problem behavior maintained by multiple functional reinforcers. Providing multiple functional reinforcers (i.e., attention and a break) in a classroom setting often may not be feasible because teachers have many students and limited time. Providing a small food item periodically may be much less time consuming and may result in comparable levels of compliance.

On the other hand, some children may prefer escape from tasks over a food item under thin schedules of reinforcement. Also, preference for reinforcers may vary over time. Previous research has shown that choice between tasks (Romaniuk et al. 2002) and reinforcers (DeLeon et al., 2001) may lead to lower levels of problem behavior and higher levels of compliance. Choice itself may be an important component of treatment because it allows participants access to tasks, treatments, or reinforcers that are most preferred at any given moment. Providing choice between treatments (see Hanley et al. 1997) or choice between reinforcers also may increase the socially acceptability of behavioral treatments because individuals with disabilities often are unable to consent to treatment. However, more research is needed to fully evaluate the parameters influencing choice.

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