CONTRIVING ESTABLISHING OPERATIONS: RESPONSES OF INDIVIDUALS

WITH DEVELOPMENTAL DISABILITIES DURING A LEARNING TASK

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# Contriving Establishing Operations: Responses Of Individuals With Developmental Disabilities During A Learning Task

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Contriving Establishing Operations: Responses Of Individuals With Developmental

Disabilities During A Learning Task

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## THESIS ABSTRACT

## CONTRIVING ESTABLISHING OPERATIONS: RESPONSES OF INDIVIDUALS WITH DEVELOPMENTAL DISABILITIES DURING A LEARNING TASK

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The field of applied behavior analysis has utilized the ability to capture and contrive establishing operations in treating aberrant behavior in individuals with developmental disabilities. However, research on the use of establishing operations in the teaching of appropriate behavior is not as systematic. This study examined the effects of establishing operations on the responses of individuals with developmental disabilities during an incremental repeated acquisition procedure. Results in both experiments showed that individuals responded more accurately during periods of longer deprivation (1-day and 2-3 days) than during shorter periods (15-minute and 2-hours). These results have implications for conducting preference assessments, scheduling daily activities, maximizing responding and teaching new skills.

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# Chapter I. INTRODUCTION

## Development of the Concept of Establishing Operations

### *Motivation*

The concept of establishing operations (EOs) derives its lineage from the psychological construct of motivation. Motivation has a long and complex history in psychology. It has been defined and examined in many ways (Kennedy & Meyer, 1998). Thus, it is important to stay within a rigorous theoretical framework that allows the concept to be analyzed experimentally.

In the operant literature, motivation has historically been defined as a “drive,” or a change in response levels as a result of a corresponding condition of satiation or deprivation (Skinner, 1957); for example, a change in the rate of lever pressing of a rat deprived of food for 24 hours (Keller & Schoenfeld, 1950; Skinner, 1953). Both Keller and Schoenfeld (1950) and Skinner (1953) placed limitations on their definitions of motivation. These authors limited the concept of motivation by stating that it was not a: (a) stimulus, (b) physiological state, (c) psychic state, (d) response, or (e) pleasure-directed.

Several other concepts related to motivation have been more precisely defined without using the traditional “motive” or “drive,” which are fraught with mentalistic connotations. These concepts have included “setting factors” (Kantor, 1959), "setting events" (Bijou & Baer, 1961; Bijou, 1996), and establishing operations (Keller & Schoenfeld, 1950; Michael, 1982, 1988, 1993, 2000).

*Setting Events*

Kantor (1959) introduced the concept of "setting events." Kantor's original description of what he called "setting factors" was framed within an interbehavioral model that addressed "multiple determination of behavior and contextual determinants in general" (Morris, Higgins, & Bickel, 1982, p.167). The interbehavioral model is comprised of interactions among variables in five categories: (a) the organism, (b) the stimulus, (c) interbehavioral history, (d) the media of stimulation, and (e) setting factors (Wahler & Fox, 1981). In his description of influences on behavior, Kantor included factors such as: (a) physiological development (e.g., visual acuity), (b) satiation, and (c) toxic conditions (e.g., hormonal or drug levels in the body).

Bijou and Baer (1961) modified Kantor's "setting factors" and renamed them "setting events." Bijou and Baer (1961) defined setting events as "a stimulus-response interaction, which, simply because it has occurred, will affect other stimulus-response relationships which follow it" (p. 21). In their discussion of setting events, they included variables such as behavioral history, verbal instructions, and gender membership of the experimenter.

However, Bijou and Baer's (1961) definition of setting events was not free of problems. The use of instructions such as "be a good boy" (p.22) could function as a setting event in altering the functions of other stimuli associated with "being good," but instructions could also serve as discriminative stimuli for behavior reinforced in its presence in the past. The same argument could be made for the inclusion of gender. Bijou (1996) later modified his initial definition of setting events, to "the general surrounding circumstances that operate as inhibiting or facilitating conditions in a behavioral unit" (p.149). Bijou no longer included in his definition behavioral history and avoided using the term in reference to discriminative stimuli.

The overarching problem with the concept of setting events is that the research literature reveals no clear definition of them, and the term is used when the events at issue are not based on any evident functional relation between behavior and environmental or biological variables. Leigland (1984) suggested that the term itself is too encompassing and should be discontinued or, at the very least, modified to allow researchers to identify and experimentally analyze variables affecting behavior independently of the three-term contingency.

*Establishing Operations*

Although not as inclusive as setting events, establishing operations are defined according to their behavioral function. Keller and Schoenfeld (1950) first described the concept of establishing operations as a classification of "drives" that included "deprivation and stimulation" (p. 274). The concept lay dormant for the next 30 years until Michael (1982) revived it (see Timberlake & Allison, 1974 for a discussion on response deprivation).

Michael (1993) defined establishing operations as an "environmental event, operation, or stimulus condition that affects an organism by momentarily altering (a) the reinforcing effectiveness of other events and (b) the frequency of occurrence of the part of the organism's repertoire relevant to those events as consequences" (p. 192; see also Michael, 2000). Michael (2000) argued that the term establishing operation should be used when referring to a change in the environment that meets the above requirements and increases the behavior. For example, food can function as a consequent stimulus to increase behavior, but the effectiveness of food as a consequence is dependent on other factors, such as food deprivation. In this case, food, will likely increase responding if the individual has not eaten for a long period of time.

Michael (2000) also stated that the term establishing operation should be replaced with the term, "abolishing operation" when referring to a change in the environment that meets the above requirements but decreases the behavior. Thus, food will serve as an abolishing operation when it decreases behavior; if an individual is satiated, food will not serve as a reinforcer and behaviors that have resulted in reinforcement (by food) in the past will decrease.

## Distinguishing Establishing Operations from Discriminative Stimuli

Distinguishing between discriminative stimuli ($S^D$) and establishing operations often requires careful analysis. Holland and Skinner (1961) demonstrated that an antecedent stimulus can set the occasion for a target response that will be followed by a specific consequence. The result of differential reinforcement, then, is that responding occurs predictably in the presence of the stimulus ($S^D$) and rarely occurs when the stimulus is absent ($S^\Delta$). A discriminative stimulus evokes responding by being previously correlated with the availability of a reinforcing stimulus. In contrast, an establishing operation alters the reinforcing effectiveness of consequences, while simultaneously evoking behavior that has previously produced those consequences.

Most variables do not qualify as discriminative stimuli because in their absence the event is not as effective a reinforcer as during its presence (Michael, 1993). Michael

(1982, 1993) provided multiple examples of this point using the removal of aversive stimulation. Because humans do not usually encounter such situations, consider the act of cleaning up spilled milk. For the spilled milk to be considered an $S^D$, it would have to be differentially correlated with reinforcement for cleaning up the floor. However, there would be no differential reinforcement history because that would require an illogical situation in which having cleaned up the spilled milk would be as reinforcing without spilled milk, as when there had been spilled milk.

In contrast, consider an example of a stimulus correctly being labeled as a discriminative stimulus. The sight of a vending machine will not always evoke purchasing food, especially if the individual is satiated. In this case, the vending machine is a discriminative stimulus for the availability of food, but eating the food would depend on the satiation/deprivation level for the individual. The vending machine would be considered an $S^D$ because the food would be just as reinforcing in the presence of the $S^D$ (vending machine) as it would be in its absence (assuming the individual is not satiated). In summary, a discriminative stimulus (vending machine) sets the occasion for the availability of a consequent stimulus (food) and an establishing operation (satiation/deprivation) alters the effectiveness of the consequent stimulus in occasioning a response (putting money in the machine).

## Types of Establishing Operations

### *Unconditioned Establishing Operations (UEOs)*

Michael (1993) differentiated between two general types of establishing operations. The first is the unconditioned establishing operation or events, objects, or stimulus conditions that do not require any learning history for their environmental change to have an evocative/abative effect. Examples of UEOs include deprivation of food, water, and sleep, temperature changes, and the presentation of aversive stimuli. Satiation of some of these events are likely to function as unconditioned abolishing operations.

### *Conditioned Establishing Operations (CEOs)*

*Development of CEOs.* Conditioned establishing operations require the organism to contact the reinforcer-establishing contingency. Although there are numerous learned forms of reinforcement that do not require learned EOs, variables exist that alter the effectiveness of reinforcers only based on the organism's prior history (Michael, 1993). Similar to UEOs, CEOs alter the momentary frequency of those behaviors that have been reinforced or punished by those events in the past. Michael (1993) subdivided these CEOs into three different categories.

*Surrogate CEO.* A surrogate CEO is a previously neutral event that is correlated with a UEO or already established CEO, and acquires similar evocative effects. For example, looking out the window and seeing that it is raining may evoke behaviors associated with the removal of aversive stimuli (e.g., avoid getting wet by putting on a raincoat).

*Reflexive CEO.* A reflexive CEO is a previously neutral event "whose removal becomes reinforcing (or punishing) through systematically 'worsening' (or 'improvement') when not terminated" (McGill, 1999, p. 395). An example of a reflexive

CEO would be after repeated pairings of a teacher entering a room and presenting a child with demands, the child has those demands removed by producing problem behaviors. The teacher has become a reflexive CEO.

*Transitive CEO*. Transitive CEOs are previously neutral events "whose occurrence alters the reinforcing (or punishing) effectiveness of another event and evokes responses that produce (or suppress) that event" (McGill, 1999, pp. 395-396). For example, a transitive CEO would be manding for a spoon to eat a bowl of ice cream. The ice cream is just as available to be eaten with or without the spoon (it is not discriminative), but eating the ice cream has been more reinforcing in the presence of the spoon.

## Establishing Operations and Functional Assessment

### *Assessment and Interventions*

Significant advances in the field of applied behavior analysis have led to improved treatment techniques for the developmentally disabled. The advent of functional assessment has encouraged behavior analysts to design interventions based on antecedent events (Iwata, Dorsey, Slifer, Bauman, & Richman, 1994; Hanley, Iwata, & McCord, 2003). This generally requires "a believable demonstration of the events that can be responsible for the occurrence or non-occurrence of that behavior" (Baer, Wolf, & Risley, 1968, p. 94). The use of pre-treatment functional analyses has also taken advantage of the concept of establishing operations. In functional analysis research, the role of a particular consequence in maintaining problem behavior is evaluated during test conditions that restrict access to the potential reinforcer and deliver it contingent upon the occurrence of problem behavior, or present an aversive stimulus and remove it contingent upon the occurrence of problem behavior. Restriction of a potential positive reinforcer or presentation of a potential negative reinforcer within functional analysis test conditions has been conceptualized as an establishing operation (Iwata et al., 1994). In addition to providing information on the etiology of the target behavior, the use of a pre-treatment functional analysis may suggest: (a) antecedent conditions that are serving as establishing operations, (b) sources of reinforcement, and (c) approaches to treatment that should be utilized or avoided (Iwata, Vollmer, & Zarcone, 1990). This ability to determine possible variables maintaining the behavior of interest has strengthened the behavior analyst's ability to both assess and treat their consumer's behaviors.

The increased use of functional assessment has promoted growth in the research area of antecedent manipulation (Iwata et al., 1990). There are several benefits in the use of these interventions developed through functional assessments, as opposed to interventions developed through arbitrary means. First, the interventions usually emphasize a reinforcement-based procedure as opposed to punishment-based procedure. Interventions also are directed at the response-reinforcer contingency and can weaken or strengthen the contingency instead of simply overpowering it. Finally, the interventions often involve the establishment of an adaptive response-reinforcer relationship, which may result in increased maintenance of treatment gains (Iwata et al., 1990).

Iwata and his colleagues suggested three broad areas of interventions: (a) modification of establishing operations, (b) the use of extinction, and (c) differential reinforcement. The field of applied behavior analysis has addressed the treatment of aberrant behavior using all three types of intervention. In recent years, more behavior analysts have begun to include modification of establishing operations in the development of treatment protocols (see reviews by McGill, 1999; Smith & Iwata, 1997; Wilder & Carr, 1998).

The empirical study of establishing operations in applied behavior analysis has largely concentrated on the analysis and treatment of aberrant behavior. Interventions developed through functional assessments have generally targeted behaviors maintained by (a) positive reinforcement, (b) negative reinforcement, and/or (c) automatic reinforcement (See Table A1 for an overview of establishing operations and possible treatments (McGill, 1999)).

*Positive Reinforcement*

Treatment of aberrant behavior maintained through positive reinforcement requires minimizing the effect of the maintaining reinforcer (e.g., attention, edibles, tangible items, etc.). The use of noncontingent reinforcement (NCR), although better labeled as a fixed-time or variable-time schedule (Poling & Normand, 1999), has become a popular procedure used in treating problem behavior. By presenting the reinforcer independent of the individual's behavior, noncontingent reinforcement weakens the response-reinforcer relation (Lalli, Casey, & Kates, 1997). Researchers also have cited a number of other benefits in the use of NCR as a treatment (Carr, Coriaty, Wilder, Gaunt, Dozier, Britton, et al., 2000). First, NCR is easy to implement because presentation of the reinforcer is time based. Second, it provides a consistent amount of reinforcement for appropriate behavior, which may decrease the individual's reinforcement through other maladaptive behaviors. Finally, NCR may help to reduce extinction bursts (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993). A key disadvantage in the use of NCR is that there are no new skills or behaviors being taught.

Vollmer, et al. (1993) compared differential reinforcement of other behavior (DRO) and NCR procedures with three females with developmental disabilities who engaged in self-injurious behavior (SIB). In the DRO condition, attention followed target behaviors only when self-injurious behavior did not occur for a pre-specified amount of time (DRO). In the NCR condition, the authors provided attention on a fixed-time schedule. Attention provided on a noncontingent basis was just as effective as the DRO procedure in decreasing self-injurious behavior.

*Negative Reinforcement*

Behavior maintained by negative reinforcement generally involves the individual escaping or avoiding demand situations (e.g., schoolwork, “difficult” demands). The treatment of aberrant behavior maintained by negative reinforcement is usually addressed in one of three ways: (a) providing escape from a task demand on a noncontingent basis, (b) modifying the complexity, rate, duration, or novelty of the task (curricular revision), or (c) initially eliminating task demands then slowly reintroducing them (demand fading) (Wilder & Carr, 1998).

Vollmer, Marcus, & Ringdahl (1995) examined the use of noncontingent escape as a treatment for self-injurious behavior with two young boys with developmental disabilities. A functional analysis for both boys showed that their SIB was maintained through escape from instructional activities. Escape from learning activities was provided on a fixed-time schedule (NCR) that was independent of the subjects’ behavior. Noncontingent escape resulted in a significant decrease in both children’s self-injurious behavior.

Smith, Iwata, Goh, & Shore (1995a) examined the effects of curricular revision[1] on the self-injurious behavior of nine individuals with profound mental retardation. In three separate experiments, the authors manipulated the rate, duration, or novelty of task demands. Duration and rate of task demands produced idiosyncratic results while the presentation of novel tasks increased SIB in all of the individuals.

Demand fading is another form of treatment for aberrant behavior maintained by negative reinforcement. Ducharme and Worling (1994) studied the effects of demand fading on two children with developmental disabilities. Requests for high-probability behavior were initially increased while low-probability requests were decreased. Once compliance increased, the authors gradually reinserted low-probability requests while fading out the higher-probability requests. In this case, the technique proved to be effective in treating non-compliant behavior, but demand fading has not always been consistently effective (Zarcone, Iwata, Mazaleski, & Smith, 1994).

There are two limitations in using treatments that manipulate establishing operations maintaining behavior through negative reinforcement. First, the procedure may interfere with the individual's instructional programming (e.g., allowing them to escape demands). Second, there is a risk of the individual's aberrant behavior reoccurring when these procedures are not used and an aversive task demand is presented. Under these conditions, extinction or differential reinforcement procedures should be used with EO manipulation (Hoch, McComas, Thompson, & Paone, 2002; Iwata et al., 1990).

*Automatic Reinforcement*

The literature on behavior maintained by automatic reinforcement is not as systematic as the studies involving other maintaining consequences. It is often difficult to identify the reinforcer maintaining behavior because nonsocial factors are involved (e.g., sensory stimulation). Behavior maintained by automatic reinforcement can involve both negative and positive reinforcement contingencies and can be treated in a similar manner to behavior maintained by other types of reinforcers.

Few studies have addressed decreasing aberrant behavior using a reduction in automatically produced aversive stimuli (Kennedy & Meyer, 1996). O'Reilly (1995) found through a functional analysis that the aggressive behavior of a severely mentally retarded man, which resulted in escape from demands, was increased during days in which the individual slept less than five hours. An intervention that included periods of rest (along with several other components) successfully decreased the individual's aggressive behavior.

Sprague, Holland, & Thomas (1997) examined the effects of providing noncontingent sensory stimulation (tactile or auditory) to two children with developmental disabilities who engaged in self-injurious behavior and stereotypical behaviors. The authors found that by noncontingently presenting a stimulus that shared properties with the stimulation produced by their stereotypy and self-injurious behavior, the frequency of these behaviors were reduced. When presentation of the stimulus was made contingent on appropriate behavior, the children tended to distribute their behavior such that both sources of reinforcement (automatic and stimulus presentation) were available. This behavior can be described in terms of the matching relation (see Appendix B).

## Establishing Operations and Appropriate Behavior

Despite increasing use of establishing operations in interventions, the field of applied behavior analysis, with exception of the area of verbal behavior (Duker, Kraaykamp, & Visser, 1994; Hall & Sundberg, 1987; Michael, 1988; Sundberg, 1993; Sundberg, Loeb, Hale, & Eigenheer, 2001), has largely ignored the use of establishing operations in addressing appropriate behavior. Only a few studies have investigated the use of establishing operations and appropriate behavior.

One of the earliest studies to address appropriate behavior and establishing operations was performed by Gewirtz and Baer (1958), who examined the role of deprivation of praise on a marble-dropping task in children. Children's' marble-dropping was higher in conditions when praise was not given prior to the task then when praise was delivered before the task. In this case, praise served as an EO that affected responding in relation to the length of deprivation.

Konarski, Johnson, Crowell, & Whitman (1980) addressed the response deprivation hypothesis, which states that when access to an activity is restricted to below baseline levels, the organism will engage in the targeted activity at a level exceeding baseline rates in order to gain access to the deprived activity (Timberlake & Allison 1974). Konarski, et al. (1980) engaged two children in either a coloring task (preferred) or math problems task (less preferred). In order to gain access to the next task (coloring or math depending on any specific trial), students had to meet an engagement level that had been mathematically determined based on free-operant levels of activity. Both students increased their coloring engagement time in order to gain access to the deprived and less preferred activity (math problems).

Vollmer and Iwata (1991) required five males with developmental disabilities to perform motor-tasks in both satiation and deprivation conditions. Small food items, praise, and music were used as reinforcers. For all five participants, responding decreased following the satiation condition and increased following the deprivation condition.

More recently, Klatt, Sherman, & Sheldon (2000) examined the effect of deprivation of preferred activities on three individuals with developmental disabilities. Deprivation of high-preference activities greatly increased engagement during transition periods, when responding was typically low. These results suggest that contriving establishing operations in an attempt to increase engagement in appropriate activities may be an effective strategy.

## Using Establishing Operations as a Teaching Strategy

The success of capturing (i.e., using an EO as it occurs naturally in the environment) and contriving (i.e., manipulating the environment to create an establishing operation) EOs to teach mands to children with autism and to increase engagement in developmentally disabled individuals suggests that EOs might be useful in teaching socially appropriate behavior. One value of studying establishing operations is that it is likely to lead to more effective techniques of teaching appropriate behavior. Their use extends beyond the treatment of aberrant behavior, with the possibility of maximizing responding or even teaching new skills needed for individuals with developmental disabilities.

Studying the effects of capturing and contriving establishing operations in teaching appropriate behavior may accomplish several goals. First, in conducting a preference assessment, the researcher will be able to determine what stimuli can be used as the most effective reinforcers. The use of identified effective reinforcers, as opposed to arbitrarily selected ones, is essential in teaching and maintaining appropriate behavior (Mason, McGee, Farmer-Dougan, & Risley, 1989). Second, this kind of study will demonstrate effective times in which to perform teaching trials. Through the analysis of satiation and deprivation periods, the study may show the most effective times to teach new skills. Third, this line of research will demonstrate ways to increase engagement in activities. By providing both novel reinforcers and teaching new skills, individuals will have the opportunity to engage in more appropriate activities. Fourth, the teaching trials will provide alternatives to challenging behaviors. Fifth, this type of study will provide access to additional reinforcers that are not usually available. The introduction of a presumably novel reinforcer and task will provide the individuals with additional reinforcers and activities to earn them. Finally, manipulating establishing operations in teaching appropriate behaviors creates the possibility of providing new skills that may increase the consumer’s independence and access within the community. The purpose of the present study is to investigate the effects of contriving establishing operations to teach new skills to individuals with developmental disabilities.

# Chapter II. EXPERIMENT 1

## Method

### *Participants*

Participants were selected from a private, non-profit, rehabilitative adult day service run by a community mental health-mental retardation center located in the southeast. Three individuals diagnosed with mental retardation were selected based on a preliminary reinforcer preference assessment test to measure the reinforcing efficacy of playing computer games.

The first participant, J.M., was a 54 year-old female with a diagnosis of mild mental retardation and a personality disorder. J.M. lived in a supported living apartment complex with a female roommate. The second participant, M.B., was a 27 year-old male with a diagnosis of mental retardation with severity unspecified and impulse control disorder. He lived with his mother, brother, and cousin. The third participant, C.B., was a 29-year old male with a diagnosis of moderate mental retardation and ADHD combined type. He lived in a group home run by the community mental health-mental retardation center.

Only individuals with appropriate consent were included in this study. The consent package included a description of the procedures and possible risks of the experiment. Possible signs of distress were described and when present during the testing caused the termination of the session. The community mental health-mental retardation center and the participant (legal guardian when applicable) were required to provide consent for each individual's participation before any testing began.

At the beginning of each session, individuals were asked if they would like to participate in the activity. If the individuals responded no, they were not required to participate in that day's session. If the individuals responded yes, they were taken to the training room. Prior to the beginning of the session, each individual was informed that they could stop the activity at any time.

*Apparatus and Setting*

The experiment was conducted in an office at the rehabilitative day service. Individuals were seated in front of a Dell Optiplex GX150 computer system equipped with an add-on touch screen (17" black KTMT-1700 Touch Screens, Inc.). Four response panels (2.5" W x 3.25" L) were centered and aligned horizontally on the computer monitor (.25" between panels). Four distinct geometric shapes were used as stimuli. The first panel contained a star, the second panel a circle, the third panel a triangle, and the fourth panel a hexagon (Figure A1). Stimuli for the experiment were displayed using the software program Visual Basic ®. This program also automatically and continuously recorded responding and created graphs of the data.

Several computer games were available as possible reinforcers. The following games were downloaded from miniclip.com and were used during the experiment: Mission Mars, Flashman, Crashdown, Magicballs, Space Invaders, Gutterball, and Galactic Warrior.

*Procedure*

*Preference assessment.* The first phase of the experiment consisted of a reinforcer preference assessment to identify each individual's preference for computer games as defined by the amount of time they were willing to spend playing the game. Previous studies have shown that the ability to identify effective reinforcers for individuals with developmental disabilities can affect the analysis of the experiment (e.g., DeLeon, Fisher, Rodriguez-Catter, Maglieri, Herman, & Marhefka, 2001; Smith, Iwata, Goh, & Shore, 1995b).

The preference assessment began by bringing the individual into the training room and having them sit down. The experimenter then presented the individual with one of the computer games. The experimenter then demonstrated how to play the computer game and asked the individual if he/she would like to try the activity. If the individual responded that he/she would like to try the activity, the experimenter started the game and began recording engagement data. Engagement was defined as actively manipulating the equipment required to play the game. The experimenter recorded engagement in terms of the aggregate duration (elapsed time between beginning and ending of engagement). Data collection continued until the individual was not engaged for a period of two minutes or until they asked to stop. Each individual was presented with the opportunity to play one computer game per session. The engagement data were used to identify the computer game(s) the individual most preferred. The preferred games were then used as reinforcers for completion of the learning task.

*Experimental phase.* An incremental repeated acquisition (IRA) procedure was used similar to that reported by Paule, Cranmer, Wilkins, Stern, & Hoffman, (1988). Repeated acquisition tasks are procedures in which subjects continually learn different discriminations within a general task. This procedure is beneficial when studying learning within subjects in several ways. First, learning can be clearly defined in terms of the acquisition of specific response sequences. Secondly, the parameters of the procedure can be changed to accommodate the participants' abilities and the needs of the experiment (e.g., changing the response chain requirement) without changing the basic features of the task. Third, the general contingencies do not change across iterations, which allows for stable conditions while studying acquisition. Finally, a detailed analysis of responses can provide insight into the behavioral mechanisms underlying the effects of the experimental condition (Cohn & Paule, 1993; Cohn, MacPhail, & Paule, 1996).

The experimental phase began by bringing the individual into the training room and having him/her sit down. The individual was then asked which computer game they would like to play today. The game that the individual requested was then used as the reinforcer for correct trials for the remainder of the session. Once the individual was seated, the computer monitor was turned on. The monitor displayed four geometric shapes (star—first panel, circle—second panel, triangle—third panel, hexagon—fourth panel) projected onto a colored screen. The screen color at any one time was determined by where the individual was in the response chain (e.g., blue for the first response, orange for the second response, scarlet for the third response, and grey for the fourth response). Position of the geometric shapes and presentation of the screen colors were kept constant throughout the experiment. During the one-link response chain, pressing the correct response panel resulted in the presentation of the reinforcer the individual had selected prior to the start of the session. The preferred computer game of the individual was presented for 40 seconds. After the 40 seconds of computer game access, the game shut off, the response screen reappeared, and a new trial began.

Once the participant selected the correct panel for three consecutive, errorless trials, the two-link response chain began. Completion of the chain turned off the panel lights and presented the reinforcer. If the individual pressed the incorrect panel (e.g., star panel when the circle panel was required), a blackout occurred for three seconds in which all panels darkened and any responses were ineffective. The chain then reset to the first required response in the sequence.

Once the individual completed three consecutive, errorless trials, a three-link response chain began. The chain length increased to a four-link response chain when the participant met the three consecutive, errorless trials criterion. Trials continued until the individual requested to stop, 20 minutes passed, or the individual completed three consecutive, errorless, four-link response trials (Figure A2).

In order to establish the continuous learning of sequences, the response chains were changed from session to session. The chain sequences were selected to be equivalent in several ways, with restrictions on their ordering across sessions (Thompson, 1973). First, a correct background color and shape did not repeat in the following session. Second, adjacent positions were always different (e.g., never two of the same panel responses in succession). Finally, within a set of eight sequences, each panel position appeared in sequential order equally often (twice) (Thompson, 1973). A sample of an eight-sequence set would be: panel one, panel three, panel four, panel two (1342), 3214, 2431, 4123, 1234, 2143, 4312, and 3421.

*Deprivation Periods.* An alternating treatment design (Barlow & Hayes, 1979) was used to examine the possible effects of deprivation on learning the response chains. The experimental phase began by selecting one of the four levels of deprivation (15min, 2hrs, 1 day, 2-3 days). Due to time restrictions and limited access to the participants, deprivation periods were predetermined. Upon completion of the first session of the day (1 day or 2-3 days), participants then entered a 15-minute or 2-hour deprivation period. If a participant was in the "2-hour condition," then the computer task was presented again two hours later. If an individual could not participate in a condition due to schedule conflicts then the next available deprivation period was chosen (e.g., if the individual was not available for a 2-hour condition, then proceed to the 1 day or 2-3 days condition). No more than three sessions were administered each testing day.

The deprivation levels used were based on Klatt et al.'s (2000) study that used lengths of time that may normally occur with access to activities, with the 15-minute condition representing a continuously available activity, the 2-hour condition an activity available every couple of hours, and the 1-3 day conditions a restricted activity. Sessions were presented between the hours of 8 o'clock a.m. and 12 o'clock p.m. with the 1 day and 2-3 day deprivation conditions being presented between 8-9 a.m. The shorter deprivation periods (15-minutes and 2-hours) were then presented accordingly at different times of the day based on the availability of the experimenter and the participant.

*Data Analysis*

At the end of each day's session, the data were examined to determine the effects associated with each deprivation period. Performance was examined in terms of the mean number of errors per deprivation period, the percentage of correct responses per session, the number of attempts versus the number of reinforcers, the number of errors per session, and the number of responses per session. These data were graphed and compared to determine possible effects of deprivation. Lower levels of errors in the longer deprivation periods (e.g., 1 day and 2-3 days) and higher levels of errors in the shorter deprivation periods (e.g., 15-min and 2-hr) would suggest that the deprivation level had been effective in increasing the learning of the response chains.

## Results and Discussion

The results of the reinforcer preference assessments for each individual are depicted in Figure 1. These data indicate that at least two games were identified for each individual that could serve as possible reinforcers during the learning task. Although all games were available to be chosen as a reinforcer prior to the learning task beginning, each individual always selected one of the games that they engaged in for the entire 20-minute time limit during the preference assessment.

The performances of the individuals in the learning task are depicted in Table 1 in terms of mean number of errors across all response chains and deprivation periods. Despite individual differences, each participant displayed a higher number of errors during the 15-minute deprivation period than in any other condition. For example, large differences can be seen in the average number of errors C.B. made across deprivation periods ($M$ = 163.33 vs. 70.00 vs. 39.00 vs. 37.00 under 15 min, 2 hr, 1 day, and 2-3 day deprivation periods, respectively). Individual differences were present again in the 2-hour deprivation condition, but in each case, errors in the 2-hour condition were higher than those in the 1-3 day deprivation periods. In the case of M.B., there was not a large difference in errors between the 2-hour ($M$ = 24.66), 1 day ($M$ = 19.00), and 2-3

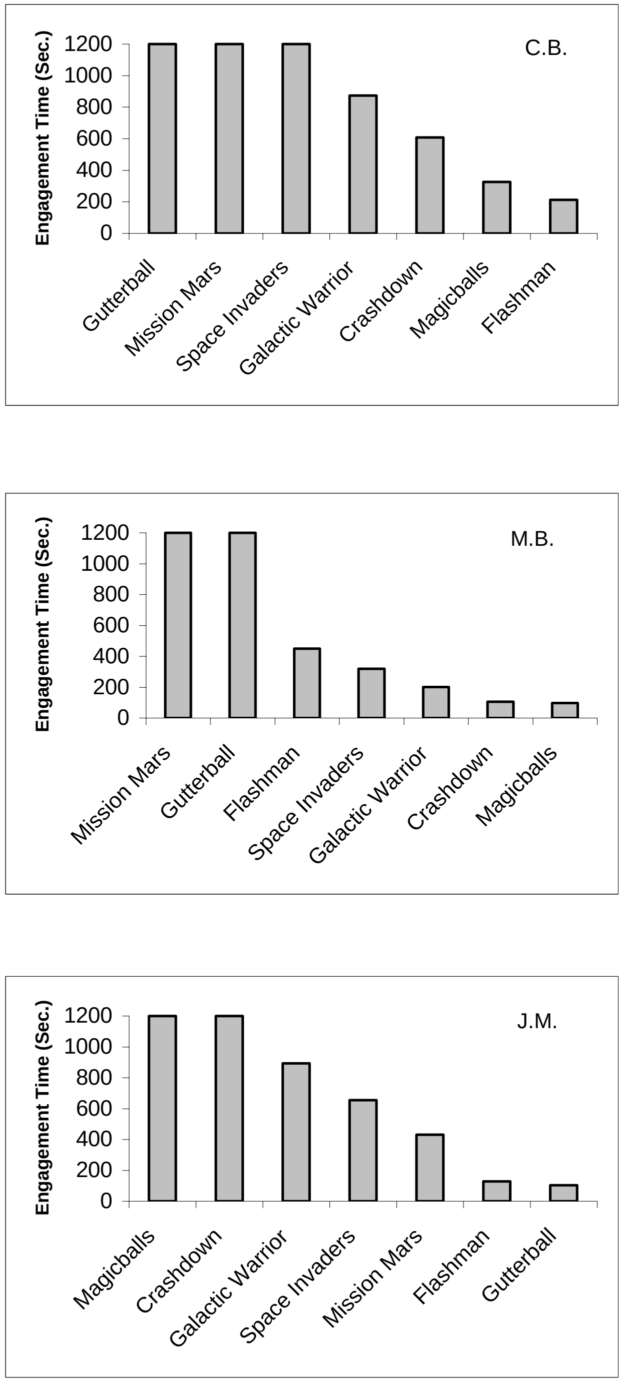


Figure 1. Reinforcer preference assessment measured by engagement time (sec.) in experiment 1.

Table 1

Mean Number of Errors – Experiment 1

| Participant: C.B. | 15 Minute | 2 Hour | 1 Day | 2-3 Days |
|---|---|---|---|---|
| 1-Link | 3.71 | 2.00 | 1.13 | 1.20 |
| 2-Link | 7.64 | 6.71 | 4.88 | 3.50 |
| 3-Link | 23.64 | 14.90 | 8.63 | 6.40 |
| **Total** | 163.33 | 70.00 | 39.00 | 37.00 |

| Participant: M.B. | 15 Minute | 2 Hour | 1 Day | 2-3 Days |
|---|---|---|---|---|
| 1-Link | 1.86 | 2.60 | 1.16 | 0.83 |
| 2-Link | 10.43 | 5.20 | 2.00 | 2.83 |
| 3-Link | 8.38 | 7.00 | 6.33 | 5.17 |
| **Total** | 93.66 | 24.66 | 19.00 | 17.66 |

| Participant: J.M. | 15 Minute | 2 Hour | 1 Day | 2-3 Days |
|---|---|---|---|---|
| 1-Link | 3.86 | 2.33 | 1.75 | 0.90 |
| 2-Link | 12.57 | 10.44 | 2.00 | 4.20 |
| 3-Link | 21.50 | 11.11 | 5.00 | 8.20 |
| **Total** | 162.67 | 71.66 | 23.30 | 44.33 |

day ($M$ = 17.66) deprivation conditions. The smaller number of errors made by M.B., as well as the smaller differences between deprivation conditions might be attributed to the fact that M.B. was diagnosed as mentally retarded with severity unspecified, while the other participants were diagnosed as more severely impaired.

When determining whether the deprivation periods were effective as establishing operations, it was necessary to examine where the specific error responses were occurring. Figure 2 shows the percentage of errors across all deprivation periods that occurred on response panels that were correct in the previous session. For example, during a one-link response chain in the 2-3 day deprivation period, the triangle was the correct response. During the next session, (e.g., 15-minute deprivation period, 1-link response—circle is correct response) the percentage of errors made on the previously correct panel (e.g., triangle) were recorded.

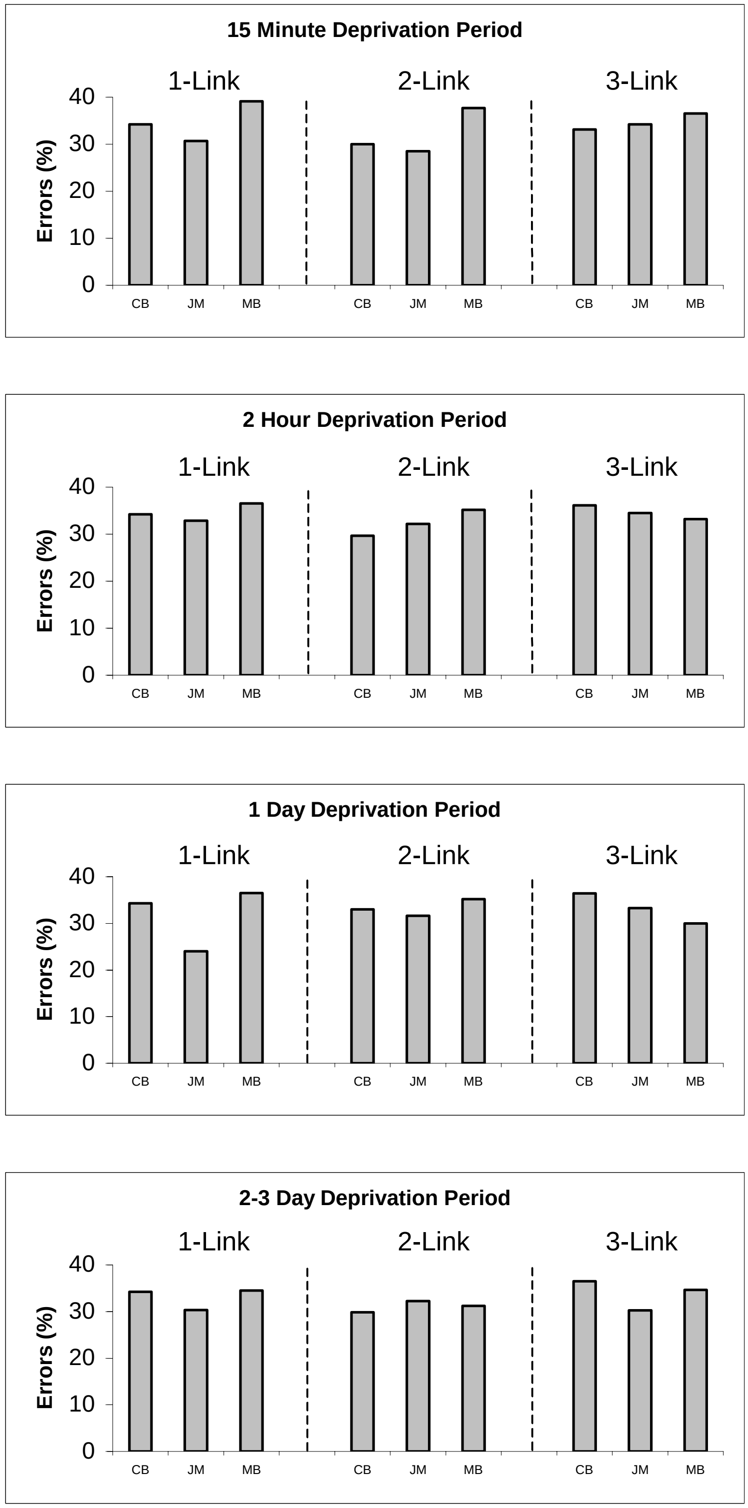


Figure 2. Percentage of errors made on response panels that were correct in the previous session in experiment 1.

The results show that the errors that individuals made were not based on sequence effects from the previous session.

When examining the data to see how the number of links in the response chain affected the number of errors, it was necessary to control for the number of possible opportunities to respond. For example, if an individual took 15 trials to meet mastery criterion in the 2-link response chain, and they took 30 trials to meet mastery criterion in the 3-link response chain, then the individual would have more trials in which to make errors during the 3-link response. To control for this, the data were examined using the percentage of correct responses during sessions. Figure 3 shows the percentage of correct responses across all response chains in the 15-minute deprivation period. With a few minor differences—between 1-day and 2-3 day deprivation periods (see Figures 4 & 5, respectively) —each individual responded most accurately in the 1-link response chains and decreased in accuracy as the number of links in the response chain increased.

Figure 6 depicts the accuracy of the individual's responses as displayed by the number of attempts versus the number of reinforcers received. An attempt was defined as any response that returned the response screen to the first link in the chain. These results show that individuals made more attempts during the shorter deprivation periods than during the longer deprivation periods. In addition, the graphs show that as the chain length increased, the number of attempts increased.

Figure 7 shows that for all three participants during the 3-link response chain the number of errors was highest in the 15-minute deprivation condition and gradually decreased as the deprivation period lengthened; however, there appears to be no

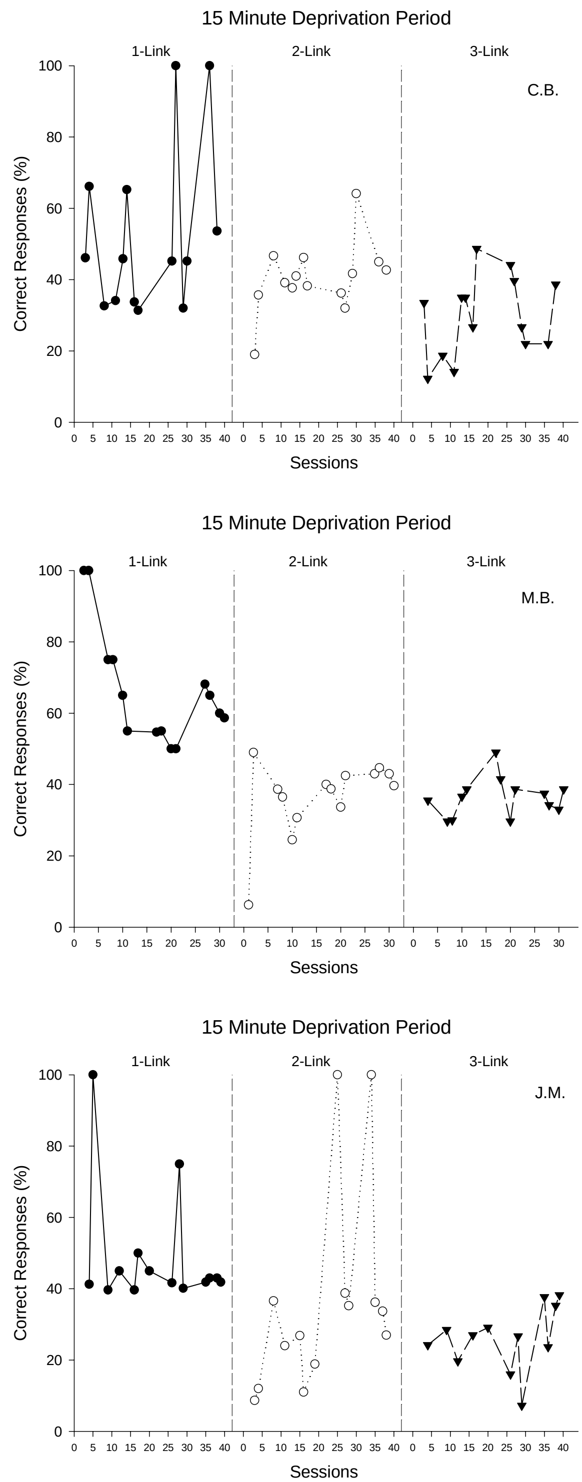


Figure 3. Correct responses (%) across all response chains in the 15-minute deprivation period in experiment 1.

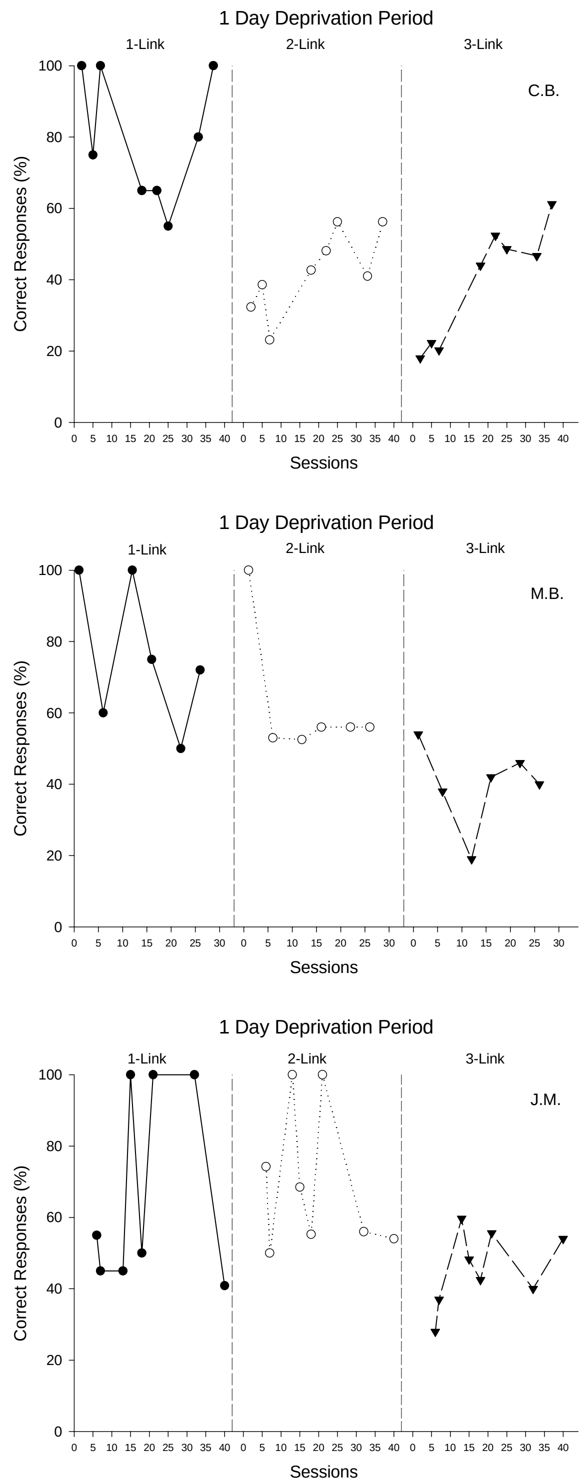


Figure 4. Correct responses (%) across all response chains in the 1-day deprivation period in experiment 1

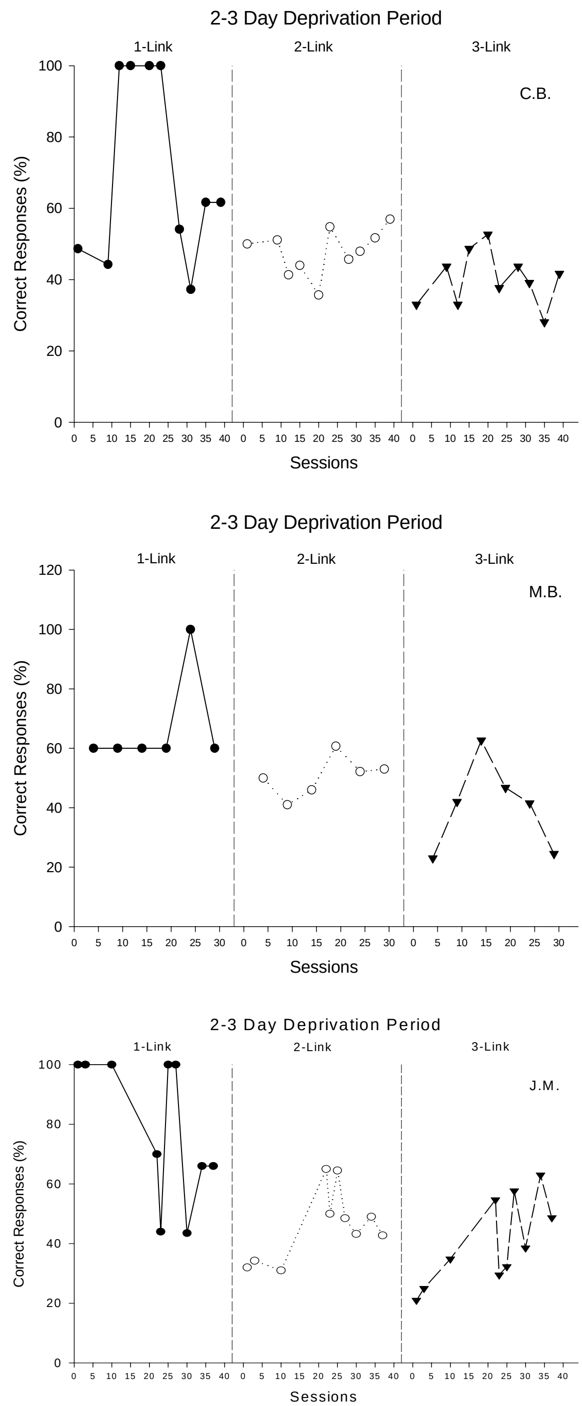


Figure 5. Correct responses (%) across all response chains in the 2-3 day deprivation period in experiment 1

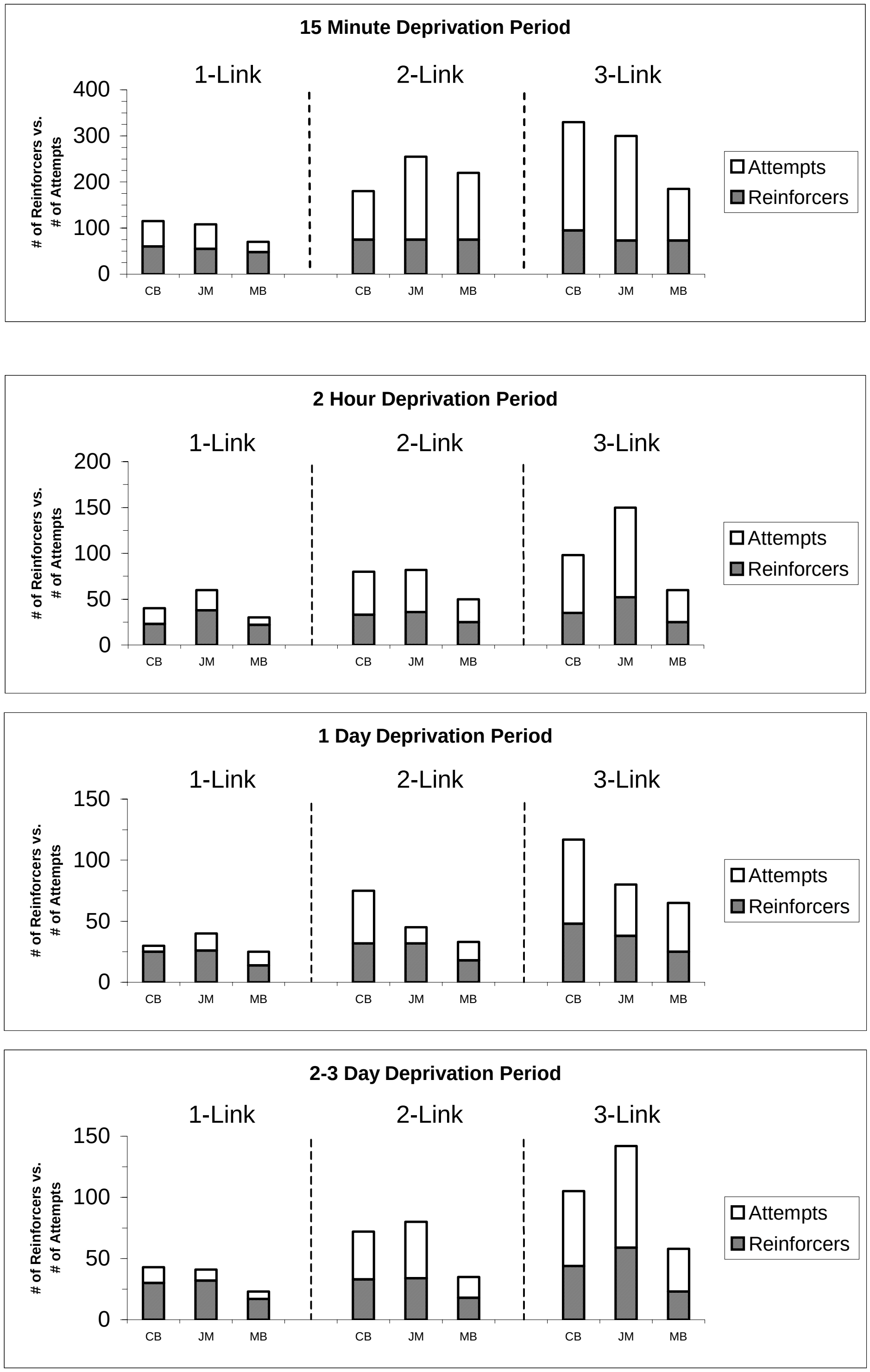


Figure 6. The number of attempts versus the number of reinforcers across all deprivation periods and response chains in experiment 1.

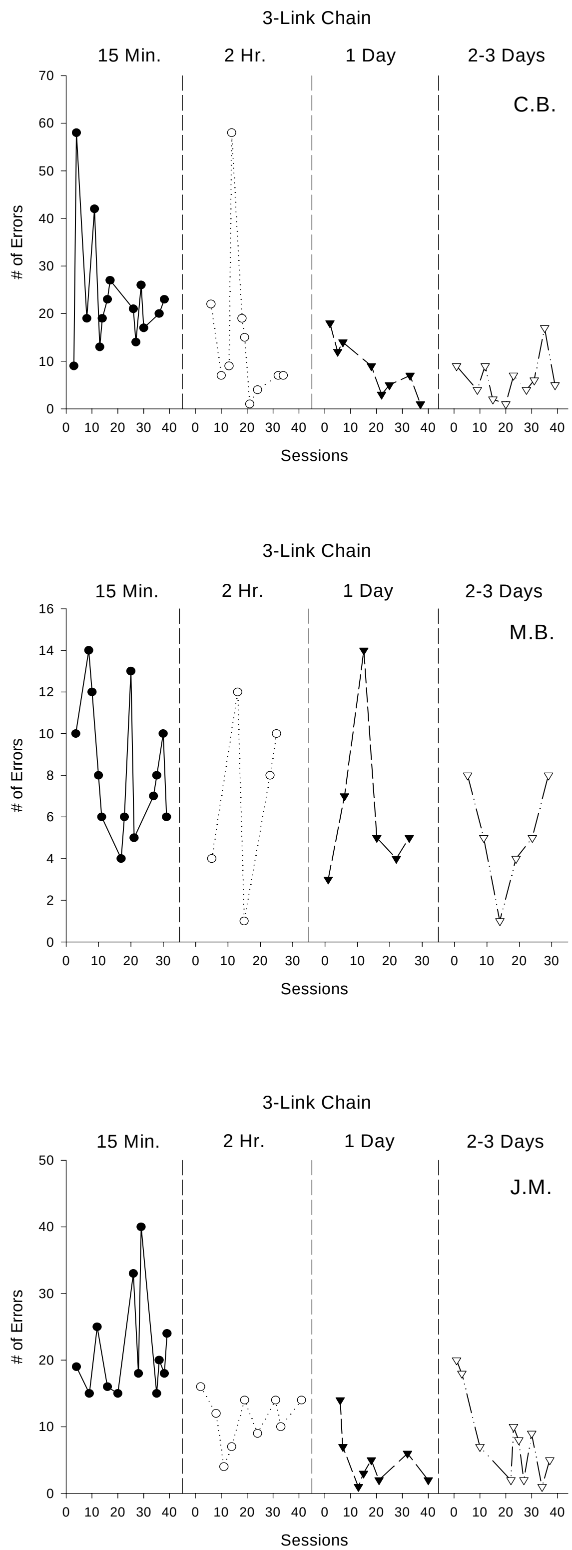


Figure 7. Number of errors in a 3-link response chain across all deprivation periods in experiment 1.

difference between the 1-day and 2-3 day deprivation periods. These results show that the shorter deprivation times – particularly the 15-minute period – corresponded to more errors per session compared to the longer deprivation periods (e.g., 1-3 days) which corresponded to fewer errors per session. Similar results were seen in the 2-link response chains (see Figure 8), and no distinct difference was found between 1-link response chains (see Figure 9) in any of the deprivation periods. The fact that no differences were found in the 1-link response chains across all of the deprivation periods suggests that response effort (e.g., physical/mental exertion required to complete the task) may have influenced the impact of the establishing operation on responses during the session (Kerwin, Ahearn, Eicher, & Burd, 1995; Piazza, Roane, Keeney, Boney, & Abt, 2002). The lower number of errors in the l-link response chains as compared to the other response chains shows that individuals were able to learn these response requirements more efficiently. The results suggest the possibility that the smaller amount of effort required to complete the 1-link response chain, as compared to the longer chains, negated the possible effects of the shorter deprivation periods.

The rate of responding (per sec.) during each deprivation condition is depicted in Figure 10. The highest rate of responding occurred in the 2-3 days and 1-day deprivation periods, with lower rates of responding in the shorter deprivation periods (15 min. and 2 hr.). The lower level of engagement (i.e., rate of responding) during the shorter deprivation periods is consistent based on previous research that indicated a decrease in engagement levels during satiation trials (Vollmer & Iwata, 1991; Klatt et al., 2000).

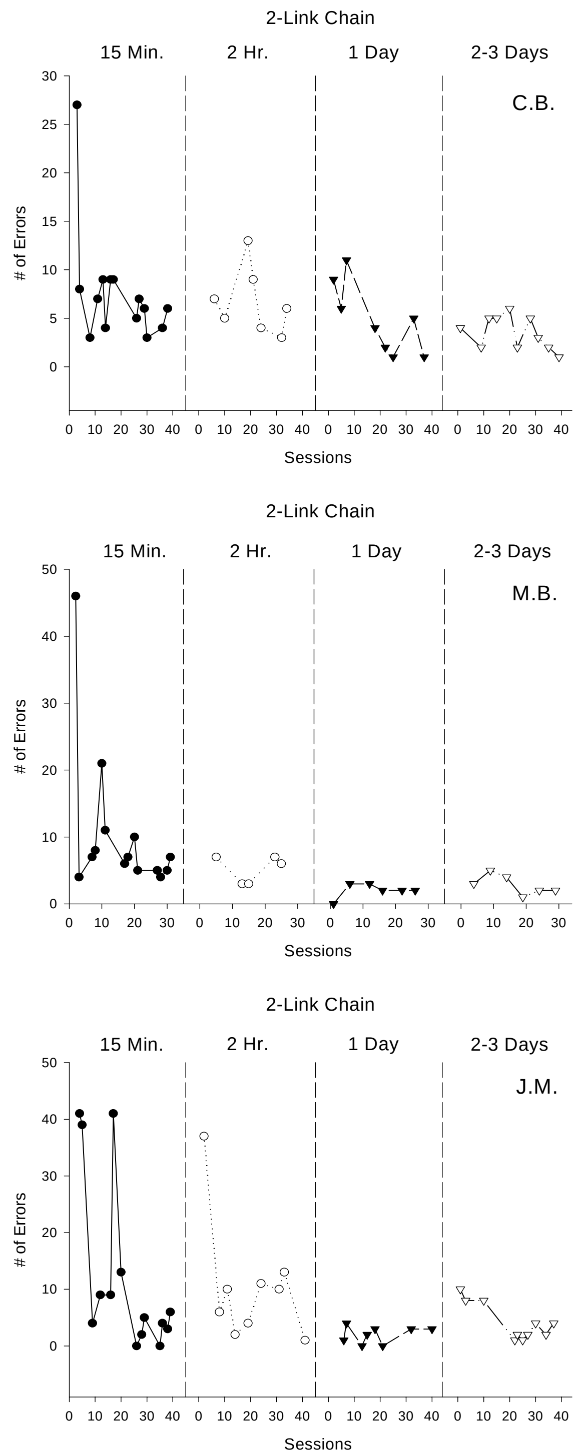


Figure 8. Number of errors in a 2-link response chain across all deprivation periods in experiment 1.

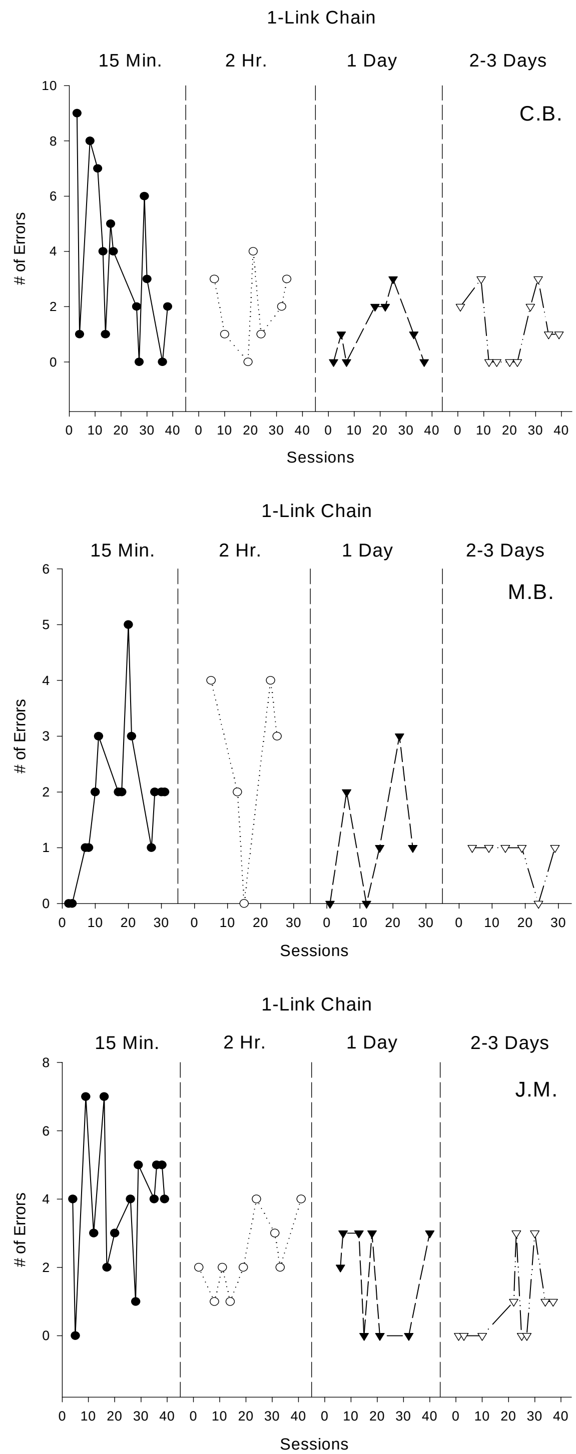


Figure 9. Number of errors in a 1-link response chain across all deprivation periods in experiment 1.

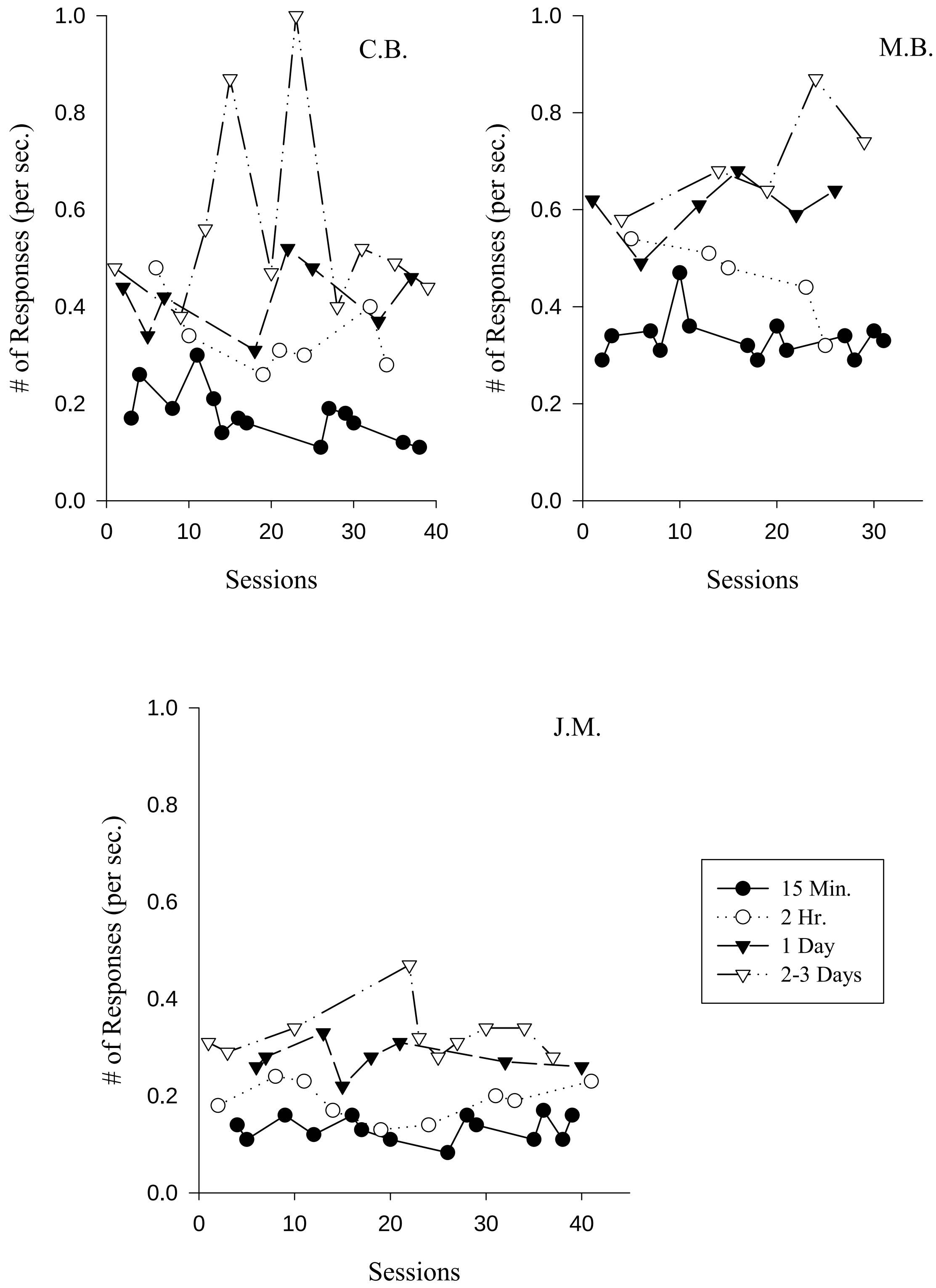

Figure 10. Rate of responding (per sec.) by individuals across all deprivation periods in experiment 1.

In summary, the large difference in the number of errors in the 15-minute deprivation condition versus the other deprivation periods was consistent with previous studies examining the effects of establishing operations on individual's responses (Klatt et al., 2000; Vollmer & Iwata, 1991). However, the relatively low number of errors in the 2-hour deprivation condition suggests that the deprivation period was not effective in providing a level of satiation. Additionally, the total number of errors in each session across all deprivation periods was much lower than what effective establishing operations would predict. These findings suggest that the learning task was easier than originally designed. Although the 2-hour deprivation period was effective in increasing the number of errors during the sessions, its effects were more similar to those of the 1-3 day deprivation periods. Additionally, there was not a noticeable difference between the 1-day and 2-3 day deprivation periods. Although participants had the opportunity to reach the 4-link response chain, due to the time limit on the sessions they were unable to. These unexpected findings, and a methodological flaw, led to the development of experiment 2.

# Chapter III. EXPERIMENT 2

*Rationale*

Experiment 2 was necessary to address several problems encountered during experiment 1. Analysis of the data showed that the largest noticeable difference in responding was between the 15-minute deprivation period and the longer deprivation periods (1 day and 2-3 days). Previous studies (e.g., Klatt et al., 2000) suggested that there would be a difference in responding between the 2-hour deprivation period and the longer deprivation periods that was not found. One possible reason for these results was that the learning task required discriminating between distinct geometric shapes. Discriminating between distinctly different stimuli may have limited the effect of the deprivation periods on responding. To address this problem, experiment two used stimuli that were more similar in geometric design (e.g., different star shapes).

In experiment 1, a 20-minute time limit was placed on each session. At the end of 20 minutes, the session was stopped regardless of where the individual was in the task. Placing a time limit on the sessions limited each participant in the number of responses and errors they could make in each chain of the task, with some participants never reaching a four-chain response. Removing the time limit in experiment 2 allowed each individual to spend as much time as necessary in each chain to fulfill the three consecutive, errorless, response requirement before moving on to the next chain or finishing the session

## Method

### *Participants*

Participants for experiment 2 were selected from the same adult rehabilitative day service as the participants from experiment one. Three individuals diagnosed with mental retardation were selected based on a preliminary reinforcer preference assessment test to measure the reinforcing efficacy of playing computer games.

The first participant, E.D., was a 43 year-old male diagnosed with mild mental retardation. E.D. lived in a group home run by the community mental health-mental retardation center. The second participant, M.V., was a 37 year-old male diagnosed with moderate mental retardation, schizophrenia (paranoid type), and cerebral palsy. M.V. also lived in a group home run by the community mental health-mental retardation center. The third participant, A.C., was a 39 year-old male diagnosed with moderate mental retardation. A.C. lived in a group home run by the community mental health-mental retardation center.

### *Apparatus and Setting*

Experiment 2 was conducted in the same office and using the same computer equipment as experiment 1. Four response panels (2.75” W x 3.60” L) were centered and aligned horizontally on the computer monitor (.25” between panels). Four different shapes of stars were used as stimuli. The first panel contained an eight-pointed star, the second panel a five-pointed star, the third panel a four-pointed star, and the fourth panel a six-pointed star (Figure A3). Stimuli for the experiment were displayed using the software program Visual Basic ®. This program also automatically and continuously recorded responding and created graphs of the data.

*Procedure*

The procedure for experiment 2 was similar to the one described in experiment 1. Individuals were given a reinforcer preference assessment, with the most preferred computer game(s) serving as the reinforcer during testing sessions. An incremental repeated acquisition task was used to assess the possible effects of the deprivation periods on the learning of the response sequences. However, trials continued until the individual requested to stop, or the individual completed three consecutive, errorless, four-chain response trials.

*Data Analysis*

The data from experiment 2 were analyzed using the same method as that described in experiment 1. Performance was examined in terms of the mean number of errors per deprivation period, the percentage of correct responses per session, the number of attempts versus the number of reinforcers, the number of errors per session, and the number of responses per session.

## Results and Discussion

The results of the reinforcer preference assessments conducted for each individual are depicted in Figure 11. The assessment identified at least one game that each individual engaged in for the entire 20-minute time limit. Although there were several games available to choose as reinforcers prior to each session, each individual always selected the game that they engaged in for the longest time during the reinforcer preference assessment.

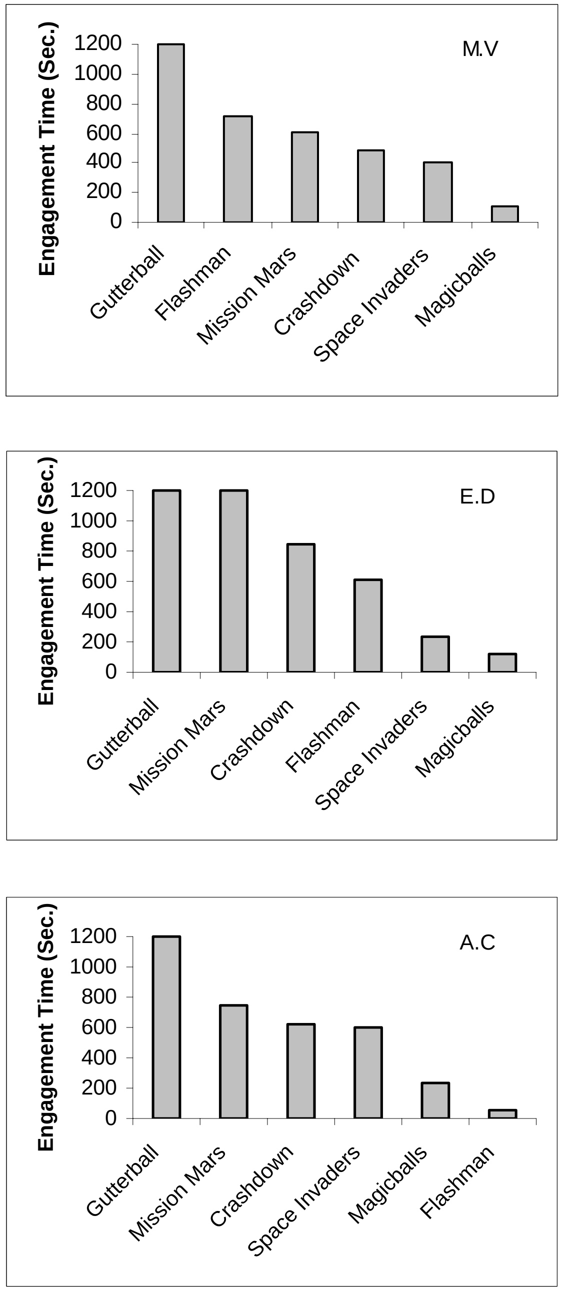


Figure 11. Reinforcer preference assessment measured by engagement time (sec.) in experiment 2.

Table 2 displays the mean number of errors made by each individual across all deprivation periods and response chains. The mean number of errors in each period and chain in experiment 2 were considerably higher than those recorded during experiment 1. The increase in the mean number of errors was most likely due to the stimuli being changed from four distinct geometric shapes (e.g., circle, triangle, etc.) in experiment 1 to four different shapes of stars (e.g., four pointed, six pointed, etc.). Despite individual differences, each individual made the most errors during the 15-minute deprivation and the number of errors decreased as the deprivation period increased (similar to results from experiment 1). For example, large differences can be seen in the mean number of errors A.C. made across deprivation periods (*M* = 283.50 vs. 154.50 vs. 62.00 vs. 81.00

Table 2

Mean Number of Errors – Experiment 2

| Participant: M.V. | 15 Minute | 2 Hour | 1 Day | 2-3 Days |
|---|---|---|---|---|
| 1-Link | 2.00 | 3.37 | 1.44 | 1.50 |
| 2-Link | 28.13 | 11.88 | 5.66 | 4.88 |
| 3-Link | 46.00 | 20.75 | 9.11 | 10.87 |
| 4-Link | 63.428 | 23.50 | 12.11 | 10.50 |
| **Total** | 263.00 | 119.00 | 63.75 | 55.50 |

| Participant: E.D. | 15 Minute | 2 Hour | 1 Day | 2-3 Days |
|---|---|---|---|---|
| 1-Link | 5.71 | 2.63 | 2.66 | 2.13 |
| 2-Link | 38.71 | 18.75 | 4.88 | 4.38 |
| 3-Link | 62.00 | 37.38 | 15.55 | 13.88 |
| 4-Link | 88.57 | 56.88 | 17.00 | 28.00 |
| **Total** | 341.25 | 231.25 | 62.00 | 96.75 |

| Participant: A.C. | 15 Minute | 2 Hour | 1 Day | 2-3 Days |
|---|---|---|---|---|
| 1-Link | 2.63 | 1.75 | 2.63 | 4.00 |
| 2-Link | 29.63 | 15.25 | 6.00 | 5.63 |
| 3-Link | 56.75 | 28.63 | 9.25 | 13.13 |
| 4-Link | 52.75 | 31.63 | 13.13 | 17.75 |
| **Total** | 283.50 | 154.50 | 62.00 | 81.00 |

under 15 min, 2 hr, 1 day, and 2-3 days, respectively). For each individual, the number of errors in the 2-hour deprivation condition was less than those in the 15-minute deprivation period and greater than those in the 1-3 day deprivation periods. The difference between the number of errors in the 2-hour deprivation period and the 1-3 day deprivation periods was relatively larger in experiment 2 than it was in experiment 1. There was also a larger difference between errors in the 1-day deprivation period and the 2-3 day deprivation period, although they do not appear to be substantial.

In order to determine whether the deprivation periods were effective as establishing operations, it was necessary to examine where the specific error responses occurred. Figure 12 shows the percentage of errors across all deprivation periods that occurred on response panels that were correct in the previous session. Results show that the percentage of errors occurring within each session was spread relatively evenly across the three possible incorrect response panels.

When examining the effects of the response chain length on the learning task, it was necessary to control for the number of opportunities to respond. Figure 13 depicts the percentage of correct responses across all response chains during the 2-hour deprivation period. Aside from individual differences, each participant responded most accurately during the 1-link response chain and decreased in accuracy as the length of the response chain increased. Similar results were found in the 15-minute, 1-day, and 2-3 day deprivation periods (see Figures 14, 15, & 16, respectively). Figure 17 illustrates the accuracy of responding by displaying the number of attempts versus the number of reinforcers received by each individual across all deprivation periods and response

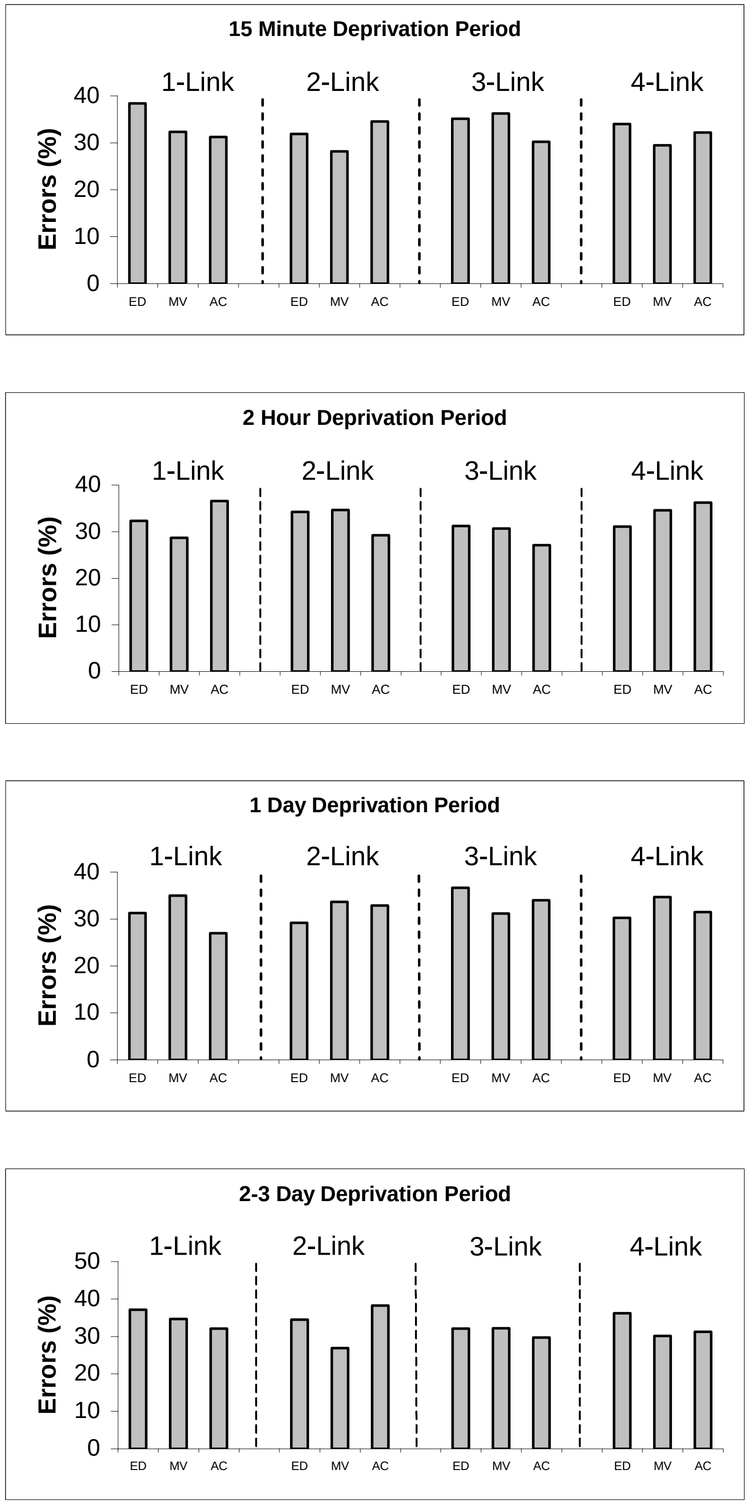


Figure 12. Percentage of errors made on response panels that were correct in the previous session in experiment 2.

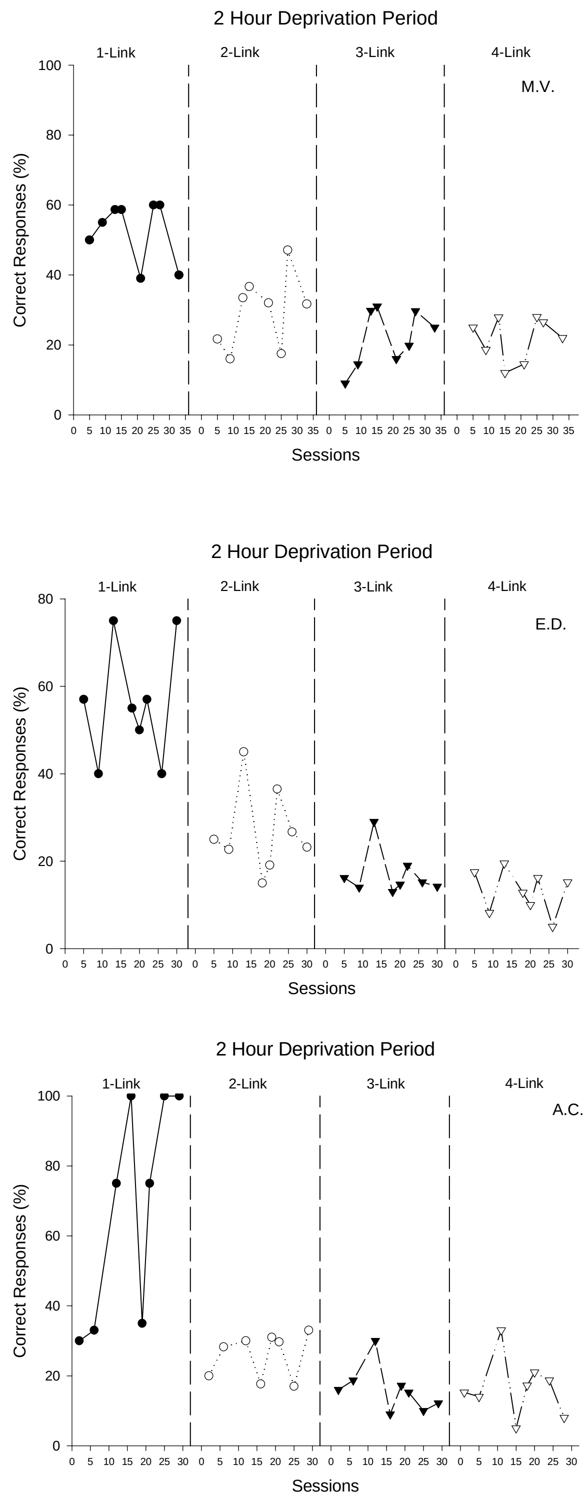


Figure 13. Correct responses (%) across all response chains in the 2-hour deprivation period in experiment 2.

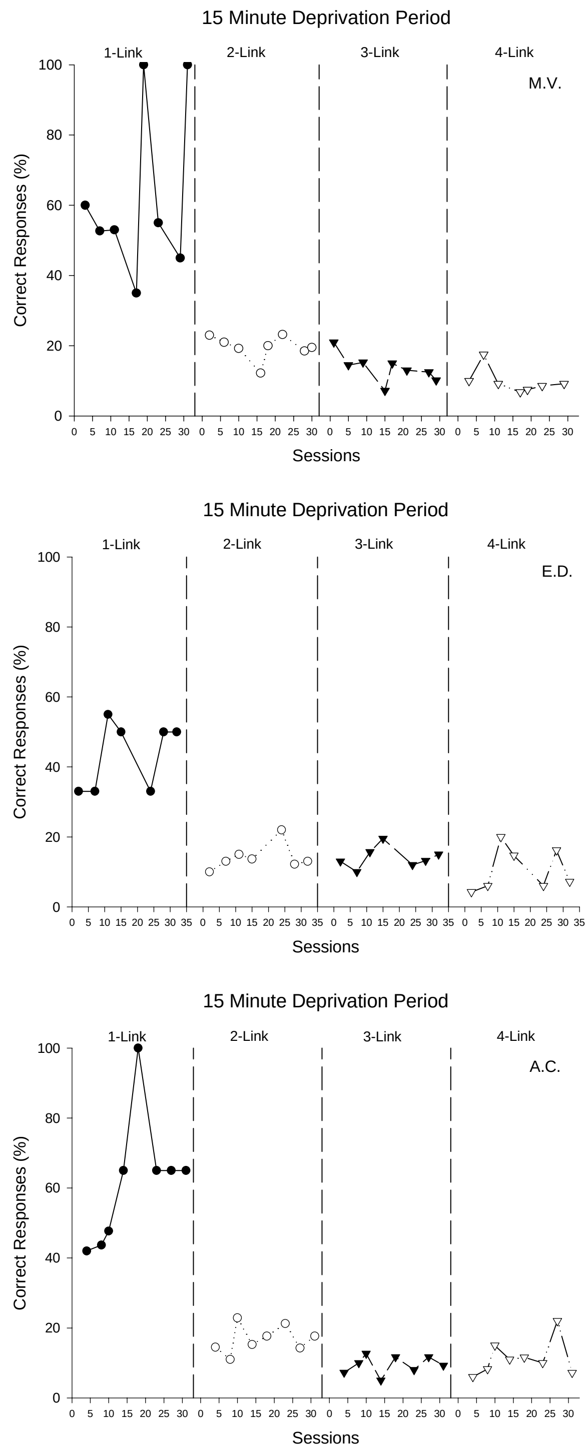


Figure 14. Correct responses (%) across all response chains in the 15-minute deprivation period in experiment 2.

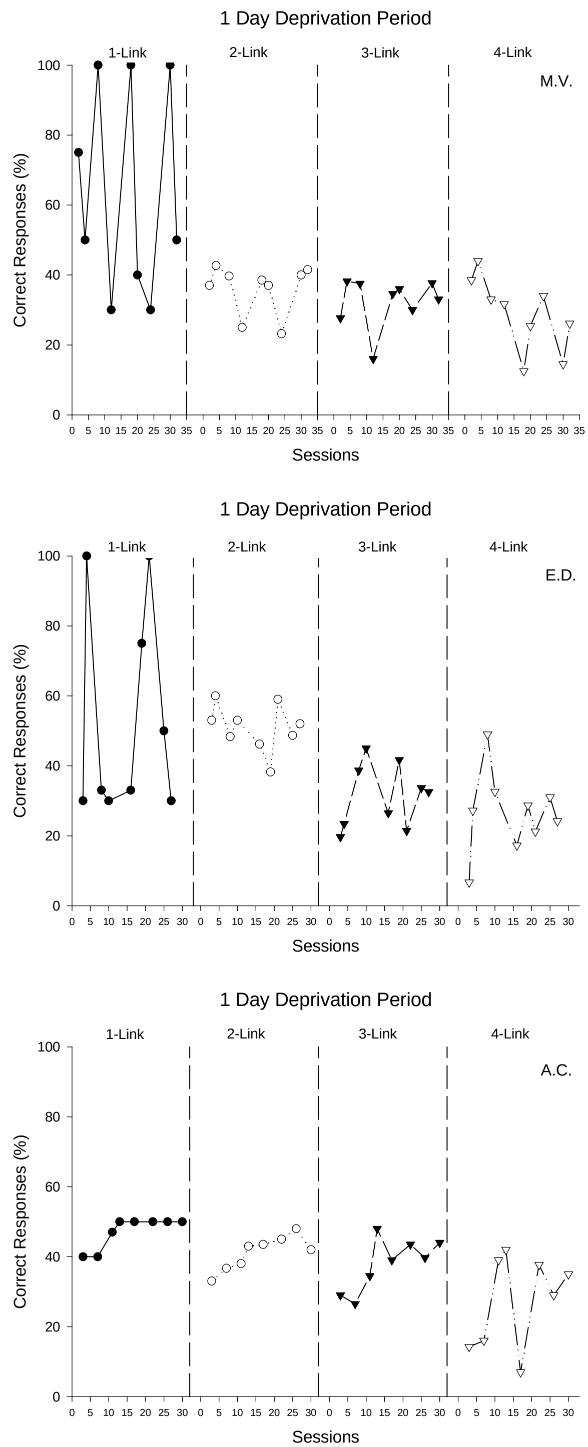


Figure 15. Correct responses (%) across all response chains in the 1-day deprivation period in experiment 2.

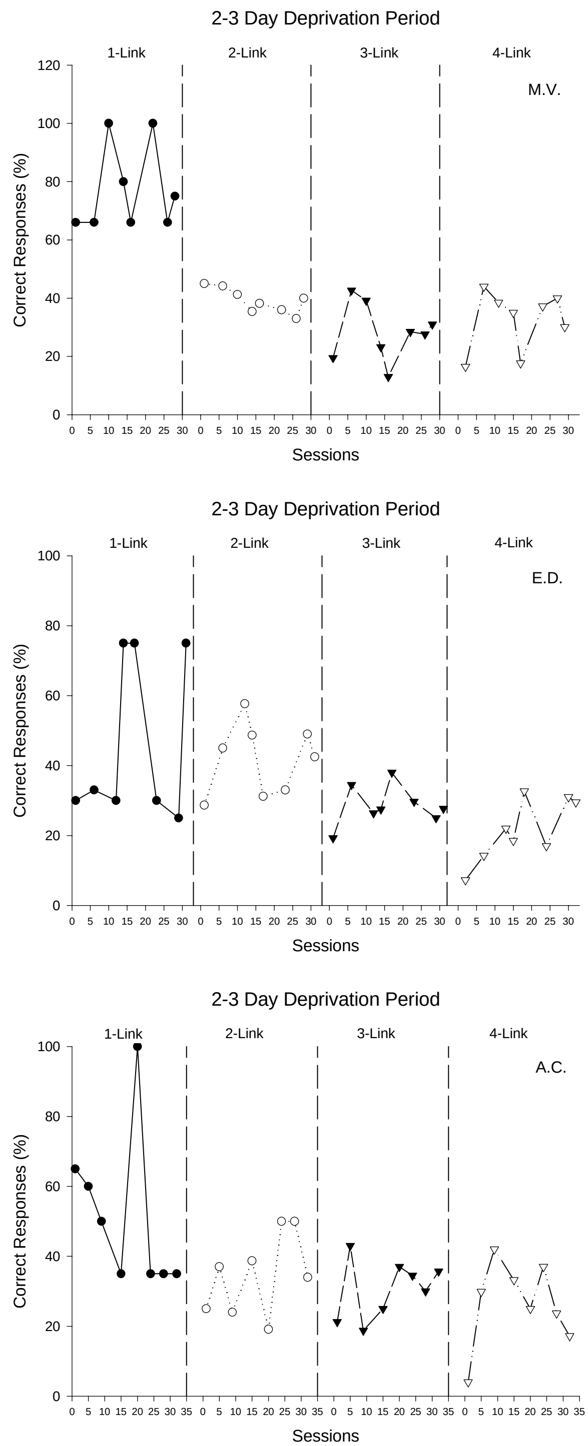


Figure 16. Correct responses (%) across all response chains in the 2-3 day deprivation period in experiment 2.

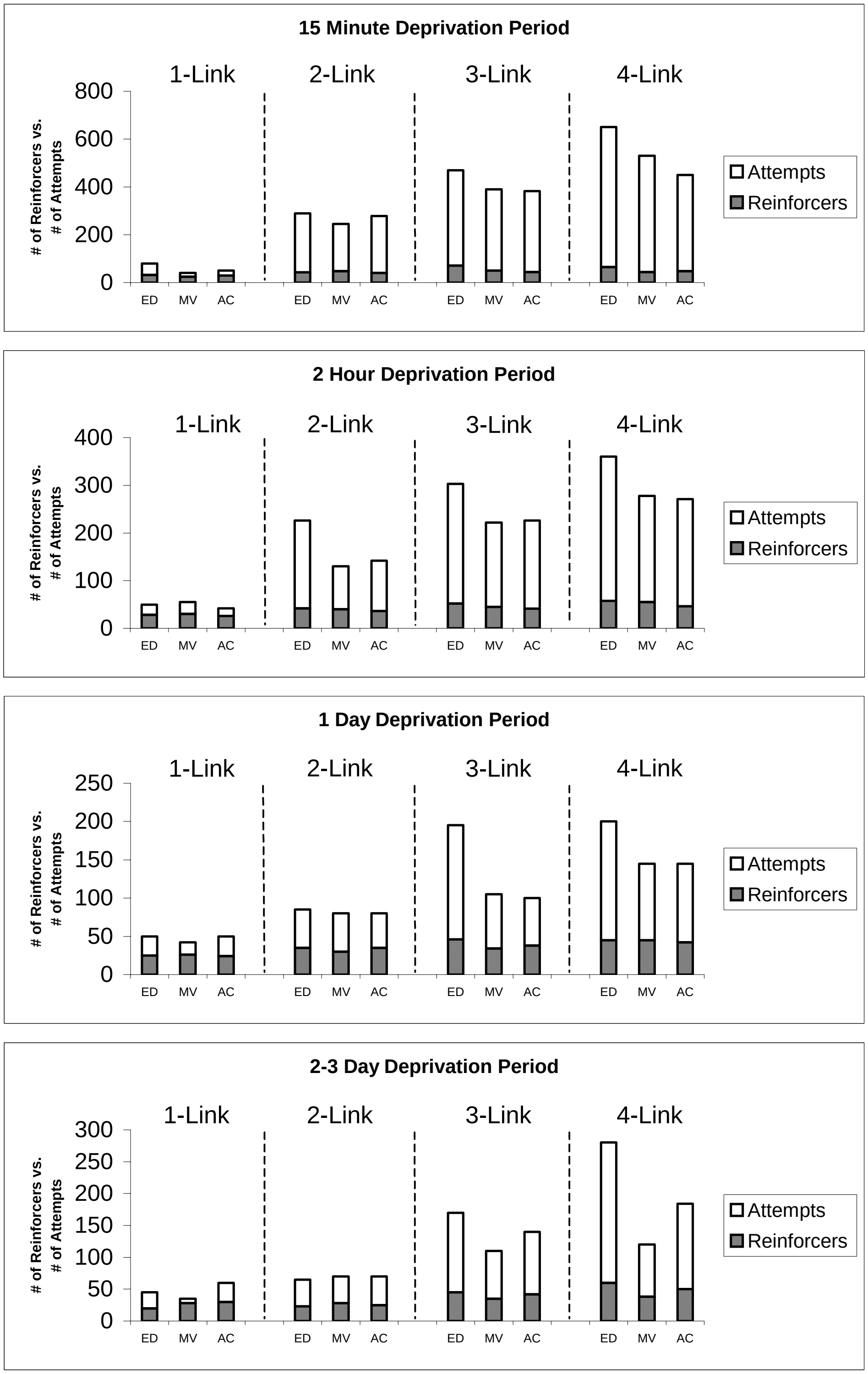


Figure 17. The number of attempts versus the number of reinforcers across all deprivation periods in experiment 2.

chains. These results are consistent with experiment 1, and show that individuals made more attempts during the shorter deprivation periods than during the longer deprivation periods. In addition, the graphs show that as the chain length increased, the number of attempts increased.

The results displayed in Figure 18 show the number of errors made in the 4-link response chains across all deprivation periods. The largest number of errors occurred in the 15-minute deprivation period and decreased as the deprivation period lengthened, with no noticeable difference between the 1-day and 2-3 day deprivation periods. These results show that the longer deprivation periods (1-day and 2-3 days) were effective in decreasing the number of errors made each session. Similar results were found for the 2 and 3-link response chains (Figures 19 & 20, respectively); however, there was no difference between deprivation periods during 1-link responses (Figure 21).

The rate of responding (in sec.) across all deprivation periods is depicted in Figure 22. Similar to experiment 1 and previous studies (Klatt et al., 2000; Vollmer & Iwata, 1991), individuals responded most frequently during the longer deprivation periods (1-day and 2-3 days) and less frequently during the shorter deprivation periods (15-minute and 2-hour), with small differences between the 1 and 2-3 day deprivation conditions. The well-defined separation between the shorter and longer deprivation periods (e.g., rate of responding and number of errors) shows that these times served as effective establishing operations.

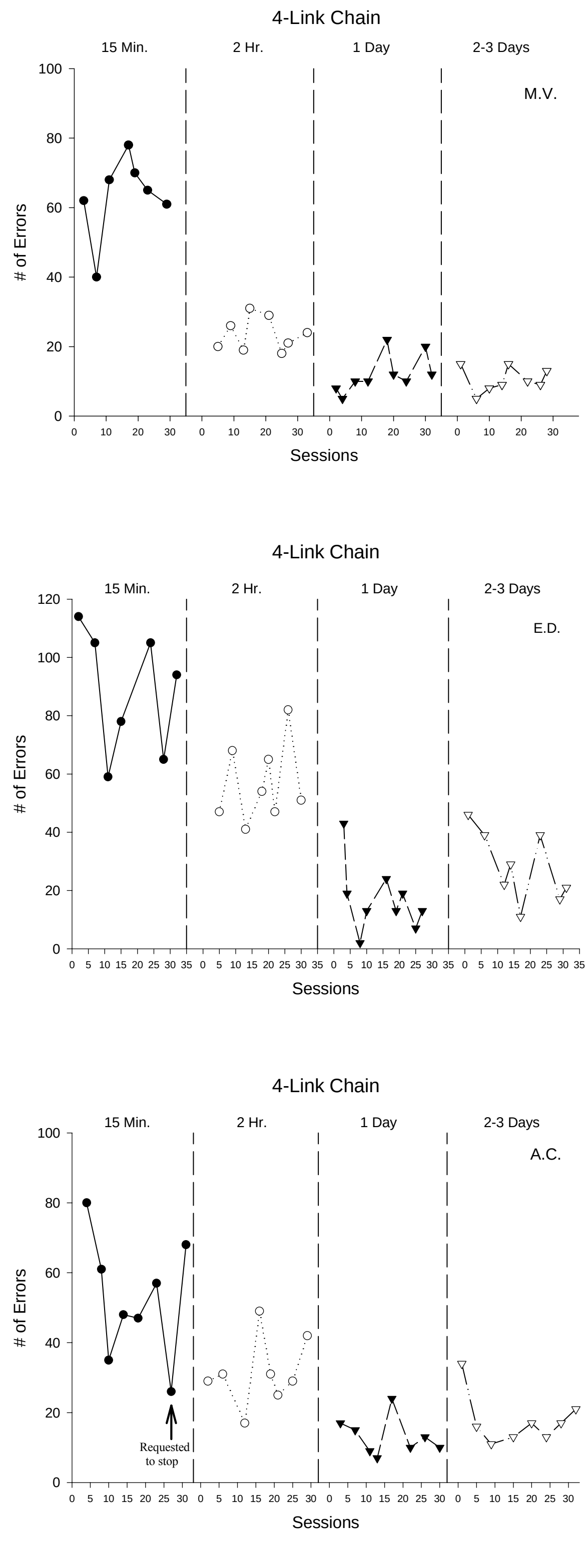


Figure 18. Number of errors in the 4-link response chain across all deprivation periods in experiment 2.

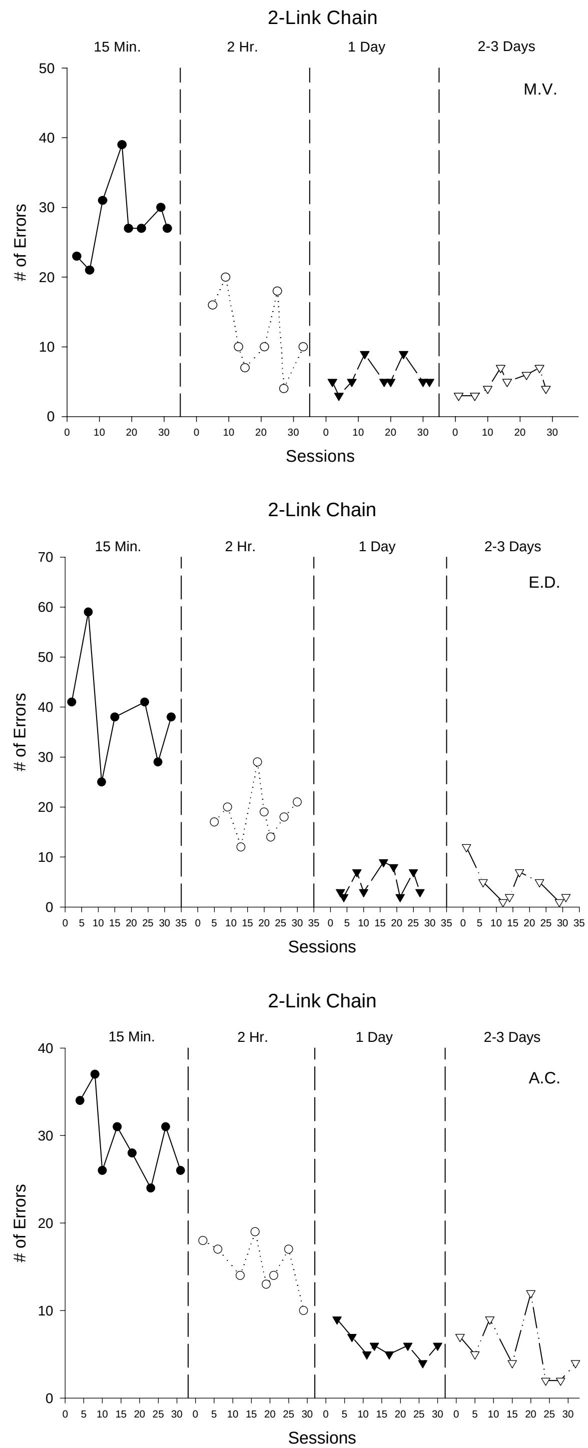


Figure 19. Number of errors in the 2-link response chain across all deprivation periods in experiment 2.

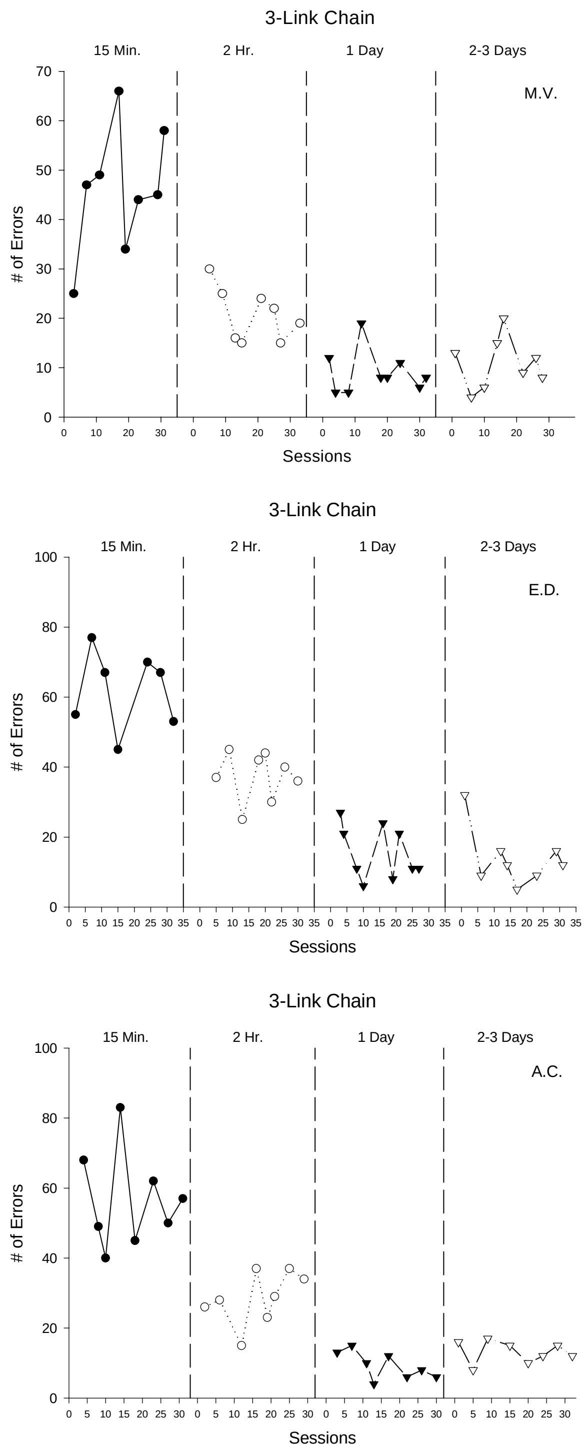


Figure 20. Number of errors in the 3-link response chain across all deprivation periods in experiment 2.

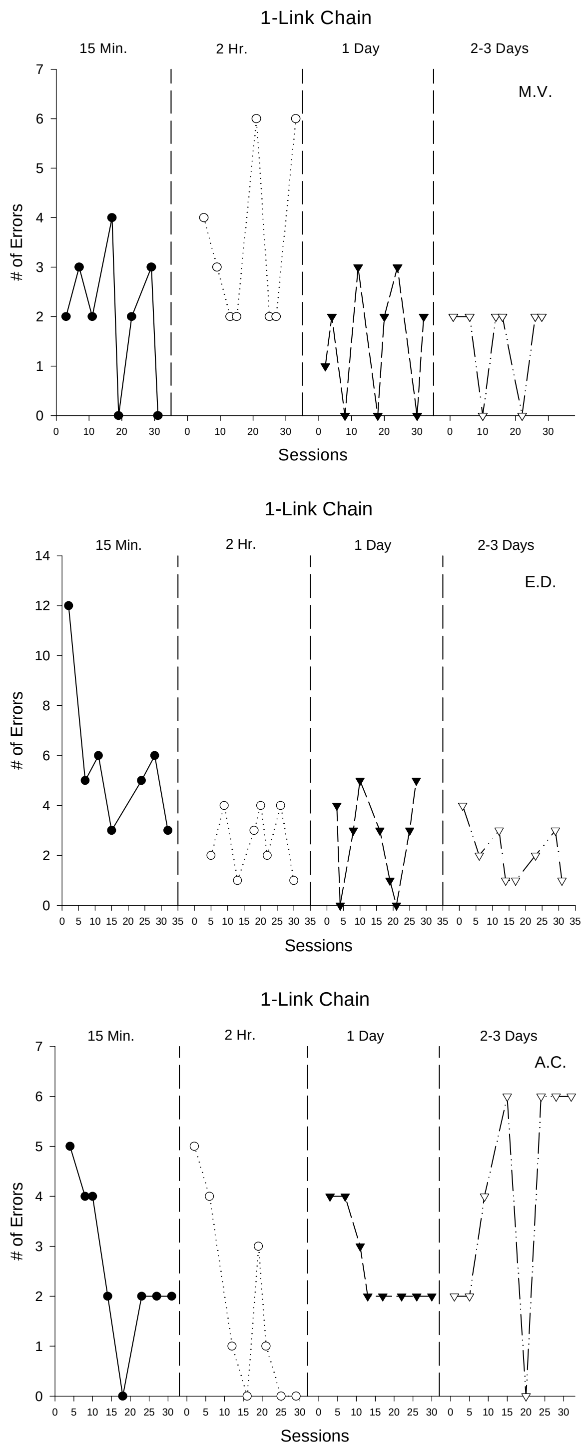


Figure 21. Number of errors in the 1-link response chain across all deprivation periods in experiment 2.

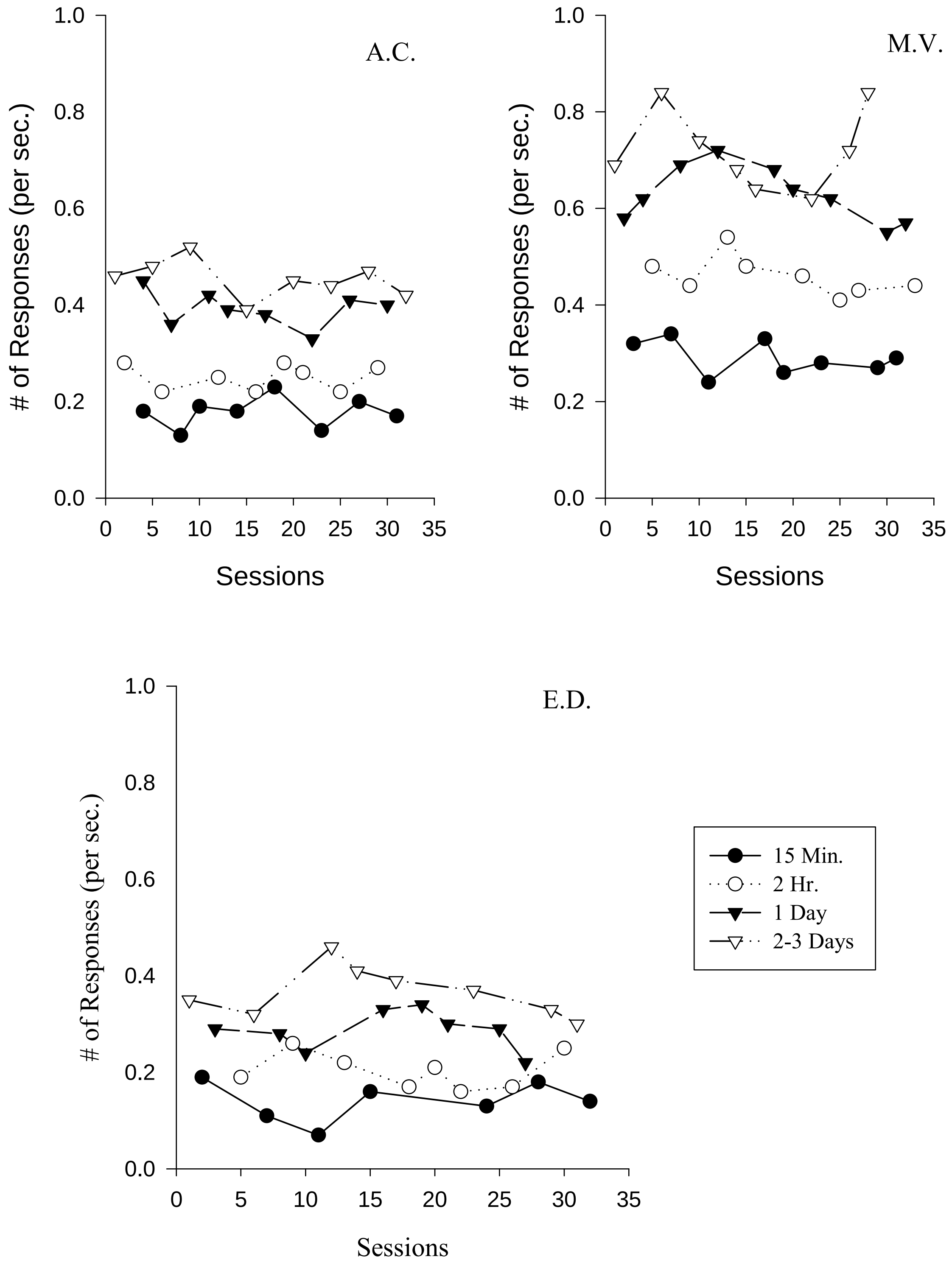


Figure 22. Rate of responding (per sec.) by individuals across all deprivation periods in experiment 2.

# Chapter IV. GENERAL DISCUSSION

The purpose of the present study was to investigate the effects of establishing operations on individual's responses during a learning task. The results in both experiments showed that the accuracy of individuals responses were a function of the amount of time since their last opportunity to play the computer game—with the longer deprivation periods (1-day and 2-3 days) resulting in fewer errors during the learning task, and the shorter deprivation periods (15-minute and 2-hour) resulting in more errors. Deprivation from the computer games for a 2-hour period resulted in more errors in both experiments. During experiment 1, however, the number of errors made in the 2-hour condition more closely resembled the number of errors in the longer deprivation periods (e.g., 1-3 days). These results are consistent with previous findings by Klatt et al. (2000) who found that the engagement times in the 2-hour deprivation period were more consistent with engagement times during the 1-day and 2-3 day conditions. However, when the learning task used similar geometric shapes (e.g., different star shapes) in experiment 2, more errors occurred in the 2-hour deprivation period—and for 2 individuals, were more consistent with the number of errors in the 15-minute deprivation condition. These results, and the fact that there were no differences in the number of errors during 1-link responses between any of the deprivation periods, suggests that response effort may influence establishing operations at an idiosyncratic level (Kerwin et al., 1995).

Similar to previous studies that examined engagement time (Klatt et al., 2000; Vollmer & Iwata, 1991), the current study found that individuals responded more frequently during the longer deprivation periods (1-3 days) than during the shorter deprivation periods (15-minute and 2 hour).

To address concerns related to sequence effects, it was necessary to examine where specific error responses were occurring. Analysis of these data show that the number of errors made on response panels that were correct in the previous session were similar to the number of errors made on the two other incorrect panels in the current session. This suggests that the establishing operations were effective in manipulating the amount of errors and not sequence effects. This study also controlled for the number of errors occurring in different chain lengths by examining the percentage of correct responding. By examining the percentage of correct responses instead of the number of errors, this controlled for the amount of time spent in each chain length. The results showed that individuals responded the most accurately in the 1-link responses and decreased in accuracy as the response chains lengthened, which was consistent with the results that measured the number of errors.

In the current study, an alternating treatment design was used to measure the effects of establishing operations on individual’s responses during a learning task. Due to scheduling conflicts and time-constraints, the conditions in the current study were only presented semi-randomly. The longer deprivation periods (1-day and 2-3 days) were always presented as the first session of the day. The shorter deprivation periods (15-minute and 2-hours) were then randomly selected if the timing constraints allowed the researcher to do so. If the selected deprivation condition could not be presented, the researcher moved to the next available condition. Despite this weakness in the study, the results were replicated across all three participants in both experiments.

Another problem with the current study was that the deprivation conditions and learning task sessions could only be conducted during the same time frame (8 am-12 pm) each day. The results across both experiments were consistent; however, it would have been beneficial to show that these same results could have been achieved throughout several time frames.

Although the results of both experiments were consistent, this study is limited in being able to generalize the findings to individuals with more severe developmental disabilities. The individuals in this study were diagnosed with mental retardation ranging from severity unspecified to moderate. Although several individuals with more severe developmental disabilities were identified as possible participants based on the reinforcer preference assessments for computer games, they did not possess the motor skills to complete the learning task.

The ability to contrive establishing operations to strengthen or weaken reinforcers has several important implications. As previous studies (Klatt et al., 2000; Vollmer & Iwata, 1991) have shown, when conducting preference assessments it is important not to conduct sessions immediately prior to or following activities in which the individual has had access to the stimuli being presented. For example, a session testing the reinforcer value of certain movies should not be held after the individual has been watching TV for an extended period of time. Computer games were selected as possible reinforcers in the current study due to the fact that the researcher could easily control the participants' access to these stimuli. As the present study showed, the ability to identify reinforcers through preference assessments allowed the researcher to contrive establishing operations to increase the accuracy of responding during a learning task. The ability to identify possible reinforcers is an essential component in teaching appropriate behavior to individuals both with and without developmental disabilities (Gewirtz & Baer, 1958; Klatt et al., 2000).

Contriving establishing operations to manipulate the effectiveness of reinforcers also has implications for scheduling daily activities (e.g., teaching sessions, leisure activities, snack times, token stores, etc.). Previous studies measuring engagement time (e.g., Klatt et al., 2000), as well as the current study measuring accuracy of responding, suggests that in order to maximize these results it is necessary to schedule activities so that individuals do not become satiated with the reinforcers (see McSweeney & Roll, 1998 and Murphy, McSweeney, Smith, & McComas, 2003 for a discussion on satiation versus habituation). Similar to scheduling reinforcer preference assessments during times when the individual has not had long periods of access to the stimuli, the scheduling of teaching sessions becomes important. For example, if a staff member was working with a consumer to help them learn to tell time using small edibles as reinforcers, teaching sessions should not be scheduled following meal times. As the current study has shown, if individuals have had rich access to reinforcers, the accuracy of their responding is lower. Instead of scheduling the training sessions after meal times, training should capture the establishing operations that are naturally present in the environment and conduct sessions prior to meal times. If this is not a possibility, either a different form of reinforcer should be used, or at the very least, the length of the teaching session should be decreased in order to maximize the effectiveness of the reinforcer.

In addition to capturing the establishing operations present in the environment, previous studies have shown that varying the type, rate, and magnitude of reinforcers can affect individual's responses (Hoch, McComas, Johnson, Faranda, & Guenther, 2002; Neef, Shade, & Miller, 1994). For example, Egel (1981) examined the effects of using constant versus varied food reinforcers on the task-related behaviors of 3 children with developmental disabilities. The results showed that the percentage of correct responding increased when reinforcers were varied within the session. Although not originally conceptualized as an establishing operation, the author showed that satiation of the food reinforcers affected the accuracy of the children's responses (see also Bowman, Piazza, Fisher, Hagopian, & Kogan, 1997).

The field of applied behavior analysis has embraced the concept of the establishing operation and has effectively utilized it in the treatment of aberrant behavior. However, despite its growth in use, it has largely been ignored when dealing with non-problem behavior (Klatt et al., 2000; Vollmer & Iwata, 1991). Additional research is necessary to continue to develop the use of establishing operations in the teaching of appropriate behavior. Future research should focus on the teaching of socially important behaviors that individuals could acquire, providing them with new skills that would allow them increased independence and access within the community.

The current study demonstrated the fact that contriving establishing operations can greatly influence the responses of individuals on appropriate tasks. The current study's findings that contriving establishing operations has the ability to increase and decrease the accuracy of responding adds to the literatures' previous findings that EOs can affect engagement time (Klatt et al., 2000; Konarski et al., 1980; Vollmer & Iwata, 1991). The ability to increase engagement in appropriate activities is important, but the ability to perform these activities correctly is essential in teaching new skills. Being able to increase the accuracy of responding during a learning task has implications not only for individuals with developmental disabilities, but also for those persons without them. Our discipline has utilized the establishing operation in the treatment of aberrant behavior, but we must now focus our attention on the other side of the spectrum and develop its use in teaching appropriate behavior.

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# APPENDICES

APPENDIX A

Figure Captions

*Figure A1.* A sample response screen of the stimuli used during the learning task in experiment 1.

*Figure A2.* Illustration of a four-chain response sequence in an incremental repeated acquisition procedure in experiment 1.

*Figure A3.* A sample response screen of the stimuli used during the learning task in experiment 2

*Figure A4.* Correct responses (%) across all response chains in the 2-hour deprivation period in experiment 1.

*Figure A5.* The number of errors across all response chains in the 15-minute deprivation period in experiment 1.

*Figure A6.* The number of errors across all response chains in the 2-hour deprivation period in experiment 1.

*Figure A7.* The number of errors across all response chains in the 1-day deprivation period in experiment 1.

*Figure A8.* The number of errors across all response chains in the 2-3 day deprivation period in experiment 1.

*Figure A9.* The number of errors across all response chains in the 15-minute deprivation period in experiment 2.

*Figure A10.* The number of errors across all response chains in the 2-hour deprivation period in experiment 2.

*Figure A11.* The number of errors across all response chains in the 1-day deprivation period in experiment 2.

*Figure A12.* The number of errors across all response chains in the 2-3 day deprivation period in experiment 2.

Figure A1.

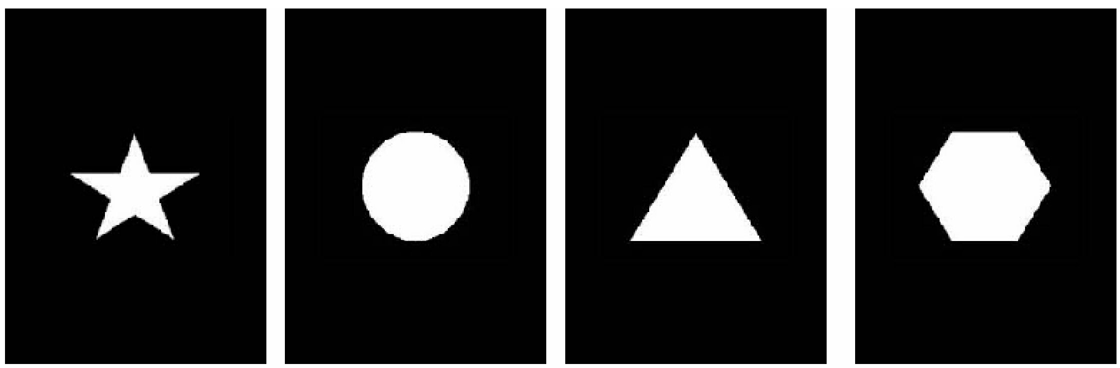
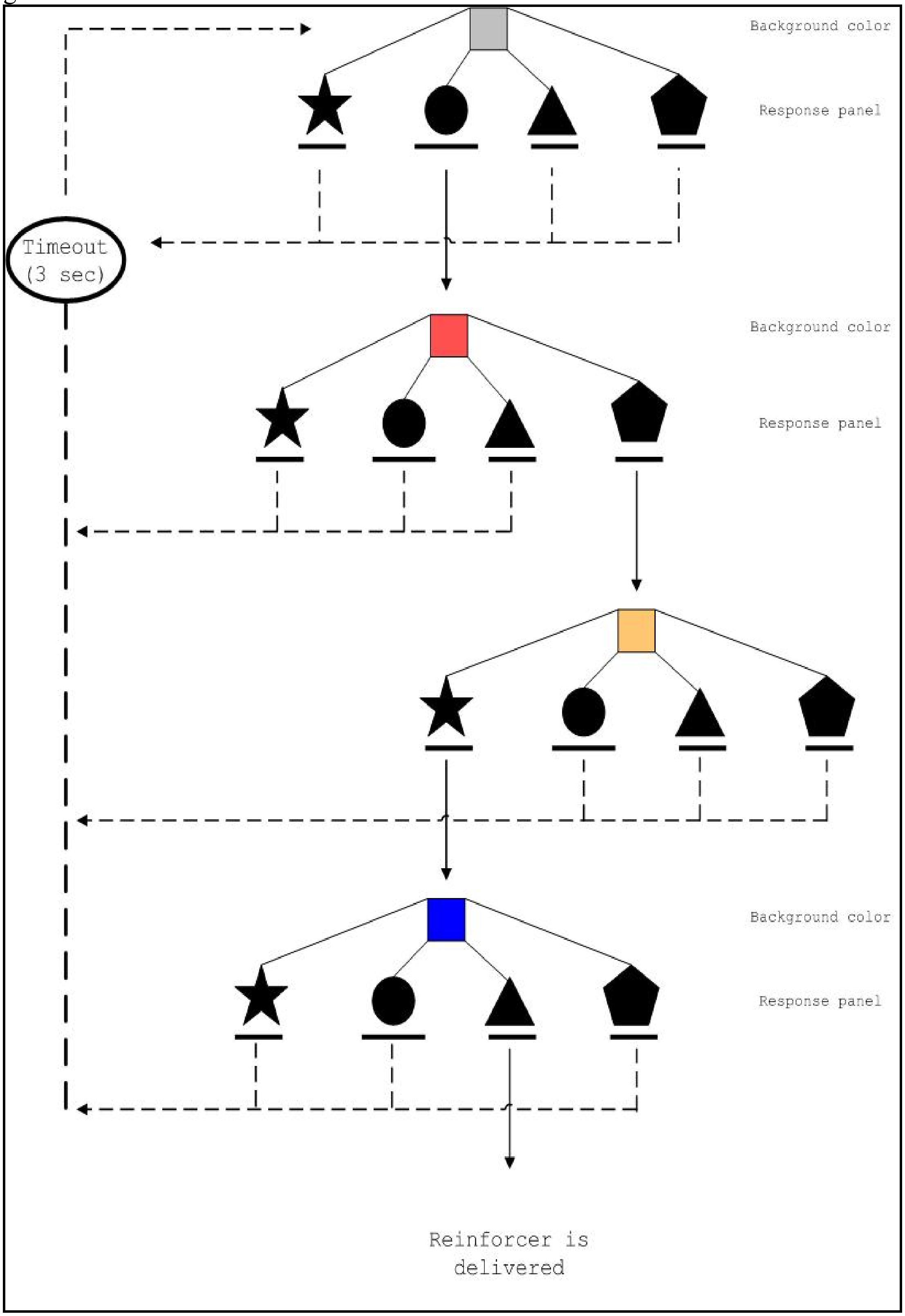


Figure A2.




(from Bickel, Higgins, & Hughes, 1991).

Figure A3.

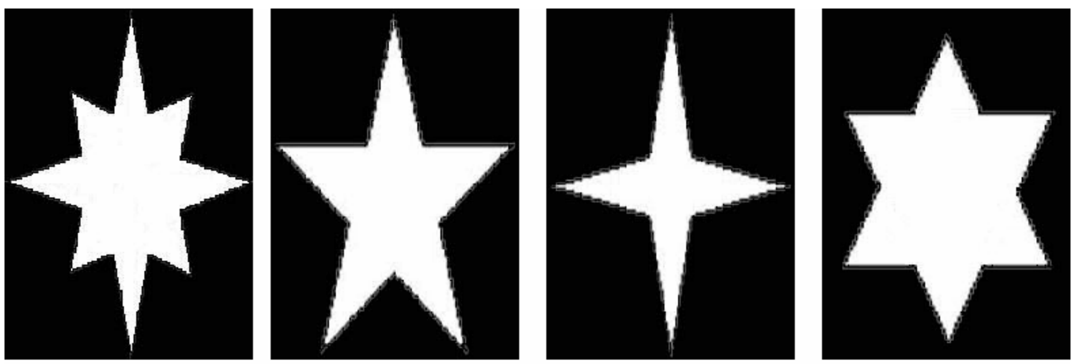


Figure A4.

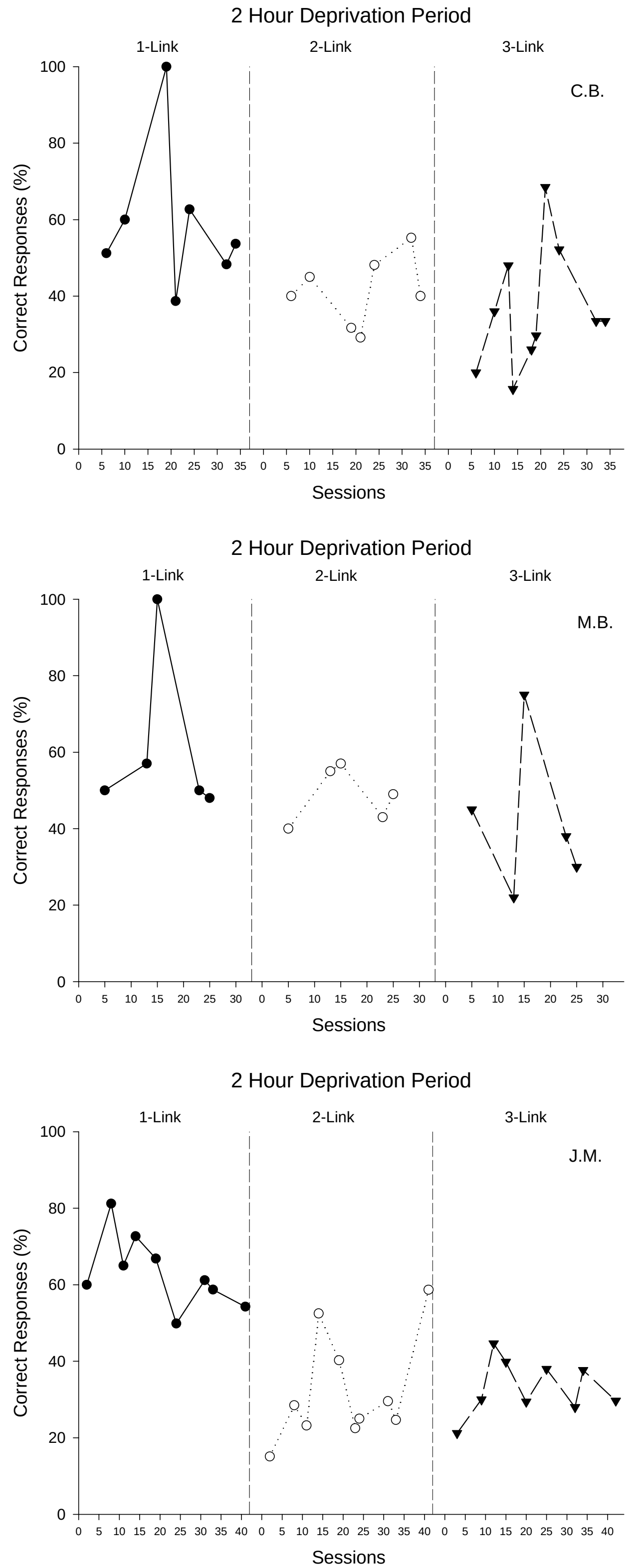

2 Hour Deprivation Period
1-Link
2-Link
3-Link
C.B.
Correct Responses (%)
Sessions
2 Hour Deprivation Period
1-Link
2-Link
3-Link
M.B.
Correct Responses (%)
Sessions
2 Hour Deprivation Period
1-Link
2-Link
3-Link
J.M.
Correct Responses (%)
Sessions

Figure A5.

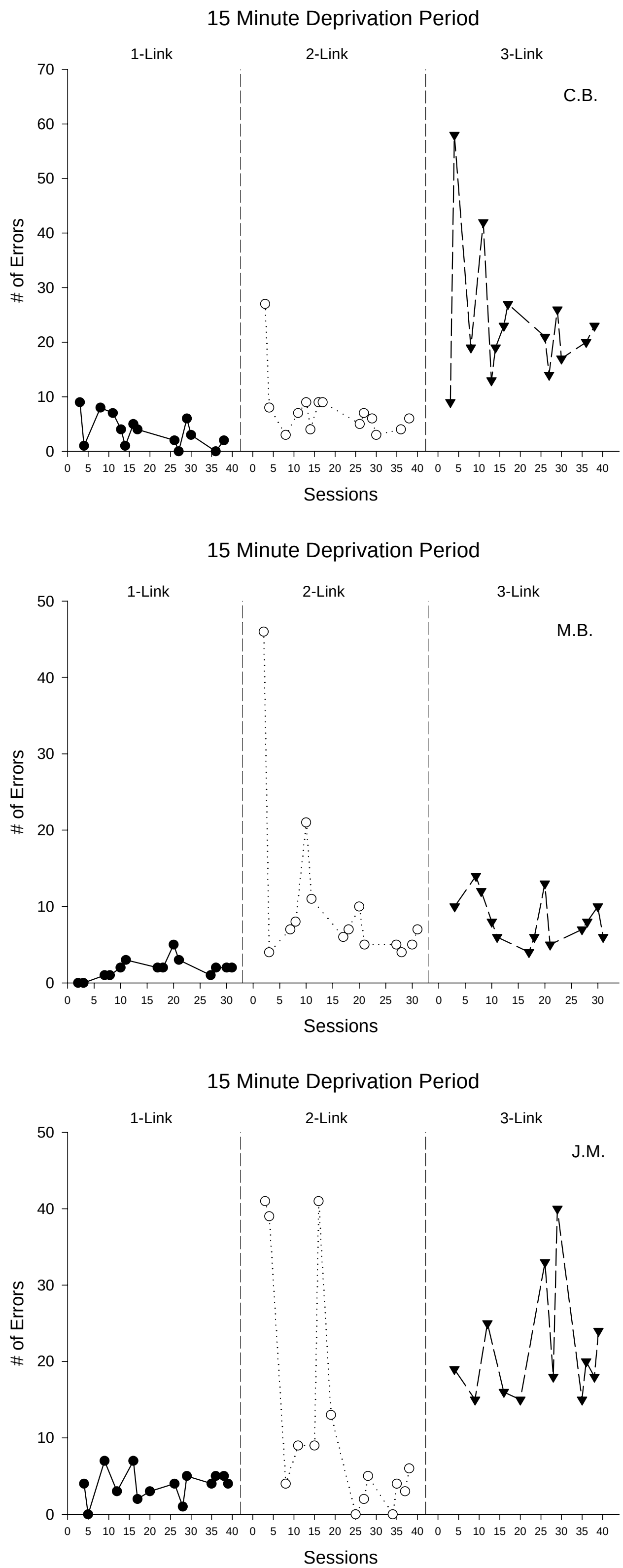
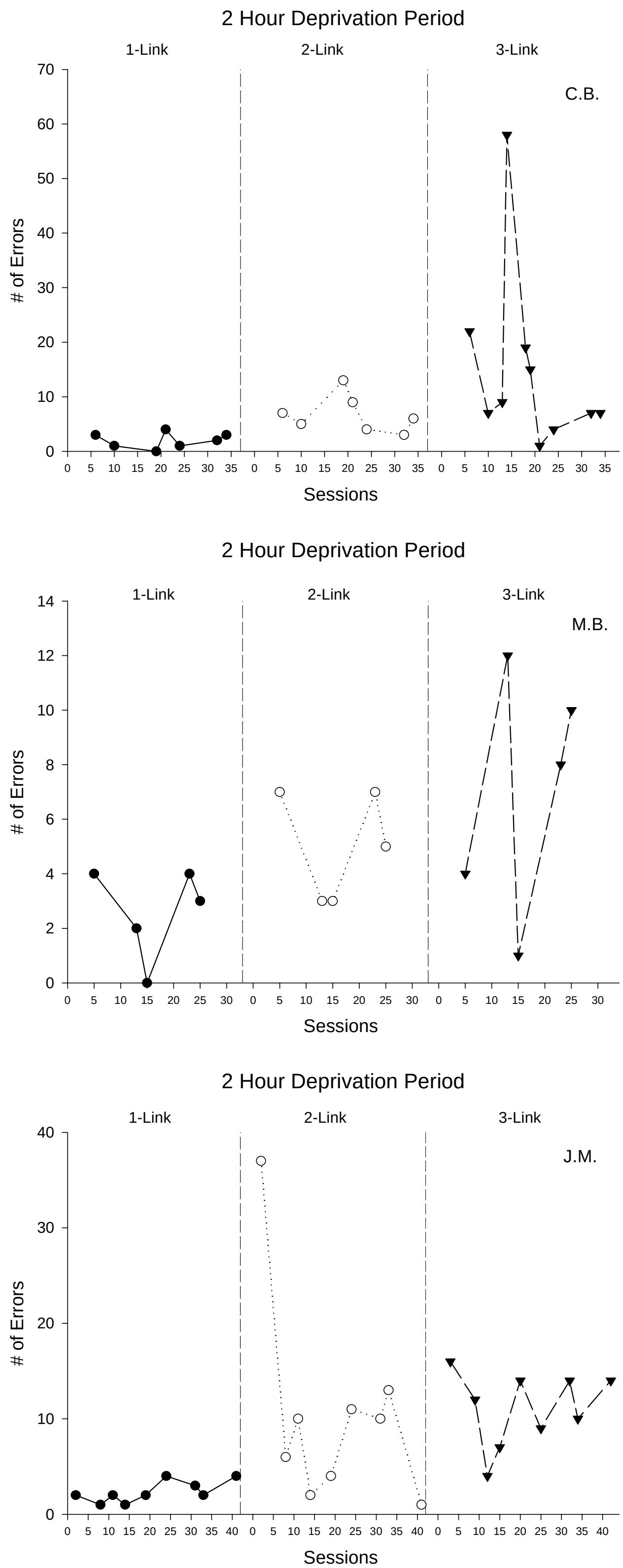

15 Minute Deprivation Period
1-Link
2-Link
3-Link
C.B.
# of Errors
Sessions
15 Minute Deprivation Period
1-Link
2-Link
3-Link
M.B.
# of Errors
Sessions
15 Minute Deprivation Period
1-Link
2-Link
3-Link
J.M.
# of Errors
Sessions

Figure A6.



2 Hour Deprivation Period
1-Link
2-Link
3-Link
C.B.
# of Errors
Sessions
2 Hour Deprivation Period
1-Link
2-Link
3-Link
M.B.
# of Errors
Sessions
2 Hour Deprivation Period
1-Link
2-Link
3-Link
J.M.
# of Errors
Sessions

Figure A7.

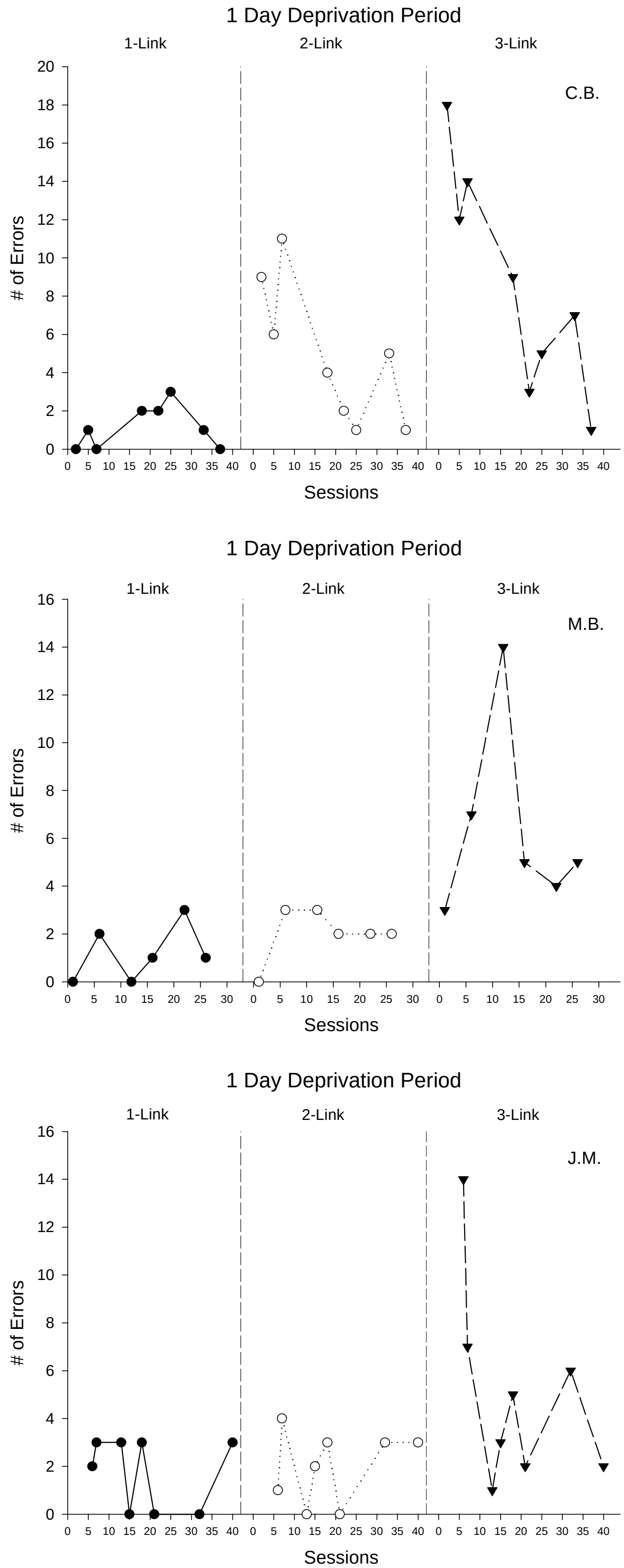
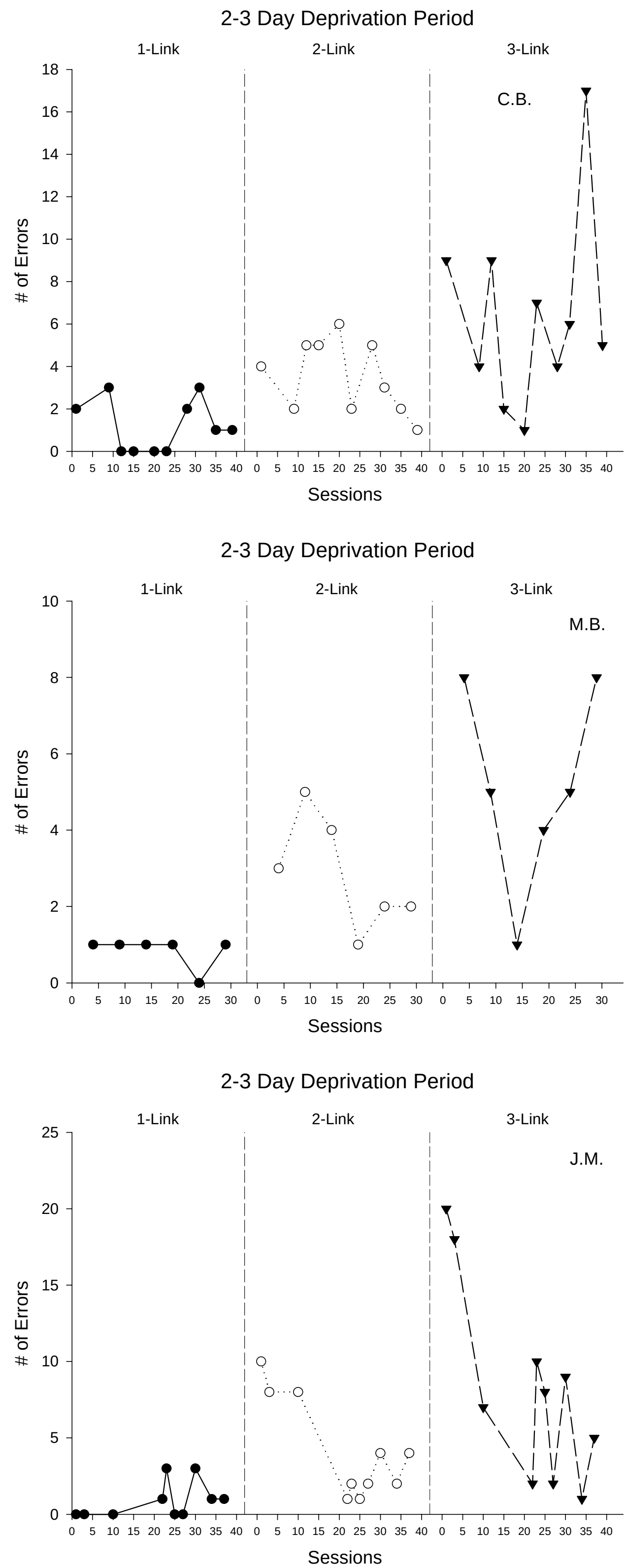

1 Day Deprivation Period
1-Link
2-Link
3-Link
C.B.
# of Errors
Sessions
1 Day Deprivation Period
1-Link
2-Link
3-Link
M.B.
# of Errors
Sessions
1 Day Deprivation Period
1-Link
2-Link
3-Link
J.M.
# of Errors
Sessions

Figure A8.



2-3 Day Deprivation Period
1-Link
2-Link
3-Link
C.B.
# of Errors
Sessions
2-3 Day Deprivation Period
1-Link
2-Link
3-Link
M.B.
# of Errors
Sessions
2-3 Day Deprivation Period
1-Link
2-Link
3-Link
J.M.
# of Errors
Sessions

Figure A9.

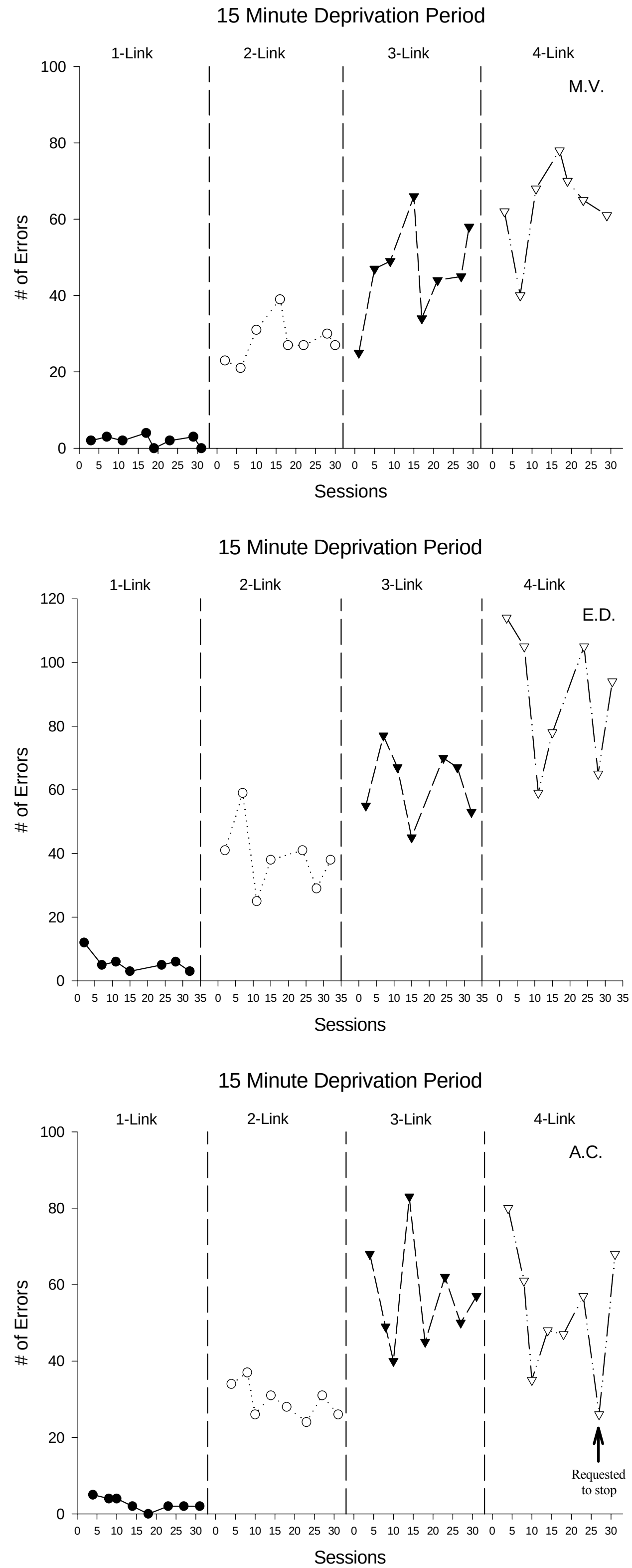

15 Minute Deprivation Period
1-Link
2-Link
3-Link
4-Link
M.V.
# of Errors
Sessions
15 Minute Deprivation Period
1-Link
2-Link
3-Link
4-Link
E.D.
# of Errors
Sessions
15 Minute Deprivation Period
1-Link
2-Link
3-Link
4-Link
A.C.
Requested
to stop
# of Errors
Sessions

Figure A10.

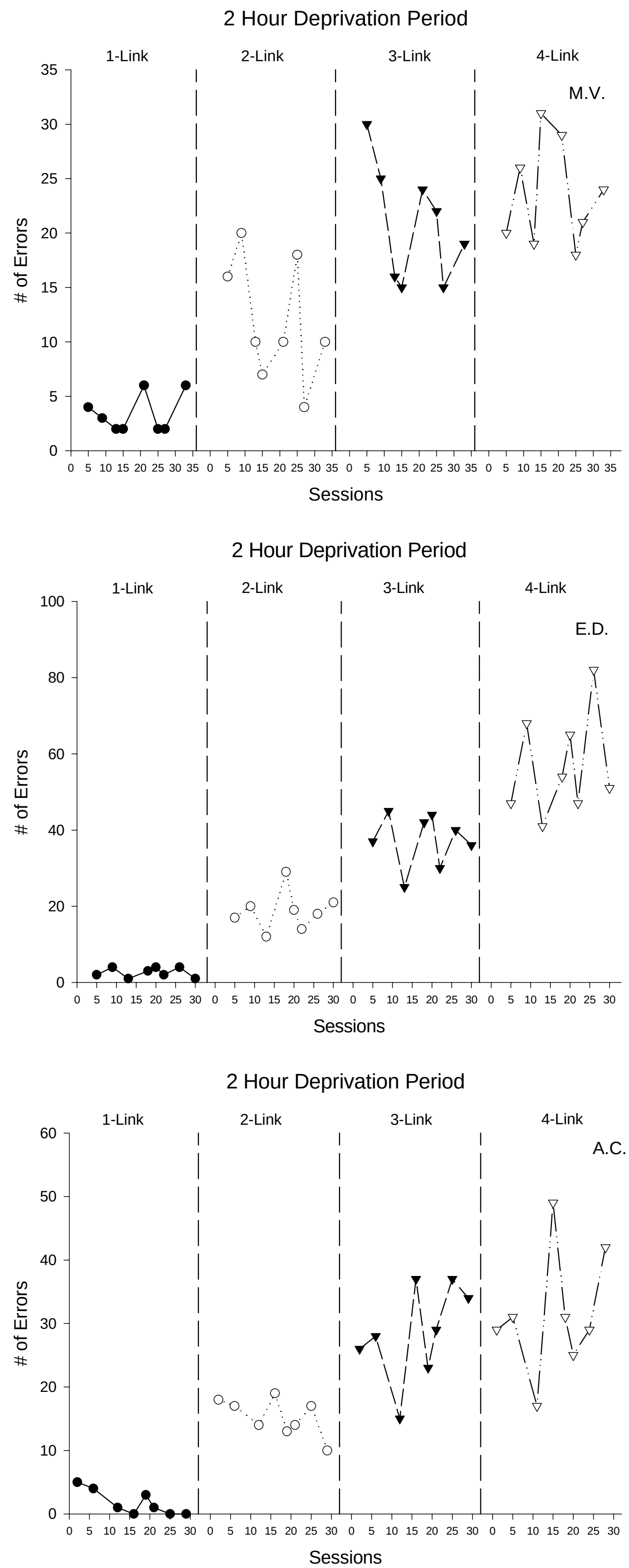

2 Hour Deprivation Period
1-Link
2-Link
3-Link
4-Link
M.V.
# of Errors
0
5
10
15
20
25
30
35
Sessions
2 Hour Deprivation Period
1-Link
2-Link
3-Link
4-Link
E.D.
# of Errors
0
20
40
60
80
100
Sessions
2 Hour Deprivation Period
1-Link
2-Link
3-Link
4-Link
A.C.
# of Errors
0
10
20
30
40
50
60
Sessions

Figure A11.

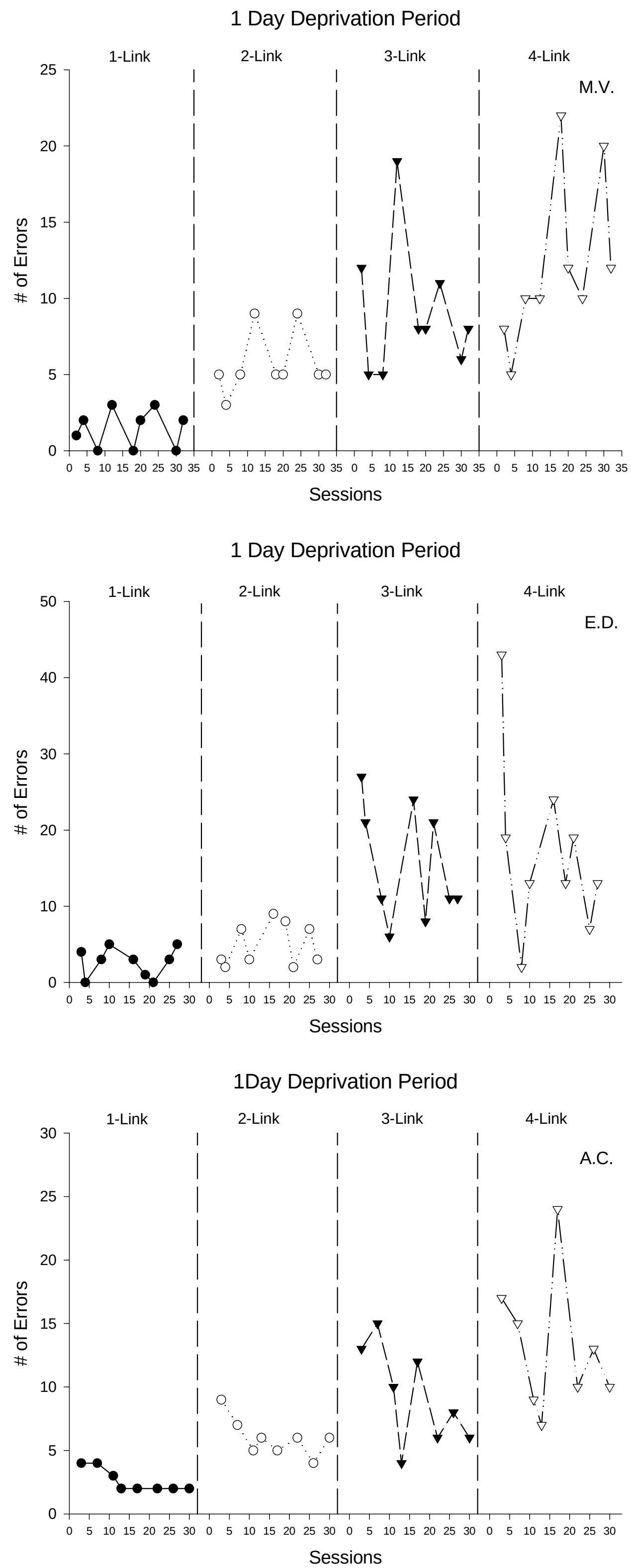

1 Day Deprivation Period
1-Link
2-Link
3-Link
4-Link
M.V.
# of Errors
Sessions
1 Day Deprivation Period
1-Link
2-Link
3-Link
4-Link
E.D.
# of Errors
Sessions
1Day Deprivation Period
1-Link
2-Link
3-Link
4-Link
A.C.
# of Errors
Sessions

Figure A12.

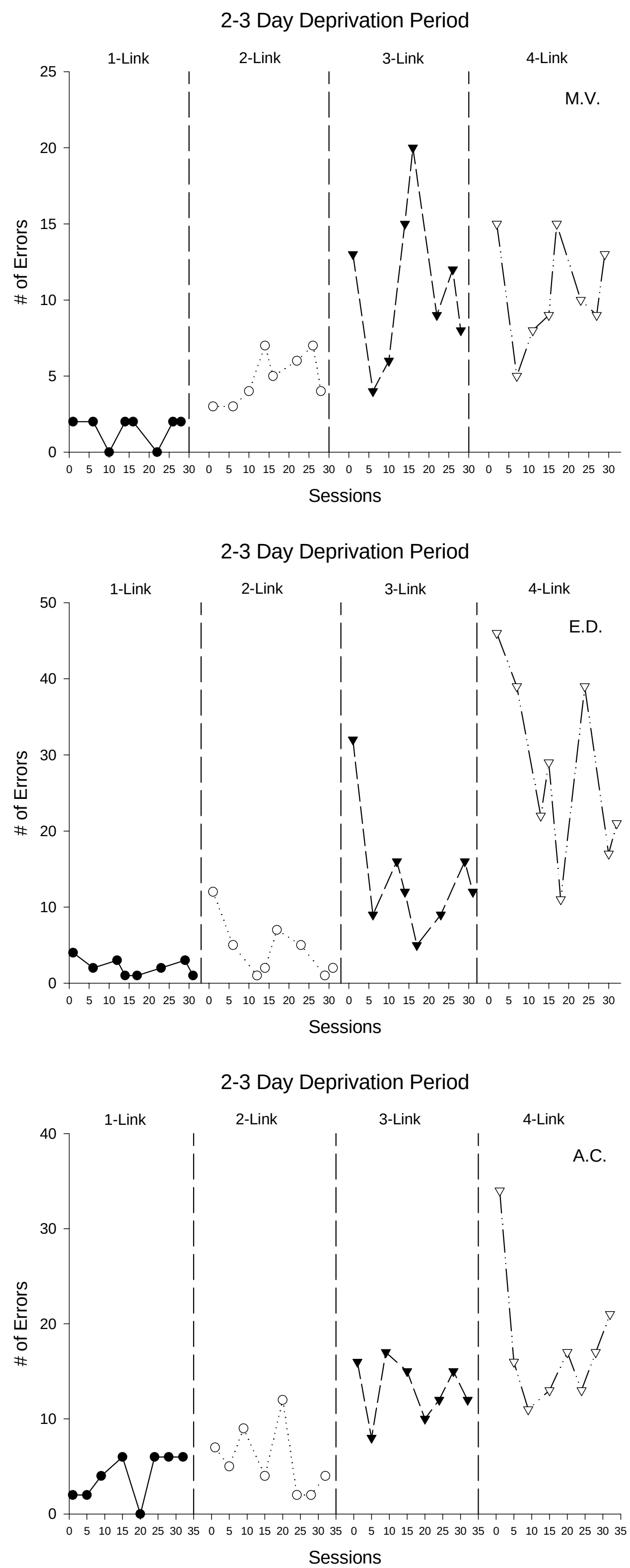

2-3 Day Deprivation Period
1-Link
2-Link
3-Link
4-Link
M.V.
# of Errors
Sessions
2-3 Day Deprivation Period
1-Link
2-Link
3-Link
4-Link
E.D.
# of Errors
Sessions
2-3 Day Deprivation Period
1-Link
2-Link
3-Link
4-Link
A.C.
# of Errors
Sessions

Table A1.

*Establishing Operations and Possible Treatments*

| Maintaining consequence | Example | Establishing Operation | Treatment |
|---|---|---|---|
| Positive Reinforcement | Attention | Deprivation of attention | Noncontingent reinforcement |
| | Edibles | Deprivation of edibles | Functional Communication Training (FCT) |
| Negative Reinforcement | Escape | Presentation of an aversive event (e.g., "difficult" demand) | Noncontingent reinforcement |
| | Avoidance | | Demand fading |
| | | | Curricular revision |
| | | | FCT |
| Automatic Reinforcement | Sensory stimulation | Deprivation of stimulation | Noncontingent reinforcement |
| | | | Satiation procedure |
| | | | Alternative sources[3] |
| | | | Reduced aversive stimulation |
| | | | FCT |

APPENDIX B

The Matching Relation and Applied Settings

The matching relation (Herrnstein, 1961) is a quantitative account of behavior that describes operant choice behavior on concurrent schedules[2]. Herrnstein argued that organisms would distribute their responses among available response alternatives in proportion to the relative rate of reinforcement received from those alternatives. This can be expressed mathematically by the following equation:

$$\frac{R_1}{R_1 + R_2} = \frac{r_1}{r_1 + r_2} \,, \qquad [1]$$

where $R_1$ and $R_2$ represent response rates on the two alternative behaviors, and $r_1$ and $r_2$ represent the reinforcement rates obtained from the respective behaviors. Equation 1 can in turn be rewritten in ratio form:

$$\frac{R_1}{R_2} = \frac{r_1}{r_2} \,. \qquad [2]$$

Behavior, however, may not always be represented in an informative manner by its rate of occurrence. Baum and Rachlin (1969) addressed this concern by examining the issue of counting versus timing behavior. The authors used a concurrent schedule, presenting pigeons with reinforcers for standing on one side of a chamber versus the alternative, standing on the other side. The authors found that similar to measuring rates of behavior, the matching relation held when behavior was measured in terms of time allocation.

The matching relation can then be rewritten in terms of time spent on each alternative (McDowell, 1988):

$$\frac{T_1}{T_1 + T_2} = \frac{r_1}{r_1 + r_2} \quad . \qquad [3]$$

Results of experimentation on the matching relation with nonhumans have been extended to the study of human behavior. A study by Conger and Killeen (as cited in Borrero & Vollmer, 2002) demonstrated that college students would distribute their verbal behavior towards a confederate in proportion to the rate of positive comments made by the confederate toward the student.

The matching relation has even been demonstrated in sporting events. Vollmer and Bourret (2000), examined college basketball players distribution of two and three point shots during games. As predicted by the equation, response allocation matched the rate of reinforcement associated with each response. In this case though, reinforcer magnitude had to be weighted.

In a more recent study, Borrero and Vollmer (2002) applied the matching relation in examining the aberrant behavior of four individuals with developmental disabilities. The authors used functional analysis to identify the reinforcers maintaining the problem behavior and then analyzed the data collected using the matching equation. Again, the matching relation showed that the rate of the individual's problem behavior to appropriate behavior approximately matched the rate of reinforcement for problem behavior.

The matching relation is of importance to behavior analysts in suggesting possible treatment strategies and awareness of potential side-effects. Similar to establishing operations, the matching relation suggests that an intervention or teaching strategy may be more or less effective depending on the amount of reinforcement that is already present in the environment (e.g., satiation/deprivation). A reinforcement procedure would produce more of a change in an environment in which reinforcement is lean, than rich. The behavior analyst must be aware of this fact in order to produce the most conducive environment for behavior modification (see Myerson & Hale, 1984 for a review of reinforcement schedules).

Behavior analysts must also be cautioned by what the matching relation suggests. Increasing reinforcement for one response will decrease the proportion of reinforcement for other behaviors. As a result, both positive and problematic behaviors may decrease. Similarly, if reinforcement for one behavior is eliminated or reduced, while the reinforcement rate for other behaviors is unaffected, then the relative rate of reinforcement of the other behaviors increases. This may lead to an increase in other non-targeted, functionally equivalent behaviors.

FOOTNOTES

[1]Kern & Dunlap (1998) define curricular variables as a broad category of antecedent and contextual circumstances including-- content and objectives of activities, materials used, behavioral topography required, scheduling and sequencing, and the manner in which they are presented.

[2]This is a schedule of reinforcement that contains two or more schedules (e.g. FI, VR) that are operating simultaneously and independently of each other. The organism is free to distribute behavior to each schedule (Catania, 1991).

[3]Provides individuals with an alternative source of the specific type of stimulation maintaining the behavior (Favell, McGimsey, & Schell, 1982).