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An evaluation of variables affecting response allocation among concurrently available mand topographies

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AN EVALUATION OF VARIABLES AFFECTING RESPONSE ALLOCATION

AMONG CONCURRENTLY AVAILABLE MAND TOPOGRAPHIES

by

Kelly Marie Vinquist

<u>An Abstract</u>

Of a thesis submitted in partial fulfillment of the requirements
for the Doctor of Philosophy degree in
Psychological and Quantitative Foundations (School Psychology)
in the Graduate College of The University of Iowa

December 2010

Thesis Supervisors: Assistant Professor Joel E. Ringdahl
Associate Professor John A. Northup

ABSTRACT

The primary purpose of the current study was to determine which variables influence or change response allocation among mand topographies. The variables evaluated consisted of response effort, schedule of reinforcement (extinction), changes in concurrent schedules arrangements, and availability of visual stimuli (i.e., a communication card). The stability of responding was evaluated across more than one reinforcement context (escape, attention, and tangible) for each of the 2 participants. Finally, a concurrent schedules arrangement was used to evaluate response allocation among card touches, manual sign, microswitch touches, and vocalizations. Results of the evaluation suggested that response allocation varied across reinforcement contexts in baseline and when responding was challenged. However, variations in response allocation were not uniform across all challenges and reinforcement contexts. Problem behavior continued to be exhibited at low levels throughout the evaluation even when mild punishment procedures were implemented. These results are discussed in terms of changes in patterns of responding across reinforcement contexts, variability in response allocation among available response options, and persistence of responding when challenges are implemented.

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Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

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PH.D. THESIS

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This is to certify that the Ph.D. thesis of

Kelly Marie Vinquist

has been approved by the Examining Committee for the thesis requirement for the Doctor of Philosophy degree in Psychological and Quantitative Foundations (School Psychology) at the December 2010 graduation.

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To
My husband, Josh
And
Kevin, may this be in your loving memory

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To all of my committee members, thank you for the time and invaluable input, not only on my dissertation but throughout my graduate school years. Joel, Dave, and John, each of you have been vital mentors to me since I first started working at the CDD seven years ago. I don't know if I will ever have the words to express my gratitude for all that you have done and what you are doing every day to help families like mine. Because of your teaching and guidance, I have become a better educator, researcher, and clinician. I look forward to many more years of collaboration and mentorship from each of you.

To my fellow students and colleagues, I am forever thankful to be part of such an incredible group of people. I cannot put it into words the importance of our group as well as Dave once did: "As individuals, we each have notable strengths but we each have some striking weaknesses….Some of us struggle to 'fit in' and some of us feel that we are misunderstood. As individuals, many of us feel that we are simply not good enough—we feel weak. As a group, we have more than enough strength to compensate for any weaknesses any one of us may experience. We all need and benefit from this strength, no matter how strong we feel at any given moment. Let's take a minute to recognize that each of us needs our group, and that each of us can help each other. And then let's start today honoring a commitment to always try to help and to always avoid making any other member of our group feel weird, left out, or weak. And when someone does this to you, forgive them and try even harder to help others."

Finally, I want to thank my family and friends. Each of you have helped me to keep moving forward and supported me as I experienced many challenges and successes. With your help, I have become a better person and I am forever thankful that I have each of you in my life. Josh, this is dedicated to you for many reasons, but one of the most important were your "lessons" about the importance of laughter. Thank you for helping me to smile and laugh every day.

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CHAPTER I

INTRODUCTION

Functional Communication Training

Functional communication training (FCT) has been established as an effective treatment for individuals who engage in problem behavior (Tiger, Hanley, & Bruzek, 2008). The treatment includes identification of the function of problem behavior followed by differential reinforcement for a functionally equivalent response (Carr & Durand, 1985). Typically a functionally equivalent response is identified by first conducting a functional analysis of problem behavior (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994) or other functional assessment to identify the reinforcers that maintain problem behavior (i.e., determine the function of the behavior). Problem behavior can have single or multiple functions and include reinforcers such as access to adult attention, access to preferred items, or escape from demands. When the function of problem behavior is identified, FCT involves teaching the individual to communicate (i.e., mand) to access the same reinforcers. In most FCT programs, mands are reinforced on a dense schedule of reinforcement and problem behavior results in extinction or punishment.

Numerous FCT studies have evaluated procedures such as extinction for problem behavior (e.g., Shirley, Iwata, Kahng, Mazaleski, & Lerman, 1997), extinction and/or contingent punishment (Fisher, et al., 1993; Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998; Wacker, et al., 1990), extinction and response blocking (Kelley, Lerman, Van Camp, 2002), and intermittent schedules of reinforcement (Worsdell, Iwata, Hanley, Thompson, & Kahng, 2000). Hagopian et al. (1998) reported the results of the effectiveness of FCT with and without extinction and punishment for 21 participants. To sufficiently decrease problem behavior, the results indicated that extinction was needed for the majority of participants. A second finding was that schedule thinning and delays to reinforcement hindered treatment when only extinction was implemented for problem behaviors. Punishment procedures were needed to sufficiently decrease problem behaviors (14 out of 21 participants) before and during schedule thinning and delays to reinforcement. Similar findings were reported in studies by Fisher et al. (1993) and Wacker et al. (1990). Thus, research has shown that responding will not consistently allocate to manding during FCT, and programmed consequences are needed to decrease problem behaviors. Programmed consequences for problem behavior such as response blocking or punishment coupled with extinction have been shown to be effective procedures, and participants allocated their responding to manding when extinction or punishment was included in the treatment package.

A large segment of studies related to FCT have focused on teaching a single mand to replace problem behavior. Target mands have included various modalities such as vocalizations (e.g., Carr & Durand, 1985), assistive communication devices (Durand, 1999), picture cards (Day, Horner, & O'Neill, 1994), and manual signs (Wacker et al., 1990). Strategies have been developed to assist practitioners in choosing a mand to use during FCT. In some cases, a mand may be chosen based on care providers' reports regarding mands (Carr & Durand, 1985), direct observation, or identifying a motoric response (Wacker et al. 1990) that is currently in the client's repertoire. Grow, Kelley, Roane, and Shillingsburg (2008) used an extinction procedure to induce the communicative response. The study demonstrated that the first appropriate communicative response (e.g., vocal, manual sign) that emerged during extinction was effectively used as a mand during FCT and problem behavior decreased significantly.

The mand chosen for inclusion in FCT may have differential effects on treatment efficacy. Ringdahl et al. (2009) demonstrated that mands requiring minimal prompting corresponded with better treatment effects compared to treatments that incorporated mands requiring extensive prompting. Winborn, Wacker, Richman, Asmus, and Geier (2002) evaluated the effects of reinforcing two different mands, a novel mand and an existing mand, during FCT. The results of this study showed that problem behavior occurred at higher levels during sessions using the existing mand than during sessions using the novel mand.

A unique aspect of Winborn et al. (2002) was the inclusion of an evaluation of response allocation when both mands were concurrently available and resulted in access to reinforcement. Thus, the authors evaluated differences in responding using a concurrent schedules design with both mand topographies. In concurrent schedules arrangements, the individual has a choice between two or more schedules that are available at the same time (Fisher & Mazur, 1997). A few studies have evaluated differences in FCT effectiveness when more than one mand was available within a concurrent schedules arrangement (e.g., Harding et al., 2009; Winborn et al., 2002; Winborn, Ringdahl, Wacker, & Kitsukawa 2009). Winborn et al. (2002) evaluated responding when the existing and novel mand were concurrently available and found that responding was primarily allocated to one mand over another. The authors hypothesized that response allocation was an indication of preference for one mand over another.

Harding et al. (2009) also evaluated functional communication training in which two or three concurrently available mand topographies were presented in a concurrent schedules arrangement. The authors demonstrated that this arrangement reduced problem behaviors and that each participant allocated more frequently to one mand topography over another. These results replicated and extended the study by Winborn et al. (2002) in two ways. First, the results demonstrated a preference for one mand topography over another. Second, the results demonstrated decreased problem behavior when existing mands were used during FCT, a finding dissimilar to Winborn et al. (2002).

Winborn-Kemmerer et al. (2009) implemented FCT with two novel mands on single schedules and demonstrated that each mand was used functionally and effectively. In a subsequent comparison, both mands were available in a concurrent schedules arrangement and the participant allocated responding to one mand more frequently than to the other, or demonstrated a mand preference.

An evaluation of responding when more than one appropriate response is available can be useful for guiding treatment plans to bias the participants' responding toward a mand topography that is most likely to result in reinforcement outside of the training setting and is easily accessible on an on-going basis. One concern with FCT is that a target mand that is initially used in communication training may not be reinforced outside of the training setting (Durand, 1999). For example, novel conversation partners might not understand the communication response (e.g., manual signs, icons), thereby increasing the difficulty for the communicator in recruiting naturally occurring reinforcement. These types of challenges may interfere with generalization of the mand outside of the treatment setting and lead to increases in problem behavior (Hagopian et al., 1998). Concurrent schedules arrangements may be more indicative of naturally occurring contingencies of reinforcement because more than one response may result in access to reinforcement. In addition, a client may also demonstrate a preference for a particular mand even if that mand is less likely to recruit reinforcement in the natural environment or is associated with higher levels of problem behavior (Winborn et al., 2002). It is important to evaluate not only changes in response allocation from problem behavior to a mand but also allocation among more than one response hypothesized to be part of the same response class.

Clinically, studies of allocation across available mands increase our knowledge of responding in a schedule arrangement that may reflect responding in the natural environment. Conceptually, these types of studies further our understanding of the dimensions of reinforcement and stimulus control and how these variables interact in concurrent schedules arrangements.

A potentially unlimited number of variables may influence response allocation across concurrently available mands. In this study, I evaluated concurrent schedule arrangements, extinction, stimulus control, and response effort because each of these variables is easily identified and manipulated. Each variable has been shown to influence responding across various topographies of behavior, but this combination of variables has not been evaluated in relation to multiple mand topographies. In addition, few if any studies have evaluated the effects of these variables on response allocation across more than one context for each participant.

Factors Affecting Response Allocation

Stimulus Control

Over time, a stimulus, object, or event that occurs directly before a response that results in reinforcement may become associated with access to reinforcement. When this specific antecedent event alters the rate, latency, duration, or amplitude of a response, then responding may be said to be under control of the stimulus. Stimulus control occurs when it is demonstrated that responding is more likely to occur in the presence of given stimuli (discriminative stimuli) but does not occur in the absence of those stimuli (Cooper, Heron, & Heward, 2007).

Response allocation may be influenced by stimulus control. For example, Guiterrez, et al. (2007) conducted a study to evaluate whether an appropriate mand was displayed when specific antecedent stimuli were present. The authors taught each participant to mand for two preferred items that were paired with two corresponding but different picture cards (e.g., gaining access to food when the food card was used during FCT). During discrimination conditions, the participant had access to one item while the other item was restricted and both corresponding communication cards were placed in front of the participant. The results of the study showed that 3 of 4 participants manded for the item that was not available and, therefore, discriminated between the different pictures.

Fisher, Kuhn, and Thompson (1998) established stimulus control by teaching participants to discriminate when reinforcement was and was not available. Discrimination training included trials in which each stimulus (e.g., two different pictures or drawings) was available and each was associated with access to reinforcement (i.e., toys or attention). The authors then demonstrated that each participant would mand when the corresponding stimulus was present (e.g., sign “hugs” for attention when the attention picture card was available) and that responding was low or did not occur when the stimulus was absent.

Winborn-Kemmerer et al. (2010) conducted an evaluation of stimulus control during FCT to determine whether response allocation changed when a distinct stimulus was present or absent. The authors taught two separate mands for each participant (i.e., card and vocal, card and sign). In a concurrent schedules arrangement, each participant demonstrated a clear preference for one mand topography over another. The authors hypothesized that responding was related to stimulus control because the participants were allocating primarily to the visual stimuli. The final phase of the evaluation consisted of a mand analysis to evaluate manding in the presence and absence of the communication card. In this phase, the authors demonstrated that the participants allocated to a different mand topography and that responding was not specific to the card.

Dimensions of Reinforcement

Mace and Roberts (1993) described several key parameters of reinforcement that influence response allocation among concurrently available options, and discussed lawful relationships among various response choices based on the matching law. The matching law states that the rate of responding for multiple responses will be proportional to the rate of reinforcement available under a concurrent schedules arrangement (Herrnstein, 1961, 1970). The matching law originally evaluated allocation of responding during concurrent variable interval schedules and for two or more choice alternatives that were symmetrical. Symmetrical choice alternatives require the same response requirements and result in the same reinforcement (McDowell, 1989). For example, a symmetrical choice arrangement may include different schedules of reinforcement to access identical amounts of the same reinforcer such as the same amount of time with a preferred item contingent on appropriate communication (Winborn et al. 2002). Therefore, the schedule requirement varies while the other response and reinforcement parameters are held constant.

A lawful or "matched" choice may not always occur. Undermatching or over-matching occurs when an organism's response allocation is not proportional to the rate of reinforcement. Over- and undermatching can occur when various aspects of the independent variable, such as response effort or preference are not held constant across the two responses (i.e., the alternative choices are asymmetrical). These asymmetrical choice alternatives are more typical of natural environments and may bias responding toward one or more alternatives (McDowell, 1989). Applied researchers have also evaluated response allocation among different response options such as two sets of work tasks (Cuvo, Lerch, Leurquin, Gaffaney, & Poppen, 1998; Neef, Shade, & Miller, 1994), problem behavior and communication (Horner & Day, 1991), and two mand topographies (Winborn et al., 2002).

Various situations have been identified that influence shifts in response allocation or bias responding to one response alternative over another. Shifts in response allocation occur based on the influence of any number of reinforcement dimensions. Several specific dimensions have been identified and include immediacy, quality, effort, and rate of reinforcement (Mace & Roberts, 1993). In concurrent schedules arrangements, these dimensions may influence the individual's choice allocation.

Immediacy of Reinforcement

Immediacy of reinforcement refers to the amount of time that elapses between displaying a target response and the delivery of reinforcement. Mace and Roberts (1993) discussed immediacy of reinforcement in terms of *discounting*. Discounting refers to the decreased value of a larger delayed reward versus a smaller more immediate reward. Neef and Lutz (2001b) evaluated differences in responding for 1 participant when responding accessed immediate reinforcement versus delayed reinforcement. Neef and Lutz conducted an evaluation to identify the reinforcement dimension that was most influential in biasing response allocation. For this participant, immediacy to reinforcement was the most salient variable affecting response allocation. The results of this initial evaluation were used to develop treatment that assessed access to immediate (at the end of the class period) reinforcement versus delayed (provided on a subsequent day ranging from 1-7 days) reinforcement contingent on decreases in problem behavior. The results of the treatment evaluation indicated that longer delays to reinforcement were correlated with higher levels of disruptive behaviors and access to immediate reinforcement sufficiently reduced disruptive behavior.

Horner and Day (1991) evaluated differences in responding when a delay to reinforcement was increased for 1 participant. The participant was able to choose between problem behavior and communication throughout the experiment. In the first condition, the delay to reinforcement (break) for communication was increased to 20 s and engagement in problem behavior resulted in immediate access to a break. In the second condition, the participant received immediate access to a break if she engaged in problem behavior. If the participant displayed the target mand, then a 1-s delay was implemented prior to access to reinforcement (break). The results of the study indicated that when a 20-s delay to reinforcement was contingent on communication, the participant engaged in higher levels of problem behavior. However, when only a 1-s delay was implemented following communication, the participant primarily allocated to the communicative response instead of to problem behavior.

The study by Horner and Day (1991) demonstrated that increased delays to reinforcement during FCT may influence response allocation and change allocation from one response (e.g., mands) to another concurrently available response (e.g., problem behavior). Thus, if there is a protracted delay between a behavior and reinforcer delivery, an individual may exhibit another behavior that historically resulted in access to reinforcement, such as problem behavior. During initial FCT training, it is common to provide access to reinforcement immediately following the target communicative response. Over time, this strategy may be time consuming and difficult for care providers to implement in a timely fashion. In these naturally occurring situations, reinforcement may not be available (e.g., needs to be prepared or purchased) or the request may not be - immediately observed by someone who can provide reinforcement. Therefore, several fading procedures have been evaluated to assist with increasing the delays to reinforcement. These procedures have included introducing competing stimuli during a delay (Hagopian, Kuhn, Long, & Rush, 2005) and gradual increases in the amount of time between the response and access to reinforcement (Fisher et al., 1993; Fisher, Thompson, Hagopian, Bowman, & Krug, 2000; Hagopian et al., 1998).

Quality of Reinforcement

Quality of reinforcement refers to a preference for one event, context, or response over another, based on some known or unknown attribute (Mace & Roberts, 1993). Recent research has demonstrated that the quality of reinforcement may vary based on variables such as preference for items (Neef & Lutz, 2001), types of attention (Gardner, Wacker, & Boelter, 2009), or combinations of reinforcers (e.g., attention and toys; Kodak, Lerman, Volkert, & Trosclair, 2007). Neef and Lutz (2001b) conducted an evaluation of reinforcer quality for 1 participant by providing either high or low preferred items contingent on the absence of problem behavior (e.g., less than 6 disruptions per day). High- and low-preferred items were identified by rank ordering items (1 to 10) and using the top three items as the high quality items and the next three items (ranked 4-6) as the low quality items. The results of the study indicated that problem behavior occurred at lower rates when the participant was provided with access to the high quality reinforcer, and higher levels of problem behavior were observed when the quality of reinforcement was relatively lower.

The quality of the reinforcer may vary depending on satiation and deprivation (availability to unavailability) of the alternative stimuli. For example McComas, Thompson, and Johnson (2003) evaluated the effects of presession attention on responding during a functional analysis of problem behavior. For participants whose problem behavior was maintained by access to attention, problem behavior was lower in sessions in which the participants had prior access to attention. The quality of the reinforcer (attention) was not as potent during sessions in which the participant was satiated versus sessions in which the participant was ignored and attention was unavailable (i.e., deprivation).

An example of an FCT study that evaluated differential responding when the quality of reinforcement was manipulated was reported by Peterson et al. (2005). Following FCT, the participants were required to make choices between requesting a break immediately or following a work task. The higher quality break (i.e., toys and attention) was available for longer periods of time if the participant chose to complete the work task. If the participant manded to take a break immediately, then the participant had access to a brief break with low quality reinforcement (i.e., attention and toys were not available). The results of the study demonstrated that response allocation consistently favored the response associated with longer duration and higher quality reinforcement

Effort

Effort differs from the other dimensions in that it is typically described in relation to the response rather than to reinforcement. Basic and applied studies have defined effort in terms of the physical exertion to emit a response such as torque or response force (Chung, 1965; Schroeder, 1972) or measured in terms of task requirement (Cuvo, et al., 1998), task difficulty (Neef, et al., 1994), and variation in response requirement (Horner & Day, 1991; Richman, Wacker, & Winborn, 2001).

Horner and Day (1991) evaluated the role of response effort with 1 participant. In the effort manipulation, the individual was first taught a higher effort response (i.e., sign a sentence), and initial decreases in problem behavior were observed along with concurrent increases in communication. However, appropriate responding soon decreased and problem behavior increased to near baseline levels. The authors then taught a low effort response (i.e., sign a word), and problem behavior decreased to zero by the second session and communication increased substantially. The results of this evaluation indicated that the effort needed to display a response may affect the rate or probability of the response being emitted.

Rate of Reinforcement

Rate of reinforcement can be influenced by the specific schedule of reinforcement delivered for one or more response options. Mace and Roberts (1993) discussed rate of reinforcement in relation to the matching law and responding in concurrent variable interval schedules. Within a concurrent schedules arrangement, the matching law predicts that responding will allocate to the response alternatives that maximize the obtained rates of reinforcement. Therefore, the rate of responding will match the obtained rate of reinforcement for each alternative.

Various types of reinforcement schedules such as variable, fixed, ratio, and interval schedules and the frequency of reinforcement (e.g., dense versus lean schedules) have been found to influence response allocation between problem behaviors and manding. The FCT literature provides many examples of response allocation based on differences in the rates of reinforcement for concurrently available responses. For example, several studies have evaluated the effectiveness of FCT when problem behavior resulted in intermittent access to reinforcement (Kelley et al., 2002; Worsdell et al., 2000). Worsdell et al. evaluated the effectiveness of FCT when problem behavior resulted in various rates of reinforcement (i.e., fixed ratio 1, fixed ratio 20). Three different response patterns were observed across participants: shifts in allocation under equal concurrent schedules arrangements (FR1:FR1), shifts in allocation with changes in the reinforcement schedule (FR2, FR3, FR20) and, for 1 participant, increases in problem behavior regardless of the schedule of reinforcement.

Purpose of the Current Study

Several dimensions of reinforcement and stimulus control can influence response allocation within a concurrent schedule. Limited research is available in terms of the influence of these variables on response allocation within a concurrent schedule following the establishment or availability of more than one mand topography. The current study was designed to further investigate variables that influence response allocation among multiple mand topographies and consisted of three purposes. First, I evaluated response allocation among asymmetrical choice options consisting of more than one mand topography (i.e., vocal, sign, card) that were available within a concurrent schedules arrangement. The second purpose was to determine which variables may influence or change response allocation among mand topographies. This was evaluated by manipulating response effort, schedule of reinforcement, and availability of visual stimuli (i.e., a communication card). The third purpose was to evaluate the stability of responding within each participant across more than one reinforcement context (i.e., escape, diverted attention, and restricted tangibles).

CHAPTER II

LITERATURE REVIEW

Introduction and Purpose

Over the past 15 to 20 years, several review articles and chapters have been published related to different parameters of reinforcement that influence response allocation. Response allocation is most often evaluated using a choice arrangement conducted within concurrent schedules of reinforcement. Such schedule arrangements may more accurately reflect the types of reinforcement schedules that operate in the natural environment, thus increasing the external validity of the findings. For example, in the natural environment, an individual can choose between several response options, with each option being associated with different outcomes that may influence future responding. In choice arrangements programmed reinforcers influence the probability of a given response, shifting response allocation among available options (Fisher & Mazur, 1997; Friman & Poling, 1995; Mace & Roberts, 1993).

Several parameters of reinforcement have been demonstrated to influence response allocation. These dimensions include immediacy, magnitude, quality, and rate of reinforcement. Along with response effort, these variables are commonly included in evaluations and discussions of variables that influence response allocation (Fisher & Mazur, 1997; Hoch, McComas, Johnson, Faranda, & Guenther, 2002; Lerman, Kelley, Van Camp, & Roane, 1999; Mace & Roberts, 1993; Neef et al., 1994). *Immediacy of reinforcement* refers to how quickly a reinforcer is delivered after a response, or the time between the response and access to reinforcement. *Reinforcer magnitude* has been defined in terms of intensity, number of reinforcers, or duration of reinforcement (Hoch et al., 2002). *Quality of reinforcement* refers to some difference in an attribute or characteristic of reinforcement. In some situations, quality is measured by an individual's preferences or response allocation (Neef et al., 2005). *Rate of reinforcement* refers to the frequency with which reinforcement is provided. *Response effort* refers to the magnitude, physical exertion, or differences in skill requirements that exist between two or more responses. *Effort* is commonly included as a dimension of reinforcement influencing response allocation (Mace & Roberts, 1993). However, unlike immediacy, magnitude, quality, and rate, effort can be conceptualized perhaps more accurately as a characteristic of the response. Response effort has been evaluated in basic and applied contexts (Friman & Poling, 1995), and research related to its impact continues to evolve and extend across various response topographies and settings.

The purpose of this chapter is threefold: (a) to provide an overview of research from the past 20 years that explores the ways in which response effort has been defined and evaluated, (b) to provide a brief discussion of the combined effects of various dimensions of reinforcement, including response effort, on response allocation, and (c) to outline several considerations for practitioners, based on the empirical evidence discussed, which may influence the development and interpretation of assessments and interventions in naturalistic environments such as classroom or home settings.

Response Effort

Applied research has evaluated the effect of effort on response allocation among response topographies such as problem behavior, work completion, food consumption, and communication. Within these applied investigations, effort to exhibit such responses was often evaluated using concurrent schedules arrangements in which more than one response option was available (e.g., Neef et al. 1994). Response effort has been operationally defined in a variety of ways across studies, each having been demonstrated to influence response allocation. The varying conceptualizations of response effort include: the skill required to display the response, physical exertion required to complete the response, and the magnitude of the response requirement (i.e., number of responses required). The effects of these parameters are the focus of the following section of this chapter along with considerations for practitioners when evaluating each type of response effort. These parameters were selected based on a review of effort-related applied literature published in the last 20 years.

Skill Level

Differences in effort can be conceptualized as the differences in skill level required to engage in or display a given response (e.g., Reed & Martens, 2008). The effort required to exhibit the skills related to any particular response may vary based on the individual's functioning and ability. Effort manipulations related to the individual's functioning and skill levels have been evaluated in relation to academic tasks, communication, and food refusal.

Several studies have defined high effort (difficult) academic tasks in terms of relatively low accuracy and rate of responding. Accordingly, low effort (easy) academic tasks are defined by relatively high rates of responding and increased accuracy and considered low effort (Lannie & Martens, 2004; Neef et al., 1994). Accuracy and fluency (speed and accuracy) of responding are often indicators of an individual's mastery, instructional, or frustration skill levels (e.g., Burns, VanDerHeyden, & Jiban, 2006). Material that is too difficult is considered a frustration level while material that is too easy or not challenging enough is considered mastery or independent level (Gravois & Gickling, 2002). Therefore, a student is able to complete a task with little or no assistance, high fluency or accuracy and low or no skill-related effort when they are functioning at an independent skill level. At an instructional level, a student may require relatively more guidance with lower percent of the tasks being correct (e.g., 70-85% items correct, Gickling & Thompson, 1985). A student's frustrational skill level can be conceptualized as a high effort task that involves skills in which high levels of guidance are required and fluency or overall accuracy is low.

If student is functioning at a high effort or frustrational skill level, then a practitioner may reduce the task difficulty or review previous skills required until the individual is functioning at an instructional level (VanDerHeyden & Burns, 2005;

VanDerHeyden, Witt, & Naquin, 2003), provide repeated practice until the individual achieves instructional level (decreasing effort of the task; Gickling et al., 1989), or intersperse low effort tasks (Billington, Skinner, Hutchings, & Malone, 2004; Cooke & Guzaukas, 1993).

One strategy that has been evaluated as a way to ameliorate difficulties with high effort tasks is interspersing easy and difficult tasks (Billington, Skinner, Hutchings, & Malone, 2004; Cooke & Guzaukas, 1993). In some situations, a ratio of 30% difficult to 70% easy tasks successfully increased fluency while little or no changes in fluency were observed with other types of academic tasks (Cooke & Guzaukas). Therefore, practitioners may examine whether interspersing a low effort task among high effort tasks successfully increases task completion and overall task accuracy for any given task. Practitioners may also conduct an evaluation to determine what ratio of high to low effort tasks are required to maintain academic success.

The effort required to exhibit a response may depend on a combination of cognitive and motor skills. In academic tasks increased effort may be observed with difficulties in writing tasks which require fine motor skills to hold and manipulate a writing utensil and cognitive skills to develop what to write. Acquisition and use of communicative responses can be affected by similar motor and cognitive skill requirements (Horner & Day, 1991; Tiger, et al., 2008). Tiger et al. noted that differences in response topography or the skills needed to exhibit an appropriate communicative response may require varying degrees of response effort. For example, manually signing different words (e.g., “drink” versus “finished”) may require different motor and cognitive skills as compared to selecting a stimulus (e.g., a picture) from an array. Signing “drink” may require specific motor skills, whereas selecting a picture from an array may require more complex cognitive skills.

In a clinical setting, evaluations of potentially life threatening behavior, such as food refusal, may be evaluated with a focus on the effort to emit a response such as chewing or swallowing. Complex food textures or larger volumes of food may require more advanced oral-motor skills (Kerwin, Ahearn, Eicher, & Burd, 1995). For example, Patel, Piazza, Layer, Coleman, and Swartzwelder (2005) conducted an evaluation of food refusal behaviors for 3 children with inadequate weight gain or failure to thrive. In this study, effort was conceptualized as differences in the texture of the foods. The skills (e.g., chewing, swallowing) required to consume more textured food were hypothesized to be more effortful than skills required for less textured foods. The authors found that higher levels of food packing occurred with more textured foods than less textured foods. Higher food consumption and weight gain were observed when less effort was required to consume the food item (i.e., food texture was decreased).

Implications

Collectively, these examples demonstrate that skill may be an integral variable affecting response effort and thus, influence response allocation. These examples of skill-related effort in academic tasks, communication, and food refusal reveal the importance of systematically evaluating an individual’s skill levels and monitoring how skills deficits may be affecting the effort required to emit a given response. Practitioners may not want to avoid higher effort situations or higher effort responses may not be easily avoided. However, higher skill-related effort has been associated with higher levels of problem behavior or hindered the display of appropriate behaviors. In combination these studies indicate that decreases in skill requirements can and does increase responding. Skill-related effort can stay constant while using alternative strategies to lessen the effects of higher effort tasks. These strategies such as interspersing easy and difficult tasks and repeated practice may be applied and should be evaluated in relation to other types of skill-based responses.

Physical Exertion

Physical exertion has been defined as torque or physical force required to move an object (Chung, 1965; Schroeder, 1972) and may be conceptualized as a physically laborious task such as heavy lifting or overcoming increased physical resistance. For example, physical exertion was manipulated by varying the heights of hurdles that required low to high levels of physical exertion to successfully jump over (Cuvo, et al, 1998).

Effort manipulations related to the evaluation of severe aberrant behavior have included changes in the physical force required to engage in the target problem behavior. In rare situations when behavior is resistant to less restrictive interventions, and/or can cause serious injury, restraint procedures that increase the amount of physical effort required to exhibit the response have been successfully implemented. Restraint procedures have included the application of wrist weights (Hanley, Piazza, Keeney, Blakely-Smith, & Worsdell, 1998; Van Houten, 1993), flexible arm sleeves (Zhou, Goff, & Iwata, 2000), and arm restraints with varying number or diameter of stays (Irvin, Thompson, Turner, & Williams, 1998; Wallace, Iwata, Zhou, & Goff, 1999). The results of these studies demonstrated that physical restraint can successfully decrease inappropriate behavior. One putative reason for the effectiveness of such strategies is the increased effort needed to engage in the inappropriate response when restraints are in place. For example, Zhou, et al. evaluated changes in responding when the effort to engage in problem behavior was increased. During low effort conditions (baseline), the participants could engage in problem behavior or object manipulation. Response effort was increased by requiring the participants to wear flexible arm sleeves, and data were collected on the individuals’ engagement in object manipulation and problem behavior. The results showed that increased physical effort concurrently decreased engagement in problem behavior.

Although restraints may reduce or eliminate problem behavior, several studies have indicated that appropriate responding (e.g., toy play) continues to occur while the participant is wearing restraints (Hanley et al., 1998; Irvin et al., 1998; Wallace et al., 1999; Van Houten, 1993). Topographically similar behaviors, such as play skills or feeding, may require less physical effort to display than the aberrant behaviors (e.g., head hitting) evaluated in these studies. For example, Hanley, et al. (1998) hypothesized that the appropriate response may have required less physical effort because distance for movement was shorter than for problem behaviors.

Physical distance may also increase the physical exertion required to exhibit a response. Shore et al. (1997) empirically evaluated differences in physical distance and the subsequent effects on response allocation. In this study, effort to manipulate preferred items was slowly increased to evaluate shifts in responding between an appropriate behavior (object manipulation) and self-injury. During low effort conditions, preferred objects were readily available (i.e., close in proximity). When this arrangement was in place, object manipulation effectively competed with self-injury. Effort was systematically manipulated by increasing the physical distance between the participants' seats and the preferred items. At some point for all participants, the increased distance ultimately resulted in shifts in response allocation from object manipulation to self injury for each participant. One participant's response allocation shifted after relatively small changes in distance were implemented (e.g., 4.5 in.). Other participants' required larger distances (e.g., 10 in, 16.75 in) before shifts in response allocation were observed. Thus, the exact effect of any given increase in distance may be individually determined.

Implications

Physical exertion may have important implications for affecting response allocation in applied settings. For example, physical transitions within and outside the classroom, community, or home setting may require increased physical exertion. These increases in physical effort may result in a student, client, or child shifting response allocation from compliance (i.e., appropriate behavior) to noncompliance (i.e., inappropriate behavior). As noted in the study by Piazza, Roane, Keeney, Boney, and Abt (2002), physical distance, even in very small amounts, may affect response allocation depending on the individual. Therefore, physical transitions from one area of a room or building to another or smaller movements such as reaching, bending, carrying task items, or standing up may be effortful depending on the individuals' physical needs. Several strategies may be evaluated in relation to decreasing physical exertion. First, practitioners may consider decreasing the distance traveled during transitions or allow frequent breaks or access to reinforcement. Second, practitioners may consider decreasing the physical requirements that may increase effort, such as carrying fewer or no items during transitions.

Response Magnitude

Increases in effort may be related to response magnitude, such as the amount, frequency, and duration of the response required. Several studies have evaluated response magnitude in relation to response allocation among instruction completion, communication, and daily activities.

Any given task may vary in terms of the amount of time engaged (Kern et al., 1994) or number of responses (Cuvo et al., 1998; Gwinn et al., 2005) required for completion. These response requirements have been demonstrated to influence response allocation. For example, Cuvo et al. evaluated response allocation when a participant was required to choose between sorting small (6 pieces) or large (30 pieces) number of silverware items to gain access to reinforcement. The authors considered these tasks to be relatively low and high effort responses (respectively). The participants consistently chose the task associated with low response effort. In another evaluation of response magnitude, Kern et al. manipulated the length of the task as one part of an intervention package. Results indicated that on-task behavior increased overall when lower response effort (i.e., shorter assignments) was included in the intervention package.

The effects of response magnitude on response allocation have been evaluated with communicative responses. Communicative responses can range from single words to multiple word phrases. Relative to single word responses, multiple word phrases may be conceptualized as a larger number of responses required and, therefore, be of relatively higher effort. Horner and Day (1991) conducted an evaluation of effort during communication training for 1 participant. In this study, effort was varied by requiring longer or shorter communicative responses to obtain the reinforcer. When the participant chose between signing (i.e., “I want to go, please”) and engagement in aggression to access a break, the participant engaged in high levels of problem behavior and minimal communication. The participant was then taught a relatively lower effort response, (i.e., “break”) and could chose between communication and aggression to access reinforcement. When a low effort response was available, response allocation shifted from aggression to appropriate communication. Thus, a lower effort response successfully competed with aggression but the higher effort response did not.

In applied settings, response magnitude has been shown or hypothesized to affect responding not only in academic tasks or communication but with compliance with daily activities. The number of steps or length of time required to complete transitions may also increase the effort to engage in the response (Sterling-Turner & Jordan, 2007). Transitions may involve several structural components that are typically designed to increase predictability and structure and include components such as visual schedules, timers, and structured work systems. A transition with multiple response requirements may involve manipulation of several pictures cards on the schedule, starting/stopping a timer, and preparing materials for the activity. These additional steps may increase response effort and may be important to consider and evaluate if problem behaviors occur within these types of activities.

Implications

Collectively these studies indicated that response magnitude affects allocation across a variety of responses. These results have important implications for teaching communication or other appropriate behaviors. For example, extended communication or task requirements may make the response more effortful, and an individual may choose to allocate responding to a different, less effortful response, such as problem behavior. Therefore, initial communicative or task requirements may need to require very little effort, such as a single response or card touch prior to increasing response requirements.

Demand or instruction fading is one way to incrementally increase response magnitude from a low effort to a higher effort response (Ringdahl, et al., 2002; Pace, Ivancic, & Jefferson, 1994; Piazza, Moes, & Fisher, 1996; Zarcone, et al., 1993). Previous studies have shown that problem behavior may increase when the response magnitude is relatively high (e.g., Horner & Day, 1991). Therefore, demand fading procedures have been used to slowly increase response effort while maintaining relatively low levels of problem behavior. Demand fading interventions often require programmed extinction or punishment to adequately decrease problem behaviors (Hagopian, et al., 1998; Ringdahl, et al., 2002) however, in some situations these reductive procedures may not be required (Piazza, Moes, & Fisher, 1996).

Dimensions of Reinforcement and Response Effort

As discussed, response effort is one of a number of variables that can affect response allocation. However, it is not the case that effort operates, or has been evaluated, in isolation. Several studies have evaluated the effects of response effort and reinforcement immediacy, quality, and rate when each dimension is in direct competition with another. In these studies, evaluations were conducted in either an extended or a brief format comparing responding when each of two dimensions of reinforcement was in direct competition with each other (Neef, Bicard, & Endo, 2001; Neef, Bicard, Endo, Coury, & Aman, 2005; Neef & Lutz, 2001a; Neef & Lutz, 2001b; Neef et al., 1994; Neef, Marckel, et al., 2005).

Neef and Lutz (2001a) evaluated responding under competing dimensions of reinforcement in a brief, computer-based assessment. The results of this study showed that 4 of 11 students allocated almost all responding to the less effortful response, regardless of the other competing dimensions. This finding contrasted slightly with the Neef et al. (1994) study in which response effort was seldom an influential dimension. As noted by the differences in the results of these two studies, response effort may or may not affect each individual's response allocation and may need to be evaluated for each individual student. A second implication is that allocation may not be specific to response effort and effort may need to be evaluated relative to other response and reinforcement parameters or controlling for differences in these variables.

Several studies have evaluated strategies to lessen the effects of response effort once it has been demonstrated to be an influential factor in response allocation. Increases in response effort, in combination with other reinforcement dimensions, have been used to shift responding from problem behavior to favor appropriate behavior (e.g., Cuvo et al., 1998; Gwinn et al., 2005; Perry & Fisher, 2001; Piazza et al., 2002). For example, the effort to exhibit problem behavior may be increased while higher quality, longer duration, and/or more frequent access to reinforcement is associated with the appropriate behavior.

One option for practitioners is to control for other variables that may influence responding and then manipulate these variables to bias responding towards a higher effort response. For example, effort and quality manipulations have been conducted to evaluate response allocation between appropriate and inappropriate behavior. Piazza et al. (2002) manipulated the effort required to engage in pica while initially controlling the quality of reinforcement. Based on the initial evaluation for all three participants, pica was hypothesized to be maintained by access to automatic reinforcement. The three participants in this study were allowed to choose between two response options, pica or an appropriate behavior (engagement with an alternative item). During low effort conditions for pica, nonfood items were placed on the floor (Brandy and Sue) or above the waist on the table (Sara). High effort conditions for pica included nonfood items placed in plastic containers with a closed lid (Brandy and Sue) or on the floor (Sara). During low effort conditions for the alternative response, preferred items were consistently available. In the high effort condition for the alternative response, the alternative item was placed in the plastic containers (Brandy and Sue) or below the waist such as on the floor (Sara). A medium effort condition for alternative items (Brandy, Sue, Sara) and nonfood items (Sara) was conducted in which items were placed throughout the room above and below the waist. The levels of effort for the nonfood food item and the alternative response were alternated across sessions.

The results of this study demonstrated that, if an alternative item was not available, increased effort for pica decreased engagement in pica; however, clinically significant results were not obtained. Generally, the addition of the alternative item, regardless of the level of effort, competed with pica overall across participants and engagement in pica decreased. Therefore, increased response effort for pica decreased problem behavior to some extent; however, a higher quality of reinforcement (i.e., preferred item) was required to decrease pica to clinically significant levels.

In another example of response effort and reinforcement quality, quality of reinforcement was manipulated as a way to shift responding from a less effortful to a more effortful task (Gwinn et al., 2005). In the high effort manipulation, the participant could choose between completing two spelling sheets (high effort task) for high or low quality reinforcement. In the low effort manipulation, the participant could choose between completing a single spelling sheet (low effort task) for access to high or low quality reinforcement. In the high effort condition, response allocation varied between low and high quality reinforcement with frequent allocation to the task associated with high quality reinforcement. In the high effort condition, higher levels of problem behavior were exhibited even when the participant had access to high quality reinforcement.

In contrast, response allocation in the low effort condition was almost exclusively allocated to the task associated with high quality reinforcement. Problem behavior occurred at lower levels relative to high effort conditions. In summary, the addition of high quality reinforcement did affect response allocation among tasks; however, higher levels of problem behavior were associated with the high effort task even when high quality reinforcement was available. Low effort tasks were required to adequately decrease problem behavior.

Another dimension of reinforcement that has been manipulated in conjunction with response effort is rate of reinforcement. Cuvo et al (1998) conducted a three-part study in which effort was manipulated by varying the task amount that needed to be completed (physical distance to throw a beanbag and varying heights to jump over hurdles). The purpose of the study was to evaluate responding under concurrent schedules of reinforcement while manipulating the effort to display a given response. Initially, the rate of reinforcement was held constant while effort (i.e., high versus low physical exertion) was manipulated, and the participants primarily allocated to the low effort response. In subsequent conditions, the rate of reinforcement was decreased for the lower effort task and responding shifted to the higher effort response associated with more frequent access to reinforcement.

In summary, several different outcomes were obtained in the reviewed studies. Piazza et al. (2002) demonstrated that decreasing effort was not sufficient to decrease problem behavior to clinically significant levels, and higher quality reinforcement was needed to adequately decrease problem behavior. In the second example (Gwinn et al., 2005), higher quality was not sufficient to bias responding exclusively to the higher effort response and to decrease problem behavior. Cuvo et al. (1998) demonstrated that responding was primarily allocated to the lower effort response when the rate of reinforcement was similar for both response options. When the schedule of reinforcement was decreased (thinned) for the low effort response, the majority of participants allocated their responding to the higher effort response associated with a higher probability and rate of reinforcement.

Given the various outcomes, practitioners should consider and develop a plan to evaluate response effort along the dimensions of skill, physical exertion, and magnitude while controlling for other variables which may influence responding. Following this type of evaluation, variables related to reinforcement such as rate, immediacy, quality, and magnitude of reinforcement may be manipulated to affect shifts in response allocation among low and high effort responses.

From an intervention standpoint, response effort may be attenuated in several ways. One relatively simple way to decrease effort is by changing the skill, physical exertion, or response magnitude required to exhibit a response. Practitioners may consider that changes in response magnitude or task difficulty may delay access to reinforcement, decrease the probability of reinforcement (Cuvo et al. 1998), or require a larger amount of response to be completed prior to accessing reinforcement (Lannie & Martens, 2004). Therefore, an effort evaluation might include manipulations of the response requirements at the current baseline and then systematically decreasing or increasing different parameters of response effort as described previously.

Summary

Research over the past 20 years has provided empirical demonstrations of the effects of response effort on response allocation. Effort manipulations have been used to affect an individual’s choice responding among appropriate and inappropriate responses and across several response topographies. Manipulations of response effort in various forms (e.g., skills, physical exertion and magnitude) may bias allocation from severe behaviors such as pica, self-injury, or aggression to appropriate behaviors such as communication, increased food consumption, or task completion.

A large number studies evaluating changes in response effort have demonstrated that increases in effort are likely to shift responding toward the less effortful response. Changes in response effort may not influence responding for all individuals and may be specific to a certain response requirement or context. For individuals whose response effort is an influential factor, several studies have demonstrated that response allocation can shift to the high effort response when other dimensions of reinforcement are manipulated in conjunction with response effort.

CHAPTER III

METHODS

Participants

Two individuals with developmental disabilities were enrolled in the study. Alex was 3 years old at the initiation of the study and was diagnosed with a developmental delay. Alex could independently mand via card touches and specific manual signs to recruit reinforcement in each of three functional contexts: “want” for tangible items, “Mom” for attention, and “all done” for breaks from demands. Alex’s parents and prior therapists reported that Alex displayed 5 to10 one-word utterances (e.g., “more,” “mom,” and “please”) at the initiation of this study and used vocal mands to access preferred items, to recruit attention, and to take breaks from task demands.

The second participant, Jake, was 5 years old at the initiation of the study and was diagnosed with autism and mental retardation. Jake exhibited independent mands including card touches and specific manual signs in each of three functional contexts: “want” for tangible items, “please” for attention, and “done” for breaks from demands. Jake’s parents and prior therapists reported that Jake displayed three to five one word utterances (e.g., “up,” “break,” and “please”) at the initiation of this study to gain access to attention, escape from a task escape, and access to preferred items.

Both participants had a history of engaging in severe problem behavior. Approximately 1 year prior to the current study, a functional analysis (Iwata et al., 1982/1994) of problem behavior was conducted for each participant and identified tangible, escape, and attention functions (Alex) and tangible and escape functions (Jake). Following the functional analysis, FCT was conducted for both participants to teach a functionally equivalent communicative mand to replace problem behavior. At the time of this study, each participant was independently communicating across three reinforcement contexts: tangible, escape, and attention.

Settings and Materials

Alex's sessions were conducted by the author and Alex's mother in the living room of his home. The room contained a portable video camera, a large couch, and a rocking chair. Several age-appropriate toys and work materials (blocks and bucket) were available, depending on session requirements. All sessions were 5 minutes in length and four to six sessions were conducted during each weekly visit.

Jake's sessions were conducted in an outpatient therapy room at the Center for Disabilities and Development. Sessions were conducted by the author and Jake's mother. The therapy room was equipped with a remote camera and microphone and also contained a table and several chairs. Several age-appropriate toys and work materials (stackable blocks) were available, depending on the session requirements. All sessions were 5 minutes in length and three to five sessions were conducted during each weekly visit.

Alex used a blue (attention context), tan (tangible context), or pink (escape context) communication card. Jake used a yellow (attention context), orange (tangible context), or blue (escape context) communication card. The communication cards were 10 x 6 cm and did not include writing or pictures. The orange card in the tangible context (Jake) was 6 x 6 cm and had a line drawing picture of two toy items and the word "leisure" on the bottom of the card. These cards were previously used during the initial FCT treatment for both participants. A 13 cm x 13 cm blue microswitch was used with Alex during two conditions (stimulus control and subsequent baseline).

Response Definitions and Target Behaviors

The target behaviors for both participants were three mand topographies: vocal mands, card touch, and manual sign (see Table 1). A fourth target mand (microswitch) was included for Alex during two conditions. Each participant exhibited all topographies of mands (vocal, sign, and card touches) in each reinforcement context and independent mands were defined as those that occurred following vocal prompts (e.g., "If you want your toys back, what do you say?”). Independent mands were recorded as a frequency measure and reported as responses per minute (rpm).

V*ocal mands* were defined as one- to two-word utterances. For Alex, target vocal mands were “mom” in the attention context, “want” in the tangible context, and “break” in the escape context. For Jake, target vocal mands were “up” in the attention context, “please” in the tangible context, and “all done” in the escape context.

The *manual sign* for “mom” was used in the attention context for Alex and was defined as touching one hand to the chin. In the tangible context, Alex signed “want,” which was defined as both hands touching the chest. In the escape context, Alex signed “all done,” which was defined as both hands starting at the center of his body and making an outward motion to each side. Jake approximated the manual sign for “Mom” in the attention context by touching his hands to each respective shoulder. In the tangible context, Jake signed “please,” which was defined as one hand touching the chest. In the escape context, Jake signed “all done” by contacting both hands together in front of him.

Card touch was defined for both participants as physical contact between the participant’s hand and the available communication card. *Microswitch touch* was defined as physical contact between the participant’s hand and the microswitch. Data were collected on the occurrence of total problem behavior in each reinforcement context. Problem behavior for Alex and Jake included a combination of aggression and destruction. For both participants, aggression included hitting, kicking, scratching, or spitting on his mother or the therapist. Destruction included throwing items or tearing items. Alex also displayed tantrum behavior which included screaming, crying, and kicking his feet.

Therapist behavior was recorded as a frequency of the delivery of reinforcement following target communication, the duration of reinforcement provided, and vocal prompts.

Measurement

Observation System

Trained observers collected data on Alex's behavior while viewing video recordings of sessions that were recorded using a hand-held video camcorder. Data were collected using a 6-s partial-interval recording system in which the occurrence of target behavior was scored if it was observed at least once during the 6-s interval (see Appendix A). Trained observers collected data on Jake's behavior during in-vivo observations of Jake's sessions via a remote camera. Data were collected on a laptop computer using a computer-based program designed specifically for behavioral observation data. The primary data collector recorded real-time data and the computer program summarized the data into frequency and duration values that could be reported as a rate (rpm) or a percentage of session time measure.

Interobserver Agreement

Interobserver agreement (IOA) was calculated by an independent trained observer who collected data in vivo or from video recordings for the purpose of obtaining IOA for a minimum of 30% of sessions (see Appendix B for a detailed summary). Data collection procedures and operational definitions of each target behavior were reviewed with each observer prior to independent data collection.

Interobserver agreement was calculated for Alex by comparing exact interval-by-interval agreement on occurrence and nonoccurrence of target behaviors across 6-s intervals. Agreement was calculated by taking the total number of agreements divided by the total number of agreements and disagreements and multiplied by 100. Interobserver agreement was 98% for card touches, 98% for manual sign, 100% for vocalizations, and 100% for combined problem behavior.

Interobserver agreement was calculated for Jake by dividing sessions into 10-s intervals and calculating occurrence and nonoccurrence data. An agreement was scored when both observers simultaneously and independently scored the occurrence or nonoccurrence of a target behavior within 2-s of the same interval. A partial agreement was scored if a behavior occurred more than once in an interval and both observers scored a different frequency of occurrence. Interobserver agreement was calculated for all target behaviors by dividing agreements and partial agreements by the total number of intervals (30) and then multiplying by 100. Interobserver agreement was 96% for card touches, 98% for manual sign, 99% for vocalizations, and 98% for combined problem behavior.

Design and Independent Variables

Manding was evaluated within a concurrent schedules design embedded within a reversal design. For both participants, a concurrent, fixed-ratio (FR) schedule was implemented across conditions. Each occurrence of the target mand topography (i.e., card touch, sign, vocal mand and/or microswitch) programmed for reinforcement for that condition resulted in 30-s access to the reinforcer. Specific concurrent schedules varied across conditions, contexts, and participants. The reversal design consisted of re-implementation of baseline or challenge phases depending on each individual context and participant. Typically, each challenge was followed by a return to baseline and either a second implementation of the same challenge or a different challenge.

The independent variables were challenge conditions that potentially altered the mand-reinforcer relation. The challenge conditions were extinction, presence/absence of a stimulus, changes in the concurrent schedule arrangement and response effort. An extinction challenge was conducted following the initial baseline sessions for each participant. The specific order of the remaining challenges varied based on the results of the first baseline phase and the subsequent extinction challenge. Following the majority of challenges, a return to the baseline phase was conducted.

Design: Alex

In the tangible and attention context, an $AB_1AC_1DE_1A$ design was implemented evaluating response allocation during baseline (A), extinction challenge (B_1), stimulus control challenge (C_1), concurrent schedule challenge (D) and effort challenge (E_1). During baseline (A) all target mand topographies were reinforced on a concurrent (FR1:FR1:FR1) schedule. In each respective functional context, the occurrence of any of the three mands resulted in 30-s access to programmed reinforcement. For example, in the tangible context, card touches, the sign “want,” or the vocalization “want” all resulted in 30-s access to preferred items. If Alex displayed a nonfunctional mand in the tangible context (e.g., manual sign “mom”) the mand did not result in access to reinforcement and was not scored by data collectors as a target mand. The visual stimuli (communication card-A and microswitch and card-D) were within arm’s reach of Alex throughout the session.

Following the first baseline (A), the extinction challenge (B_1) was implemented. During extinction (B_1), the target mand displayed during the highest percentage of intervals in baseline no longer resulted in access to reinforcement (FR1:FR1:EXT) while the two mands that occurred at the lowest levels during baseline continued to be reinforced on an FR1 schedule. This challenge was designed to disrupt the response-reinforcement contingency for the mand that was displayed at the highest levels during baseline. When stability in responding was established for all three mand topographies, the baseline reinforcement schedule (A) was re-implemented and stability in responding was established.

The second baseline was followed by the stimulus control challenge (C_1) in which a novel stimulus, a microswitch, was introduced to replace the card. Each mand topography (microswitch, sign, or vocalization) resulted in 30-s access to reinforcement (FR1:FR1:FR1). The concurrent schedule challenge (D) was implemented in the same manner as the previous baseline (A) condition, with one modification. Target mands were reinforced on a concurrent fixed-ratio schedule as in previous baselines and included the communication card, sign, vocalization, and microswitch. All four target mand topographies were concurrently available and reinforced on an FR1 schedule (FR1:FR1:FR1:FR1).

Following the concurrent schedule challenge (D), the response effort challenge (E_1) was implemented. The response effort challenge was designed to determine if changes in response effort affected response allocation. Effort was increased for the mand topography that was displayed during the highest percentage of intervals in the previous baseline condition. Effort was increased by increasing the physical distance the participant was required to move to touch the communication card.

A final baseline (A) phase was implemented using identical procedures as outlined in previous baseline phases. The final baseline phase included reinforcement for the original three target mand topographies: communication card, sign, and vocalization. Each time a target mand was displayed in the tangible or attention context, it resulted in access to preferred items or attention, respectively.

In the escape context, an $AB_2AB_1AB_3A$ design was implemented evaluating response allocation during baseline (A) and the extinction challenges (B_1, B_2, B_3). Each time a target mand was displayed during baseline sessions, Alex was provided with a 30-s break from the work task. Baseline phases continued until stability was established for all three target mand topographies.

Following stable responding in the baseline phase, the extinction challenge (B_1, B_2, and B3) was implemented in the escape context. During the extinction challenge, the target mand that was displayed during the highest percentage of intervals in the previous baseline phase no longer resulted in access to reinforcement while the two mands that occurred at the lowest levels during baseline continued to be reinforced on an FR1 schedule (FR1:FR1:EXT). The target mand in each extinction condition slightly differed and included extinction for the card (B_1), vocal and manual sign (B_2), and manual sign (B_3). Vocalizations and manual sign were both targeted in the second extinction challenge because the vocalizations typically occurred simultaneously with each manual sign.

When stability in responding was established for all three mand topographies within the extinction challenge, the baseline reinforcement schedule (FR1:FR1:FR1) was re-implemented and stability in responding was re-established. The baseline phase and extinction condition were repeated to show consistency in responding within the A and B conditions each time they were implemented.

Design: Jake

In the tangible context, an $AB_1AB_3AE_2AE_1A$ design was implemented evaluating response allocation during baseline (A), extinction challenges (B_1, B_3), and response effort challenges (E_1, E_2). The baseline phase (A) was identical to baseline described for Alex. Similar to the baseline phase for Alex, responding during the baseline was considered to be low effort because only one response was required in order to access reinforcement, and the communication card was within arm's reach of the participant at all times.

Procedurally, the extinction (B_1, B_3) and response effort (E_1, E_2) conditions were conducted in the same manner as the conditions described for Alex. The only difference was the mands targeted in the each of the conditions. The first extinction condition (B_1) consisted of extinction for the communication card and the second extinction condition (B_3) consisted of extinction for the manual sign. Effort was increased in one of two ways depending on the topography of the target mand: the physical distance the participant was required to move to touch the communication card was increased (E_1), or the number of responses (i.e., sign, vocalizations) required to access reinforcement was increased (E_2). In the attention context, an $AB_1C_2B_1C_2A$ design was implemented evaluating response allocation during baseline (A) and challenge conditions: extinction (B_1) and stimulus control (C_2) manipulations. Baseline (A) and extinction (B_1) were identical to conditions described for Alex.

Following the extinction condition (B_1), a stimulus control challenge (C_2) was implemented and differed from the condition that was implemented for Alex. In this condition, Jake's communication card was not available during the sessions. Two target mands, the vocalization "mom" or the sign "mom," resulted in access to reinforcement. Once stability in responding was established when the communication card was not present, the extinction (B_1) and stimulus control (C_2) challenges were repeated to show that changes in responding occurred as a function of changes in condition. The final phase was a return to baseline (A) in which all three mand topographies were concurrently available and each mand resulted in access to reinforcement (FR1:FR1:FR1).

In the escape context, an AB_1A design was implemented evaluating response allocation during baseline (A) and an extinction challenge (B_1). Both the baseline phase (A) and extinction (B_1) conditions were identical to those described previously.

Procedures

Preference Assessment

At the beginning of the study, a free-operant preference assessment (Roane, Vollmer, Ringdahl, & Marcus, 1998) was conducted to identify high and low preferred leisure items. Each participant chose leisure items from an array of items in a toy cabinet and these items were used as the high preferred items. On subsequent visits, a multiple stimulus (MS) preference assessment (Windsor, Piché, & Locke, 1994) was conducted in which each participant could choose from an array of toy items in a cabinet. These items were used as high preferred items during sessions, and items that were not chosen for the initial free operant preference assessment or three consecutive sessions were used as the low preferred items in the tangible and attention contexts.

Phase 1: Baseline (A)

At the beginning of the session, the communication card was placed in front of the participant and the therapist prompt was given. The communication card was placed within arm's reach of the participant and, if the participant moved to a different location in the room, the card was moved to maintain the same level of effort for manding. Following the independent occurrence of any target mand topography, the participant was provided with 30-s access to the reinforcer. During the reinforcement interval, the card was removed. At the conclusion of the reinforcement interval, the card was re-presented and the prompt was restated.

In the tangible context, the prompt was, "It's my turn; if you want your toy, what do you say?" The participant was allowed 30-s access to the preferred item contingent on the independent occurrence of any of the target mands. The low preferred item was continuously available throughout the tangible sessions. During the reinforcement interval (i.e., 30-s access to highly preferred items), the communication card or microswitch was removed. After 30-s access to reinforcement elapsed, the preferred item was removed and the therapist restated the communication prompt. If a mand was not exhibited within 10 s of a vocal prompt, the prompt was repeated every 10 to15 s until the participant displayed a target mand or the session ended. Nonfunctional mands did not result in any programmed consequences.

In the attention context, the prompt was, "If you want me to play with you, what do you say?" A low preferred toy was present in the room, and attention and social interaction were provided contingent on target mands. After each target mand, praise and social interaction were provided for 30 s and often included tickling, interactive songs (e.g., "head, shoulders, knees and toes"), and hide and seek. Nonfunctional mands (e.g., a vocal mand for "break") did not result in programmed consequences. During the reinforcement interval, the communication card or microswitch was removed. Following the reinforcement interval, therapist and parent attention were diverted and the participant was prompted to mand. If a mand was not exhibited within 10 s of a vocal prompt, the prompt was repeated every 10 to 15 s until the participant displayed a target mand or the session ended.

The prompt for the escape context was, “If you want a break, what do you say?” Toys were not available during the session. After each target mand, the participant was given a 30-s break from the work task. During the reinforcement interval, the communication card or microswitch was removed until the interval ended. Following the 30-s reinforcement interval, the work task was re-presented and the participant was prompted to mand. If a mand was not exhibited within 10 s of a vocal prompt, the prompt was repeated every 10 to 15-s until the participant displayed a target mand or the session ended. Nonfunctional mands did not result in programmed consequences.

If the participant engaged in problem behavior in the attention or tangible contexts, a brief time-out procedure was implemented in which the participant was not allowed to have access to his preferred item (tangible context) or attention (attention context) for 10 to 20 s. Following time out, the prompt was given. If problem behavior occurred in the escape context, the participant was required to complete one work task (i.e., putting a block in a bucket for Alex or putting blocks together for Jake) without engaging in problem behavior. A three-step, least-to-most prompting procedure was used with a 3 to 5-s delay between each step of the prompt sequence. The prompting sequence continued until the participant independently complied with the task escape. The three step prompting procedure consisted of a vocal prompt (e.g., “Put the block in the bucket”), a model prompt (e.g., “like this” while demonstrating how to complete the task), and finally, hand-over-hand assistance.

Phase 2: Challenges

Challenges were introduced to determine if they biased response allocation, and included extinction, presence/absence of a stimulus, changes in the concurrent schedule arrangement, and response effort manipulations. The same materials described previously were available in each context, and prompts for each functional context were conducted the same as described for Jake.

Extinction (B)

The extinction challenge evaluated whether changes in responding occurred when the mand displayed at the highest rate (Jake) or during the highest percentage of intervals (Alex) in the previous baseline condition resulted in extinction. The two mand topographies displayed with the lowest frequency or percentage of intervals continued to result in 30-s access to reinforcement. Across all functional contexts, the procedures implemented in the baseline condition for that functional context continued to be implemented in this condition. Extinction was implemented for either the communication card (B_1), vocalization and manual sign (B_2) or manual sign (B_3).

Stimulus Control (C)

The stimulus control challenge evaluated whether exclusive allocation to the communication card was related to stimulus control. Session materials and prompts were identical to baseline excluding the communication card, which was not present in the room. The remaining target mands, vocalization and sign, resulted in 30-s access to reinforcement on an FR1:FR1 schedule. Procedures were otherwise identical to those described for the baseline condition.

<u>Specific procedures (Alex).</u> The stimulus control challenge was implemented in the attention context (C_2) for Alex and included one additional component. During this challenge (C_2), a novel stimulus, a microswitch, was used in a concurrent schedules arrangement (FR1/FR1/FR1) in which reinforcement was provided for the microswitch, sign, and vocalizations. Session materials and prompting schedules were identical to those outlined during baseline. Therefore, the microswitch was placed within arms' reach of the participant and was removed following a target mand (i.e., during the reinforcement interval).

Concurrent Schedules (D)

The concurrent schedules challenges evaluated response allocation when an additional mand topography was available and resulted in access to reinforcement. This challenge was conducted in a similar manner to baseline conditions with one modification. A fourth mand topography, the microswitch, was included and reinforced on an FR1 schedule. In this condition, the microswitch and communication card were placed within arm's reach of Alex.

Response Effort (E)

The response effort challenge evaluated whether changes in responding occurred when the effort to emit the response was increased. The response effort challenge was conducted using the mand topography displayed most frequently during the previous baseline, the card (Alex and Jake) and sign (Jake)**.** Session materials and therapist prompts for each functional context were identical to procedures described for baseline.

Specific procedures (Alex and Jake). During baseline sessions, the communication card was within arm's reach of the participant. During the increased effort sessions (E_1), the physical effort to emit the response was increased by moving the card to the opposite side of the room, approximately 2.5 to 3 m from the participant. Therefore, the participants were required to physically move from their seats at the table or on the floor to walk across the room and touch the card. At the beginning of the session, the therapist oriented the participant to the location of the card by pointing to the card and stating, "Your card is right here."

Specific procedures (Jake). Baseline conditions were considered low effort because the participant was provided with access to reinforcement after each occurrence of the target mand, signing "please" in the tangible context. Therefore the response requirement included only one mand (FR1). During the increased effort condition (E_2), effort was increased by requiring three consecutive mands (FR3) per trial to gain access to reinforcement. The response requirement was reset following the reinforcement interval.

Table 1. Communication Topographies

Participant	Vocal Mands	Manual Sign	Card Touch
Alex			
Attention	Mom	Mom	Blue
Tangible	Want	Want	Tan
Escape	Break	Break	Pink
Jake			
Attention	Up	Want	Yellow
Tangible	Please	Please	Orange
Escape	Break	Finished	Blue

CHAPTER IV

RESULTS

The results are presented individually for each participant and reinforcement context (tangible, attention, and escape) and are summarized in Tables 2 and 3. The individual graphs depict responding among three mand topographies, problem behavior, and the independent variables manipulated for each participant and reinforcement context.

Individual Results

Alex: Tangible

Figure 1 displays Alex's responding in the tangible reinforcement context. In baseline (A), Alex's response allocation favored card touches (M= 8.0 % of 6-s intervals) compared to manual sign (M= 4.4%) or vocalizations (M= 5.2%). When card touches were placed on extinction (B_1) card touches decreased to zero or near zero percentage of intervals (M= 2.8%), while responding with manual sign and vocalizations increased (M= 13.2%, M= 13.6%, respectively). The manual sign and vocalizations typically occurred simultaneously during card extinction. When baseline (A) was re-implemented, Alex touched the card during a higher percentage of intervals (M= 8.7%) while manual sign (M= 6.2%) and vocalizations (M= 6.7%) decreased over the first five sessions.

Following the second baseline, a stimulus control challenge (C_1) was implemented by removing the communication card and replacing it with a microswitch. Alex allocated responding to microswitch touches for a higher percentage of intervals (M = 14.0% of 6-s intervals) compared to zero or near zero percent for manual sign (M= 1.0%) and vocalizations (M= 0%).

During the next condition (D) the card was re-introduced while the microswitch remained. Alex could access reinforcement by touching the microswitch or card, signing, or vocalizing. With these contingencies in place, Alex's response allocation favored card touches (M= 10.0% of 6-s intervals) with variable responding using microswitch touches

(M= 3.2%). Manual sign occurred in only one of the 11 sessions and vocalizations did not occur.

Responding was allocated primarily to the manual sign (M= 9.3% of 6-s intervals) in the effort challenge (E_1) when effort to touch the communication card was increased. Card touches and vocalizations did not occur during the effort challenge. When baseline (A) was re-implemented, responding again allocated primarily to the communication card (M= 11.3%). Manual sign and vocalizations were not exhibited.

Problem behavior (aggression, destruction, or tantrum behavior) was exhibited at least once in baseline, extinction and the stimulus control challenge, but no consistent patters occurred. Problem behavior varied between zero or near zero mean percentage of intervals (M= 2.4%; range 0-14%). Problem behavior was not exhibited in the effort challenge.

Alex: Attention

Figure 2 displays Alex's responding in the attention reinforcement context. During baseline (A), Alex responded during a higher percentage of intervals using card touches (M= 11.6% of 6-s intervals) compared to the manual sign (M= 0.8%) or vocalizations (M= 0.4%). When card touches were placed on extinction (B_1) they occurred at a relatively low percentage (M= 4.5%) compared to increases in the manual sign and vocalizations (M= 10.0%, M= 12.8%, respectively). The manual sign and vocalizations typically occurred simultaneously during this challenge. When baseline (A) was re-implemented, Alex only exhibited card touches (M= 14.7%).

Following the second baseline, a stimulus control challenge (C_1) was implemented in which the communication card was not available and a microswitch was introduced. Alex responded exclusively using microswitch touches (M= 15.5% of 6-s intervals).

In the concurrent schedules challenge (D), the card was re-introduced and Alex could access reinforcement by touching the microswitch or card, signing, or vocalizations. Card touches were exhibited at the highest percentage of intervals (M= 13.0% of 6-s intervals) and a decreased percentage of microswitch touches (M= 3.3%) were observed. The manual sign (M= 0%) and vocalizations (M= 0.3%) did not occur or were exhibited during a low percentage of intervals.

An effort challenge (E_1) was implemented following the concurrent schedules challenge. Manual sign was exhibited during a higher percentage of intervals (M= 7.8% of 6-s intervals) when effort to touch the communication card was increased; however, responding was variable (range 0-14%). Card touches continued to occur during a low and variable percentage of intervals (M= 3.8%, range 0-16%) and vocalizations were exhibited at low percentage of intervals (M= 0.2%). When baseline (A) was re-implemented, elevated responding were exhibited with the communication card (M= 14.5%) while the manual sign or vocalizations were not exhibited.

Problem behavior was not exhibited in the initial baseline condition. In the subsequent baseline and challenge conditions, problem behavior (aggression, destruction, or tantrum behavior) was exhibited but with no discriminable pattern or trend. Problem behavior varied between zero or near zero mean percentage of intervals (M= 1.8%; range of 0-14%).

Alex: Escape

Figure 3 displays Alex's response allocation in the escape reinforcement context. Alex exhibited the manual sign (M= 9.8% of 6-s intervals) and vocalizations (M= 10.5%) during a higher percentage of intervals compared to card touches (M= 3.4%) in the initial baseline (A). These responses (manual sign and vocalizations) typically occurred simultaneously during baseline sessions. When manual sign and vocalizations no longer resulted in access to reinforcement (B_2), card touches were exhibited during a relatively high percentage of intervals (M= 14.4%). The manual sign and vocalizations were displayed during a low percentage of intervals (M= 2.8%, M= 1.6%, respectively). When baseline (A) was re-implemented, Alex responded exclusively by touching the card (M= 14.7%) while manual sign and vocalizations were not exhibited.

An extinction challenge (B_1) was implemented and card touches were placed on extinction. In this challenge, card touches decreased to near zero percentage of intervals (M= 3.7% of 6-s intervals) and a higher percentage of responding occurred with the manual sign and vocalizations (M= 12.0%, M= 9.7% respectively). Baseline (A) was re-implemented and responding primarily re-allocated to manual sign (M= 10.0%) with low and variable manding using vocalizations (M= 11.7%; range 0-52%) or card touches (M= 1.3%).

An extinction condition (B_3) was conducted in which the manual sign was placed on extinction. In this challenge, the manual sign decreased to near zero percentage of intervals (M= 3.0%) with similar responding for vocalizations (M= 3.9% of 6-s intervals). Card touches (M= 10.4%) increased relative to manual sign and vocalizations. Baseline was re-implemented and responding primarily allocated to card touches (M= 16.0%) with manual sign (M= 2.0%) and vocalizations (M= 0.7%) occurring during a low percentage of intervals.

Problem behavior (aggression, destruction, or tantrum behavior) was exhibited at least once in baseline and each challenge conditions but no consistent patterns emerged. Problem behavior was not exhibited in the final baseline condition. Problem behavior was exhibited during a low mean percentage of intervals (M= 5.4%; range of 0-22%).

Jake: Tangible

Figure 4 displays Jake's response allocation in the tangible reinforcement context. Jake displayed higher rates of responding in baseline (A) with the communication card (M= 1.3 rpm) compared to manual sign (M= 0.3 rpm) or vocalizations (M= 0 rpm). When card touches were placed on extinction (B_1) card touches decreased to zero or near zero rates of responding (M= 1.7 rpm) while responding using the manual sign increased (M= 1.0 rpm) relative to baseline. Vocalizations were not exhibited in this challenge.

Baseline (A) was re-implemented and Jake used the manual sign at a higher rate (M= 1.2 rpm). Card touches occurred at variables rates initially and then decreased to near zero rates (M= 0.5 rpm).

A second extinction challenge (B_3) was implemented following the second baseline and manual sign was placed on extinction. Elevated responding was exhibited using the communication card (M= 1.6 rpm) and the manual sign decreased to near zero rates following the first two sessions (M= 1.0 rpm). In the third implementation of baseline (A), elevated rates of responding occurred with the manual sign (M= 2.4 rpm) while allocation to the card maintained at low rates (M= 0.4 rpm). Vocalizations were not exhibited in either baseline or the extinction challenge.

An effort challenge (E_2) was implemented following baseline. Jake responded at higher rates using card touches (M= 2.1 rpm) and a downward trend in responding was exhibited for manual sign (M= 0.8 rpm).When baseline was re-implemented, a higher rate of responding was exhibited using the communication card (M= 2.0 rpm). The manual sign or vocalizations were exhibited a zero or near zero rates (M= 0.1 rpm; M= 0 rpm, respectively). A second effort challenge (E_1) was implemented and Jake allocated responding exclusively to card touches (M= 1.6 rpm) while manual sign and vocalizations were not exhibited. Baseline was re-implemented following the effort manipulation and Jake manded exclusively by touching the communication card (M= 1.9 rpm). Overall, vocalizations were not exhibited in any of the baseline or challenge conditions.

Problem behavior (aggression and destruction) was exhibited in baseline and the challenge conditions. Problem behavior did not consistently occur in each condition. When the card was placed on extinction, a significant increase in problem behavior was observed followed by low rates of problem behavior (M= 0.3 rpm; range 0-5.8 rpm).

Jake: Attention

Figure 5 displays Jake's response allocation during the attention reinforcement context analysis. Jake displayed higher rates of responding in baseline using the communication card (M= 1.5 rpm) compared to manual sign (M= 0 rpm) or vocalizations (M= 0 rpm).

When card touches were placed on extinction (B_1) card touches were displayed at high rates (M= 2.3 rpm) compared to baseline levels of responding. Little or no vocalizations (M= 0.4 rpm) and no manual sign was exhibited.

Following the extinction challenge, a stimulus control challenge (C_2) was implemented. The communication card was no longer available in sessions and allocation to vocalizations or manual sign resulted in access to reinforcement. In these sessions, higher rates of responding were observed with the communication card (M= 0.5 rpm).

A second extinction challenge (B_1) was implemented and vocalizations occurred at relatively high and variable rates (M= 1.1 rpm, range 0-2.2 rpm) throughout these sessions with variable rates of card touches (M= 0.8 rpm, range 0-2.4 rpm). A second stimulus control challenge (C_2) was implemented following extinction and vocalizations were exhibited exclusive (M= 1.6 rpm) to manual sign. Manual sign did not occur in the extinction or stimulus control challenges. When baseline was re-implemented, card touches occurred at relatively high rates (M= 1.4 rpm) compared to manual sign (M= 0 rpm) and vocalizations (M= 0.1 rpm).

Problem behavior was not exhibited in the initial baseline. Problem behavior (aggression and destruction) was exhibited in the subsequent baseline and challenge conditions, but no consistent pattern of responding was observed. Responding occurred at low rates in each of these conditions (M= 0.4 rpm; range 0-4.0 rpm).

Jake: Escape

Figure 6 displays Jake's response allocation in the escape reinforcement context analysis. Jake allocated responding to all three mand topographies during baseline. Jake displayed elevated rates of responding using the communication card (M= 1.2 rpm) and lower rates of responding were exhibited using the manual sign (M= 0.4 rpm) and vocalizations (M= 0.1 rpm).

When card touches no longer resulted in access to reinforcement (B_1), card touches decreased overall but occurred at variable rates (M= 0.5 rpm, range = 0-2.0 rpm). Rates of manual sign and vocalizations increased from baseline levels and occurred at variable rates (M= 0.6, range 0-2.2 rpm; M= 0.2, range 0-2.6 rpm, respectively). When baseline was re-implemented, higher rates of responding were exhibited with card touches (M= 0.8 rpm), manual sign (M= 0.3 rpm), and vocalizations (M= 0.3 rpm).

Problem behavior (aggression and destruction) was exhibited in each of the baseline and challenge conditions but no consistent pattern of responding was observed. Problem behavior was exhibited at relatively high rates throughout baseline and challenge conditions (M= 0.8 rpm; range 0-5.4 rpm).

General Summary

Baseline

Baseline phases were conducted more than once for each reinforcement context. In five out of the six reinforcement contexts, the participants allocated responding to the communication card during the initial baseline session. In 4 out of those 5 evaluations, the participants continued to primarily allocate to card touches in subsequent baseline sessions (Jake allocated to card touches for 3 out of the 5 returns to baseline in the tangible conditions). No consistent patterns of responding were observed with problem behavior in baseline.

Extinction Challenges

In the extinction challenges, responding primarily shifted to a response (9 out of the 10 extinction challenges) that was different than the response displayed for the highest levels in the previous baseline. On 1 out of the 10 extinction challenges, responding allocated to the mand topography that did not result in access to reinforcement (card, attention context-Jake). In this reinforcement context, Jake initially allocated responding exclusively to the card. No consistent patterns of responding were observed with problem behavior in the extinction challenges.

A baseline phase was conducted immediately following an extinction challenge on 8 out of 10 instances. In these baseline conditions, responding allocated back to the mand displayed in the initial baseline on 4 out of 8 phases. For the other 4 instances, responding was similar to response allocation in the previous extinction condition.

Stimulus Control Challenge

The stimulus control challenge was implemented in three reinforcement contexts (tangible and attention-Alex, attention-Jake). Overall, responding allocated to the other visual stimulus (attention and tangible-Alex) or a different mand topography (attention-Jake) when the communication card was not available. No consistent patterns of responding were observed with problem behavior in the stimulus control challenges.

Concurrent Schedule Challenge

A concurrent schedule challenge was implemented in two reinforcement contexts (tangible and attention-Alex), and Alex continued to allocate responding to the communication card, similar to responding in baseline. No consistent patterns of responding were observed with problem behavior in the concurrent schedule challenges.

Effort Challenge

An effort challenge was implemented in 3 reinforcement contexts (tangible and attention-Alex, tangible-Jake). Two effort challenges were implemented in the tangible reinforcement context (Jake). In 3 out of the 4 challenges, increased effort affected response allocation and the participant allocated to an alternative mand topography. No consistent patterns of responding were observed with problem behavior in the effort challenges.

Table 2. Data Summary (Percentage of 6-s Intervals): Alex

	Baseline (A)	Extinction Challenge (B_1)	Extinction Challenge (B_2)	Extinction Challenge (B_3)	Stimulus Control Challenge (C_1)	Concurrent Schedule Challenge (D)	Effort Challenge (E_1)
Tangible ($AB_1AC_1DE_1A$)							
Card	M= 8.0, 8.7, 11.3	M= 2.8	NA	NA	NA	M= 10.0	M= 0
Sign	M= 4.4, 6.2, 0	M= 13.2	NA	NA	M= 1.0	M= 2.0	M= 9.3
Vocal	M= 5.2, 6.7, 0	M= 13.6	NA	NA	M= 0	M= 0	M= 0
Switch	NA	NA	NA	NA	M= 14.0	M= 3.2	NA
Aggression	M=0, 1.3, 0	M= 0	NA	NA	M= 1.0	M= 2.0	M= 0
Destruction	M=1.5, 0.7, 2.0	M= 0.4	NA	NA	M= 2.5	M= 1.7	M= 0
Tantrum	M= 0, 0.6, 0	M= 0.4	NA	NA	M= 0	M= 0	M= 0
Attention ($AB_1AC_1DE_1A$)							
Card	M= 11.6, 14.7, 14.5	M= 4.5	NA	NA	NA	M= 13.0	M= 3.8
Sign	M= 0.8, 0, 0	M= 10.0	NA	NA	M= 0	M= 0	M= 7.8
Vocal	M= 0.4, 0, 0	M= 12.8	NA	NA	M= 0	M= 0.3	M= 0.2
Switch	NA	NA	NA	NA	M= 15.5	M= 3.3	NA

Table 2 (continued)

	Baseline (A)	Extinction Challenge (B_1)	Extinction Challenge (B_2)	Extinction Challenge (B_3)	Stimulus Control Challenge (C_1)	Concurrent Schedule Challenge (D)	Effort Challenge (E_1)
Aggression	M= 0, 0	M= 0.5	NA	NA	M= 0.5	M= 0.7	M= 0.2
Destruction	M= 0, 0.7	M= 0.7	NA	NA	M= 0.5	M= 5.0	M= 0.5
Tantrum	M= 0, 0.7	M= 0.7	NA	NA	M= 0	M= 0	M= 0.7
Escape ($AB_2AB_1AB_3A$)							
Card	M= 3.4, 14.7, 1.3, 16.0	M= 3.7	M= 14.4	M= 10.4	NA	NA	NA
Sign	M= 9.8, 0, 10.0, 2.0	M= 12.0	M= 2.8	M= 3.0	NA	NA	NA
Vocal	M= 10.5, 0, 11.7, 0.7	M= 9.7	M= 1.6	M= 3.9	NA	NA	NA
Aggression	M= 0.6, 2.0, 1.0, 0	M= 8.3	M= 1.2	M= 0.7	NA	NA	NA
Destruction	M=1.8, 4.7, 0.7, 0	M= 4.0	M= 1.2	M= 0.6	NA	NA	NA
Tantrum	M= 2.9, 0.7, 0.3, 0	M= 2.9	M= 2.4	M= 0	NA	NA	NA

Table 3. Data Summary (Responses per Minute, rpm): Jake

	Baseline (A)	Extinction Challenge (B_1)	Extinction Challenge (B_3)	Stimulus Control Challenge (C_2)	Effort Challenge (E_1)	Effort Challenge (E_2)
Tangible ($AB_1AB_3AE_2AE_1A$)						
Card	M= 1.3, 0.5, 0.4, 2.0, 1.9	M= 1.7	M= 1.6	NA	M= 1.6	M= 2.1
Sign	M= 0.3, 1.2, 2.4, 0.1, 0	M= 1.0	M= 1.0	NA	M= 0	M= 0.8
Vocal	M= 0, 0, 0, 0, 0	M= 0	M= 0	NA	M= 0	M= 0
Aggression	M= 0, 0, 0, 0, 0	M= 2.3	M= 0.1	NA	M= 0	M= 0
Destruction	M= 0, 0, 0, 0, 0	M= 0	M= 0	NA	M= 0	M= 0
Attention ($AB_1C_2B_1C_2A$)						
Card	M= 1.5, 1.4	M= 2.3, 0.8	NA	NA	NA	NA
Sign	M= 0, 0	M= 0, 0	NA	M= 0, 0	NA	NA
Vocal	M= 0, 0.1	M= 0.4, 1.1	NA	M= 0.5, 1.6	NA	NA
Aggression	M= 0, 0.1	M= 0.6, 0.4	NA	M= 0.4, 0.2	NA	NA
Destruction	M= 0, 0	M= 0.3, 0.1	NA	M= 0, 0	NA	NA

Table 3 (continued)

	Baseline (A)	Extinction Challenge (B_1)	Extinction Challenge (B_3)	Stimulus Control Challenge (C_2)	Effort Challenge (E_1)	Effort Challenge (E_2)
Escape (AB_1A)						
Card	M= 1.2, 0.8	M= 0.5	NA	NA	NA	NA
Sign	M= 0.4, 0.3	M= 0.6	NA	NA	NA	NA
Vocal	M= 0.1, 0.3	M= 0.2	NA	NA	NA	NA
Aggression	M= 0.5, 0.6	M= 0.8	NA	NA	NA	NA
Destruction	M= 0.1, 0	M= 0.2	NA	NA	NA	NA

Table 4. Summary of Response Allocation in Baseline (A) Across Participants and Reinforcement Contexts

	Alex: Tangible	Alex: Attention	Alex: Escape	Jake: Tangible	Jake: Attention	Jake: Escape
Initial Baseline						
Card	x	x		x	x	x
Sign			x			
Vocal			x			
Subsequent Baseline/s						
Card	x (2/2)	x (2/2)	x (2/3)	x (2/4)	x (1/1)	x (1/1)
Sign			x (1/3)	x (2/4)		
Vocal			x (1/3)	x(2/4)		

Table 5. Summary of Response Allocation in the Extinction Challenge/S (B_1, B_2, B_3) Across Participants and Reinforcement Contexts

	Alex: Tangible	Alex: Attention	Alex: Escape	Jake: Tangible	Jake: Attention	Jake: Escape
Extinction Challenge						
Mand on Extinction	Card (B_1)	Card (B_1)	Sign Vocal (B_2)	Card (B_1)	Card (B_1)	Card (B_1)
Card			x		x	
Sign	x	x		x		x
Vocal	x	x				
Extinction Challenge						
Mand on Extinction	N/A	N/A	Card (B_1)	Sign (B_3)	Card (B_1)	N/A
Card				x		
Sign			x			
Vocal			x		x	
Extinction Challenge						
Mand on Extinction	N/A	N/A	Sign (B_3)	N/A	N/A	N/A
Card			x			
Sign						
Vocal						

Table 6. Summary of Response Allocation in the Stimulus Control Challenges (C_1, C_2) Across Participants and Reinforcement Contexts

	Alex: Tangible	Alex: Attention	Jake: Attention
Stimulus Control Challenge			
	No Card Microswitch (C_1)	No Card Microswitch (C_1)	No Card (C_2)
Card			
Sign			
Vocal			x
Microswitch	x	x	
Stimulus Control Challenge			
			Card (C_2)
Card			
Sign			
Vocal			x

Table 7. Summary of Response Allocation in the Concurrent Schedule Challenges (D) Across Reinforcement Contexts For Alex

	Alex: Tangible	Alex: Attention
Concurrent Schedule Challenge		
Card	x	x
Sign		
Vocal		
Microswitch		

Table 8. Summary of Response Allocation in the Effort Challenges (E_1 And E2) Across Participants and Reinforcement Contexts

	Alex: Tangible	Alex: Attention	Jake: Tangible
Effort Challenge			
	Card (E_1)	Card (E_1)	Sign (E_2)
Card			x
Sign	x	x	
Vocal			
Effort Challenge			
			Card (E_1)
Card			x
Sign			
Vocal			

Figure 1. Percentage of allocation to card touches, manual sign, vocalizations, switch presses, destruction, tantrums, and aggression for Alex in the tangible context.

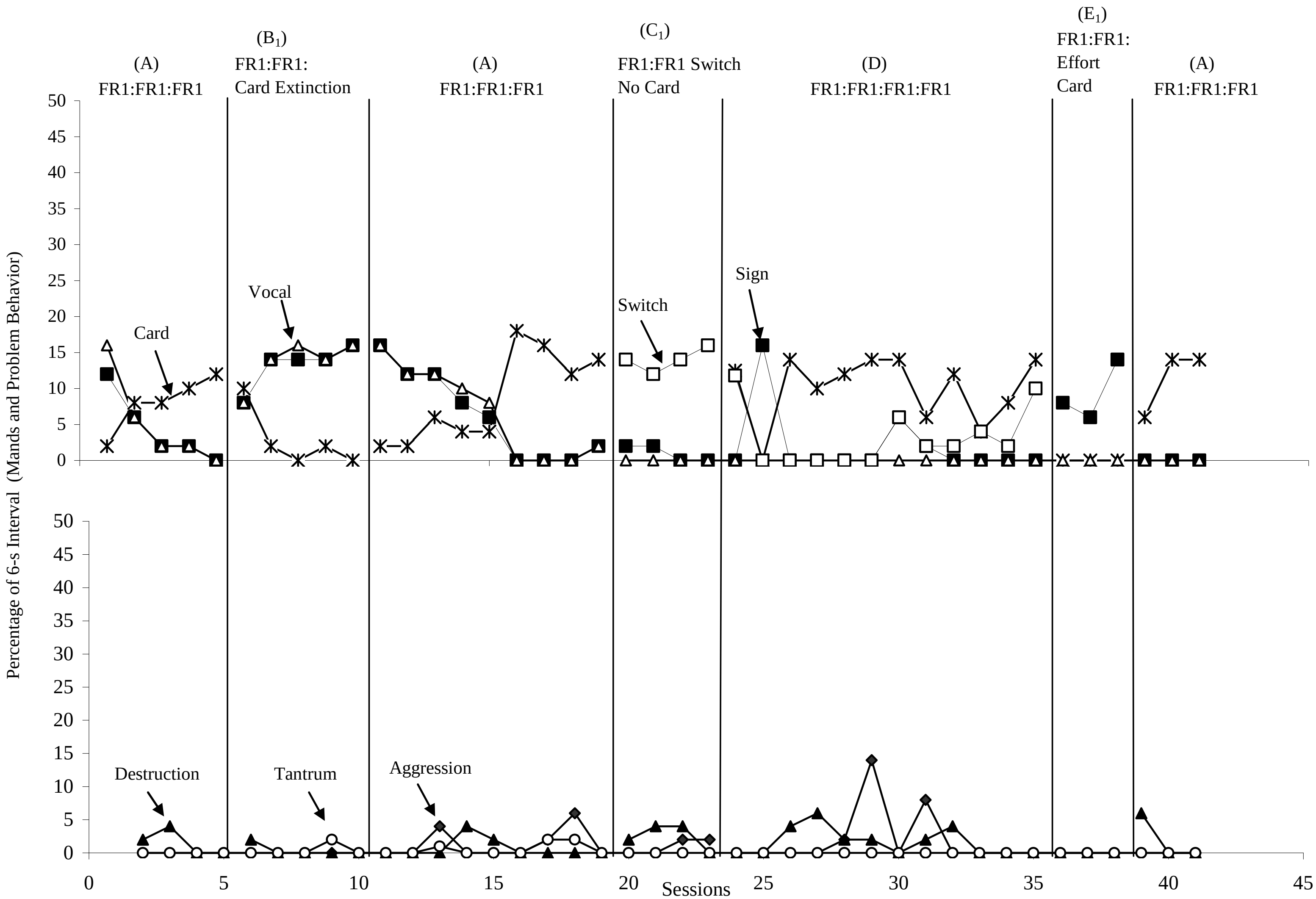

(A)
FR1:FR1:FR1
(B1)
FR1:FR1:
Card Extinction
(A)
FR1:FR1:FR1
(C1)
FR1:FR1 Switch
No Card
(D)
FR1:FR1:FR1:FR1
(E1)
FR1:FR1:
Effort
Card
(A)
FR1:FR1:FR1
Percentage of 6-s Interval (Mands and Problem Behavior)
Card
Vocal
Switch
Sign
Destruction
Tantrum
Aggression
Sessions
0
5
10
15
20
25
30
35
40
45
50

Figure 2. Percentage of session of card touches, manual sign, vocalizations, switch presses, destruction, tantrums, and aggression for Alex in the attention context.

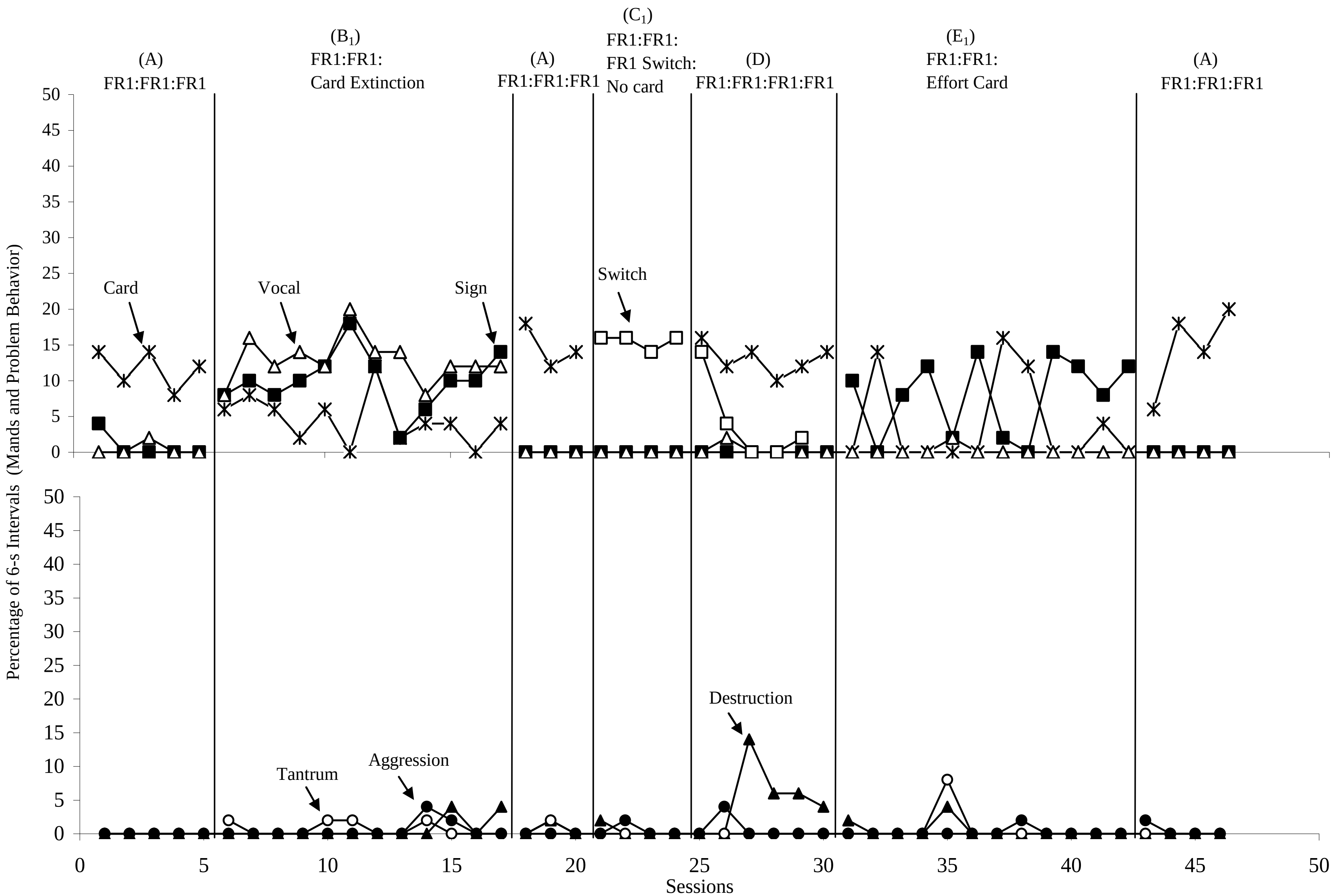
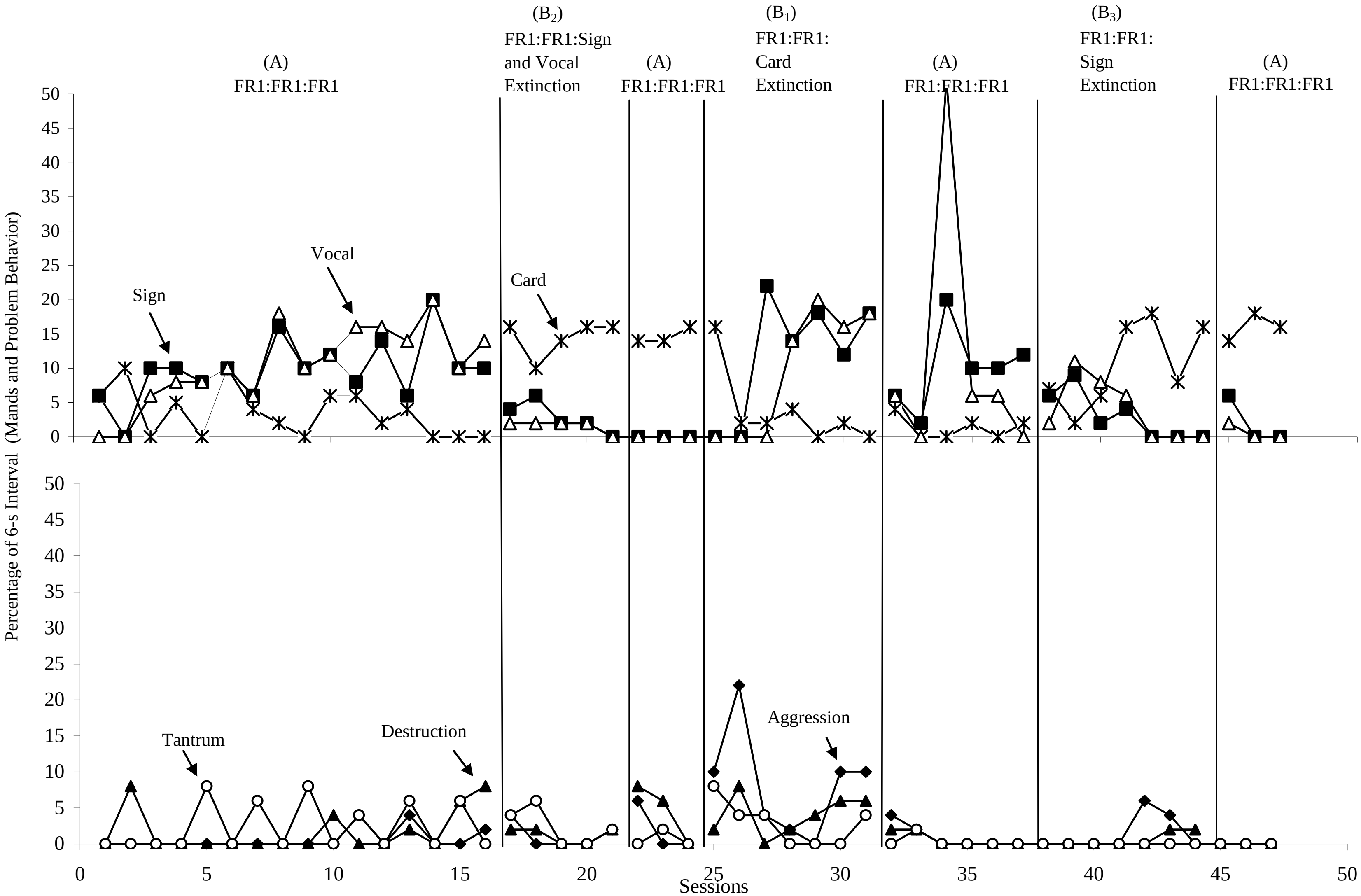
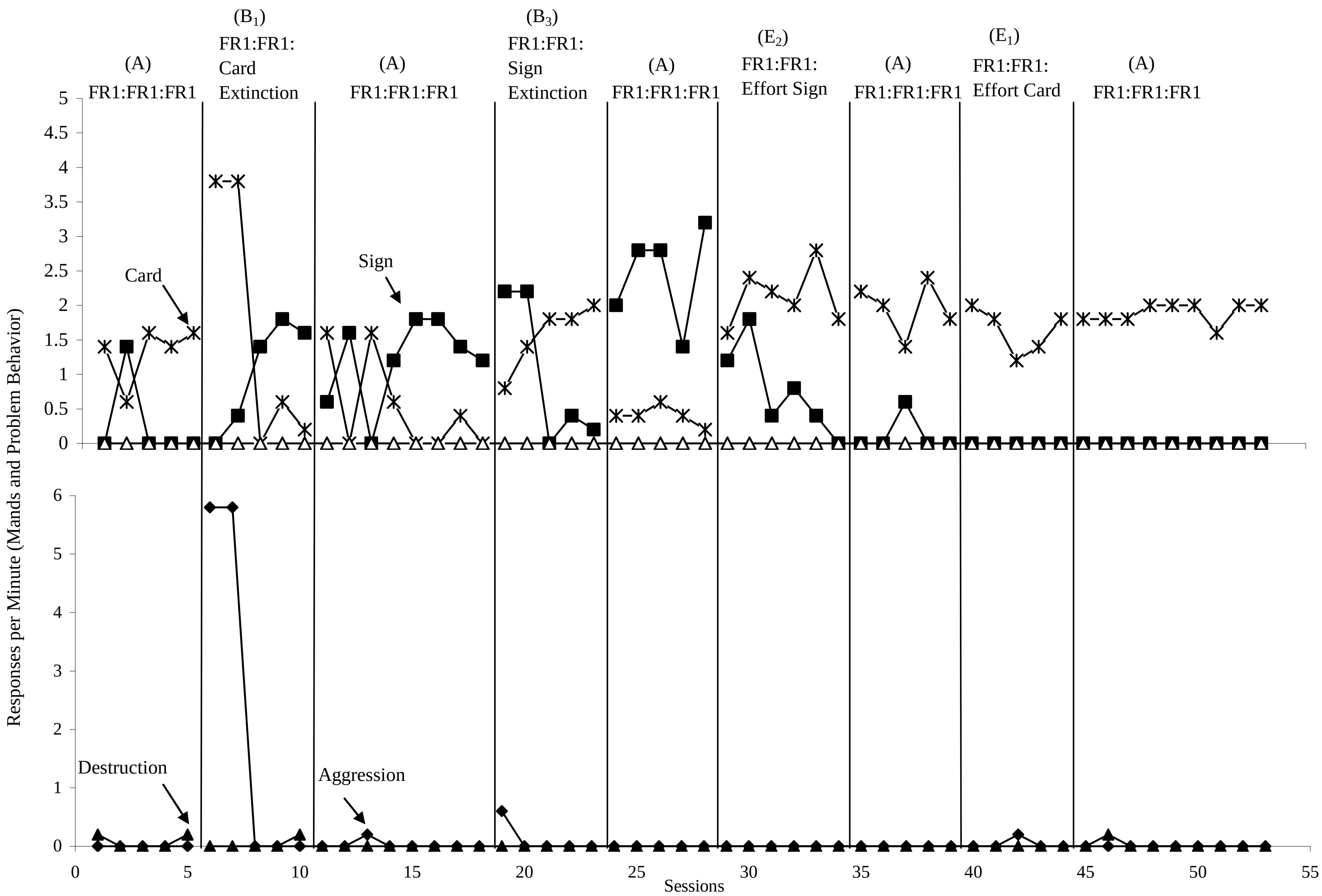

(A)
FR1:FR1:FR1
(B1)
FR1:FR1:
Card Extinction
(A)
FR1:FR1:FR1
(C1)
FR1:FR1:
FR1 Switch:
No card
(D)
FR1:FR1:FR1:FR1
(E1)
FR1:FR1:
Effort Card
(A)
FR1:FR1:FR1
Card
Vocal
Sign
Switch
Tantrum
Aggression
Destruction
Percentage of 6-s Intervals (Mands and Problem Behavior)
Sessions

Figure 3. Percentage of session of card touches, manual sign, switch presses, destruction, tantrums, and aggression for Alex in the escape context.



(A)
FR1:FR1:FR1
(B2)
FR1:FR1:Sign
and Vocal
Extinction
(A)
FR1:FR1:FR1
(B1)
FR1:FR1:
Card
Extinction
(A)
FR1:FR1:FR1
(B3)
FR1:FR1:
Sign
Extinction
(A)
FR1:FR1:FR1
Percentage of 6-s Interval (Mands and Problem Behavior)
Sign
Vocal
Card
Tantrum
Destruction
Aggression
Sessions

Figure 4. Responses per minute of card touches, manual sign, vocalizations, destruction, and aggression for Jake in the tangible context.



(A)
FR1:FR1:FR1
(B1)
FR1:FR1:
Card
Extinction
(A)
FR1:FR1:FR1
(B3)
FR1:FR1:
Sign
Extinction
(A)
FR1:FR1:FR1
(E2)
FR1:FR1:
Effort Sign
(A)
FR1:FR1:FR1
(E1)
FR1:FR1:
Effort Card
(A)
FR1:FR1:FR1
Card
Sign
Destruction
Aggression
Responses per Minute (Mands and Problem Behavior)
Sessions

Figure 5. Responses per minute of card touches, manual sign, vocalizations, destruction, and aggression for Jake in the attention context.

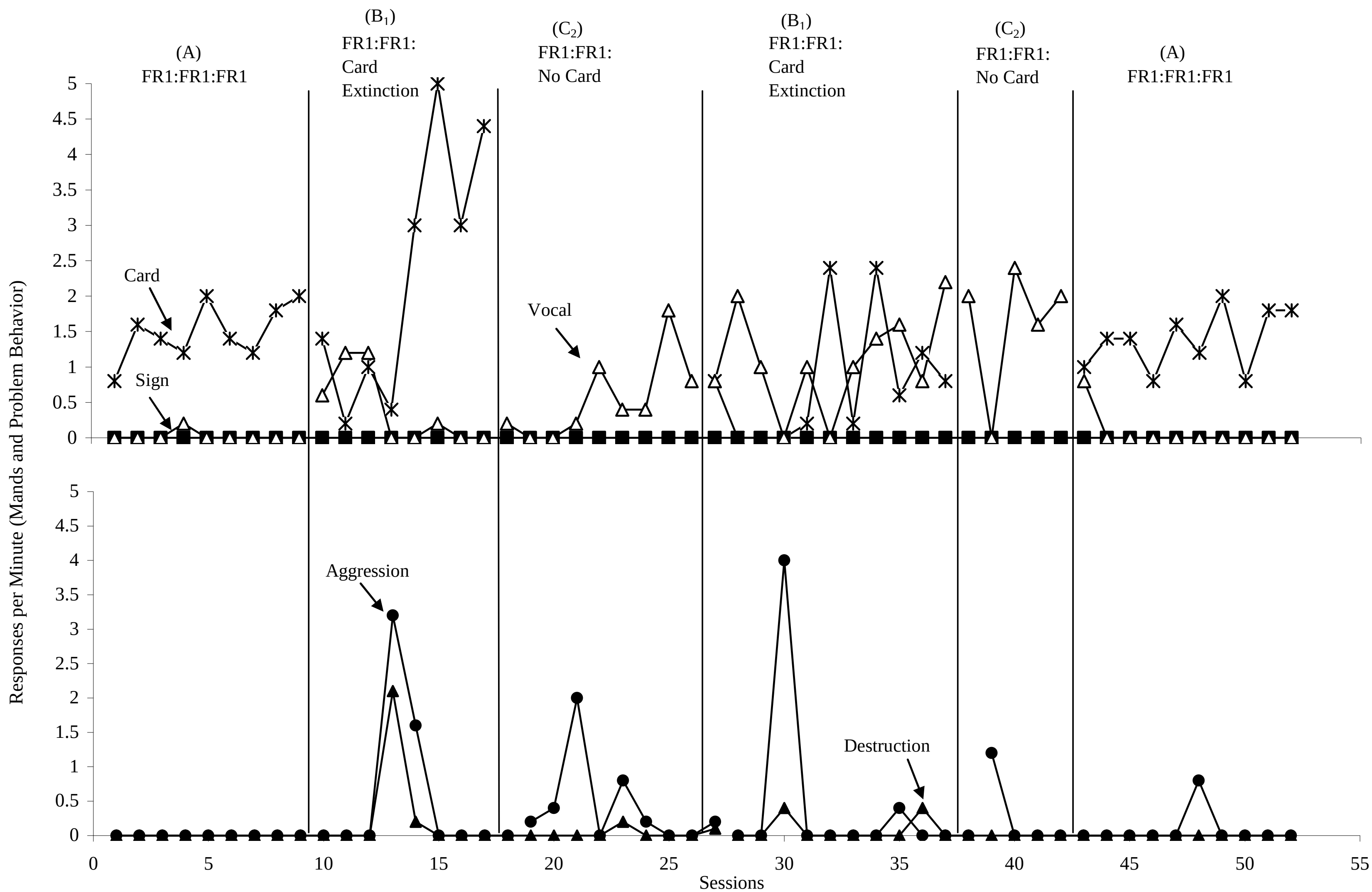
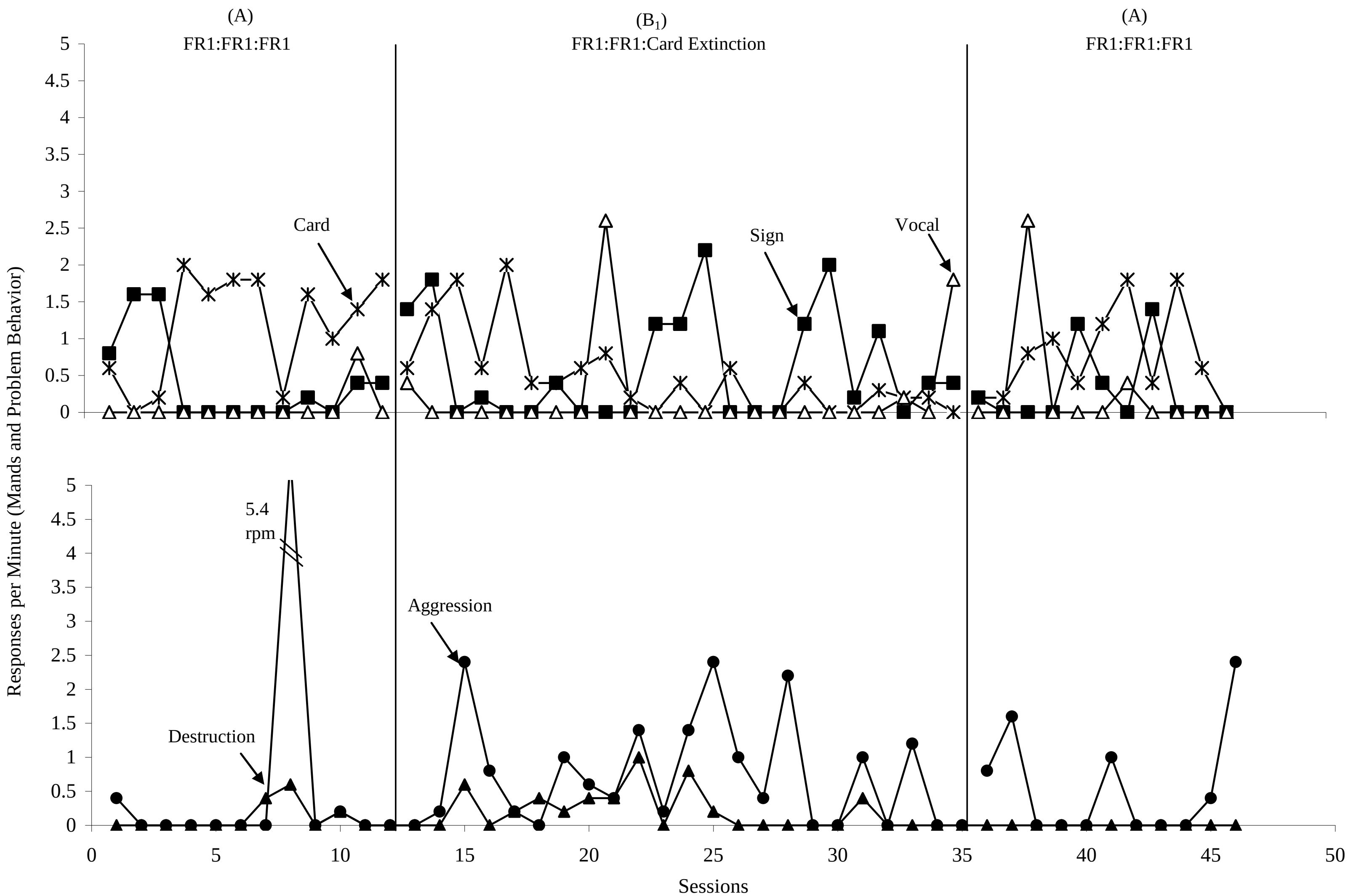

(A)
FR1:FR1:FR1
(B1)
FR1:FR1:
Card
Extinction
(C2)
FR1:FR1:
No Card
(B1)
FR1:FR1:
Card
Extinction
(C2)
FR1:FR1:
No Card
(A)
FR1:FR1:FR1
Card
Sign
Vocal
Aggression
Destruction
Responses per Minute (Mands and Problem Behavior)
Sessions
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
5
10
15
20
25
30
35
40
45
50
55

Figure 6: Responses per minute of card touches, manual sign, vocalizations, destruction, and aggression for Jake in the escape context.


(A)
FR1:FR1:FR1
(B_1)
FR1:FR1:Card Extinction
(A)
FR1:FR1:FR1
Card
Sign
Vocal
5.4
rpm
Aggression
Destruction
Responses per Minute (Mands and Problem Behavior)
Sessions

CHAPTER V

DISCUSSION

The primary purpose of the current study was to determine which variables influence or change response allocation among mand topographies. The variables evaluated consisted of reinforcement context, response effort, schedule of reinforcement (extinction), and availability of visual stimuli (i.e., a communication card). To address this purpose, I evaluated the stability of responding when several variables were manipulated for each participant across more than one reinforcement context (escape, attention, and tangible). Finally, I evaluated response allocation among multiple mand topographies within a concurrent schedules arrangement.

Summary of Findings

Variables That Influence Response Allocation

I observed changes in patterns of responding related reinforcement context, extinction, concurrent schedule arrangements, and response effort, but not stimulus control. Response allocation varied across reinforcement contexts such as tangible, attention, and escape context. In all but one reinforcement context, placing a previously exhibited response on extinction effectively shifted responding to a response that resulted in access to reinforcement. Changes in the concurrent schedules arrangement did not disrupt response allocation from the mand exhibited most frequently in the initial FR1:FR1:FR1 arrangement; however, responding was slightly more variable. Increased effort shifted response allocation but not for each effort challenge. Stimulus control did not appear to alter responding given that each participant allocated responding to an alternative mand topography when the card was not present.

Response Allocation Across Reinforcement Contexts

The current study extended the research on concurrent schedules arrangements by evaluating response allocation across more than one reinforcement context: tangible, attention, and escape. Previous research (e.g., Harding, et al., 2009; Winborn, et al., 2002;

and Winborn-Kemmerer et al., 2009) evaluated response allocation in one reinforcement context for each participant. For example, Harding, et al. evaluated each participant's response allocation among multiple mand topographies in attention (Kit) and tangible (Al and Lou) reinforcement contexts. Similarly, Winborn-Kemmerer et al. evaluated mand allocation during a positive reinforcement (tangible) context for each participant. Winborn, et al. evaluated two participant's responding (across novel and existing mands) during FCT for escape. In these examples, the evaluation focused on responding in either positive or negative reinforcement contexts. To date, no research has been published regarding the stability of responding across multiple reinforcement contexts for the same individual.

The results of the current study indicated that when each mand resulted in access to reinforcement, the participants did not consistently allocate responding to the same mand in each reinforcement context. For example, Alex primarily allocated responding to card touches in the attention and tangible reinforcement context but primarily allocated to a manual sign and vocalizations in the escape reinforcement context. This finding has applied significance in that it demonstrates that individual preferences can and do vary as a function of the reinforcer(s) available in various choice contexts. Previous research on preferences for mands concluded that an evaluation of mand preferences be conducted for each individual (Harding, et al., 2009; Winborn-Kemmerer, et al, 2009). The results of the current study support this recommendation but also indicate that preferences be established for each reinforcement context.

Extinction

In the majority of reinforcement contexts (excluding the attention reinforcement context for Jake), problem behavior was shown previously to result in access to reinforcement, and manding in that reinforcement context occurred to access the functional reinforcer. In all but one reinforcement context, extinction effectively biased responding to an alternative mand topography within a hypothesized response class.

These results for mands are similar to the results for problem behavior presented by Lieving, et al. (2004). Several patterns of manding occurred when relatively brief periods of extinction were implemented: a) extinction produced variability of responding which typically consisted in the display of a different mand topography, b) responding persisted and appeared related to the most recent reinforcement history from a previous condition, and c) in one reinforcement context, responding did not follow a predictable pattern and may have been related to prompt-dependency.

Several studies have demonstrated that when one response is placed on extinction, the occurrence of that response will decrease with subsequent increases in another response in their repertoire (Lalli, Mace, Wohn, & Livezey, 1995; Shabani, Carr, & Petursdottir, 2009; Sprague & Horner, 1992). These effects are observed when an individual shifts response allocation from one response to another, and may be indicative of a response class hierarchy. Thus, as one response fails to produce reinforcement, a second response in the same response class hierarchy may emerge. If the first and second target behaviors are placed on extinction, then a third response in the response class hierarchy emerges and so on (Harding, et al., 2001; Lalli, et al., 1995; Richman, et al, 2001). The current study did not establish a response hierarchy for all mands, but it demonstrated that extinction can produce variability in responding. Of interest was that several mands and at least one topography of problem behavior were recorded. The vast majority of the shifts in allocation were primarily to other mands (97 % of all sessions) and not to problem behavior (i.e., problem behavior did not increase). An example of this phenomenon was observed in the attention condition for Jake. When the card was placed on extinction, Jake primarily allocated responding to manual sign and vocalizations (M= 10.0% and 12.8% of 6-s intervals, respectively) and low levels of problem behavior (M=0.8%) were maintained.

In some conditions, responding in a previous condition appeared to affect the probability of responding for a given mand topography in a following condition. For example, in the escape reinforcement context, Alex allocated responding to manual sign and vocalization in baseline. These mands were subsequently placed on extinction and Alex allocated to card touches. In the following baseline, Alex continued to allocate to card touches rather than shift allocation back to manual sign and vocalizations. Two different patterns of responding emerged when extinction was initially implemented and when the schedule of reinforcement was re-instated (FR1:FR1:FR1). In the first instance, a communicative response continued to be exhibited (initially) when the response did not result in access to reinforcement. Following the initial persistence of the previously reinforced mand, continued extinction produced a change in response allocation to a mand that produced reinforcement. In the second instance, responding in baseline reflected response allocation from the extinction condition rather than responding that was observed in the previous baseline (e.g., escape-Alex, tangible-Jake). This demonstrates that brief periods of extinction may bias responding to a different topography of behavior. One possible explanation for this response pattern is that the most recent history of reinforcement may have influenced responding in these situations. My results are similar to findings reported by Dube, McIlvane, Mazzitelli, and McNamara (2003). Dube et al. evaluated the persistence of responding following disruption of reinforcement across 10 participants diagnosed with developmental disabilities. The authors demonstrated that a higher rate of reinforcement was associated with higher rates of responding when reinforcement was disrupted. Similar results were observed in the current study. In several instances, a given mand resulted in access to reinforcement, and when a disruption (e.g., extinction) occurred, the participant continued to emit the same response, or the response persisted in the following condition for a longer period of time than the other available responses. Thus, extinction can produce changes in allocation, but depending on the immediate history of reinforcement, responding may persist during at least short term periods of extinction.

The final pattern of responding during extinction was increased rates of responding for the mand that was placed on extinction (attention-Jake). For Jake, the functional analysis of problem behavior did not identify attention as a reinforcer for problem behavior, but Jake communicated to access reinforcement. These results are similar to Schieltz, et al. (2010) who also showed that manding for reinforcement was not directly tied to the functional reinforcers for problem behaviors. A possible consideration is that attention was not a reinforcer for mands; instead, Jake may have been complying with the therapist's prompts. A second consideration is that persistence in responding may have been related to stimulus-reinforcement relations with stimuli such therapist prompts or the communication card exerting stimulus control. Higher rates of reinforcement may have been obtained by touching the communication card resulting in persistence, even when touching the card no longer resulted in access to reinforcement (Dube, et al., 2003).

Effort

Previous research on response effort has indicated that effort can influence response allocation between problem behavior and appropriate behaviors such as communication (e.g., Horner & Day, 1991). Similar results were obtained when effort manipulations using three topographies of appropriate behaviors were manipulated. In this study, the participants' responding allocated to the less effortful mand topography when the effort to emit a response was increased.

I extended the study by Horner and Day (1991) in two ways. First I demonstrated that increased effort may not reliably affect response allocation. For example, I observed variable responding in one reinforcement context (attention-Alex) when effort (physical distance) was increased. Second, the results provide preliminary evidence that different effort manipulations (e.g., response magnitude versus physical distance) may have differential effects on responding. For example, in the tangible reinforcement context, Alex shifted allocation to an alternative response when the magnitude of responding was increased but not when the physical distance was increased.

Stimulus Control

The results of the stimulus control challenges demonstrated that the participants did not exclusively allocate responding to the communication card. These results are consistent with the findings by Winborn-Kemmerer et al. (2010), in that responding allocated to an alternative mand topography when the communication card was not available. In the current study, when the communication card was not available, Alex allocated responding to the microswitch (attention and tangible reinforcement contexts) and Jake allocated responding to vocal mands (attention reinforcement context). One difference in procedures between Winborn-Kemmerer, et al. and the current study is that the communication card was removed and a different visual stimulus was added to the concurrent schedules arrangement. Therefore, it was possible that the visual stimuli, whether it was the communication card or the microswitch, may have functioned as a discriminative stimulus for responding.

Response Allocation Among Multiple Mand Topographies

I evaluated responding among three or four mand topographies within concurrent schedules arrangements (i.e., baseline and concurrent schedules challenges). The results of the concurrent schedules arrangements are consistent with findings reported by Winborn et al. (2002), Harding et al. (2009), and Winborn-Kemmerer et al. (2009) in that the participants primarily allocated responding to one mand topography when more than one mand topography was available and programmed for reinforcement. These results may have occurred because of a preference for one mand topography over another (e.g., Winborn-Kemmerer et al. 2009). Preference was defined by the participants’ response allocation among available response options. Another possible explanation is that exhibiting one mand topography was less effortful than emitting one of the other available responses (e.g., card; Jake).

Implications and Future Directions

The current study demonstrated that several variables (reinforcement context, extinction, effort, and removal of a visual stimulus) changed response allocation and, in some cases disrupted responding such that alternative responses were emitted. The current study did not establish a predictable order of responding across responses and, thus, a hierarchy of responding was not established. Instead, the results indicated that these variables have individualistic effects on communicative responding. No discriminable effects occurred in problem behavior which remained low throughout the study. Future research should continue to focus on challenges to response-reinforcer relations to evaluate if similar patterns occur when, for example, distinct extinction procedures (e.g., cessation of reinforcement delivery, response-independent delivery of reinforcement) are used. Several studies have conducted evaluations of different types of challenges, typically within a basic research laboratory with only a few demonstrations of the effects of challenges on the persistence of responding in applied settings. (Nevin & Wacker, in press). Future research should evaluate challenges common in the applied setting, specifically relating to response allocation among mands when responding is challenged.

Future studies might also evaluate the effects of reinforcement for appropriate behaviors in addition to the occurrence of problem behaviors. In this study, the participants allocated responding to other appropriate mands, typically at higher levels than problem behavior. However, problem behavior continued to be exhibited throughout the evaluation, even when mild punishment procedures, such as timeout from reinforcement, were implemented. These results may support the notion that when one behavior is reinforced, each member of the response class may be reinforced or that the response strength is increased for all members of the response class (Mace et al., 2009; Mace et al., 2010). In all but one context, problem behavior and mands were maintained by access to the same reinforcers as identified by the results of the previous functional analysis and current mand evaluations. The tangible reinforcement context (Alex) may be a good example of this phenomenon. In this reinforcement context, each occurrence of problem behavior (aggression and destruction) resulted in extinction and punishment whereas three mands were reinforced. Target mands occurred at higher levels than problem behavior and implementation of different challenges effectively changed allocation among the target mands. However, problem behavior continued to occur at very low levels throughout the evaluation. Therefore, even with five or six different responses (aggression, destruction, tantrums (Alex), card touches, manual sign, and vocalizations) within a hypothesized response class, the individual continued to allocate responding to each of the responses, even though reinforcement was only provided for the three appropriate responses.

Limitations

There were several limitations to the current study. First, a prompt was provided immediately following the reinforcement interval and the participant was not provided with an opportunity to communicate prior to delivery of the verbal prompt. Thus, it is possible that responding occurred only as a function of the prompt as opposed to as a function of the various programmed consequences. However, rates of responding did not consistently match prompt rate so it is unlikely that responding was completely dependent on the issuance of a verbal prompt. To address this limitation, procedures in the future should be amended to provide a 3-5 s delay in prompting allowing for an opportunity for independent responding.

Second, each of the target mands was already in the participants' repertoire and each mand had a different history of reinforcement in the clinic and at home. Although this arrangement is typical the applied settings it may be important to establish independent and consistent responding with each mand topography in each reinforcement context prior to challenging the response-reinforcer relations. Another consideration would be conducting a similar study with novel responses that have no previous history of reinforcement.

Finally, the challenges differed for each reinforcement context depending on the pattern of responding in the initial baseline and extinction challenge conditions. These differences in challenges make it difficult to compare response allocation across each reinforcement context. Challenges such as stimulus control, concurrent schedule, and effort were varied and were not consistently evaluated for each situation. To address this limitation, increased numbers of sessions may be required to evaluate each participant's responding for each challenge across reinforcement contexts.

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APPENDIX A

DATA COLLECTION FORM

Data Coding Sheet

		6			12			18			24			30			36			42			48			54			60	
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	1
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	2
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	3
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	4
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	5
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	6
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	7
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	8
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	9
E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	E R- R+ C P X	C + -	+ - S A D 1	10

Name:	
Date:	Time:
Condition	#
Collector (P/R):	
Therapist:	
Room:	

Therapist Behavior
E = EO ________________
R-- = Negative Reinforcement
R+ = Positive Reinforcement
C = Comm. Prompt
P = Punishment
X Extinction

Client Communication
C = Card touches
+ = Manual Sign
- = Vocalizations

○ Microswitch Touches

Client Behavior
+ = Appropriate/engaged
- = Inappropriate
S = Self-Injury
A = Aggression
D = Destruction of property
1 = Tantrums

APPENDIX B

INTEROBSERVER AGREEMENT

Table B1. Summary of Interobserver Agreement: Alex (Tangible)

	Total Sessions	Number of Sessions with IOA	Percentage of Sessions with IOA
Baseline (A)	17	7	41%
Extinction Challenge (B_1)	5	3	60%
Stimulus Control Challenge (C_1)	4	4	100%
Effort Challenge (E_1)	3	0	0%
Concurrent Schedule Challenge (D)	12	4	33%
Total	41	18	44%

Table B2. Percentage of Session Agreement: Alex (Tangible)

	Card Touches	Sign	Vocal	Problem Behavior	EO	Sr
Baseline (A)	M=97% (92-100)	M=98% (96-100)	M=99% (96-100)	M=98% (92-100)	M=94% (92-98)	M=94% (90-100)
Extinction Challenge (B_1)	M=98% (95-100)	M=98% (96-100)	M=98% (96-100)	M=100%	M=93% (90-94)	M=93% (90-94)
Stimulus Control Challenge (C_1)	M=99% (96-100)	M=100%	M=100%	M=99% (96-100)	M=92% (86-98)	M=92% (86-98)
Effort Challenge (E_1)	M=100%	M=92%	M=100%	M=96%	M=100%	M=100%
Concurrent Schedule Challenge (D)	M=99% (96-100)	M=100% (98-100)	M=100%	M=97% (90-100)	M=96%	M=96%
Total	M=99%	M=98%	M=99%	M=98%	M=95%	M=95%

Table B3: Summary of Interobserver Agreement: Alex (Attention)

	Total Sessions	Number of Sessions with IOA	Percentage of Sessions with IOA
Baseline (A)	12	4	33%
Extinction Challenge (B_1)	12	7	58%
Stimulus Control Challenge (C_1)	4	4	100%
Effort Challenge (E_1)	12	4	33%
Concurrent Schedule Challenge (D)	6	3	50%
Total	46	22	48%

Table B4. Percentage of Session Agreement Alex (Attention)

	Card Touches	Sign	Vocal	Problem Behavior	EO	Sr
Baseline (A)	M=94% (88-100)	M=99% (96-100)	M=100% (98-100)	M=100%	M=93% (90-96)	M=93% (90-96)
Extinction Challenge (B_1)	M=96% (88-100)	M=98% (92-100)	M=94% (84-100)	M=96% (88-100)	M=95% (88-100)	M=95% (90-100)
Stimulus Control Challenge (C_1)	M=97% (92-100)	M=100%	M=100%	M=99% (98-100)	M=96% (92-100)	M=95% (92-100)
Effort Challenge (E_1)	M=99% (96-100)	M=99% (94-100)	M=99% (98-100)	M=99% (98-100)	M=96% (92-100)	M=96% (92-100)
Concurrent Schedule Challenge (D)	M=97% (96-98)	M=100%	M=100%	M=97% (96-100)	M=94% (92-96)	M=93% (92-96)
Total	M=97%	M=99%	M=99%	M=98%	M=95%	M=94%

Table B5. Summary of Interobserver Agreement: Alex (Escape)

	Total Sessions	Number of Sessions with IOA	Percentage of Sessions with IOA
Baseline (A)	28	10	36%
Extinction Challenge (B_2)	5	2	40%
Extinction Challenge (B_1)	7	3	43%
Extinction Challenge (B_3)	7	3	43%
Total	47	18	38%

Table B6. Percentage of Session Agreement: Alex (Escape)

	Card Touches	Sign	Vocal	Problem Behavior	EO	Sr
Baseline (A)	M=99% (96-100)	M=96% (85-100)	M=97% (90-100)	M=99% (96-100)	M=97% (90-100)	M=99% (96-100)
Extinction Challenge (B_2)	M=100%	M=100%	M=100%	M=100%	M=93% (92-94)	M=94%
Extinction Challenge (B_1)	M=99% (96-100)	M=95% (92-96)	M=93% (88-96)	M=95% (92-98)	M=95% (90-98)	M=95% (90-98)
Extinction Challenge (B_3)	M=93% (84-100)	M=100%	M=100%	M=97% (94-100)	M=99% (96-100)	M=99% (96-100)
Total	M=98%	M=98%	M=98%	M=98%	M=96%	M=97%

Table B7. Summary of Interobserver Agreement: Jake (Tangible)

	Total Sessions	Number of Sessions with IOA	Percentage of Sessions with IOA
Baseline (A)	32	10	31%
Extinction Challenge (B_1)	5	3	60%
Extinction Challenge (B_2)	5	2	40%
Effort Challenge (E_2)	6	2	33%
Effort Challenge (E_1)	5	6	43%
Total	53	23	43%

Table B8. Percentage of Session Agreement: Jake (Tangible)

	Card Touches	Sign	Vocal	Problem Behavior	EO	Sr
Baseline (A)	M=96% (87-100)	M=98% (94-100)	M=100%	M=99% (97-100)	M=90% (83-97)	M=96% (92-98)
Extinction Challenge (B_1)	M=91% (76-100)	M=96% (92-100)	M=100%	M=97% (92-100)	M=95% (90-98)	M=98% (96-99)
Extinction Challenge (B_2)	M=97% (93-100)	M=94% (93-94)	M=100%	M=99% (97-100)	M=95% (93-97)	M=89% (80-98%)
Effort Challenge (E_2)	M=95% (90-100)	M=94% (87-100)	M=100%	M=100%	M=94% (87-100)	M=96% (92-100)
Effort Challenge (E_1)	M=100%	M=99% (93-100)	M=98% (93-100)	M=90% (93-100)	M=96% (83-100)	M=97% (90-100)
Total	M=96%	M=96%	M=100%	M=97%	M=94%	M=95%

Table B9. Summary of Interobserver Agreement: Jake (Attention)

	Total Sessions	Number of Sessions with IOA	Percentage of Sessions with IOA
Baseline (A)	19	6	32%
Extinction Challenge (B_1)	19	7	37%
Stimulus Control Challenge (C_2)	14	6	43%
Total	52	19	37%

Table B10. Percentage of Session Agreement: Jake (Attention)

	Card Touches	Sign	Vocal	Problem Behavior	EO	Sr
Baseline (A)	M=93% (87-100)	M=100%	M=100%	M=99% (97-100)	M=93% (80-97)	M=96% (93-98)
Extinction Challenge (B_1)	M=94% (82-100)	M=97% (84-100)	M=99% (96-100)	M=100%	M=97% (92-100)	M=97% (93-100)
Stimulus Control Challenge (C_2)	M=100%	M=99% (93-100)	M=98% (93-100)	M=90% (93-100)	M=96% (83-100)	M=97% (90-100)
Total	M=96%	M=99%	M=99%	M=96%	M=95%	M=97%

Table B11. Summary of Interobserver Agreement: Jake (Escape)

	Total Sessions	Number of Sessions with IOA	Percentage of Sessions with IOA
Baseline (A)	23	7	30%
Extinction Challenge (B_1)	23	7	30%
Total	46	14	30%

Table B12. Percentage of Session Agreement: Jake (Escape)

	Card Touches	Sign	Vocal	Problem Behavior	EO	Sr
Baseline (A)	M=98% (94-100)	M=98% (92-100)	M=99% (93-100)	M=95% (82-100)	M=94% (87-100)	M=97% (91-100)
Extinction Challenge (B_1)	M=96% (92-100)	M=96% (86-100)	M=99% (96-100)	M=96% (88-100)	M=97% (90-100)	M=96% (87-100)
Total	M=97%	M=97%	M=99%	M=96%	M=96%	M=97%