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Examining Effects of Technology Level and Reinforcer Arrangements on Preference and Efficacy

Audrey N. Hoffman
Utah State University

EXAMINING EFFECTS OF TECHNOLOGY LEVEL AND REINFORCER ARRANGEMENTS ON PREFERENCE AND EFFICACY

by

Audrey N. Hoffmann

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Approved:

Tyra P. Sellers, Ph.D. Major Professor	Timothy A. Slocum, Ph.D. Committee Member
Sarah Pinkelman, Ph.D. Committee Member	Jared C. Schultz, Ph.D. Committee Member
Michael P. Twohig, Ph.D. Committee Member	Mark R. McLellan, Ph.D. Vice President for Research and Dean of the School of Graduate Studies

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ABSTRACT

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by

Audrey N. Hoffmann, Doctor of Philosophy

Utah State University, 2017

Major Professor: Tyra P. Sellers, Ph.D.
Department: Special Education and Rehabilitation

Understanding dimensions that influence reinforcement is important for applied behavior analysts. Preference, and reinforcer effectiveness, may change depending upon several dimensions of reinforcement. Two influential dimensions that may influence preference and reinforcer efficacy are response-reinforcer arrangements and stimulus type. Many leisure items used as reinforcers may be classified depending upon technology level (e.g., highly technological items versus non-technological items). In recent years use of highly technological items has increased among individuals with disabilities. When using high- and low-tech reinforcers, reinforcer deliveries may be arranged to occur in a distributed manner (i.e., every response results in a reinforcer delivery), or an accumulated manner (i.e., reinforcers are accumulated and exchanged following completion of all the work). The purpose of this study was to examine the interaction and effects of reinforcer arrangements (i.e., distributed reinforcement and accumulated reinforcement) and technology level of items (i.e., high-tech and low-tech) on preference and reinforcer efficacy with three children with autism. Results demonstrated higher response rates and preference toward accumulated reinforcer arrangements compared to distributed reinforcer arrangements regardless of technology level. Overall, participants' responding and preference were sensitive to different reinforcer arrangements but were less sensitive to differences in the technology level of the reinforcers used.

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PUBLIC ABSTRACT

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Applied behavior analysts use reinforcement to enact socially meaningful outcomes with the individuals that they work with. Identifying the ways in which reinforcers function optimally is an important consideration for behavioral research. Preference for reinforcers, and how effective reinforcers are, may change depending upon several factors. Two important factors to consider are how reinforcers are arranged and the technology level of the reinforcers used. Reinforcers can be delivered following every response in a distributed manner or they can be delivered following several responses in an accumulated manner. Additionally, leisure items used as reinforcers can be classified according to technology level, for example high- and low-tech items. The purpose of this study was to examine the interaction and effects of reinforcer arrangements (i.e., distributed reinforcement and accumulated reinforcement) and technology level of items (i.e., high-tech and low-tech) on preference and reinforcer efficacy with three children with autism. Participants selected a preferred high- and low-tech item and engaged in academic tasks to earn the items in either accumulated or distributed arrangements. Results of two experiments demonstrated that participants responded more quickly when reinforcers were provided in an accumulated arrangement regardless of whether a high-tech or low-tech item was provided. Participants also preferred to work for reinforcers provided in accumulated arrangements. Overall, participants' responding and preference were sensitive to different reinforcer arrangements but were less sensitive to differences in the technology level of the reinforcers used.

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CHAPTER I

INTRODUCTION

Reinforcement is an integral component in applied behavior analysis. Previous researchers have identified several dimensions of reinforcement that influence preference and reinforcer efficacy (Athens & Volllmer, 2010). Researchers have identified additional factors, such as the arrangement of reinforcers, which may also influence preference and reinforcer efficacy (Ward-Horner, Cengher, Ross, & Fienup, 2016). Some individuals may prefer accumulated reinforcement arrangements, in which reinforcers are accumulated and delivered for a longer duration following completion of multiple responses. Other individuals may prefer distributed reinforcement arrangements in which reinforcers are delivered following completion of each response.

Practitioners and caregivers also use a variety of stimuli as putative reinforcers. Researchers have categorized stimuli according to several classifications including leisure items, edible items, or forms of social reinforcement (Clay, Samaha, Bloom, Bogoev, & Boyle, 2013; Daly et al., 2009; Fahmie, Iwata, & Jann, 2015). When classifying leisure items, it may be useful to classify items by technology level, differentiating between highly technological items and items that do not include any technological components. Despite an increased use of high-tech items by individuals with disabilities, there is still a lack of understanding of the ways in which the technology level of items may influence behavioral outcomes. Previous research results have demonstrated ways in which the technology level of items interacts with magnitude to influence behavioral outcomes, however more research is needed investigating additional dimensions (Hoffmann, Samaha, Bloom, & Boyle, 2017).

Although extensive research has been conducted examining some dimensions of reinforcement, less research has been conducted examining the ways in which technology level may interact with reinforcer arrangements to influence preference and reinforcer efficacy. Given practitioners' and caregivers' use of differing reinforcer arrangements and different types of reinforcers, it may be important to examine the interaction between these variables. It is still yet unknown how reinforcer arrangements (i.e., distributed and accumulated arrangements) interact with different types of reinforcers (i.e., high-tech and low-tech reinforcers) to influence preference and performance. Therefore, the purpose of this study was to examine effects of reinforcer arrangements and technology level of reinforcers on preference and performance with individuals with disabilities. Within the following sections I summarize previous literature related to dimensions of reinforcement, high- and low-tech reinforcers, and reinforcer arrangements. This review provides information regarding each independent variable and the importance of further examining these variables using the later described methods.

CHAPTER II

LITERATURE REVIEW

Reinforcement

Reinforcement is the primary means by which applied behavior analysts influence human behavior, both in areas focusing on skill acquisition and on problem behavior reduction (Northup, Vollmer, & Serrett, 1993; Vollmer & Hackenberg, 2001). Identifying effective reinforcers is a critical component involved in providing behavior analytic services. In order for an item to function as a reinforcer it must increase the likelihood of future occurrences of the behavior it follows. Researchers have discussed, at length, variables related to reinforcer value, reinforcer contingencies, and reinforcer effectiveness. The principle of reinforcement may be examined and analyzed to differing degrees. Analyzing the principle of reinforcement in greater depth may uncover a more complex process, involving multiple interconnected and influential parameters and dimensions.

Researchers have identified several variables that influence preference for putative reinforcers, reinforcer efficacy, and reinforcer value. For example, schedules of reinforcement have been shown to influence reinforcer value (Lattal & Neef, 1996). Schedules of reinforcement determine when a reinforcer will be delivered, as well as how frequently reinforcer deliveries will occur (Ferster & Skinner, 1957). Continuous reinforcement schedules involve a reinforcer delivery following every targeted response, whereas intermittent (also referred to as variable) schedules program reinforcer delivery following only some determined targeted responses (some responses result in reinforcement but not every response). Fixed and intermittent schedules of reinforcement can also be programmed according to time-based schedules (interval) or response-based schedules (ratio). The resulting combinations include fixed-ratio (FR), fixed-interval (FI), variable-ratio (VR) and variable-interval (VI) schedules. For example, a reinforcer could be delivered following every fifth response (an FR-5 schedule), or a reinforcer could be delivered following the first response occurring after 30 s elapses (an F-I 30 s schedule). Researchers have demonstrated general patterns in responding depending upon schedule type. Fixed schedules of reinforcement result in consistent responding, including a post-reinforcement pause following reinforcer access. Intermittent schedules of reinforcement generally produce steady responding and do not typically result in post reinforcement pauses. It is important to note that reinforcement contingencies can be influenced by the schedule used to deliver reinforcement. For example, using the same reinforcer in a variable schedule and a fixed schedule may result in different rates of responding.

In addition to schedules influencing responding, reinforcer value and responding can also be influenced by having more than one reinforcing alternative available at a given time. Reinforcer value and efficacy may differ depending upon if the reinforcer is the only source of reinforcement available (single operant arrangement), versus if multiple reinforcers are available (concurrent operant arrangement). Concurrent schedules can be arranged in which individuals are required to choose between multiple response alternatives. For example, responding to earn a reinforcer provided on one schedule (e.g., edible item, VI-25 min schedule), versus responding to earn a different reinforcer arranged on a different schedule (e.g., social attention, FR-1 schedule). Herrnstein (1974), first described that an organism's rate of responding toward two concurrently available response alternatives will match the programmed reinforcement schedules available.

When multiple reinforcers are available concurrently, the relative value of reinforcers can be evaluated. If an individual responds to obtain reinforcement from one alternative more than he/she responds to obtain reinforcement from the other alternative, it can be assumed that the selected reinforcer is more valuable than the reinforcer to which he/she did not respond. This may also be relevant to assessing reinforcer preference, where other alternative putative reinforcers may influence relative preference.

Parameters of Reinforcement

There are several parameters of reinforcement that influence responding. In recent years, a large and growing body of research has examined parameters of reinforcement (Athens & Vollmer, 2010). Like many topics in the field of behavior analysis, the examination of reinforcer parameters was first conducted in basic laboratories and later examined in human operant arrangements and applied settings. Researchers have identified several influential parameters of reinforcement including immediacy, quality, and magnitude.

Immediacy

Immediacy of reinforcement refers to how quickly a reinforcer is delivered following a response. Researchers have also commonly referred to this parameter as reinforcer delay (Neef, Mace, & Shade, 1993). The term "immediacy" may more closely describe the parameter at all potential ranges, rather than just at one level (i.e., delayed) and may be more aligned to other parameter descriptors; therefore, we will use the term immediacy. Some individuals are sensitive to reinforcer immediacy, as evidenced by responding for more immediate reinforcers even when manipulations to other parameters favor a different response alternative (Neef et al., 1993). Results of previous research demonstrate that when reinforcers are delayed, rather than immediate, response rates may decrease and response acquisition may occur more slowly (Jarmolowicz, Hudnall, & Lemley, 2015). Immediacy has frequently been examined in conjunction with other parameters in self-control paradigms. In self-control research, researchers typically program concurrent options in which a participant chooses between a smaller more immediate reinforcer, and a larger delayed reinforcer. If the participant selects the "smaller sooner" reinforcer over the "larger later" reinforcer it indicates a sensitivity to immediacy and less sensitivity to magnitude. If an individual is sensitive to immediacy, it is important to provide reinforcers immediately following correct or desirable responses in order to ensure temporal contiguity between the response and reinforcer. Similar to other parameters of reinforcement, immediacy may influence preference and reinforcer efficacy and is an important consideration in reinforcer contingencies.

Quality

Quality of reinforcement refers to the value of a reinforcer and is sometimes referred to as analogous to preference. Quality has been defined by relying on repeated preference assessment results. For example, a highly preferred item is said to be of higher quality than a lesser preferred item. Quality has also been examined by determining the level of responding that a stimulus maintains. For example, hypothetically, a higher quality reinforcer would sustain more responding (e.g., higher rates) than a lower quality reinforcer. Researchers have examined quality of reinforcement in concurrent arrangements in which an individual selects among reinforcers of differing qualities (Hoch, McComas, Johnson, Faranda, Guenther, 2002; Lalli et al., 1999; Peck et al., 1996). When quality is manipulated with other parameters, sensitivity to manipulations to quality or to other parameters can be determined. For example, researchers can provide two response alternatives differing in reinforcer quality (high preferred item versus low preferred item), but provide the same reinforcer magnitude (e.g., 50-s toy access). If participants consistently respond to gain access to the higher quality reinforcer it can be determined they are sensitive to quality (Hoch et al., 2002).

Magnitude

Magnitude refers to the amount, intensity, or duration of reinforcement. For example, if using a tangible reinforcer, magnitude is manipulated by providing a long or short duration of access. When using an edible reinforcer, magnitude is manipulated by providing more or less of the reinforcer (i.e., five bites versus two bites, or a large cupcake versus a small cupcake). In basic research, magnitude can also be manipulated by differing the intensity of a substance (i.e., more concentrated dose of drugs). In applied research, intensity may be manipulated by varying the degree of sensory stimulation. For example, an auditory reinforcer could be presented more loudly (more intensely) to increase the magnitude of the reinforcer. Generally, in applied research magnitude is manipulated as number of items, amount of items, or duration of access. Several studies have demonstrated that when magnitude is manipulated in favor of one response alternative, individuals will respond more toward (or select more frequently) the alternative with the highest magnitude (Trosclair-Lasserre, Lerman, Call, Addison, & Kodak, 2008).

It is important for behavior analysts to recognize that sensitivity to parameters of reinforcement varies on an individual basis. (Neef & Lutz, 2001; Neef et al., 1993; Neef, Shade, & Miller, 1994; Perrin & Neef, 2012). For example, one individual might be more sensitive to manipulations to reinforcer magnitude, whereas another individual might be more sensitive to manipulations to quality. The body of literature surrounding the effects of parameters of reinforcement on human behavior (including preference, responding, and reinforcer efficacy) highlights the complexities of reinforcement on an individual basis and the need for careful analysis of reinforcement contingencies.

Reinforcer Type

An additional dimension that may influence reinforcement contingencies is the type of reinforcer used. Reinforcers vary in terms of physical properties. For example, tangible items, edible items, human interactions, and activities have all been classified as reinforcers, yet all differ in physical properties. The differing physical properties of reinforcers can be categorized to aid in the description of reinforcers and potentially further our understanding of reinforcers. Thus far, researchers have made several broad topographical classifications of reinforcers including edible reinforcers (Fahmie et al., 2015; Paramore & Higbee, 2005), leisure reinforcers (Fahmie et al., 2015; Jones, Dozier, & Neidert, 2014), social reinforcers (Clay et al., 2013), and activity reinforcers (Daly et al., 2009).

Topographical definitions based upon physical properties may define reinforcers depending on their sensory properties, that is, based upon the ways in which stimuli affect same or different sensory modalities (e.g., edibles versus leisure items; DeLeon, Iwata, Goh, & Worsdell, 1997). Although definitions for similar and dissimilar types of reinforcers may differ, other researchers have assessed differences in preference based upon dissimilar types of reinforcers. Typically, these arrangements involve categorizing reinforcers as edibles or tangibles (Bojak & Carr, 1999; DeLeon, Iwata, & Roscoe, 1997; Fahmie et al., 2015; Ortega, Iwata, Gonzales, & Frades, 2012). Further, research has classified some reinforcers as being social (e.g., Clay et al., 2013; Lang et al., 2014), which can be conceptualized as an additional category of reinforcers affecting still different sensory modalities than leisure items and edible items.

In recent years, use of technology has increased across many segments of society (Pew Research Center, 2015). The increased use and availability of highly technological items poses an opportunity to further classify potential reinforcers. When describing reinforcers traditionally identified as leisure or tangible reinforcers, we can define sub-categories such as activity-based reinforcers (e.g., reinforcers requiring continuity of access and completion of an activity) (DeLeon, et al. 2014). Accordingly, another way in which we can classify tangible or leisure reinforcers is in terms of the level of technology of an item. Hoffmann et al. (2017) proposed a conceptualization of reinforcers along a continuum of technology. For example, highly technological (high-tech) items require batteries or electricity to function, and include sophisticated computer components and associated software. Examples of high-tech items include personal gaming devices, portable DVD players, cellular phones, and tablet computers. In contrast, items that do not require batteries or electronic components to function may be classified as low-tech items. Both types of items would fall under the umbrella of leisure items, however the differing technology level of the items results in a more specific classification system.

Researchers have begun to examine the use of high-tech items as reinforcers or otherwise. Increasing studies report use of high-tech items for reinforcement purposes (e.g., Deleon et al., 2011; Hanley, Jin, Vanselow, & Hanratty, 2014), as leisure items (Chan, Lambdin, Graham, Fragale, & Davis, 2014), or for educational purposes (Kagohara et al., 2013; Ramdoss et al., 2012). However, fewer studies specifically examine the effects of high-tech items on reinforcer preference and efficacy (Hoffmann et al., 2017). Multiple reviews of the literature exist categorizing uses of high-tech items (Kagohara et al., 2013; Stephenson & Limbrick, 2013). Additionally, researchers have examined the effects of using high-tech items within academic interventions (Knight, McKissick, & Saubders, 2013), in preference assessments (Brodhead, Al-Dubayan, Mates, Abel, & Brouwers, 2015), and in programs to reduce problem behavior (Neely, Rispoli, Camargo, Davis, & Boles, 2013).

In classifying reinforcers as high- or low-tech, many tangible reinforcers fall into the low-tech category. There are many studies examining the effects of different putative reinforcers on efficacy and preference. However, there are few studies, if any, that isolate the effects of low-tech reinforcers as a type of reinforcer. More commonly, reinforcers identified as tangible items simply fall under that category of low-tech reinforcers.

Although behavior analysts typically define environmental variables in functional rather than topographical terms, when defining broad classes of reinforcers, a precedent exists to define reinforcers topographically (Clay et al., 2013; DeLeon et al., 1997; Fahmie et al., 2015; Lang et al., 2014). For research purposes it may be difficult to define reinforcers functionally because definitions may vary on an individual basis. For example, an individual may interact with edible reinforcers rather than ingest them, or an individual may use a piece of an activity reinforcer as a simple tangible item reducing the accuracy of an activity-based definition of the item. Recognizing that the definition of high-tech and low-tech reinforcers is based upon the topography of the items, for the purposes of this study we will classify reinforcers according to technology level rather than on a functional definition based upon how individuals interact with the items.

Although high- and low-tech items may affect similar sensory modalities, it may be that high- and low-tech items do differ in the ways in which, or the degree to which, they affect the senses. The differences may be due to the ways in which humans learn to interact with high- and low-tech items. Many high-tech items are dynamic and affect multiple sensory receptors simultaneously (e.g., a tablet device providing simultaneous sound, visual, and tactile stimulation). In contrast, many low-tech items require the individual interacting with the item to engage in specific responses in order for the individual to contact sensory stimulation from the item. For example, a high-tech device can be held passively in an individual’s hands while providing varying input to visual, auditory, and tactile sensory receptors. In contrast, a low-tech item held passively is not likely to have a similar effect on sensory receptors until the individual moves the item, actively uses the item to make noise, or interacts with the item to obtain sensory input. It may be that these differences in high- and low-tech items warrant classification in separate categories and further investigation.

It is also important to note the influence of learning history on the efficacy of reinforcers. As high-tech items are increasingly used in society, it may be that increased access and availability lead to increased pairing opportunities with other reinforcers. For example, if an individual's environment is filled with various high-tech items, as well as other social reinforcers (e.g., preferred people), it may be that the value of high-tech items increase by pairing and conditioning. A relevant example may involve all the "cool" kids at school having the new video game console, thus increasing the value of the video game console for an individual who may not have access to the new console yet. The pairing of the high-tech item with established social reinforcers may increase its value. Another example may be a child who regularly plays video games paired with social interactions, or uses a tablet device allowing social contact with friends and other preferred individuals. Increased use of high-tech items in the greater society may increase their value because they are common, "popular," or sought after items. Although research demonstrating these phenomena is lacking, it is possible that varied and complex pairings with established social reinforcers may influence preference for, and efficacy of, high-tech items differently than low-tech items.

Interaction Effects

Although we have discussed several dimensions of stimuli and reinforcement contingencies that may affect preference and reinforcer efficacy, it is also important to discuss how these dimensions interact to influence reinforcers. For example, parameters of reinforcement may differentially influence preference and efficacy depending on the type of reinforcer provided or depending on the way in which a reinforcer is delivered. Several researchers have examined the influence of interacting parameters on reinforcer efficacy and various outcomes. For example, magnitude and quality may differentially interact to influence choice behavior (Peck, 1996; Peck-Peterson et al., 2005), immediacy and magnitude may interact to influence self-control behavior (Dixon et al., 1998), and rate, immediacy, quality, and magnitude may interact to influence the development of response-class hierarchies (Beavers, Iwata, & Gregory, 2014).

Another relevant example is described by Hoffmann et al. (2017). Researchers examined the influence of technology level of items on reinforcer efficacy and preference. They found that preference and efficacy were differentially affected by both magnitude and item technology level. Participants responded differently on progressive-reinforcer (PR) schedules depending upon item type and magnitude. For example, participants generally responded more for access to a low-tech item when reinforcer magnitude was low (e.g., 10 s, or 30 s) but responded more for access to a high-tech item when reinforcer magnitude was high (e.g., 10 min). These results highlight the importance of examining interactions between reinforcer type and other independent variables, such as parameters of reinforcement.

Reinforcer Arrangements

In addition to schedules, parameters, and reinforcer type influencing behavior, the ways in which reinforcers are delivered may also influence behavior. Response-reinforcer arrangements may involve providing reinforcement following every response or according to a schedule, or they may include arrangements that allow participants to accumulate reinforcers until the end of a given period and then have access to a "larger" accumulated reinforcer. When examining reinforcer arrangements, reinforcer schedules can be referred to as schedules of work or as schedules of reinforcement. Although researchers may be examining the same arrangement, they can discuss the arrangement differently. Although previous researchers have examined similar phenomena, the language used to discuss effects differs across studies. Arrangements have been referred to as continuous, fluent, or accumulated in comparison to discontinuous, disfluent, or distributed (Bukala, Hu, Lee, Ward-Horner, & Fienup, 2015). Although researchers have not used consistent terminology across studies, several researchers have examined distributed and accumulated reinforcement (Ward-Horner et al., 2016).

Although the literature examining reinforcer arrangements refers to them in a way that may indicate they are separate, distinct phenomena, it is important to note that reinforcer arrangements are simply the ways in which we arrange schedules of reinforcement and reinforcer deliveries of differing magnitudes within contingencies. For example, a distributed arrangement can simply be referred to a contingency composed of earning 30 s magnitude reinforcer on an FR-1 schedule. Similarly, an accumulated reinforcer arrangement may be referred to an FR-10 schedule of reinforcement delivering a 5-min magnitude reinforcer. The terms accumulated and distributed arrangements may be useful tools to describe differences in reinforcer contingencies manipulating schedules of reinforcement and reinforcer magnitude. For the purposes of this study, we refer to reinforcer arrangements, which is consistent with previous research in this area.

In one of the earlier applied studies specifically examining reinforcer arrangements, Fienup, Ahlers, and Pace (2011) examined preference for fluent versus disfluent work schedules in an adolescent female diagnosed with nonverbal learning disorder. The authors conducted a preference assessment and then a three-choice concurrent operant reinforcer assessment. When the researchers provided access to preferred activities or nothing, the participant chose no activity. The researchers hypothesized this may have been due to a preference for a fluent schedule of work. For example, selecting nothing resulted in getting back to work more quickly rather than selecting a reinforcer which would result in frequent breaks from the work schedule. The authors conducted a second experiment to further examine the hypothesis that the participant preferred fluent work. In the second experiment, they specifically examined preference for fluent versus disfluent work using concurrent operant procedures.

The experiment was conducted in three phases, each phase consisted of concurrent-operant trials in which reinforcers were signaled using cards. The first phase examined selecting between nothing and a high-preferred or low-preferred activity in the absence of a work requirement. The second phase examined selecting between a high-preferred and low-preferred activity, and access to worksheets. The third phase examined fluent and disfluent work schedules by measuring selections for fluent work (with or without a reinforcer) and selections for disfluent work. The work/reinforcer schedules assessed included completing six worksheets followed by a high-preferred activity (i.e., fluent work schedule with reinforcement), completing six worksheets earning an equal amount of reinforcement provided in a distributed manner following completion of each worksheet (i.e., disfluent work schedule with distributed reinforcement), or completing six worksheets followed by no reinforcer (i.e., fluent work schedule with no reinforcement).

Results from phases two and three demonstrated that the participant preferred access to the high-preferred activity more than access to nothing or a low-preferred activity (phase one), and more than access to work or a low-preferred activity. During the third phase, results demonstrated that the participant chose to complete work within an accumulated reinforcer arrangement resulting in access to a reinforcer following task completion. The authors concluded that the participant preferred access to completing continuous work rather than discontinuous work. The results confirmed the unexpected results of the initial experiment. A limitation of Fienup et al. (2011) is that procedures were only conducted with one participant. Additionally, the study did not include all potential control conditions (e.g., a third phase including a disfluent schedule with no reinforcers presented during waiting periods). However, this study provides initial evidence supporting the idea that distributed and accumulated reinforcer arrangements may result in differences in preference and responding.

In an extension of Fienup et al. (2011), Ward-Horner, Pittenger, Pace, and Fienup (2014) further examined the influence of reinforcer magnitude on preference for accumulated versus distributed reinforcer arrangements with one participant. The authors systematically manipulated the duration of access during the accumulated reinforcement schedule compared to a baseline condition, in which magnitude was held constant between the accumulated and distributed reinforcement conditions. When magnitude was held constant, the participant preferred working under accumulated reinforcement conditions. When the magnitude for accumulated reinforcement condition was decreased relative to the distributed condition, preference shifted (e.g., distributed resulted in 10 min access while accumulated resulted in 2 or 6 min access). When magnitude was similar (e.g., 10 min distributed versus 8 min accumulated), preference shifted back toward the accumulated arrangement. The results of this study provide more evidence that preference for reinforcer arrangements may be influenced by dimensions of reinforcement, in this case magnitude.

Kocher, Howard, and Fienup (2015) extended research on accumulated and distributed reinforcer arrangements in a school setting with three students with autism spectrum disorders (ASD) as participants. The authors specifically examined the effects of reinforcer arrangements when the tasks assessed were targets in acquisition, rather than mastered targets (commonly assessed in previous studies). Researchers first conducted a color preference assessment. They examined the effects of the reinforcer arrangements on percentage of correct responses and session duration (measured from first presentation of the schedule to final reinforcer consumption period). They also tracked the percentage of intervals with reinforcer engagement. They assessed preference for discontinuous or continuous work-reinforcer schedules (i.e., distributed or accumulated reinforcement arrangements).

The authors conducted preference assessments and then baseline, to determine unknown targets for use in the next phase. They then taught skill acquisition programs, alternating between schedule types (distributed versus accumulated), and finally conducted a free choice phase. Overall, results indicated no clear effects, or mixed effects. One participant had better performance under continuous reinforcer arrangements, and performance was mixed for the other two participants. Results also indicated that session duration was shorter during the continuous arrangements for all participants. This led to conclusions that using continuous reinforcer arrangements may be more efficient in applied settings, such as schools. Additionally, two participants were slightly more engaged during discontinuous (distributed reinforcement) work schedule sessions, and results indicated that continuous work schedules (accumulated reinforcement) were either the same as, or better than, discontinuous work schedules for reaching mastery criteria more quickly, and for efficiency.

Kocher et al. (2015) included an interesting extension of the literature on this topic thus far, by measuring engagement with reinforcers. Measuring this variable potentially indicated if accumulated or distributed reinforcer arrangements led to higher levels of engagement depending on the arrangements. Results showed generally higher levels of engagement during the distributed reinforcer arrangement, indicating that when the reinforcers were delivered for a shorter duration following one instance of task completion, the participants were more engaged with that reinforcer during the access interval. One potential limitation of this measure was that the authors did not provide an operational definition for reinforcer engagement. This may be critical in examining engagement with the particular reinforcers used. For one participant, the authors posited that engagement during accumulated reinforcer deliveries may have been lower due to the physical nature of riding a scooter. Perhaps the participant was physically tired when provided with 5 min of time to ride a scooter in the accumulated reinforcement sessions, as compared to only 1 min in the distributed reinforcement sessions. The other two participants' reinforcers were iPods, which may pose difficulties for measuring engagement. If engagement requires physical manipulations of the item, it could lead to deflated engagement scores because an iPod can be "used" without physical manipulation (e.g., listening to music, watching a movie, etc.). This highlights the importance of explicitly accounting for the uses of high-tech items when measuring reinforcer engagement. If the authors had operationally defined engagement, and had provided information regarding how the participants interacted with their iPods, readers could better evaluate effects on this dependent variable.

Bukala et al. (2015) also examined work-reinforcer schedules, performance, and preference in a classroom setting with three students with ASD. The authors examined effects of schedule arrangements on preference for continuous or discontinuous schedules and on performance under continuous or discontinuous schedules. Similar to previous studies (Fienup et al., 2011), the researchers used choice cards to depict the work-reinforcer schedules. Additionally, cards were used to depict the activity reinforcers used in the study. Measurements included session duration (i.e., from first instruction to completion of the last reinforcer consumption), task duration (i.e., duration of each individual instruction to the completion of the task), and transition durations (i.e., secondary measure subtracting task durations from total session durations).

The authors first conducted preference assessments to identify non-preferred colors for associating with schedules in later sessions, and to identify a highly-preferred leisure activity. Procedures included alternating between continuous and discontinuous arrangements in a multi-element design. The authors then examined preference for work schedules using a concurrent schedule. Results indicated that all participants preferred working under the continuous schedule of reinforcement. For two participants, sessions were shorter for continuous schedules, and for one participant transitions were shorter. The results only identified higher response rates for one participant when the reinforcer was an activity. The authors mentioned that future research could examine task difficulty when examining reinforcer arrangements. Bukala et al. (2015) discussed the inclusion of a measure of transitions as an important extension offered by this study. They also discussed the potential influence of duration of access and handling costs (i.e., a behavioral economic conceptualization of potential costs associated with accessing a reinforcer) on preference for discontinuous or continuous work schedules and proposed that future researchers further examine these variables.

Deleon et al. (2014) examined differences between activity-based reinforcers and non-activity reinforcers, depending upon reinforcer arrangements, with four individuals with disabilities in an inpatient hospital setting. Their study compared activity based reinforcers to edible reinforcers looking at effects of reinforcer arrangement, and reinforcer type on rates of responding. The authors hypothesized that activity-based reinforcers may be more effective when provided in accumulated reinforcer arrangements in which a larger magnitude of reinforcement is provided in a given reinforcer delivery. This may be due to the nature of activity reinforcers that involve progression through stages of use of the item (e.g., completing a puzzle, watching a movie, etc.). The authors hypothesized that activity-based reinforcers and edible reinforcers may differentially influence preference for and performance under accumulated and distributed reinforcer arrangements. They also examined effects of reinforcer arrangement and reinforcer type on preference using a concurrent-chains procedure.

The procedures included identifying putative reinforcers using preference assessments. The authors then conducted two studies, one examining the effects of reinforcer arrangement (accumulated and distributed) on response rates, and the second examining the effect of reinforcer arrangement on preference. During the first experiment (with three participants), the authors conducted a reinforcer assessment alternating between baseline sessions in which no reinforcement was provided, and reinforcement sessions, in which reinforcers were delivered either in an accumulated arrangement or a distributed arrangement (alternating arrangements per session within a multi-element design). One limitation of this arrangement was that the researchers did not use tokens during both distributed and accumulated arrangements, which may have influenced effects of the arrangements. The results demonstrated that for two participants, the stimuli did function as reinforcers, increasing response rates relative to baseline. For one participant responding during baseline was elevated, limiting conclusions about reinforcing effects. When comparing response rates under the different arrangements, all participants engaged in higher response rates during accumulated reinforcer arrangement sessions.

In the second experiment, DeLeon et al. (2014) examined preference for reinforcer arrangements with four participants. They conducted a concurrent-chains schedule arrangement in which participants were pre-exposed to each reinforcer arrangement and then provided a choice between working under either the accumulated or distributed arrangement. Selections of the initial-link in the chain were used an an indicator of preference. During this experiment, they also assessed if preferences differed depending on if the reinforcer used was an edible or an activity-based reinforcer. They conducted subsequent analyses, such as taking away the tokens from both arrangements, reversing the tasks and stimuli, and inserting a delay to reinforcement during the distributed condition during one phase. Results were mixed, but generally, all four participants demonstrated preference for the accumulated reinforcer condition. Only one participant demonstrated clear differences depending on activity or edible reinforcers (e.g., one participant preferred accumulated reinforcement with activity reinforcers but did not demonstrate clear preference when edibles were used). Although the researchers attempted to interpret results in relation to activity-based reinforcers, several limitations of this study should be noted. The authors did not use tokens consistently throughout the study across the distributed and accumulated reinforcer conditions. This could have resulted in increased reinforcing value of the accumulated arrangement due to the addition of a token (i.e., conditioned reinforcer) which was absent from distributed conditions. Further, in the second experiment, the authors used different tasks and stimuli to signal the different arrangements, but did not conduct stimuli and task reversals with all participants. They specifically did not conduct reversals with the participant with the clearest results depending on activity or edible reinforcers, which limits the interpretation of those results.

As briefly introduced, when examining reinforcer arrangements, definitions and descriptions have varied across published studies. The descriptions have generally taken two perspectives, from the perspective of the reinforcer delivery, or the response. From a response point of view, we define the arrangement by response schedules (e.g., fluent work schedules versus disfluent work schedules, or continuous work schedules versus discontinuous work schedules). This definition may involve an assumption that responses within a work schedule are interrupted by reinforcer deliveries, or that the work schedule is the controlling variable. Both Kocher, and Bukala examined the effects of reinforcer work arrangements from the perspective of the response or work-schedule. Related research has examined difference in work schedules, examining massed trials versus distributed trials during skill acquisition arrangements. For example, Majdalany, Wilder, Greif, Mathisen, and Saini (2014) examined massed-trials compared to distributed trials, and found that massed trials led to faster acquisition for 5 of 6 participants. This may be similar to findings by Kocher who found that continuous work schedules led to shorter sessions for all participants. These results were similar to findings by Bukala et al. (2015), who found shorter session durations for two of three participants, and shorter transition durations for three participants. It may be that continuous work schedules are more time efficient. In these cases, defining arrangements by the work schedule may have been useful in conducting those particular studies.

Alternatively, we may define the arrangement by the schedule of reinforcement (e.g., accumulated schedules of reinforcement versus distributed schedules of reinforcement). This definition may involve the assumption that the schedule of reinforcement is the element being manipulated, thus influencing the work schedule. It may be an empirical question whether or not these definitions influence our understanding of reinforcer arrangements and work schedules, and whether one perspective is more useful than the other. It may be more conceptually systematic to define the arrangements according to the programmed reinforcer contingencies, similar to historical accounts describing research on reinforcer schedules.

Reinforcer arrangements involve manipulations to multiple parameters of reinforcement simultaneously. These manipulations are often mitigated through means of conditioned reinforcers such as tokens or points. As described in reviewing literature on reinforcer arrangements, many researchers have used tokens while examining the effects of reinforcer arrangements. When examining token economies, a reinforcement contingency includes both a production schedule (e.g., schedule for earning conditioned reinforcers), and an exchange schedule (e.g., schedule for exchanging conditioned reinforcers for backup reinforcers). Within a token economy tokens are delivered immediately following every response and are then exchanged according to an exchange schedule which can be distributed or accumulated. For example, many researchers examining reinforcer arrangements have used a consistent FR-1 production schedule during all conditions, but have varied the exchange schedule (FR-1 during distributed arrangements, and FR-10 during accumulated arrangements). It is important to note the complex variables involved in examining reinforcer arrangements including manipulations to schedule, magnitude, and immediacy.

Ward-Horner et al. (2016) conducted a recent review of the literature examining response-reinforcer arrangements. The authors summarized research examining variables that influence preference for, and performance under, response-reinforcer arrangements. They noted that previous studies were conducted with individuals with disabilities between the ages of 13 and 20, and that future researchers could extend research on response-reinforcer arrangements by working with other populations. This may be especially important when considering that differences in reinforcer arrangements include differences in immediacy of reinforcer deliveries, which may influence outcomes with younger populations (Perrin & Neef, 2012).

Ward-Horner et al., (2016) summarized that the research surrounding response-reinforcer arrangements thus far points to several variables that influence participant preference for accumulated or distributed reinforcement arrangements and participant responding under either arrangement. Influential variables include, reinforcer type, tokens, and task difficulty; however, technology-level of items was not included as it has not been examined thus far.

Individuals with Disabilities and Technology Use

Many people report that a large portion of leisure time includes accessing technological items such as televisions, portable multimedia devices, or computers

(Kagohara, 2011). Additionally, researchers have documented increased use of technological items by individuals with disabilities (Clarke, Austin, & Craike, 2015; Kagohara et al., 2013). It would be difficult to find a behavior analyst who has *not* encountered a client in recent years who preferred, or whose behavior was reinforced, by high-tech items such as personal gaming devices, tablet computers, or cellular devices. Further, teachers and parents are reporting increased use of high-tech items with individuals with disabilities (Clark et al., 2015; Kagohara et al., 2013). Although use of high-tech items has increased, there does not seem to be a similar increase in understanding of technological items as reinforcers or as part of behavioral contingencies. Due to the increase in use of high-tech items by individuals with disabilities, more research is warranted.

Some researchers have examined high-tech items as leisure devices (Hammond, Whatley, Ayres, & Gast, 2010; Kagohara, 2011; Kagohara et al., 2011). This may be especially important considering many of the environments where individuals with disabilities attend school, live, and work may include a variety of leisure items, including high- and low-tech reinforcers. These environments may also frequently employ different reinforcer schedules, token economies, and response-reinforcer arrangements. It may be important to investigate high- and low-tech items in relation to the various ways they are used as reinforcers. To date, there are very few studies that examine high-tech items as reinforcers and specifically seek to isolate the effects of technology level as an independent variable (e.g., Hoffmann et al., 2017).

Technology Level and Arrangement

A combination of variables that may influence reinforcer value involves the interaction of technology-level of items and reinforcer arrangements. It may be that technology level may influence preference for and efficacy of reinforcer arrangements. As researchers have noted, high-tech reinforcers may be more preferred or more effective at longer durations when compared to low-tech reinforcers which may be more preferred or more effective at shorter durations (Hoffmann et al., 2017). Hoffmann et al. examined the interaction of differing magnitudes (i.e., duration of access) and technology level on preference and efficacy. The authors identified a highly preferred high-tech item and a highly preferred low-tech item in an initial phase. They then examined two differing durations of access (10 min and 10 s) during a paired stimulus preference assessment using the high- and low-tech items. Results demonstrated participants differentially preferred the high- and low-tech items depending on duration or access; however, results were variable. In a final phase the researchers examined the effects of magnitude and technology level on reinforcer value by conducting multiple PR reinforcer assessments providing differing magnitudes of either the high-or low-tech item within PR assessment sessions. The results demonstrated that reinforcer value differed depending on item-type and duration of access. Generally, the high-tech items were more valuable when provided for longer durations of access and the low-tech items were more valuable at shorter durations of access.

The results of Hoffmann et al. (2017) may be related to the effects of reinforcer arrangements. Some arrangements produce larger magnitudes of reinforcer access (e.g., accumulated) versus other arrangements which provide smaller magnitudes (e.g., distributed). The overall magnitude within a given session may be yoked (or identical across arrangements), but the distribution of the reinforcement (locally versus globally) affects magnitude and may therefore affect preference and efficacy. Given the results of Hoffmann et al. demonstrating differences based on technology level, it may also be important to examine different effects of reinforcer arrangements depending on reinforcer type.

Deleon et al. (2014) hypothesized that reinforcer type (edibles versus activity-based reinforcers) could influence preference and efficacy depending on reinforcer arrangement. DeLeon et al. also discussed the influence of handling costs on reinforcer value, a conceptualization from the field of behavioral economics. Handling costs are associated with some reinforcers and refer to the costs associated with accessing a reinforcer. Handling costs may be relevant when examining differences in high- and low-tech reinforcers. Some high-tech reinforcers naturally lend themselves to ongoing stimulation. For example, when playing a game on a device, or listening to a song on a device, the activity may gain reinforcing value due to the continuity of the stimulation provided by the device. This may be different from a low-tech item such as a slinky or a ball, in which the reinforcing properties do not necessarily depend upon continuity of access. It may be that many high-tech items may be conceptualized as activity-based reinforcers based upon DeLeon's definition. If this is the case, one could argue that the results of DeLeon et al. are directly relevant to high- and low-tech reinforcers. It may be that high- and low-tech reinforcers differ along an active-to-static reinforcer continuum.

The definition of activity-based reinforcers may depend on what the individual does with the reinforcer (i.e. a block can be static, or activity-based depending on interaction). The classification relies on the behavior of the organism, and not the stimulus alone. Even an edible can be used in an activity (e.g., playing with Sour Patch Kids™ or gummy worms as characters). In contrast, the classification of high- and low-tech reinforcers depends on stimulus characteristics only. Although the definitions are topographical or based on physical properties, there may be less ambiguity in the classification of high- and low-tech reinforcers, thus making it easier to examine the differences between types of items. Further, more research is needed to determine if the classification of reinforcers along a high- and low-tech continuum is useful. In addition to classifying reinforcers as high- and low-tech, it is also important to examine how differences in reinforcer type interact with other variables to influence behavioral outcomes. For example, to date, no research has examined preference for, and efficacy of, high- and low-tech reinforcers delivered in distributed or accumulated reinforcer arrangements. It may be that when using differing reinforcers, the arrangement may interact with the technology-level to influence behavior.

Specific to examining reinforcer arrangements, no study to date has examined technology level in regards to reinforcer arrangements. Two participants used high-tech reinforcers in Kocher et al., (2015) however there were no clear patterns in results depending on type of reinforcer and the authors did not specifically evaluate the types of reinforcers as in independent variable. DeLeon et al. (2014), included some high-tech items as activity-based reinforcers, but did not specifically examine high-tech reinforcers compared to low-tech reinforcers. Further, researchers have not examined effects of reinforcer arrangements with populations under the age of 10. Although research has examined distributed and accumulated reinforcement with older individuals with disabilities, we do not know how technology level of reinforcers influences preference for, and value of accumulated and distributed reinforcer arrangements with children with disabilities under the age of 10.

Summary and Purpose

The purpose of the current study was to examine the interaction between technology level of reinforcers and reinforcer arrangements. Specifically, we sought to answer the following research questions.

1. What effects will access to a high-tech or low-tech reinforcers have on individuals with disabilities' rates of responding under distributed and accumulated reinforcer arrangements as measured by rate of responding?

2. What effects will access to a high-tech or low-tech reinforcers have on individual with disabilities' preference for accumulated or distributed reinforcer arrangements as measured by percentage selection?

CHAPTER III

METHODS

Participants and Setting

Participants included three children diagnosed with autism spectrum disorder (ASD). Participants were recruited through a local school district from a functional skills classroom. Karen was an 8-year-old female, Steve was an 8-year-old male, and Billy was a 7-year-old male. Karen and Steve communicated using full vocal sentences, and Billy communicated in one- or two-word utterances. All participants had a history of using high- and low-tech items. Based on teacher input regarding potential participants' history of problem behavior, none of the participants engaged in problem behavior significant enough to interrupt sessions.

All sessions were conducted at an elementary school in a common seating area, including a table and chairs. Participants were seated at a table across from the therapist during sessions. Other tables were vacant during times when sessions were conducted.

Reliability

Two independent data collectors collected data on all dependent variables across all phases during at least 30% of sessions for the purposes or calculating interobserver agreement (IOA). Data collectors were trained using training videos (Dempsey, Iwata, Fritz, & Rolider, 2012). All data collectors were trained to at least 90% accuracy before collecting research data. During all phases, except phase 4, IOA was calculated using point-by-point agreement. Agreements were scored if both data collectors scored the same dependent variable. Disagreements were scored if measurements did not match across data collectors. Percentage agreements were calculated by dividing the number of agreements by the number of agreements plus disagreements and then multiplying by 100 to yield a percentage. During phase 4, IOA was scored using interval-by-interval comparison. Sessions were divided into 10 s intervals. Disagreements were scored if both data collectors did not agree completely on data collected within each 10 s interval. Percentage agreements were calculated by dividing the number of interval agreements by the number of interval agreements plus disagreements and then multiplying by 100 to yield a percentage. Table 1 lists the percentages of IOA data collected, average

Table 1

Interobserver Agreement

Phase/participant	Percentage of sessions w/ IOA	Average agreement	Range of agreement
Phase I			
Karen	100	100	n/a
Steve	100	100	n/a
Billy	33	100	n/a
Phase II			
Karen	33	99	97-100
Steve	38	98	95-100
Billy	44	99	98-100
Phase III			
Karen	75	100	n/a
Steve	57	100	n/a
Billy	42	100	n/a
Phase IV			
Karen	38	94	73-100
Steve	32	93	74-100
Billy	32	95	75-100
Phase V			
Karen	31	100	n/a
Steve	31	100	n/a
Billy	31	97	86-100

agreement scores, and ranges for all phases of the study for each participant.

Treatment Fidelity

A trained data collector collected data on therapist behavior during at least 30% of all sessions for purposes of calculating treatment fidelity. Treatment fidelity data collectors were trained on implementation procedures for any sessions they gathered data during. Percentage of correct treatment implementation per session was calculated by dividing the number of components completed correctly by total number of components and multiplying by 100 to yield a percentage. Table 2 lists percentages of fidelity collected, average fidelity scores, and ranges for all phases for each participant.

Table 2

Treatment Fidelity

Phase/participant	Percentage of sessions w/fidelity	Average fidelity	Range of fidelity
Phase I			
Karen	33	100	n/a
Steve	33	97	94-100
Billy	33	100	n/a
Phase II			
Karen	33	100	n/a
Steve	33	99	92-100
Billy	33	96	83-100
Phase III			
Karen	50	100	n/a
Steve	57	100	n/a
Billy	42	99	98-100
Phase IV			
Karen	31	99	97-100
Steve	33	99	96-100
Billy	36	99	93-100
Phase V			
Karen	31	100	n/a
Steve	31	99	97-100
Billy	31	100	n/a

Procedures

Phase I: Multiple Stimulus Without Replacement Preference Assessments

The purpose of Phase I was to conduct two multiple stimulus without replacement (MSWO) preference assessments in order to identify highly preferred high- and low-tech items for use in subsequent phases.

Materials. We used seven high-tech items in one preference assessment. Examples of high-tech items used included an iPad ®, Kindle eReader, digital camera, Nintendo DS, Samsung tablet, mini laptop computer, and portable DVD player. We used seven low-tech items in an additional preference assessment. Examples of low-tech items included an Etch-A-Sketch ®, pin molder, silly putty, or coloring pages. Table 3 lists a complete list of all potential items used during Phase I. Items differed across participants based upon teacher input of potentially preferred items to include in the assessments.

Response measurement. During phase I we measured selection, defined as the participant pointing to or selecting an item by touching and/or holding the item. Data were collected using paper and pencil methods and we measured the dependent variable as percentage selection.

Procedures. Preference assessment procedures were based on procedures described by Deleon and Iwata (1996). During sessions, participants sat across from a therapist at a table. Sessions began with a pre-exposure to each of the seven items. The therapist placed an item on the table in front of the participant and provided 30-s access to interact with the item. Following 30 s, the therapist removed the item and provided

Table 3

List of All Potential High- and Low-Tech Items Used During Phase I MSWO Preference Assessments

High-tech stimuli	Low-tech stimuli
Apple iPad Mini loaded with various children's apps	Etch A Sketch
Mini laptop computer opened to a variety of online educational games	Pin Molder
Kindle™ eReader loaded with 3-4 children stories	Slinkies (2 metal mini)
Camcorder that could capture images or video	Spirograph with colored pencils and mini papers
Camera loaded with pictures of animals, or could capture images	View-Master with 5 slides of various animal and character images
Nintendo DS with both Tetris or MarioKart	Squigz (suction cup toys)
DVD Player playing- Disney's Cars, Beauty and the Beast, or Charlie Brown (one DVD per participant).	Coloring pages and 5 mini markers
	Bendies (plastic covered bendable wire toy)
Samsung tablet loaded with various children's apps	Silly Putty

access to the next item. This was repeated for all seven items. Following pre-exposure, the therapist placed all seven items on the table, equidistant from one another, and instructed the participant to select their favorite. Upon selecting an item, we provided the participant 30-s access to the item. Following 30-s access, the item was removed from the array, and the remaining items were re-presented in a differing order than the prior presentation. These procedures were repeated until all seven items had been selected. If participants attempted to select multiple items at once, we blocked the items, and then removed and re-presented the array. The preference assessment procedures were repeated three times in order to identify an average preference hierarchy.

Phase II: Quality Assessment

The purpose of Phase II was to conduct a reinforcer quality assessment in order to identify a high- and low-tech reinforcer that supported similar levels of responding. Previous researchers manipulated multiple parameters or did not hold all parameters constant when evaluating effects of different parameters of reinforcement. We conducted this phase in order to identify a preferred high-tech item and a preferred low-tech item that maintained similar levels of responding. This was an attempt to hold quality constant across the two-types of reinforcers so that it would be less likely that differences in responding were due to differential quality of items, rather than the different technology-levels of the items. We conducted a progressive ratio (PR) assessment using three most preferred high-tech and three most preferred low-tech items identified during Phase I.

Materials. For Karen and Steve, the response requirement was to trace a letter or number on a small square of paper using a pencil. For Billy, the response requirement was to trace a letter or number on a laminated card using a dry-erase marker. Tracing one letter or number square/card was considered one response. Responses were determined based on teacher input and the teacher reported each participant had mastered letter and number tracing but could benefit from further practice engaging in the responses. All squares/cards were black and white with printed letter or numbers on them. For Billy, the dry erase markers used varied randomly between four different colors. We also included three most preferred high-tech and three most preferred low-tech items identified during phase I for each participant.

Response measurement. The dependent variable during Phase II was the average break point for each item. We also measured the average total number of responses for each item. The break point was the last schedule value reached before a participant ceased responding on the PR schedule. Data were collected using paper and pencil methods.

Procedures. PR assessment sessions were based upon procedures described by Roane, Lerman, and Vorndran, (2001). We assessed the top three preferred high- and low-tech items. PR assessments were repeated three times for each item. We assessed the six high- and low-tech items alternating between a high- and low-tech item for each assessment. This was repeated in a different order two additional times for a total of 18 PR assessments per participant. We conducted a pre-exposure prior to PR sessions in which the participants were exposed to the contingency of the session. The therapist sat at a table with the participant, placed the task materials in front of the participant, and said: "If you do this (*while modeling engaging in the task),* you will get this (*gestured to the high- or low-tech item*)." The therapist then required the participant to engage in the task to gain access to the item. A secondary rule was used to introduce the PR schedule. The therapist said: "Sometimes you have to do this (*gestured to the task*) a lot of times to earn (*indicated high- or low-tech item*)." When the session began, the participant engaged in the task and earned 30-s access to the putative reinforcer based upon the pre-determined progressive ratio schedule. Schedule values were increased within session by doubling after every reinforcer delivery (e.g., FR-1, FR-2, FR-4, FR-8, FR-16, FR-32, FR-64, etc.). For example, participants were required to engage in one task, then two, then four, then eight, then sixteen, etc., prior to earning the reinforcer at each schedule value. Because the tasks were mastered tasks for all participants, we did not prompt participants to engage in the task. Sessions continued until participants ceased responding for 2 min, vocally indicated they were done responding, or until 15 min elapsed (whichever occurred first).

Once all items had been assessed three times, we identified a high-tech item and a low-tech item that had the most similar average break points and average total number of responses for use in subsequent sessions. These items were identified as having similar levels of quality, but of differing technology levels (e.g., high-tech versus low-tech).

Phase III: Token Training

Subsequent phases included token deliveries and exchanges, therefore participants were required to demonstrate mastery of independent token production and exchange. The purpose of this phase was to conduct token training to teach participants to independently exchange tokens for reinforcer access.

Materials. All participants engaged in letter and number tracing responses on laminated cards using dry-erase markers during token training. Materials included necessary task completion materials (e.g., dry erase markers and letter and number cards), tokens (laminated discs affixed with Velcro®), and a laminated token board.

Response measurement. We measured percentage of independent and prompted token exchanges during Phase III. An independent token exchange was defined as independently handing the therapist the filled token board (i.e. tokens affixed to the blank spots of the board). Data were collected using paper and pencils and data sheets.

Procedures. Participants sat at a table across from the therapist. The therapist placed the task materials in front of the participant and pre-exposed the participant to the contingency by saying: “If you do this” (*modeling completing the task),* “you get this” (*placing token on token board).* “You can exchange your token like this” (*model token exchange),* “to earn this” (*gesture to reinforcer*). We conducted token training with all participants regardless of previous exposure to token systems.

If the participant did not independently exchange the token within 10 s of token delivery (and a filled token board), we used three-step prompting to prompt him/her to exchange the token for 30 s of reinforcer access. We varied between delivering the high-tech or low-tech item contingent upon responses. Deliveries were determined using a random number generator (e.g., www.random.org). We provided equal exposure to both reinforcers across the phase. The initial token-exchange schedule was FR-1. The criteria to increase the token exchange schedule from FR-1 to FR-5, and finally to FR-10 was two consecutive sessions including 100% independent token exchanges. The token-production schedule remained FR-1 throughout token training, (i.e., every instance of independent task completion resulted in token delivery). We discontinued token training following two consecutive sessions with 100% independent token exchange at the FR-10 token-exchange schedule value.

Phase IV: Performance Under Distributed and Accumulated Reinforcer Arrangements

The purpose of this phase was to examine the effects of reinforcer type (i.e., high- or low-tech) on rate of responding under distributed and accumulated reinforcement arrangements. Data were collected using electronic handheld devices and ABC Data Pro software.

Response measurement and experimental design. We measured rate of task completion during Phase IV. The research design was an ABCACB reversal design. Condition A was baseline (no reinforcement). Condition B was a multi-element design varying between accumulated and distributed reinforcement arrangements using the low-tech item. Condition C will be a multi-element design varying between accumulated and distributed reinforcement arrangements using the high-tech item.

Materials. We used the same responses and response task materials used during token training.

Procedures. Prior to every session we conducted a pre-exposure to expose the participant to the relevant contingencies for that session. This included a pre-session rule stating the contingency for that session. Throughout the phase, each token was worth 30-s access to the highly preferred item (high-tech or low-tech depending on condition). Sessions ended after 5-min of response-time or completion of 10 tasks (and 10 token deliveries). Session duration did not include token delivery or reinforcer consumption time. Data collectors paused the data collection device during all token deliveries, exchanges, and reinforcer consumption throughout all conditions. Accumulated versus distributed conditions varied randomly within the high- and low-tech phases. Random sequences were generated using an online random number generator site (e.g., www.random.org). Within the different phases, accumulated and distributed arrangement condition sessions were conducted until stability was determined based upon visual inspection of the data.

Baseline. The purpose of this condition was to examine the rate of responding when no reinforcer was provided. This condition served as a control condition to determine if either the high-tech or low-tech item (or both) functioned as reinforcers for task completion. During sessions, task materials were placed on the table in front of the participants and completion of the task resulted in no programmed consequences. Baseline sessions continued until data showed stability at or near zero rates of responding. Sessions ended following 2 min of nonresponding, or when 5 min total had elapsed, whichever occurred first.

Distributed reinforcement condition. The purpose of this condition was to examine the effects of high- and low-tech reinforcers on rate of responding when reinforcement was delivered in a distributed arrangement, rather than accumulated. During sessions participants earned tokens on an FR-1 production schedule and exchanged tokens on an FR-1 exchange schedule. Each token was worth 30-s access to the preferred high- or low-tech item (depending upon phase).

Accumulated reinforcement condition. The purpose of this condition was to examine the effects of high- and low-tech reinforcers on rate of responding when reinforcement was accumulated, rather than distributed. During sessions, participants earned tokens on an FR-1 production schedule and exchanged tokens on an FR-10 exchange schedule. Each token was worth 30-s access to the highly preferred high- or low-tech item (depending upon phase) accumulating to 5 min total reinforcer access.

Highly preferred high-tech phase. The purpose of this phase was to assess how providing a preferred high-tech item as a reinforcer influenced rate of responding depending on the reinforcer arrangement. During this phase, the preferred high-tech item was provided as a reinforcer contingent upon task completion and following independent token exchange. Duration of access varied depending upon reinforcer arrangement condition (i.e., distributed or accumulated).

Highly preferred low-tech phase. The purpose of this phase was to assess how providing a preferred low-tech item as a reinforcer influenced rate of responding depending on the reinforcer arrangement. During this phase, the preferred low-tech item was provided as a reinforcer contingent upon task completion and following independent token exchange. Duration of access varied depending upon the reinforcer arrangement condition (i.e., distributed or accumulated).

Phase V- Preference for Accumulated or Distributed Reinforcer Arrangements

The purpose of Phase V was to conduct a concurrent chains reinforcer assessment to examine preference for accumulated or distributed reinforcer arrangements depending on the type of reinforcer presented, either high-tech or low-tech.

Response measurement and experimental design. We measured percentage of initial-link selections during Phase V. Selection was defined as the participant selecting the initial link by pointing to, touching, or grasping the contingency card or task materials associated with the contingency card. Data were collected using paper and pencil methods. We also measured preference by analyzing selections as cumulative number of selections per choice trial. Preference for reinforcer arrangements was assessed using high- and low-tech items in a reversal design varying between various conditions (i.e., ABABCDFE reversal design). Condition A used the high-tech reinforcer; Condition B used the low-tech reinforcer; Condition C altered the token colors associated with the reinforcer arrangements using the high-tech reinforcer; Condition D altered the colors associated with the previous reinforcer arrangements using the low-tech reinforcer; Condition E used the high-tech reinforcer but did not include tokens; Condition F used the low-tech reinforcer but did not include tokens.

Materials. We used identical tasks for each contingency, but used different contingency cards to signal each contingency. We also used grey shaded tokens during the accumulated condition, and white tokens during the distributed. These colored tokens were reversed during the color reversal phases. The purpose of the colored tokens was to help aid in discrimination of contingencies**.** We used cards (i.e., contingency cards) visually listing the respective reinforcer arrangement contingencies. For example, the card depicting the distributed condition showed 10 pictures of tokens and an arrow from each token pointing to a picture of the reinforcer with a clock representing 30 s. The card depicting the accumulated condition showed 10 pictures of tokens and an arrow from the token pointing to a token board accumulating tokens. At the bottom of the card when the token board was shown filled, there was a picture of the reinforcer and a clock representing 5 min. Reinforcers depicted were specific to the condition (i.e., high-tech or low-tech reinforcer will be depicted in respective conditions). During the no-token conditions we used identical cards with the exception that tokens were not depicted on the contingency card. Figure 1. shows an example of two contingency cards.

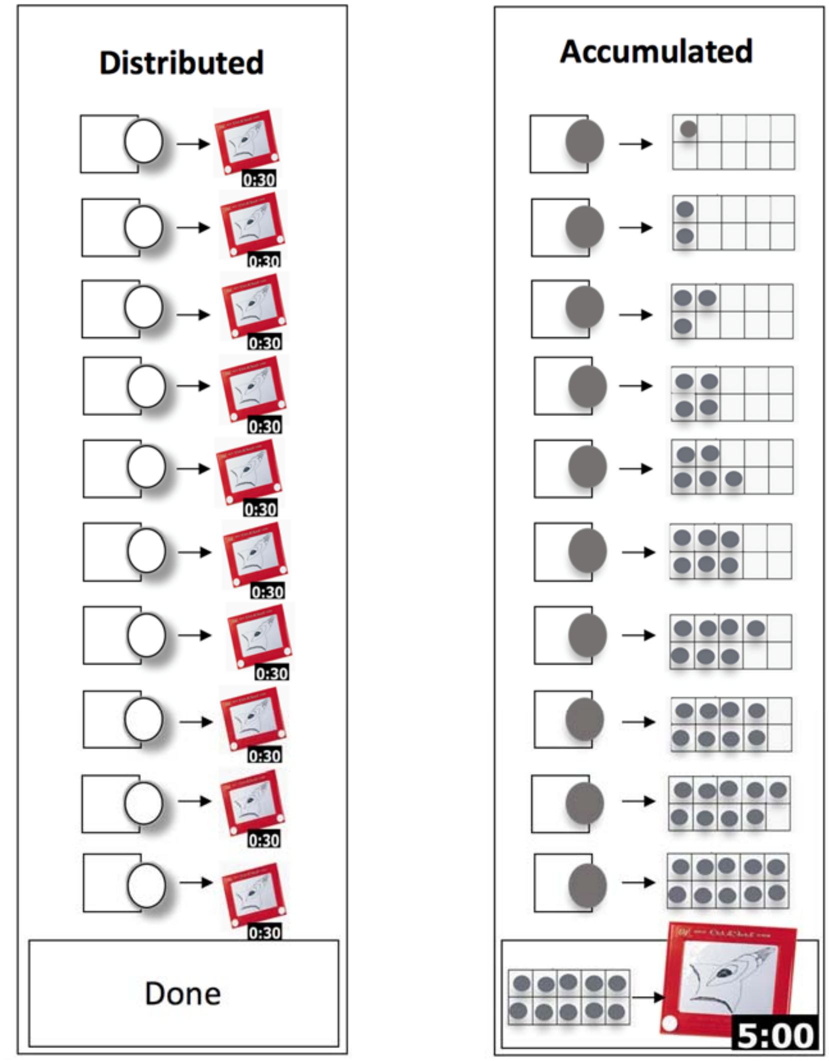

Figure 1. Example of a distributed (left) and accumulated (right) contingency card for a low-tech reinforcer (i.e., Etch-a-sketch).

Procedures. We conducted a forced exposure to each contingency (i.e., initial link, then terminal link contingency) prior to every series of five choice trials. Sessions consisted of five choice trials. Each choice trial included an initial link. The initial link consisted of the two contingency cards and two piles of response materials being placed in front of the participant. The participant selected the reinforcer arrangement condition under which they would work. Following every choice trial the location of the contingency (accumulated or distributed) was varied in order to detect side biases and increase confidence that participants were selecting based upon the contingencies presented and not some other idiosyncratic feature. Each contingency depicted on the card included 10 token opportunities and relevant reinforcer deliveries (e.g., distributed or accumulated). We delivered one token following each instance of independent task completion (e.g., FR-1 token production schedule for both contingencies).

Following the two initial forced-choice trials, the therapist presented the two cards depicting contingencies and instructed the participant to select a contingency. Following the initial high- and low-tech phases assessing preference for accumulated versus distributed reinforcement (e.g., ABAB), we conducted further phases to assess if participants were selecting based upon the arrangements or other variables, such as tokens or colors. We conducted three sessions in each A and B phase. During subsequent contingency reversal phases, we conducted one session per phase.

Highly preferred high-tech phase. The purpose of this phase was to assess how providing the high-tech reinforcer during accumulated or distributed reinforcer arrangements influenced preference for the reinforcer arrangement. During this condition, the highly preferred high-tech item was provided as a reinforcer contingent upon task completion and following independent token exchange. Duration of access varied depending upon the selected reinforcer arrangement.

Highly preferred low-tech item phase. The purpose of this condition was to assess how providing the low-tech reinforcer during accumulated or distributed reinforcer arrangements influenced preference for the reinforcer arrangement. During this condition, the highly preferred low-tech item was provided contingent upon task completion and following independent token exchange. Duration of access varied depending upon the selected reinforcer arrangement.

Color reversal phase. The purpose of this phase was to assess whether participants were tracking the contingencies or idiosyncratic variables, such as token color. During the color reversal phases, we reversed the prior contingencies associating colored tokens with either the accumulated or distributed arrangements. We reversed the grey tokens previously used during the accumulated condition and the white tokens used during the distributed condition.

No-token phase. The purpose of the no-token phase was to assess whether preference would shift or remain the same depending on the absence of tokens. During the no-token phases procedures were identical to previous phases with the exception that tokens were not delivered during either reinforcer arrangement.

CHAPTER IV

RESULTS

Figure 2 depicts results for Phase I for all participants. We identified high-tech (right graphs) and low-tech (left graphs) preference hierarchies for all participants. Karen's top three selected low-tech items included the Etch-A-Sketch, pin molder, and View master, and her top three selected high-tech items included the iPad, DVD player, and camera. Steve's top three selected low-tech items included the View master, pin molder, and Squigz, and his top three selected high-tech items included the iPad, Nintendo DS, and DVD Player. Billy's top three selected low-tech items included the View Master, Etch-A-Sketch, and slinkies, and the camera, camcorder, and DVD player were his top three selected high-tech items. These items were used in the subsequent Phase II quality PR assessments.

Results from Phase II are depicted in Figure 3. Karen's data are shown in the top panel, Steve's in the middle panel, and Billy's in the bottom panel. Break point averages (and ranges depicted by error bars) for three high-tech items and three low-tech items are depicted in the left graphs. Total response averages are shown in the right graphs. We considered both average break point average total responses per item when comparing the three high- and low-tech items. The iPad and View master had the most similar average break points and total responses for Karen and were selected to be used in subsequent sessions. The Nintendo DS and View master were selected for subsequent sessions for Steve. For Billy, the DVD player and View master were selected for use in subsequent sessions. The items selected for subsequent sessions are depicted by a patterned data bar.

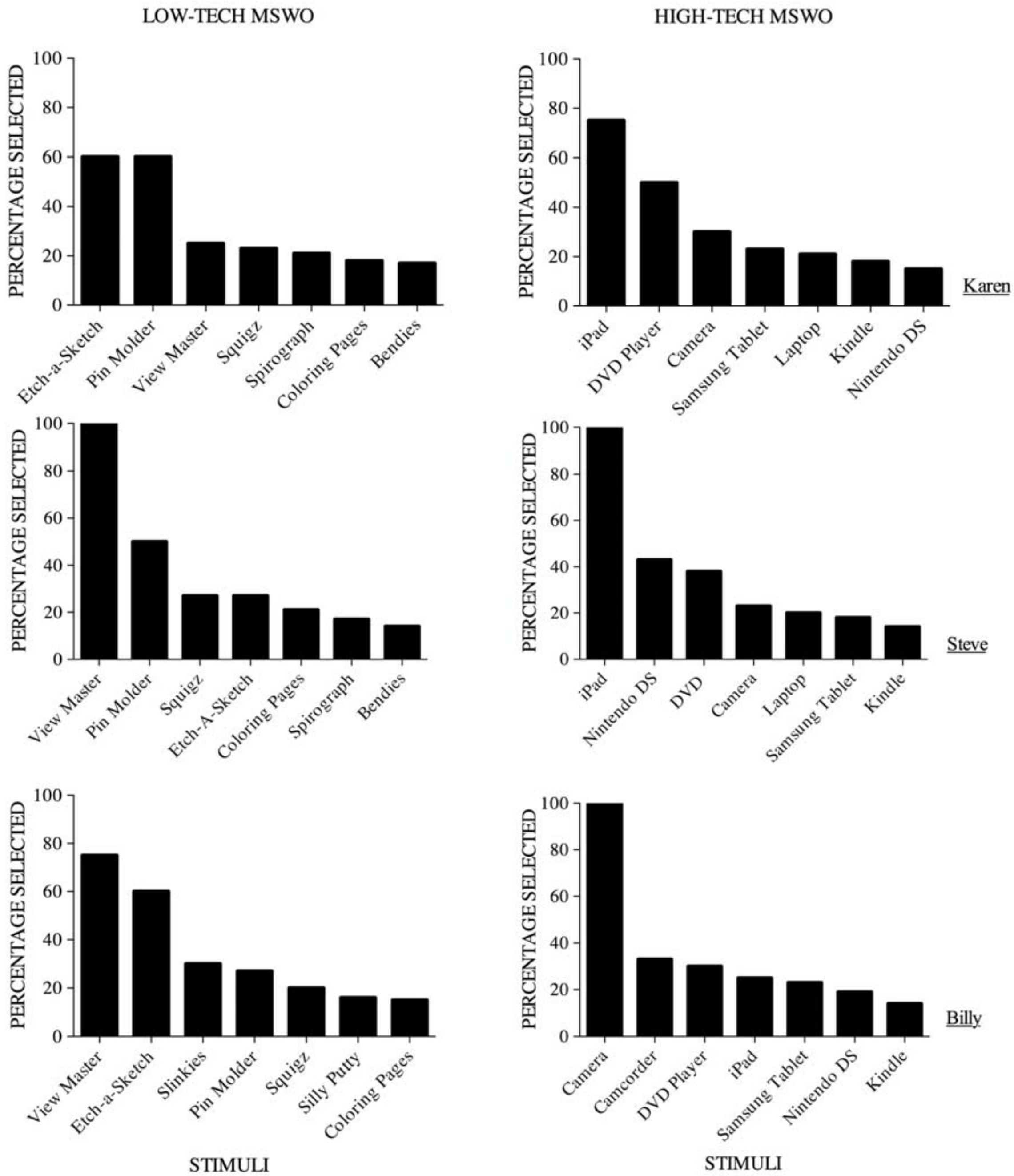

Figure 2. Results from Phase I MSWO preference assessments for all participants. Results from the low-tech array are depicted on the left graphs and results from the high-tech array are depicted on the right graph.

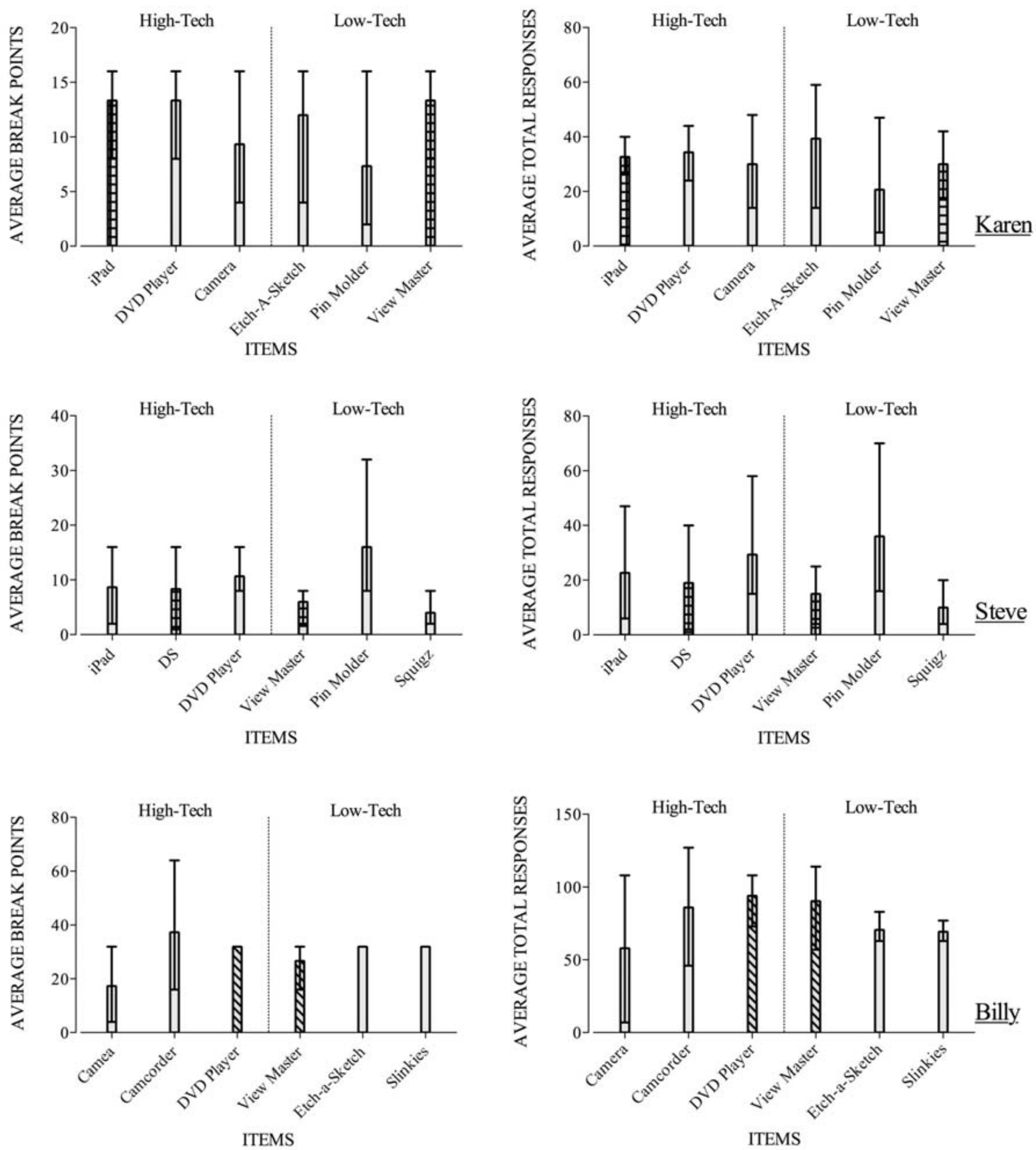

Figure 3. Results from Phase II quality PR assessments for all participants. Bars depict average break points (left graphs) and average total responses (right graphs). Error lines within the bars depict the range of responses. Patterned bars depict the high- and low-tech item selected for subsequent phases.

Figure 4 displays token training results conducted during Phase III for all participants. Karen's data are shown in the top graph, Steve's in the middle graph, and Billy's in the bottom graph. Steve and Billy engaged in nearly identical responding, requiring three sessions at FR-1 token exchange ratio before meeting criteria and moving to FR-5, and then FR-10. Karen required an additional FR-1 session to meet criteria of two consecutive sessions with 100% independent token exchanges. All participants had a history of token use, likely contributing to their rapid mastery in token training.

Results from the Phase IV rate assessments are shown in Figure 5. Results for Karen are depicted in the top graph. During baseline, Karen did not engage in the target response. When the View master was provided as reinforcement in the first low-tech phase she engaged in highest rates of responding during the accumulated reinforcement condition relative to response rates during the distributed condition. This pattern continued when the iPad was provided as reinforcement during the high-tech phase. Response rates were variable in both accumulated and distributed conditions. Response rates for the low-tech reinforcer provided in a distributed reinforcer arrangement were slightly lower compared to response rates for the iPad when provided in a distributed reinforcer arrangement for Karen. Overall, Karen's results indicate both the iPad and View master functioned as reinforcers when provided in accumulated and distributed reinforcer arrangements with differences in response rates due to arrangements, and only only slightly due to technology level of items (i.e., lower rates for low-tech distributed condition than high-tech distributed).

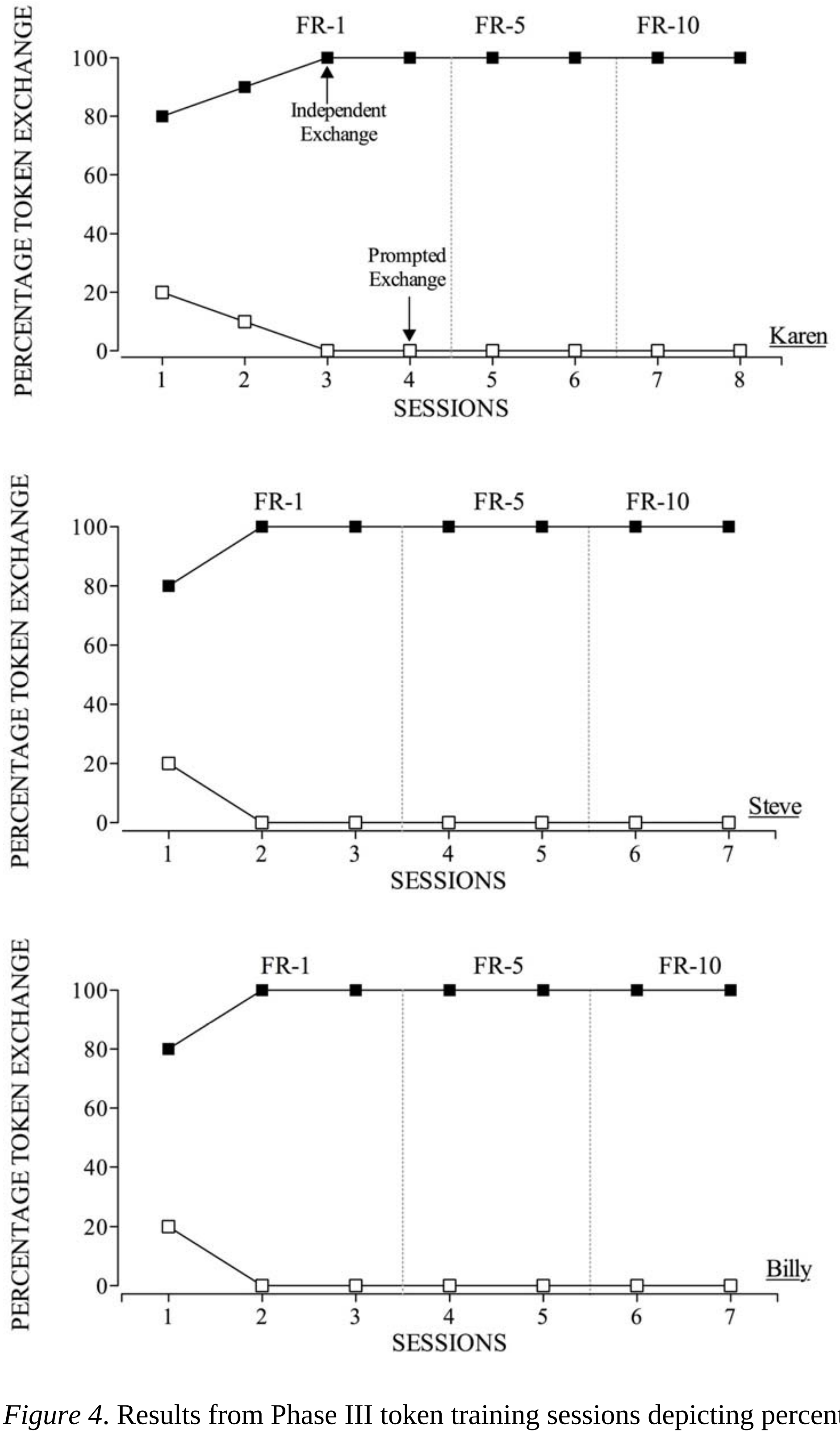

Figure 4. Results from Phase III token training sessions depicting percentage of independent token exchanges for all participants.

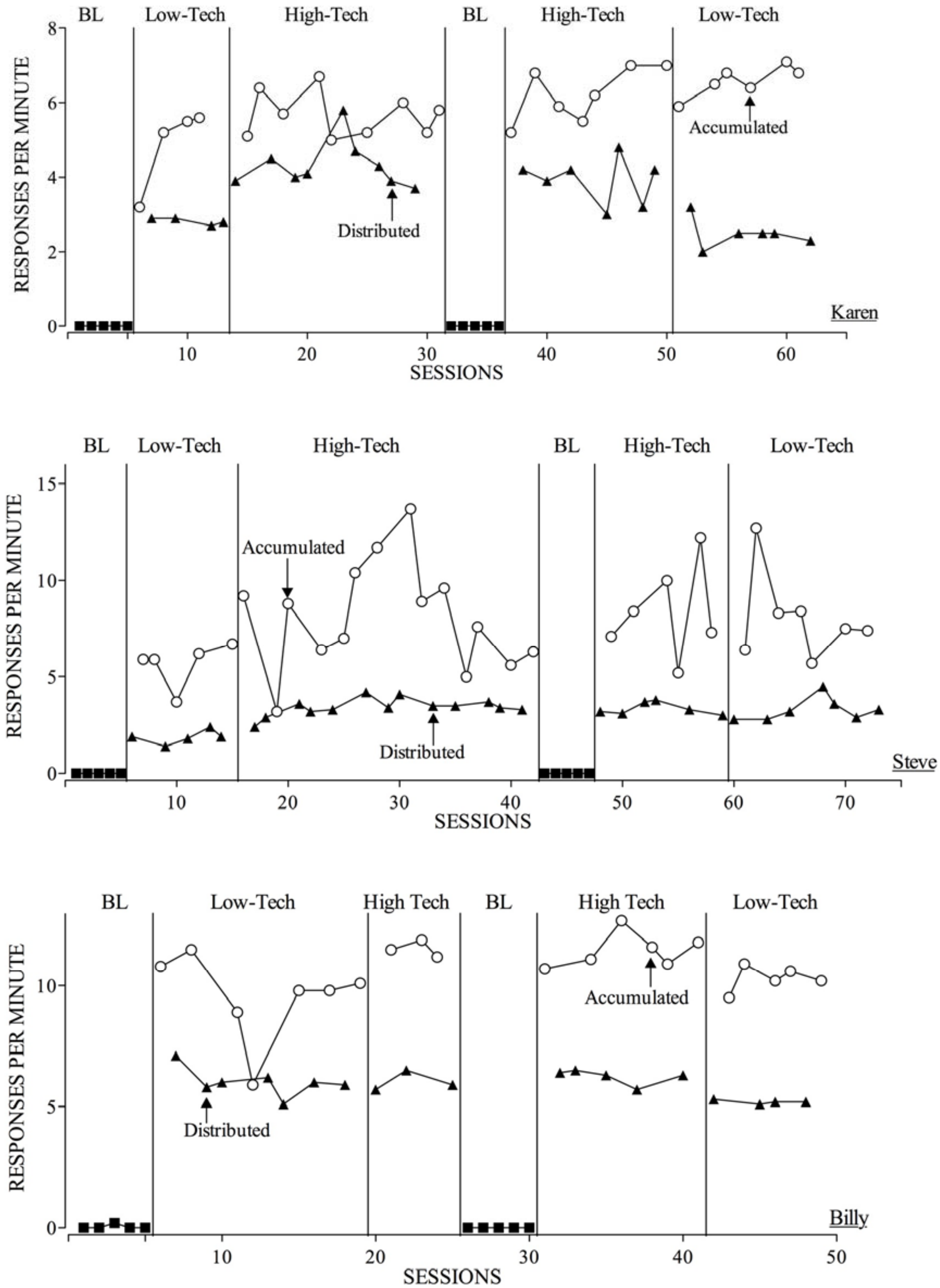

Figure 5. Results from Phase IV depicting effects of distributed and accumulated reinforcement and reinforcer type on rate of responding.

Results for Steve are depicted in the middle graph of Figure 5. Steve did not engage in responding during baseline conditions. When the Nintendo DS and the View master were provided, response rates increased, indicating that both items functioned as reinforcers for Steve. Results across high- and low-tech phases did not differ, in that Steve's response rates were similar across conditions regardless of whether the high-tech or low-tech item was provided. Rates of responding under distributed reinforcer arrangements were less variable than rates of responding under accumulated reinforcer arrangements across high- and low-tech phases. Overall, Steve engaged in higher response rates under accumulated reinforcer arrangements compared to response rates under accumulated reinforcer arrangements.

Billy's results are shown in the bottom graph of Figure 5. Billy engaged in little to no responses during baseline conditions, but responding increased when the View master and iPad were provided as reinforcement. Similar to Steve's results, Billy's responding was more stable under the distributed arrangements than under the accumulated arrangements. Overall, Billy engaged in higher response rates when reinforcement was provided in accumulated arrangements, regardless of whether the high-tech or low-tech item was provided. Billy's response rates for the DVD player in the accumulated reinforcer arrangements were slightly higher compared to responding for the View master in accumulated conditions, perhaps indicating slight sensitivity to technology level of items under accumulated reinforcement arrangements.

In general, all participants engaged in higher rates of responding when reinforcement was provided in an accumulated arrangement than when it was provided in a distributed arrangement, regardless of technology level of the reinforcer provided (e.g., high-tech or low-tech).

Figure 6 depicts averages and ranges of responding during the Phase IV rate assessment. Karen's data are depicted in the top graph, Steve's in the middle, and Billy's in the bottom. The white bars depict average responding during distributed arrangement conditions, and grey bars depict average responding during accumulated arrangements. The error bars depict the range for each condition. Overall Karen's ranges were similar across conditions; however, Steve and Billy engaged in more variable responding under accumulated reinforcer arrangements. The y axis also allows for comparison across participants, indicating that all participants engaged in differing rates of responding across conditions.

Finally, Figures 7 through 9 depict results from the Phase V reinforcer arrangement preference assessments for Karen, Steve, and Billy, respectively. The top panels of each figure depict percentage of selections per session (including five choice trials). The bottom panel depicts the same data plotted as cumulative number of initial-link selection responses per choice trial. Figure 7 depicts Karen's responding. When both the high- and low-tech items were provided, Karen nearly exclusively preferred to work under accumulated reinforcer arrangements. When the colors associated with accumulated and distributed reinforcement were reversed, and when tokens were removed from both conditions, Karen continued to demonstrate preference for working under accumulated reinforcer arrangements. Figure 8 depicts Steve's responding during Phase V. Steve demonstrated overall higher percentages of selection toward working

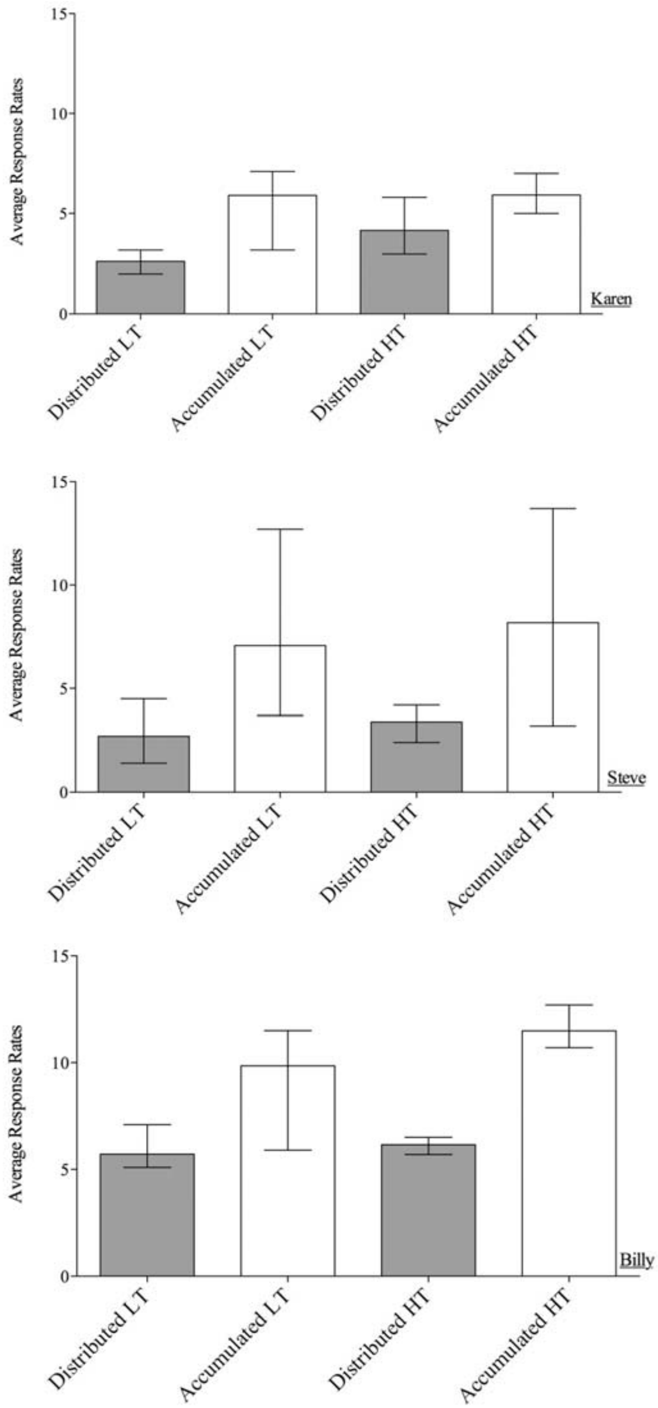

Figure 6. Results from Phase IV rate assessments plotted as averages per condition and phase. Grey shaded bars depict average response rates under the distributed reinforcer arrangement condition and white shaded bars depict average response rates under accumulated reinforcer arrangements. Error bars depict the range of responding per condition.

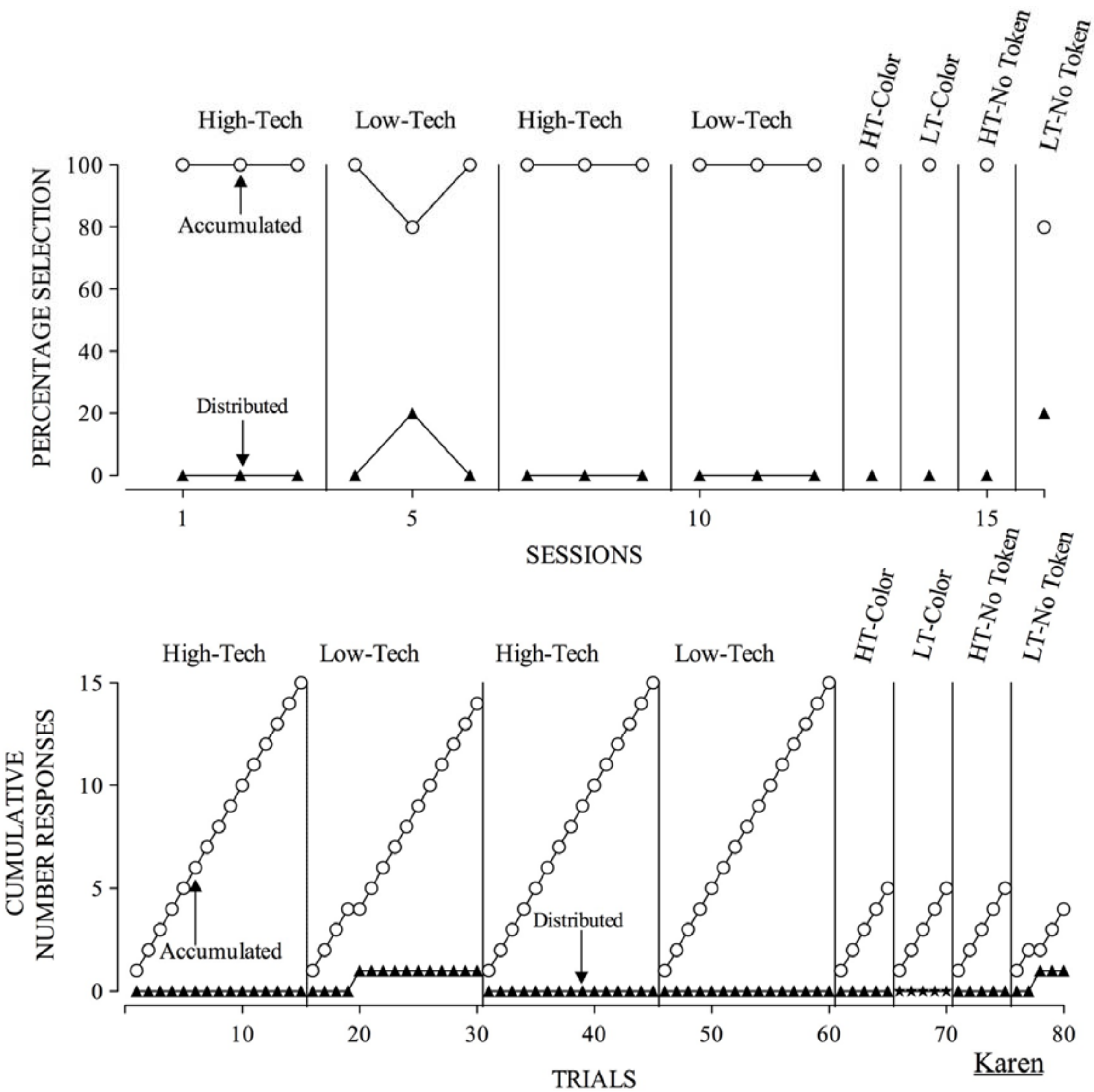

Figure 7. Results from Phase V for Karen depicting percentage selections toward accumulated or distributed arrangements (top panel) and cumulative number of initial link selections for accumulated or distributed reinforce arrangements using high- and low-tech reinforcers.

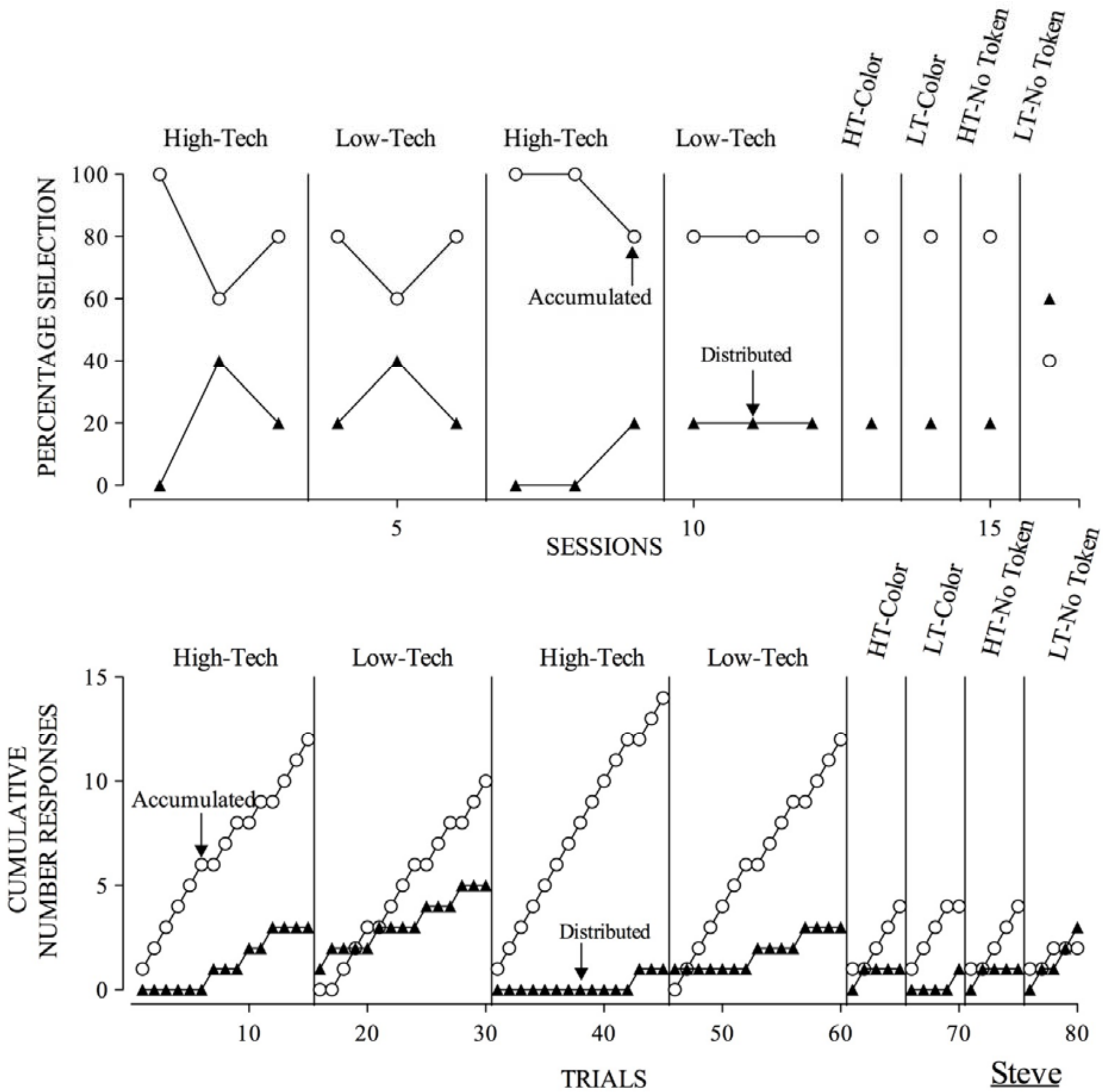

Figure 8. Results from Phase V for Steve depicting percentage selections toward accumulated or distributed arrangements (top panel) and cumulative number of initial link selections for accumulated or distributed reinforce arrangements using high- and low-tech reinforcers.

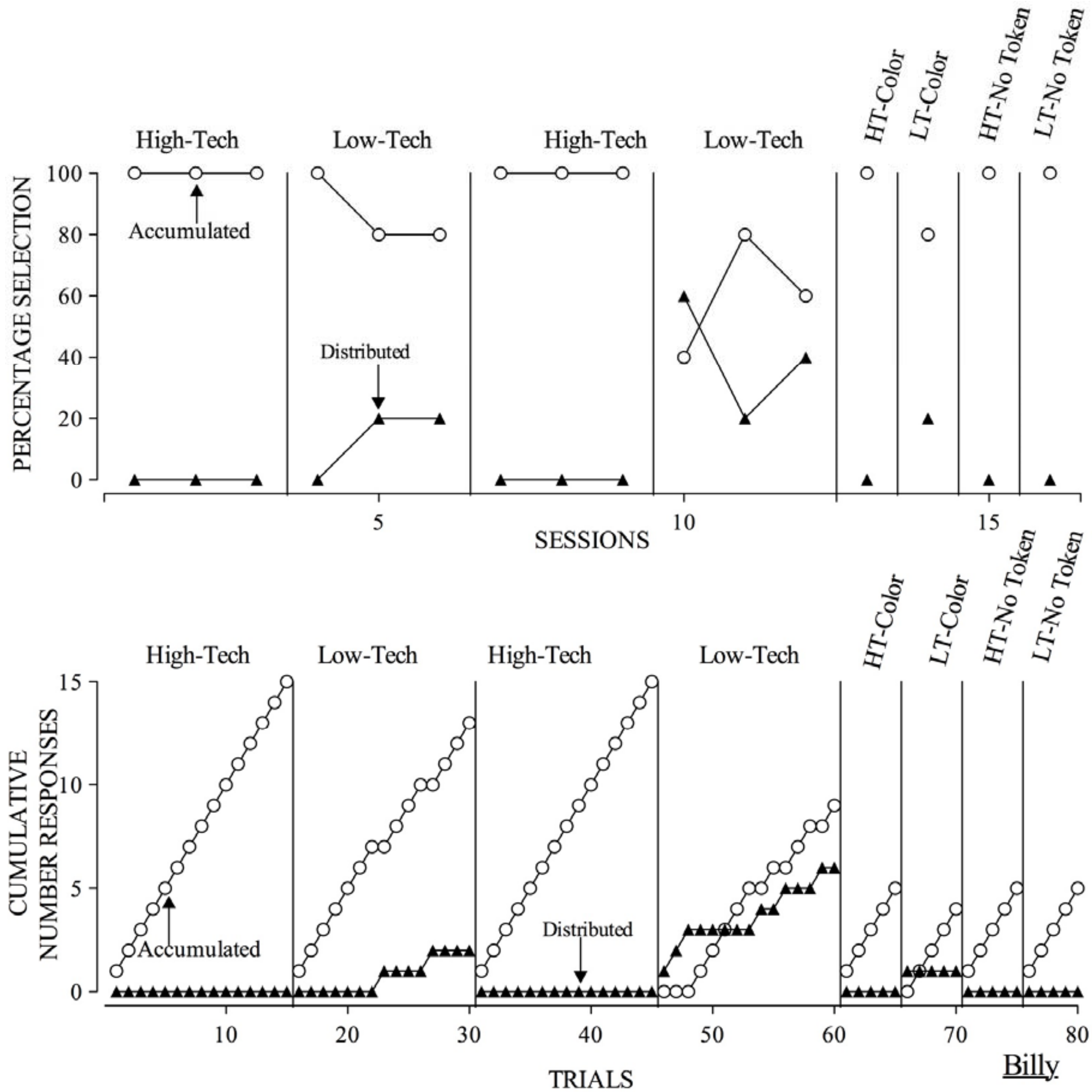

Figure 9. Results from Phase V for Billy depicting percentage selections toward accumulated or distributed arrangements (top panel) and cumulative number of initial link selections for accumulated or distributed reinforce arrangements using high- and low-tech reinforcers.

under accumulated reinforcer arrangements; however, he did select to work under distributed conditions in almost every session. Steve’s pattern continued during color reversals. However, following token removal, Steve’s preference reversed in the low-tech condition and he demonstrated a preference for the distributed reinforcer arrangement.

Billy’s data from Phase V are depicted in Figure 9. He demonstrated exclusive preference for working under accumulated reinforcer arrangements when the high-tech item was provided. When the low-tech item was provided, he still engaged in a higher percentage of selections toward the accumulated arrangement, but did select working under the distributed condition during several trials. Billy’s responding may demonstrate slight differences in preference depending on item-type; however, an overall preference for accumulated reinforcement was also demonstrated. Similar patterns or responding continued when color reversals were implemented. When tokens were removed, Billy exclusively selected to work under the accumulated arrangement.

Figure 10 depicts the overall percentage of selections toward accumulated or distributed arrangements for all participants. This figure demonstrates the overall preference for accumulated and distributed reinforcement shown by all participants. Karen selected the distributed arrangement in only 3% of low-tech trials and never during high-tech trials, Steve selected the distributed reinforcer arrangement in 15% of high-tech trials, and 30% or low-tech trials, and Billy selected the distributed arrangement in 22% of low-tech trials but never during high-tech trials.

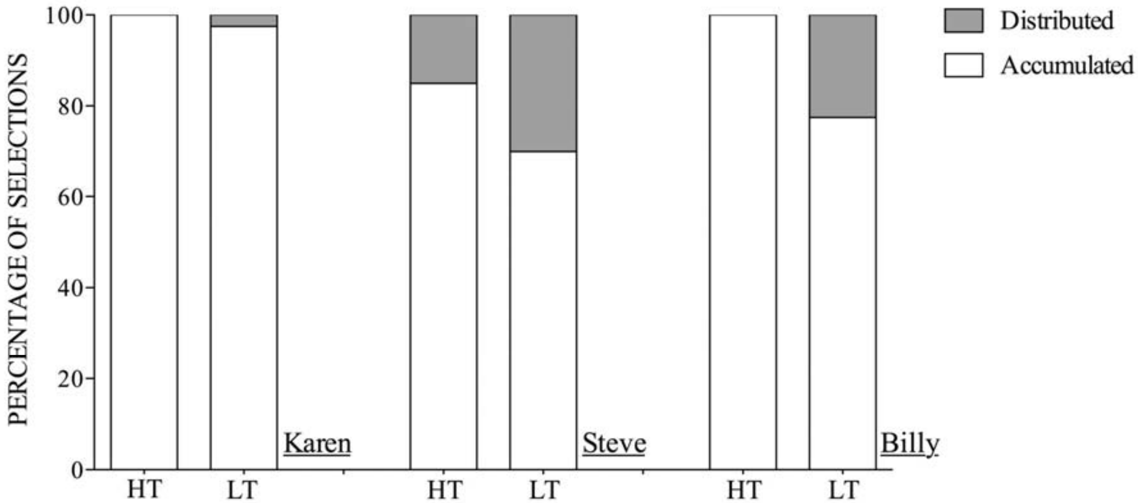

Figure 10. Overall percentages of selection toward the accumulated and distributed arrangements during Phase V per participant.

CHAPTER V

DISCUSSION

The results of this study add to the growing body of literature examining accumulated and distributed reinforcer arrangements. Participants included in this study were under the age of 10; a population with whom reinforcer arrangements have not been examined prior to this study. The age of the participants may provide an interesting consideration when examining the results. Some existing research has demonstrated that young individuals with autism may be sensitive to delays to reinforcement (Lerman, Addison, & Kodak, 2006; Perrin & Neef, 2012). The results of the current investigation demonstrate that all participants engaged in higher response rates under the accumulated reinforcer arrangements, which contains a delay to reinforcement. Additionally, all participants demonstrated a preference for accumulated reinforcement, despite the inherent delay to the terminal reinforcer in accumulated reinforcer arrangements. These results indicate that sensitivity to reinforcer delays may depend on contextual variables, such as use of conditioned reinforcers, and reinforcer arrangements, and may not always be predictable.

The present study also extends previous research on accumulated and distributed reinforcement by examining an additional variable; technology level of the reinforcers used. DeLeon et al. (2014) examined activity reinforcers compared to edible reinforcers and results did not demonstrate differences based upon reinforcer type. The current study replicated procedures by DeLeon et al., but also attempted to control for limitations from previous research by including tokens in all conditions. Similar to results obtained by

DeLeon et al., participants in the current study demonstrated overall higher response rates under accumulated reinforcer arrangements, and general preference for accumulated reinforcer arrangements. These studies combined may indicate that participant sensitivity to reinforcer arrangement may influence responding more than sensitivity to differences in types of reinforcers.

Results from the current study also provide further evidence regarding the influence of accumulated and distributed reinforcer arrangements on response rates and preference. Similar to previous research, accumulated reinforcer arrangements produced higher response rates. Additionally, participants demonstrated preference for accumulated reinforcer arrangements. These results were consistent across both high- and low-tech reinforcers. These results may have implications relevant to using both high- and low-tech reinforcers. Specifically, accumulated reinforcer arrangements may be more effective for some young learners with autism.

Although previous researchers obtained differences in responding depending on high- and low-tech reinforcers (Hoffmann et al, 2017), this study did not obtain similar results. Our results demonstrated minimal differences in responding due to stimulus type. Namely, in Phase IV, Karen showed slight decreases in response rates under distributed conditions when the low-tech item was provided, compared to when the high-tech item was provided. Billy also showed slight increases in responding under accumulated reinforcer arrangements when the high-tech item was provided, compared to when the low-tech item was provided. Also, in Phase V, both Karen and Billy demonstrated exclusive preference for accumulated reinforcement when the high-tech item was provided, and any preference for the distributed arrangement only occurred when the low-tech item was provided. We may tentatively conclude that Karen and Billy showed slight effects based on technology level, but Steve did not demonstrate response patterns consistent with effects of technology level.

Although we are unable to account for the lack of replication of the effect observed by Hoffmann and colleagues, we may speculate. The participants included in the Hoffmann study were adults, all with long learning histories with high- and low-tech reinforcers. In contrast, the current study participants were children under the age of ten. It is possible that length of learning history with high- and low-tech items may influence differences in responding due to technology level of items. Because the classification of high-tech and low-tech items is based upon physical properties of the items, it may be more likely that an individual learns about differences across tangible and leisure items as they grow and are exposed to a larger array of differing items. Younger individuals may have less exposure to a range of different high-tech and low-tech items, and may not have enough exposure and experience to develop different preferences and response patterns depending on technological feature of items. This speculation would need to be examined by future researchers in order to draw any conclusions regarding age of participants and influences of technology level of items.

Further, Hoffmann et al. (2017) used the highest preferred high- and low-tech items. The current study attempted to hold quality constant by selecting a preferred high- and low-tech item that supported similar levels of responding, as measured by average total responding and average break points obtained during PR schedule assessments. For

Karen, the high-tech item used was the highest preferred during the MSWO preference assessment, but the low-tech item used was the third highest preferred in the MSWO preference assessment. For Steve the low-tech item was highest preferred in the MSWO assessment, however the high-tech item used was second highest preferred. Billy's low-tech item was highest preferred as well, but his high-tech item was third highest preferred in the MSWO preference assessment. Demonstrating that the items reinforced completion of a task, rather than simply relying on preference assessment results would presumably lead to reliable outcomes. However, it is unclear if differences in responding due to technology level may have been clearer had the highest preferred high- and low-tech item been used in subsequent phases.

The results demonstrate that classifying reinforcers according to technology level may not be a useful designation in every context. In the current study, participant responding did not differ according to technology level of items with few exceptions (e.g., Billy and Karen results); however, it is difficult to draw conclusions based on such small differences in responding. It may be that the particular items used were not different enough, in terms of technology level. All participants used the View master as the low-tech item. This particular item may include complexity that other low-tech items do not contain (e.g., changes in visual images, moving pieces and parts within the item, etc.), perhaps making it closer to high-tech items along the technology-level continuum. Perhaps the differences in responding are related to particular items, and less influenced by the technology level classification those items happen to fall under. Future research may further examine technology level differences to examine if the findings Hoffmann et al., (2017) obtained were specific to the particular items used, or if classification by technology level is a replicable finding and useful conceptualization.

The results of this study may provide information that caregivers and applied clinicians can consider to more effectively use reinforcers (both high- and low-tech) in distributed and accumulated reinforcer arrangements. For example, it may be important for clinicians, teachers, and caregivers to assess preference for reinforcer arrangements when using either high- or low-tech reinforcers. The current results demonstrate that participants preferred, and worked more efficiently under, accumulated reinforcer arrangements. These results may highlight the importance of caregivers, teachers, and clinicians identifying the conditions of reinforcement that are optimal for individuals with disabilities. Contrary to conventional thinking indicating that young individuals with disabilities will prefer reinforcer contingencies including immediate reinforcers, this study provides evidence as to the utility of accumulated reinforcer arrangements. It may be important for applied clinicians to consider the value of accumulated reinforcer arrangements which may be more efficient (e.g., allow for frequent task completion) and preferred by many individuals with disabilities. Considering reinforcer arrangements may ensure that applied clinicians are creating reinforcement contingencies designed to maximize learning and reinforcement opportunities.

Some limitations to this study should be noted. One limitation may be the classification of high- and low-tech items. We arbitrarily classified high- and low-tech items based upon physical properties of the different stimuli, but we cannot be sure that participants responded to the different types of items according to our classification system. Although we attempted to control for this by holding quality constant, it may be that the differences in responding toward the high- and low-tech items were not due to the technology level of the items, but to some idiosyncratic difference between the stimuli of which we were not aware, and therefore, could not control. Although this research provided minimal evidence of the utility of classifying leisure items by technology level, future research is needed to continue to assess the validity of such a classification system.

As discussed in light of previous research, one potential limitation may be that we did not use the participant's highest preferred high- and low-tech item based upon the preference assessments. When considering the results in light of the preference assessment results, it is unknown if we would have observed different patterns of responding or more sensitivity to technology levels if highly preferred items were exclusively used. We attempted to control for any differences in quality by selecting items from each technology level class that supported similar levels of responding based upon results of Phase II procedures. Future research may compare differences in responding based upon a high- and low-tech item selected solely on results of preference assessment compared to items selected based upon similar response output.

Another limitation may be that we could not conduct extended reversals during Phase V. Specifically for Steve, when the low-tech item was provided with no tokens in the reinforcer arrangements, his preference shifted toward the distributed reinforcer arrangement. It is difficult to draw conclusions based on the limited number of choice trials demonstrating this effect. Future researchers may consider conducting further examinations specifically controlling for the use of tokens within accumulated and distributed reinforcer arrangements and if that differentially influences outcomes based on high- and low-tech items.

Similarly, it may be a limitation that this study was only conducted with a limited number of participants. These results may have been strengthened by further replication across participants; however, practical considerations and resources prohibited this. Future researchers should replicate these findings to contribute to the overall findings of this line of research. Additionally, researchers should extend this study by examining related independent variables or the effects of similar independent variables on other dependent variables. For example, researchers could examine other types of reinforcers, and the effects of manipulating various dimensions of reinforcement within response-reinforcer arrangements.

An interesting consideration may be that differences in responding and preference, depending on accumulated and distributed reinforcement, may be related to different response efforts associated with each arrangement. McFarland and Lattal (2001) examined accumulated reinforcement in terms of response effort in rats (manipulated as distance between reinforcer earn and collect levers). Results indicated that increases in response effort influenced reinforcer accumulation, with increases in response effort yielding increases in reinforcer accumulation. Initially we hypothesized that the concept of response effort may be related to high-tech items and low-tech items if handling costs are conceptualized as being analogous to manipulations to response effort. For example, an increase in handling costs may be analogous to a more effortful response, and a response with low-handling costs could be conceptualized as having a lower response effort. This may be related to handling costs associated with high-tech reinforcers, which may be higher when reinforcers are distributed. For example, every reinforcer delivery of a high-tech reinforcer may involve re-orienting to the stimuli including starting a video clip over, orienting to a song, or waiting for an application to load. It may be that when participants select accumulated reinforcement, it is due to the decreases in handling costs associated with one large-magnitude reinforcer delivery compared to multiple small-magnitude deliveries involved in distributed arrangements. However, in light of the results of this study, the effects of handling costs associated with technology level may not be as influential as the response effort involved in accumulated and distributed arrangements.

Anecdotally, the participants' response effort (and perhaps handling costs) involved in accumulated and distributed reinforcer arrangements differed. During accumulated arrangements, the participant could engage in ten tasks fluently without putting down the pen used to engage in the response, and without needing to extend their arms forward to engage in a token exchange. In contrast, in distributed arrangements, following every response the participant traded in a token, involving extending their arm forward to hand the token to the researcher, and potentially placing the pen used for responding on the table. This arrangement also required a re-orienting to the task materials following every reinforcer interval that was not as necessary in accumulated arrangements where responding could be conducted fluently. These differences may be conceptualized as differences in handling costs and response effort, and similar to

McFarland and Lattal’s finding, may have influenced efficacy and preference toward the response alternative with fewer handling costs (i.e., accumulated reinforcement). Although differences in handling costs associated with high- and low-tech items may have existed (e.g., costs associated with re-orienting to the game or video on the high-tech device compared to reorienting to the View master), these differences may have had less of an influence on responding than the handling costs associated with task response effort within reinforcer arrangements in the current experimental preparation. Additionally, it is unclear if handling costs associated with different schedules of token exchanges may have influenced responding. Although the tasks within the different reinforcer arrangements remained the same, the effort associated with and FR-1 token exchange schedule and an FR-10 token exchange schedule differ in the amount of effort required to exchange tokens (i.e., ten token exchanges compared to one exchange). This may have influenced overall response effort and handling costs within each reinforcer arrangement thus influencing outcomes. Future research could examine handling costs in relation to high- and low-tech reinforcers, response effort related to token exchange schedules associated with reinforcer arrangements, and more specifically related to proximal and distal reinforcer manipulations similar to McFarland and Lattal’s research with non-humans.

Future researchers could also extend this line by making the procedures used in the current study more applied. Specifically, researchers may further examine assessment methods that teachers and clinicians can use to more easily and efficiently identify effective high- and low-tech reinforcers and conditions under which different types of reinforcers will be most effective.

This research could be extended by examining reinforcer arrangements using high- and low-tech reinforcers in home and community settings, or with other populations. Further, this research could be extended by examining how these variables interact to influence other outcomes such as problem behavior. Researchers could examine which combinations of reinforcer arrangements and high- and low-tech reinforcers are differentially effective in the reduction of problem behavior or in conjunction with function-based interventions such as functional communication training for escape maintained behavior.

This line of research can also be advanced by examining other interactions with dimensions of reinforcement and high-tech items. For example, if the delay to reinforcement is lengthened by presenting longer-duration tasks, does preference for high- or low-tech items shift? If differing qualities of high- and low-tech items are used, does it influence preference for reinforcer arrangements? It may be that high- and low-tech items differentially interact with other dimensions of reinforcement to influence behavior. As use of high-tech items continues to grow, it may be increasingly important for caregivers, teachers, and clinicians to understand the effects of these items on behavior. By further examining these independent variables we might better identify and utilize both high- and low-tech reinforcers to enact socially meaningful outcomes in the lives of the individuals whom we serve.

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APPENDICES

Appendix A

Data Sheets

Technology and Arrangement Interview Form
Examining Effects of Technology Level and Reinforcer Arrangements On Preference and Efficacy

Participant (pseudonym): _________________________
Date: ____________

Does your child/student use any high-tech items? Yes/No
Provide examples:
____
How often does he/she use high-tech items? _____________________

Does your child/student prefer to use low -tech items? Yes/No
Provide examples:
____
How often does he/she use low-tech items? ____________________

Does your son/daughter(student) ever engage in problem behavior when a preferred activity or item is restricted or unavailable? Yes/No
Describe: ____
____

How often does problem behavior occur when your son/daughter (student) uses high-tech or low-tech devices?
____

Information regarding high-tech items:

Examples of highly preferred high-tech items	Examples of less preferred high-tech items

Particulars regarding content accessed on items:
____
____

Information regarding low-tech items:

Examples of highly preferred low-tech items	Examples of less-preferred low-tech items

PHASE I: *MSWO Data Sheet*

Participant (pseudonym): ___________________________
Date: _____________
☐ Primary Data Collector:____________________
☐ Reliability Data Collector: __________________
Assessment (circle): High-Tech Low-Tech

Items:

1. Selected ______/_______=_______*100=_______%
2. Selected ______/_______=_______*100=_______%
3. Selected ______/_______=_______*100=_______%
4. Selected ______/_______=_______*100=_______%
5. Selected ______/_______=_______*100=_______%
6. Selected ______/_______=_______*100=_______%
7. Selected ______/_______=_______*100=_______%
8. Selected ______/_______=_______*100=_______%

Trials ⇒ Selections ⇓	1	2	3
1.			
2.			
3.			
4.			
5			
6.			
7.			
8.			

*List top 3 items for use in subsequent phase:

____
____
____

PHASE II: *Quality PR Assessment Data Sheet*

Participant: ____________________ Item: ________________

Session #:_______________ Date:_________________

Data Collector: __________ Primary ☐ Reli ☐

FR

1	1

2	1	2

4	1	2	3	4

8	1	2	3	4	5	6	7	8

16	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

32	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

64	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64

128	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128

PHASE III: *Token Training Data Sheet*

Participant: ____________________

Session # :______________ Date:________________

Data Collector: __________ Primary ☐ Reli ☐

	TASK COMPLETED	TOKEN Exchanged	REINFORCER DELIVERED
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

+:independent mp+: model prompted correct fp: full physical prompt

Session # :________________ Date:________________

Data Collector: __________ Primary ☐ Reli ☐

	TASK COMPLETED	TOKEN Exchanged	REINFORCER DELIVERED
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

+:independent mp+: model prompted correct fp: full physical prompt

PHASE V: *Arrangement Preference Assessment Data Sheet*

Participant: ____________________

Session # :________________ Date:________________
Data Collector: __________ Primary ☐ Reli ☐

	Right	Left
1		
2		
3		
4		
5		

Session # :________________ Date:________________
Data Collector: __________ Primary ☐ Reli ☐

	Right	Left
1		
2		
3		
4		
5		

Session # :________________ Date:________________
Data Collector: __________ Primary ☐ Reli ☐

	Right	Left
1		
2		
3		
4		
5		

Appendix B

Treatment Fidelity Data Sheets

PHASE I: *MSWO Treatment Integrity Data Sheet*

Date: Item: Therapist:
Session: Data Collector: Participant:

	Yes	No
Gives correct prompt		
Delivers access for 30s (+/- 5 s)		
Re-orders items prior to next presentation		

PHASE II: *Quality Assessment Treatment Integrity Data Sheet*

Date: Item: Therapist:
Session: Data Collector: Participant:

	Yes	No
Correct materials present: • **Timers** • **Data Sheets** • Writing utensils • Reinforcer • Response materials		
Delivers Reinforcer for 30s (+/- 5 s)		
Delivers reinforcer following correct schedule value		
Delivers correct reinforcer for session		
Ends Session when criterion is met: • **After 15-min, 2 min of non-responding, or vocal request to end**		

PHASE III: *Token Training Treatment Integrity Data Sheet*

Date: Item: Therapist:
Session: Data Collector: Participant:

	Yes	No
Correct materials present: • **Tokens** • **Token Board** • **Response materials** • Timers • Data Sheets • Writing utensils • Reinforcer		
Administers pre-exposure to contingency		
Uses 3 step prompting, if needed		
Delivers Token after every target response		
Delivers reinforcer following correct schedule value		
Delivers Reinforcer 30 s, 2.5 min or 5 min (+/- 5 s)		
Delivers reinforcer after token exchange		
Alternates delivery of reinforcers on random schedule		
Ends session after completion of 10 tasks (and 10 token deliveries)		

PHASE IV: *Rate Assessment Treatment Integrity Data Sheet*

Date: Item: Therapist:
Session: Data Collector: Participant:

	Yes	No
Correct materials present: • **Tokens** • **Token Board** • **Response materials** • Timers • Data Sheets • Writing utensils • Reinforcer		
Administers pre-exposure to contingency		
Uses either accumulated or distributed conditions (within HT and LT phases) according to schedule sheet		
Delivers Token after every target response		
Delivers reinforcer following correct schedule value (FR-1 or FR-10)		
Delivers Reinforcer for 30s (+/- 5s) or 5 min (+/- 5 s)		
Delivers correct reinforcer following token exchange		
Ends Session when criterion is met: • **After 5-min of response-time *or*** • **Completion of 10 tasks (and 10 token deliveries)**		

PHASE V: *Concurrent Chains Treatment Integrity Data Sheet*

Date: Item: Therapist:
Session: Data Collector: Participant:

	Yes	No
Correct materials present: • **Tokens (correct color)** • **Token Boards** • **Contingency Cards** • **Response Items** • Timers • Data Sheets • Writing utensils • Correct Reinforcer		
Administers forced-exposure to each contingency (i.e., initial link, then terminal link contingency) prior to every series of five choice trials		
Rotates position of contingency cards following every choice trial		
Uses either accumulated or distributed conditions (within HT and LT phases) according to participant's choice		
Delivers Token after every target response		
Delivers Reinforcer following correct schedule value		
Delivers Reinforcer for 30s (+/- 5s) or 5 min (=/- 5 s)		
Delivers HT or LT reinforcer after token exchange		
Ends session after 5 choice trials		

CURRICULUM VITAE

AUDREY NELSON HOFFMANN

2865 Old Main Hill
Utah State University
Logan, UT 84322-2865
(435) 797-3217

EDUCATION

2013-2017	Ph.D.	Utah State University Disability Disciplines Concentration: Applied Behavior Analysis Advisor: Tyra P. Sellers, SpEd Department
2011-2014	M.S.	Utah State University, Logan, UT Special Education and Rehabilitation Emphasis in Applied Behavior Analysis Advisor: Andrew L. Samaha, Psychology Department
2005-2008	B.S.	Utah State University, Logan, UT Major: Psychology Minor: Family and Human Development
2003-2005		Idaho State University, Pocatello, ID General studies toward B.S. degree

LICENSES AND CERTIFICATIONS

Utah Licensed Behavior Analyst License: 9548807-2506
October 2015- Present

Board-Certified Behavior Analyst Certificate: 1-14-9500
August 2014-Present

Board-Certified Behavior Analyst-Doctoral Level
Summer 2017

CLINICAL EXPERIENCE

2014-Present	Utah Behavior Support Clinic Assistant Clinic Director Utah State University Logan, Utah
2015-2016	Granite School District ABA Support Clinic Team Program Director- Consultant Salt Lake City, Utah
2014-2015	Cache Employment and Training Center Behavior Consultant Logan, Utah
2011-2015	Independent Evaluation Team Transition Specialist Master's Program Grant (OSEP funded) Utah State University Logan, Utah
2011-2014	Severe Behavior Clinic Clinician and Therapist Utah State University Logan, Utah
2011-2012	Autism Support Services: Education, Research, Training (ASSERT) Preschool Instructor Center for Persons with Disabilities Logan, Utah
2007-2016	Educational Research Consultant EndVision Research and Evaluation Logan, Utah

PEER-REVIEWED PUBLICATIONS

Hoffmann, A. N., Samaha A. L., Bloom, S. E., & Boyle, M. A. (2017). Preference and reinforcer efficacy of high-tech items: A comparison of item type and duration of access. *Journal of Applied Behavior Analysis.*

Boyle, M. A., Samaha, A. S., Slocum, T. A., Hoffmann, A. N., & Bloom, S. E., (2016). A human-operant investigation of behavioral contrast. *The Psychological Record*

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Morgan, R. M., Callow-Heusser, C. A., Horrocks, E., & Hoffmann, A. N. (2014). Competencies needed by transition teachers: literature review and survey findings from national experts and practitioners. *Career Development and Transition for Exceptional Individuals*.

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PEER-REVIEWED PUBLICATIONS (ACCEPTED FOR PUBLICATION)

Boyle, M. A., Hoffmann, A. N., & Lambert, J. M. (*in press*) Behavioral Contrast: Theories, Previous Research, and Areas for Investigation. *Journal of Applied Behavior Analysis*

PEER-REVIEWED PUBLICATIONS (UNDER REVIEW)

Hoffmann, A. N., Bogoev, B. K., Callard, C., & Sellers, T. P. Using a Tablet Device to Examine Effects of Varied Reinforcement on Responding and Preference, *Journal of Applied Behavior Analysis*

Hoffmann, A. N., Halverson, H. A., Sellers, T. P., Bloom, S. E. Implementation of Interventions for Problem Behavior Based on the Results of Precursor Functional Analyses in an Early Childhood Setting. *Journal of Applied Behavior Analysis*

MANUSCRIPTS AND PROJECTS IN PREPARATION

Hoffmann, A. N., Bogoev, B. K., Sellers, T. P. Using telehealth for assessment & intervention: behavior specialist as coach and caregivers as implementers. *Final editing for submission*

Sellers, T. P, Clay, C. J., Hoffmann, A. N., Collins, S. Application of a performance diagnostic checklist-human services informed performance management

intervention to increase use of trial-based functional analysis. *Final editing for submission*

Hoffmann, A. N., Bogoev, B. K., Callard, C., Lee, J., & Sellers, T. P. An Applied Examination of Resurgence and Effects of Training Multiple Mands During Functional Communication Training. *Conducting data analysis and editing manuscript for submission.*

Hoffmann, A. N., Brady, A., Sellers, T. P. Using Pictures Depicting App Icons to Conduct an MSWO Preference Assessment on a Tablet Device. *Final editing for submission*

Bogoev, B. K., Hoffmann, A. N., Sellers, T. P. An evaluation of published treatment selection models. *Conducting data analysis and editing manuscript for submission.*

Hoffmann, A. N., Lee, J. L., Sellers, T. P. Teaching Discriminated Use of a Tablet Device for Leisure and Educational Activities. *Conducting data analysis and editing manuscript for submission.*

Hoffmann, A. N., Sellers, T.P. Examining Effects of Technology Level and Reinforcer Arrangements on Preference and Efficacy (Doctoral Dissertation). *Conducting data analysis and editing manuscript for submission.*

Hoffmann, A. N., Brady, A., Sellers, T. P. The Displacement of No-Tech Items by High-Tech Items During MSWO Preference Assessments. *5 participants completed, gathering data with additional participants.*

Hoffmann, A. N., Mattson, S., Sellers, T. P. Using Activity Schedules with Children with Autism to Increase Appropriate Use of Tablet Devices. *Gathering data with two participants*

CONFERENCE PRESENTATIONS

Bogoev, B. K., **Hoffmann, A. N.,** & Sellers, T. P. (2017, May). An Evaluation of a Published Treatment Selection Guide for Escape Maintained Problem Behavior. In A. Hoffmann (Chair) *Built to Last: Considerations for Designing and Implementing Durable Interventions for Socially Mediated Challenging Behavior*. Symposium accepted for presentation at the 43rd annual meeting of the Association for Behavior Analysis International, Denver, CO.

Hoffmann, A. H., Bogoev, B. K., **Callard, C. H**., & Sellers, T. P. (2017, May). An Applied Examination of Training Multiple Mands During Functional Communication. In A. Hoffmann (Chair) *Built to Last: Considerations for Designing and Implementing Durable Interventions for Socially Mediated Challenging Behavior*. Symposium accepted for presentation at the 43rd annual meeting of the Association for Behavior Analysis International, Denver, CO.

Hoffmann, A. N. (April, 2017) Considerations for Using High-Tech Reinforcers When Working with Individuals with ASD. Presentation at the 2017 Utah Valley University Conference on Autism, Orem, UT.

Hoffmann, A. N., Bogoev, B. K., Callard, C. H., & Sellers, T. P., (March, 2017) An Applied Examination of Training Multiple Mands During Functional Communication. In T. Sellers (Chair) Recent Advances in Treatment of Problem Behavior. Symposium accepted for presentation at the 7th annual Association for Professional Behavior Analysts conference, New Orleans, LA

Hoffmann, A. N., & Gerenscer, K. R. (2016, June). *Using Technology to Provide Training, Teaching, and Reinforcement for Children with Autism Spectrum Disorder.* Break-out Session Presentation at the Utah Association for Behavior Analysis (UTABA) Annual Convention, Salt Lake City, UT.

Hoffmann, A. N., Sellers, T. P., Halversen, H., & Bloom, S. E. (2016, May). *Implementation of Interventions for Problem Behavior Based on the Results of Precursor Functional Analyses in an Early Childhood Setting.* In T. Sellers (Chair) *Advances in Applications of Varied Functional Analysis Methodology: Latency, Precursor, and Tele-Health.* Symposium presented at the 42nd annual meeting of the Association for Behavior Analysis International, Chicago, IL.

Hoffmann, A. N., **Bogoev, B. K.**, & Sellers, T. P. (2016, May). *Functional Analyses and Functional Communication Training with Children Under Three Using Telehealth and Existing Supports: Early Childhood Special Education Behavior Specialist as Coach and Caregivers as Implementers.* In T. Sellers (Chair) *Advances in Applications of Varied Functional Analysis Methodology: Latency, Precursor, and Tele-Health.* Symposium presented at the 42nd annual meeting of the Association for Behavior Analysis International, Chicago, IL.

Collins, S. D., Sellers, T. P., Clay, C. J., & Hoffmann, A. N. (2016, May*). Effects of A Performance Management Package on Sustained Implementation of Trial-Based Functional Analyses in Adult Residential and Day Programs Following Training.* In C. Anderson (Chair) Further Exploration of Trial-Based Functional Analysis. Symposium presented at the 42nd annual meeting of the Association for Behavior Analysis International, Chicago, IL.

Hoffmann, A. N., Sellers, T. P., Halversen, H., & Bloom, S. E. (2016, April). *Implementation of Interventions for Problem Behavior Based on the Results of Precursor Functional Analyses in an Early Childhood Setting.* Utah State University Graduate Research Symposium, Logan, UT.

Hoffmann, A. N., **Bogoev, B. K.,** Sellers, T. P., (2016, April). *Using Telehealth to Assess and Treat Problem Behavior of Children Under Three Using Existing Supports- ECSE Behavior Specialist as Coach and Caregivers as Implementers.* Utah State University Graduate Research Symposium, Logan, UT.

Hoffmann, A. N., Sellers, T. P., Halversen, H., & Bloom, S. E. (2016, February). *Implementation of Interventions for Problem Behavior Based on the Results of Precursor Functional Analyses in an Early Childhood Setting.* In D. Shabani (Chair) *Recent Advances in Functional Analysis Methodology.* Symposium presented at the 34th annual meeting of the California Association for Behavior Analysis, Santa Clara, CA.

Hoffmann, A. N., Sellers, T. P., Bogoev, B. K. (2016, February). *Using Telehealth to Assess and Treat Problem Behavior of Children Under Three Using Existing Supports- ECSE Behavior Specialist as Coach and Caregivers as Implementers.* In T. Higbee (Chair) *Strategies for Teaching Independent Play Skills to Children with Autism and Distance Training Procedures to Train Natural Change Agents.* Symposium presented at the 34th annual meeting of the California Association for Behavior Analysis, Santa Clara, CA.

Hoffmann, A. N., Samaha, A. L., Bloom, S. E., & Boyle, M. E. (2015, October). *Preference and reinforcer efficacy of high-tech items: A comparison of item type and duration of access.* In A. Samaha (Chair) *Preference and Technology in Applied Behavior Analysis.* Symposium presented at the 35th annual meeting of the Florida Association for Behavior Analysis, Daytona, FL.

Hoffmann, A. N., Samaha, A. L, Boyle, M. A., Bloom, S. E. (2015, May) *The Effects of Item Type and Duration of Access on Reinforcer Preference and Efficacy*. In M. Boyle (Chair) *Translational Investigations with Individuals with Intellectual and Developmental Disabilities*. Symposium presented at the 41st annual convention of the Association for Behavior Analysis International, San Antonio, TX.

Boyle, M. A., Samaha, A. L., Slocum, T. A., & Hoffmann, A. N. (2015, May) *A Human-Operant Investigation of Behavioral Contrast.* In M. Boyle (Chair) *Translational Investigations with Individuals with Intellectual and Developmental Disabilities*. Symposium presented at the 41st annual convention of the Association for Behavior Analysis International, San Antonio, TX.

Hoffmann, A. N., Samaha, A. L, Boyle, M. A., Bloom, S. E. (2015, April) *Effects of Item Type and Duration of Access on Reinforcer Preference and Efficacy*. Utah State University Graduate Research Symposium, Logan, UT.

Rodewald, A. M., Samaha, A. L., Boyle, M. A., Hoffmann, A. N., Nickerson, C. I., & Halversen, H. (May 2013). *Reinforcer efficacy of social reinforcement for individuals with ASD: A meta-analysis.* In W. Berg, (Chair) Treatment Outcomes Across Type of Reinforcement and Treatment Setting for Persons with ASD and ID. Symposium presented at the 39th annual convention of the Association for Behavior Analysis International, Minneapolis, MN.

Callow-Heusser, C. A., Kupferman, S., & **Hoffmann, A. N.** (2012). *What do Transition Specialists Need to Know?* Survey findings presented at the Utah Conference on Effective Practices for Teachers and Human Service Professionals: Interventions Across the Lifespan, Logan, UT.

Callow-Heusser, C. A., **Hoffmann, A. N.,** Morgan, R. M. (2012). What do Transition Specialists Need to Know: Results of Two National Surveys presented at the Division on Career Development and Transition Regional Conference: Transition…Reaching New Altitudes, Denver, CO.

POSTER PRESENTATIONS

Hoffmann, A. H., Bogoev, B. K., Callard, C., & Sellers, T. P. (2016, June) *An Applied Examination of Resurgence and Effects of Training Multiple Mands During Functional Communication Training.* Poster presented at the Utah Association for Behavior Analysis (UTABA) Annual Convention, Salt Lake City, UT.

Hoffmann, A. H., Bogoev, B. K., Callard, C., Sellers, T. P. (2016, June). *Using a High-Tech Item to Examine Effects of Varied Reinforcement on Responding.* Poster presented at the Utah Association for Behavior Analysis (UTABA) Annual Convention, Salt Lake City, UT.

Hoffmann, A. H., Bogoev, B. K., Sellers, T. P. (2016, June). *FA and FCT with Children Under Three using Telehealth and Existing Supports: ECSE Behavior Specialist as Coach & Caregivers as Implementers.* Poster presented at the Utah Association for Behavior Analysis (UTABA) Annual Convention, Salt Lake City, UT.

Hoffmann, A. H., Bogoev, B. K., Callard, C., & Sellers, T. P. (2016, April) *An Applied Examination of Resurgence and Effects of Training Multiple Mands During Functional Communication Training.* Poster presented at the 9th annual Four Corners Association for Behavior Analysis, Loveland, CO.

Hoffmann, A. H., Bogoev, B. K., Callard, C., Sellers, T. P. (2016, April). *Using a High-Tech Item to Examine Effects of Varied Reinforcement on Responding.* Poster presented at the 9th annual Four Corners Association for Behavior Analysis, Loveland, CO.

Hoffmann, A. H., Callow-Heusser, C. (November 2015) *Meeting Utah's Transition Needs:*
Evidence-Based Outcomes from USU's Transition Specialists Masters Program. Poster presented at the 19th International Division on Career Development and Transition (DCDT) Conference, Portland, Oregon.

Hoffmann, A. H., Callow-Heusser, C. (June 2015) *Meeting Utah's Transition Needs: Evidence-Based Outcomes from USU's Transition Specialists Masters Program.* Poster presented at the third annual Utah Multi-Tiered Systems of Supports (UMTSS) Connections Conference.

Hoffmann, A. N., Samaha, A. L, Boyle, M. A., Bloom, S. E. (June 2015) *The Effects of Item Type and Duration of Access on Reinforcer Preference and Efficacy* Poster presented at the Utah Association for Behavior Analysis (UTABA) annual convention. Layton, UT.

TEACHING EXPERIENCE

Fall 2015: Instructor, Department of Special Education and Rehabilitation, Utah State University
SPED 4000: Education of Exceptional Students

Summer 2015: Teaching Assistant, Department of Special Education and Rehabilitation, Utah State University. Distance Education Course
SPED 6780: Ethics in Applied Behavior Analysis

Spring 2015: Teaching Assistant, Department of Special Education and Rehabilitation, Utah State University. Distance Education Course
SPED 6730: Educational Applications of Behavior Analysis

Spring 2015: Teaching Assistant, Department of Special Education and Rehabilitation, Utah State University.
SPED 4000: Education of Exceptional Students

Spring 2014: Teaching Assistant, Department of Special Education and Rehabilitation, Utah State University. Distance Education Course
SPED 5050: Applied Behavior Analysis 2: Applications

Guest Lectures

Spring 2017: Department of Special Education and Rehabilitation, Utah State University
Sped 6730: Educational Applications of Behavior Analysis
Topic: Functional Analyses of Problem Behavior-Applications
Fall 2015: Department of Psychology, Utah State University
Psych 3210: Abnormal Psychology
Topic: Developmental Disabilities and Applied Behavior Analysis

Fall 2015: Department of Special Education and Rehabilitation, Utah State University
SPED 6780: Ethics in Applied Behavior Analysis
Topic: Evidence Based Practice, Literature Searching, and Pseudoscience

Spring 2015: Department of Special Education and Rehabilitation, Utah State University
SPED 6730: Educational Applications of Behavior Analysis
Topic: Observational Learning and Teaching Complex Social Skills

Spring 2015: Department of Special Education and Rehabilitation, Utah State University
SPED 4000: Education of Exceptional Students
Topic: Emotional and Behavioral Disorders

Spring 2014: Department of Special Education and Rehabilitation, Utah State University
SPED 5050: Applied Behavior Analysis 2: Applications
Topic: Punishment Procedures and Ethical Considerations

SUPERVISION EXPERIENCE

2015-present	BCBA Independent Fieldwork Supervisor Private Consultant Logan, Utah
2014-present	BCBA Independent Fieldwork/Practicum Supervisor Department of Special Education BCBA Master's Program Utah State University Logan, Utah
2012-present	Undergraduate Apprenticeship Supervisor Department of Psychology: PSYCH 4950 course Severe Behavior Clinic/Utah Behavior Support Clinic Utah State University Logan, Utah

2011-2015 Practicum Supervisor: Transition Specialist Students
Department of Special Education Master's Program
Utah State University
Logan, Utah

2007-2009 Data Staff Manager: Data Collectors and Data Entry Staff
EndVision Research and Evaluation
Logan, Utah

TRAININGS AND WORKSHOPS

Hoffmann, A. N. *Taking an Individualized Approach to Client Care: Strategies from the Field of Applied Behavior Analysis.* Invited Presentation for the 2016 Utah Health Care Association Annual Convention and Showcase, Sandy, Utah, September 2016.

Sellers, T. P., & Hoffmann, A. N. *Tier III LRBI Intensive Interventions*. Professional Development Training for the Utah Professional Development Network, Richmond, Utah, February 2016.

Hoffmann, A. N., Bogoev, B. K., Shea, K. *Trial-Based Functional Analysis*. Invited presentation for local disability agencies, school district special education personnel, and behavior analytic professionals, Logan, Utah, January 2016.

Hofmann, A. N. *Making Modifications in the Moment*. Presentation at the Idaho Partnerships Conference, Boise, Idaho, October 2015.

Sellers, T. P., Hoffmann, A. N. *Function Based Intervention Selection*. Presentation and Training for the Utah Professional Development Network and Granite School District, Salt Lake City, Utah, April & May, 2015

Sellers, T. P., Clay, C. J., Hoffmann, A. N. *Functional Behavioral Assessment: What is TBFA?* Invited training presentation for Chrysalis Behavior Summit. Cedar City, Utah, September 2014.

Bloom, S.E., Samaha, A.L., Lambert, J.M., & Hoffmann, A. N. *Approaches to functional behavior assessment including trial-based FA.* Invited training presentation at the Carmen B. Pingree Center for Children with Autism, Salt Lake City, Utah, April 2013.

Callow-Heusser, C. A., Hoffmann, A. N., & Barnes, T. *Dynamic Indicators of Basic Early Literacy Skills.* Teacher professional development workshop at the St. Stephens Indian School, St. Stephens, Wyoming, September 2009.

EDITORIAL EXPERIENCE

Guest Reviewer	Journal of Applied Behavior Analysis
Guest Reviewer	Education and Treatment of Children
Guest Reviewer	Journal of Intellectual Disabilities

REPORTS AND EVALUATIONS

Callow-Heusser, C. A., **Hoffmann, A. N.** (2016). *Idaho Mathematics-Science Partnership (MSP) Teaching for Excellence in Science and Literacy Achievement: 2015-2016 Evaluation Report*. Lewiston, ID: Lewis Clark State College.

Callow-Heusser, C. A., **Hoffmann, A. N.** (2015). *Idaho Mathematics-Science Partnership (MSP) Teaching for Excellence in Science and Literacy Achievement: 2014-2015 Evaluation Report*. Lewiston, ID: Lewis Clark State College.

Callow-Heusser, C. A., **Hoffmann, A. N**. (2014). *Idaho Mathematics-Science Partnership (MSP) Teaching for Excellence in Science and Literacy Achievement: 2013-2014 Evaluation Report*. Lewiston, ID: Lewis Clark State College.

Callow-Heusser, C. A., **Hoffmann, A. N.** (2013). *Idaho Mathematics-Science Partnership (MSP) Teaching for Excellence in Science and Literacy Achievement: 2012-2013 Evaluation Report*. Lewiston, ID: Lewis Clark State College.

Callow-Heusser, C. A., **Hoffmann, A. N**. (2012). *Idaho Mathematics-Science Partnership (MSP) Teaching for Excellence in Science and Literacy Achievement: 2011-2012 Evaluation Report*. Lewiston, ID: Lewis Clark State College.

Callow-Heusser, C. A., **Hoffmann, A. N**., & Major, C. (2011). *Idaho Mathematics-Science Partnership (MSP) Teaching for Excellence in Science and Literacy Achievement: 2010-2011 Evaluation Report*. Lewiston, ID: Lewis Clark State College.

MEMBERSHIPS

Association for Behavior Analysis International: 2012-Present
Utah Association for Behavior Analysis: 2012-Present
California Association for Behavior Analysis: 2014-Present
Florida Association for Behavior Analysis: 2014-Present
Four Corners Association for Behavior Analysis: 2014-Present
Association for Contextual Behavioral Science: 2014-Present
American Psychological Association: 2016-Present

Council for Exceptional Children: 2016-Present
Vermont Association of Behavior Analysis: 2017 to Present

SERVICE

2015-2017	Graduate Student Representative on the Graduate Student Council Department of Special Education and Rehabilitation College of Education and Human Services
2013-2017	Human Rights Committee Member, Cache Employment and Training Center
2008-2013	Meeting Facilitator and Volunteer LDS Family Services Addiction Recovery Program Cache Valley Utah and Cache County Jail
2008-2011	Mobile Crisis Team: Domestic Violence and Rape Advocate Community Abuse Prevention Services Agency (CAPSA) Logan, Utah

AWARDS & GRANTS

2016-2017	Utah Multi-Tiered Systems of Support (UMTSS) Student Doctoral Dissertation Research Grant ($1000) Utah State Office of Education
2016	Fredrick Q. Lawson Fellowship ($9000) Emma Eccles Jones College of Education and Human Services
2016	Utah Association for Behavior Analysis Annual Convention Student Poster Competition for: Hoffmann, Bogoev, & Sellers, *FA and FCT with Children Under Three…*, and Hoffmann, Bogoev, Callard, & Sellers, *An Applied Examination of Resurgence...*,
2016	Four Corners Association for Behavior Analysis Annual Convention Student Poster Competition for: Hoffmann, Bogoev, Callard, Sellers, *Using a High-Tech Item to Examine Effects of Varied Reinforcement on Responding*