

June 2017

# Comparing the Effects of Static and Dynamic Signals during Multiple Schedules

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Comparing the Effects of Static and Dynamic Signals during Multiple Schedules

by

Lori Kollin

A thesis submitted in partial fulfillment  
of the requirements for the degree of  
Master of Arts in Applied Behavior Analysis  
Department of Child and Family Studies  
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Date of Approval:  
June 23, 2017

Keywords: functional communication training, multiple schedules, static signals, Time Timers®

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## **Abstract**

Functional communication training (FCT) is an effective procedure to teach a functional communication response (FCR) and decrease problem behavior. However, there are limitations to FCT. These limitations include excessive manding (e.g., requesting items at a high rate) and manding at inappropriate times (e.g., requesting attention when caregiver is driving). Multiple schedules using static signals (e.g., colored cards) have been used to decrease these limitations while maintaining appropriate levels of the FCRs and low levels of problem behavior. Moreover, dynamic signals have been used to maintain low levels of problem behavior and appropriate levels of alternative responses outside of a multiple schedule format. Presently, no research has examined the comparison of static and dynamic signals to address the limitations of FCT. Therefore, the purpose of the current study is to compare the effects of static and dynamic signals (i.e., Time Timer<sup>®</sup>) during multiple schedules consisting of reinforcement and extinction components following FCT.

*Key words:* functional communication training, multiple schedules, static signals, Time Timers<sup>®</sup>

## **Chapter 1:**

### **Introduction**

When individuals engage in severe problem behavior, functional analyses (FAs) are used to manipulate environmental contingencies to identify the maintaining variables of the problem behavior (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). When an FA identifies a social positive or negative function, functional communication training (FCT) may be used to teach functional communication responses (FCRs). Functional communication training has repeatedly demonstrated effectiveness for teaching and maintaining these responses while decreasing problem behavior (Carr & Durand, 1985).

Carr and Durand (1985) used FCT to decrease disruptive behavior and increase communication in four children with developmental disabilities in a classroom setting. The children were taught verbal communicative phrases (e.g., “I don’t understand”) to request adult assistance when completing a task. Results demonstrated that FCT successfully reduced problem behavior and taught an alternative response. Wacker et al. (1990) implemented FCT to teach FCRs in three subjects with developmental disabilities who engaged in self-injury, stereotypy, and aggression. Following FCT, the rate of severe problem behavior decreased and FCRs increased in all subjects. Kahng, Iwata, DeLeon, and Worsdell (1997) compared FCT and noncontingent reinforcement (NCR) to treat three adults with developmental disabilities who engaged in self-injurious behavior (SIB). Results indicated that both procedures were effective in decreasing rates of SIB, however, FCT produced more stable increases in subjects’ use of FCRs.

Similarly, Hanley, Piazza, Fisher, Contrucci, and Maglieri (1997) used both FCT and NCR procedures to reduce destructive behavior in two children with developmental disabilities. Both procedures were found to be effective in decreasing problem behavior. A concurrent chains procedure was then introduced to evaluate subjects' preference between the schedules of reinforcement. Subjects preferred FCT over NCR. These studies demonstrate that FCT can be used to reduce high rates of severe problem behavior and teach a functionally equivalent response. Furthermore, at least some subjects prefer FCT when the option is available (e.g., NCR or FCT).

Although FCT has been repeatedly shown as an effective treatment for teaching FCRs and decreasing severe problem behavior, there are limitations to this procedure. One limitation is that after implementing FCT, individuals engage in the appropriate response at high rates (Fisher et al., 1993; Hagopian, Fisher, Sullivan, Acquistio, & LeBlanc, 1998). A second limitation of FCT is that individuals engage in the appropriate response at inappropriate times (Fisher, Kuhn, & Thompson, 1998; Hagopian et al., 1998; Fisher, Thompson, Bowman, Hagopian, & Kung, 2000). These limitations make it impractical for caregivers to reinforce FCRs on a Fixed Ratio 1 (FR 1) schedule. Further, if the FCR is frequently denied or there is a delayed access to reinforcement, the response may be weakened (Fisher et al., 2000), resulting in the reemergence of problem behavior and reduction in the use of the alternative response (Hagopian et al., 1998).

Multiple schedules are commonly used to mitigate these limitations. Multiple schedules are compound schedules of reinforcement that alternate. Each schedule is signaled with a specific discriminative stimulus (Hanley, Iwata, & Thompson, 2001). Multiple schedules are used because they have the potential to reduce high rates of FCRs during inappropriate situations while maintaining low levels of problem behavior (Hanley et al., 2001).

Hanley et al. (2001) evaluated four methods to decrease unsustainable high rates of learned mands. The subjects were three adults with developmental disabilities whose problem behavior was maintained by positive reinforcement. All subjects were exposed to graduated mixed and multiple schedules of reinforcement. The graduated mixed schedule consisted of alternated un signaled reinforcement FR 1 and extinction (EXT) components. The multiple schedule consisted of alternated signaled FR 1 (i.e., white card) and EXT (i.e., red card). Sessions were 10 to 12 min and FCRs during the FR 1 component were reinforced with 10-s access to attention (e.g., statements of concern) or edibles (e.g., candy). Functional communication responses during the EXT component produced no programmed consequences. Problem behavior produced no programmed consequences during all components. Component durations were initially 45-s FR 1 and 15-s EXT and were gradually increased to 60-s FR 1 and 240-s EXT. The results of the study showed that during the multiple schedule, the individuals emitted the alternative communication response at high and stable rates during the reinforcement component and at near zero rates during the extinction component. Also, problem behavior remained low during both components. Similarly, Tiger and Hanley (2004) used multiple and mixed schedules to teach three typically developing children in a preschool setting to request teacher attention during appropriate class activities. The results showed that signals and rules used during the multiple schedule resulted in differentiated responding in all subjects.

More recently, Betz, Fisher, Roane, Mintz, and Owen (2013) used a multiple schedule with four children with developmental disabilities to decrease excessive rates of manding for tangibles and attention. The multiple schedule consisted of a rapid alternation of the reinforcement (i.e.,  $S^D$ ) and extinction (i.e.,  $S^\Delta$ ) components. Both components were 60 s and were signaled with colored bracelets or vests worn by the experimenters. All requests for

tangible items or adult attention during the  $S^D$  component were reinforced with 20-s access to toys or reading by an adult. All requests during the  $S^A$  component were placed on extinction. Additionally, the multiple schedule was rapidly changed from a dense schedule of reinforcement (i.e., 60-s FR 1 and 60-s EXT) to a leaner schedule of reinforcement (i.e., 60-s FR 1 and 240-s of EXT). As a result of the multiple schedule, children engaged in differentiated responding between the reinforcement and EXT components, problem behavior remained relatively low during both components, and the FCRs remained at high and stable rates during the  $S^D$  component.

Likewise, Leon, Hausman, Kahng, and Becraft (2010) used a multiple schedule to teach a young boy with pervasive developmental disorder to mand for attention under naturally occurring discriminative stimuli in the home environment. Sessions were divided into two 5-min periods which alternated between pairs of busy (i.e.,  $S^A$ ) and nonbusy (i.e.,  $S^D$ ) activities. During the first set, the busy period was signaled by having the experimenter simulate busy work (e.g., completing paperwork) and the nonbusy period was signaled by having the experimenter sit down and do not engage in any activity. The second set included busy periods where the experimenter engaged in conversation with another person and nonbusy periods where the experimenter sat down with reading materials. Appropriate mands (e.g., “excuse me”) resulted in adult attention for 30 s during nonbusy periods ( $S^D$ ) and no attention was provided during busy periods ( $S^A$ ). Results suggested that the subject engaged in differentiated responding during busy and nonbusy periods. This study also suggests that natural signals used as discriminative stimuli may be as effective as static (e.g., picture cards, colored shirts, bracelets, vests) signals.

Multiple schedules have repeatedly shown to be effective at thinning the schedule of reinforcement while maintaining low levels of problem behavior. However, most of the signals

that have been used during multiple schedules in past research have been static (Hanley et al., 2001; Tiger & Hanley, 2004; Betz et al., 2013). Currently, there is little research on the effects of more dynamic (e.g., electronic applications) signals during schedule thinning procedures.

Campillo et al. (2014) used dynamic signals in the form of a Tic-Tac visual software to evaluate its effect in reducing anxiety-related behavior (e.g., stereotypy, nervous utterances, and wandering) in three adults with autism spectrum disorder (ASD) during situations where reinforcement was delayed (e.g., waiting in line for food, waiting for classes to begin). The Tic-Tac visual software included the use of visual timers displayed on electronic devices (e.g., iPads<sup>®</sup>) and used a variety of visual stimuli (e.g., sand through an hourglass) to dynamically display the passage of time. The presence of the colored visual stimuli (e.g., gradually decreasing grey bar) on the software signaled the unavailability of the reinforcer. After the duration of time had passed and the bar was no longer visible, the reinforcer (e.g., snack) was available. The duration of the time delay to reinforcement was gradually increased to a maximum of 5 min. The results showed that signaling the duration of waiting periods with the Tic-Tac visual software reduced all anxiety-related behavior in all subjects. Additional findings supported no differences between longer and shorter waiting periods.

Grey, Healy, Leader, and Hayes (2009) and Mechling, Bryant, Spencer, and Ayres (2015) used a dynamic timer (i.e., Time Timer<sup>®</sup>) to signal gradual delays to reinforcement. The Time Timer<sup>®</sup> is a modified timer that resembles a clock face and can be set to a desired amount of time by revolving its arm to a designated duration, ranging from 1 to 55 min. When the timer is set, a red portion is displayed and gradually disappears as the hand moves across the clock face until the set duration has elapsed. Grey et al. (2009) paired red cards, verbal cues (e.g., “wait”), and the gradual introduction of the Time Timer<sup>®</sup> to signal the unavailability of reinforcement to teach

a child with ASD to wait. After discriminated manding was achieved, the red cards and verbal cues were removed and the Time Timer<sup>®</sup> served as the only signal to delay reinforcement. The use of the Time Timer<sup>®</sup> was effective; delays to reinforcement were signaled and waiting was increased from 1 s to 10 min. Moreover, Mechling et al. (2015) compared the use of a video of a Time Timer<sup>®</sup> and a video of a daily living activity (e.g., waiting for water to boil; waiting for stain removal) to signal the interresponse time (IRT) between task steps. Results indicated that the Time Timer<sup>®</sup> was as effective as the video of the daily living activity for signaling the passage of time and the appropriate time needed to independently complete the steps on the task analyses (e.g., food preparation).

Finally, static signals have been used successfully to teach discriminated manding using reinforcement and EXT components while maintaining the appropriate rates of the alternative response and low rates of problem behavior. Dynamic signals have been effective in signaling delays to reinforcement and decreasing problem behavior. Currently, no research has examined the comparison of static and dynamic signals to address the challenge of high-rate responding sometimes seen after implementing FCT. Therefore, the purpose of the current study is to compare the effectiveness of static (i.e., colored cards) and dynamic (i.e., Time Timer<sup>®</sup>) signals during multiple schedules consisting of reinforcement and extinction components following FCT.

## **Chapter 2:**

### **Methods**

#### **Subjects & Setting**

Three subjects participated in this study. Benson was a 4 ½-year-old male of Caucasian ethnicity, Ellie was a 3 ½-year-old female of Egyptian ethnicity, and Malcom was a 8-year-old male of Hispanic ethnicity. All three subjects were diagnosed with Autism Spectrum Disorder (ASD). All subjects were recruited from local behavior analysis agencies or through the Center for Autism and Related Disorders (CARD). All sessions were conducted in the subjects' homes and were 10 min.

#### **Materials**

Laminated white index cards (i.e., “toys card” for Ellie, “attention card” for Malcom) were used for two subjects during FCT and the multiple schedules phases to request their specific reinforcers. Benson used a vocal response (i.e., “I want letters”) during FCT and the multiple schedules phase to request for letters. During the static signals multiple schedule, laminated white and red index cards were used to sign reinforcement and EXT components, respectively. During the dynamic signals multiple schedule, the Time Timer<sup>®</sup> components were displayed on a tablet and signaled the reinforcement (i.e., white portion) and EXT (i.e., red portion) components. All data were collected on tablets or iPhones<sup>®</sup> using a data collection application to record behavioral data in real time (i.e., Countee).

#### **Response Measurement, Reliability, and Treatment Integrity**

Data were collected on subjects' rate of problem behavior or percentage of intervals in which problem behavior occurred, FCRs, and prompts used during FCT (e.g., full physical, gestural, or verbal prompt). Benson's problem behavior was tantrum defined as screaming, crying with or without tears, and throwing items to the floor. Ellie's problem behavior was aggression which consisted of grabbing someone else's skin or clothing items, scratching with or without breaking skin, and biting. Malcom's problem behavior was aggression defined as pulling on clothing items, pulling hair, hitting with open or closed fist, and kicking.

Interobserver agreement (IOA) was calculated to assess the reliability of the observation system. Sessions were divided into 10-s intervals. Two observers scored in vivo or recorded sessions independently. Data collected were compared within intervals and percentage agreement was determined by dividing the number of agreements by the total number of intervals and then multiplied by 100%. Intraobserver agreement was calculated for an average of 35.18% (range, 33% to 40%) of sessions for all subjects. During all phases of the study, we calculated IOA for problem behavior and FCRs for all subjects (except Ellie, only IOA for problem behavior was calculated during the FA). For Benson, IOA was calculated for 35% of FA sessions, 33% of FCT sessions, and 35% of the multiple schedules sessions. In the FA, the average IOA for FCRs was 91% (range 82% to 100%) and 100% for problem behavior. In FCT, the average IOA for FCRs was 95% (range, 93% to 96%) and 100% for problem behavior. In the multiple schedules phase, the average IOA for FCRs was 96% (range, 91% to 100%) and 100% for problem behavior. For Ellie, IOA was calculated for 37% of FA sessions, 36% of FCT sessions, and 34% of multiple schedules sessions. In Ellie's FA, the average IOA for problem behavior was 99% (range, 96% to 100%). In FCT, the average IOA for FCRs was 91% (range, 83% to 96%) and 100% for problem behavior. In the multiple schedules phase, the average IOA

for FCRs was 96% (range, 85% to 100%) and 100% for problem behavior. For Malcom IOA was calculated for 33% of FA sessions, 36% of FCT sessions, and 34% of the multiple schedules phases. In the FA, the average IOA for FCRs was 100% and 92% (range, 87% to 96%) for problem behavior. In FCT, the average IOA for FCRs was 92% (range, 85% to 96%) and 98% for problem behavior (range, 92% to 100%). For the multiple schedules phase, the average IOA for FCRs was 92% (range, 80% to 98%) and 96% for problem behavior (range, 88% to 100%).

Treatment integrity (TI) was calculated for an average of 34.57% (range, 34% to 36%) of sessions for all subjects. We assessed the extent to which the therapist provided reinforcement on an FR 1 schedule during the reinforcement components in both signals and the extent to which the therapist did not reinforce FCRs in the extinction components in both signals. Percentage agreement was determined by dividing the number of agreements by the total number of agreements plus disagreements and then multiplied by 100%. For Benson, TI was calculated for 36% of sessions with an average of 97% (range 91% to 100%) agreement for FCRs during FR 1 and 100% agreement for FCRs during EXT. For Ellie, TI was calculated for 34% of sessions with an average of 99% (range 90% to 100%) agreement for FCRs during FR 1 and 99% (range 92% to 100%) agreement for FCRs during EXT. For Malcom, TI was calculated for 34% of sessions with an average of 99% (range 92% to 100%) agreement for FCRs during FR1 and 100% agreement for FCRs during EXT.

### **Indirect Assessments**

A Functional Assessment Screening Tool (FAST; Iwata, DeLeon, & Roscoe, 2013) was completed with all subjects' parents to identify factors that may influence problem behavior, topographies of the problem behavior, and potential sources of reinforcement. Also, a demographic questionnaire was used to obtain background information for all subjects.

## **Preference assessments**

A multiple stimuli without replacement (MSWO; Deleon & Iwata, 1996) preference assessment was used to identify preferred tangible items used during the FA and other phases of the study for Benson and Ellie. No preference assessment was conducted with Malcom because he had recently participated in another research study for which preference assessments had been conducted to identify preferred items.

## **Functional Analysis**

Functional analyses based on the procedures described by Iwata et al. (1982/1994) were conducted for Benson and Ellie to identify environmental variables maintaining each subjects' problem behavior. Attention, tangible, escape, play, and ignore (Benson only) conditions were conducted using a multielement design. No ignore condition was conducted for Ellie because the topography of the response (i.e., aggression) required the presence of another individual. All sessions were 10 min. For Malcom, an FA was not conducted for this study because he had recently participated in a different research study for which a traditional FA had been completed. The results from that FA showed that his aggression was maintained by access to adult attention. Instead, a CR/NCR baseline was conducted (described below) to confirm the result of the previously conducted FA.

**Attention.** This condition was conducted to determine if the target behavior was maintained by access to adult attention. The subject and therapist were in the same room. The subject had access to a low-preferred tangible item. When the session started, the therapist said (i.e., “You can play with your toy if you want to, I will be working over here”) and moved to the other side of the room. Following the occurrence of the target problem behavior, the therapist immediately provided a brief verbal reprimand (e.g., “I don’t like it when you hit me”) for approximately 10

s.

**Tangible (Benson and Ellie).** We included a tangible condition for Benson and Ellie because, during the indirect assessments, parents reported that problem behavior resulted in access to preferred items. Therefore, this condition was conducted to determine if problem behavior was maintained by access to tangibles (e.g., toys). Subjects were provided with high-preferred tangibles for 2 min prior to beginning the session. When the session started, the experimenter said (e.g., “No more toys”) and removed the toys from the subjects’ reach. All appropriate and inappropriate responses were ignored and the target problem behavior resulted in 30-s access to the highly preferred toys.

**Escape (Benson and Ellie).** This condition was conducted to determine if the target problem behavior was maintained by access to escape from demands. During this condition, the therapist presented non-preferred academic and gross motor tasks (e.g., “Put the block in the bucket”; “touch your nose,” “clap your hands”) using a least-to-most prompting procedure (i.e., verbal, gestural, and physical). Contingent on the target problem behavior, the task materials were removed and the therapist said (e.g., “That’s ok, you don’t have to do it”) and provided a 30-s break.

**Play.** This condition was used as a control condition to which all test conditions were compared. During the play condition, the subjects had continuous access to highly preferred items and therapist attention was delivered every 30 s. No demands were presented and there were no programmed consequences for problem behavior.

**Ignore (Benson).** This condition was conducted to determine if the target behavior was maintained by automatic reinforcement. In this condition the subject was in the session room without any materials. The therapist was also in the room but did not interact with the subject.

All appropriate and inappropriate responses were ignored. Target problem behavior resulted in no programmed consequences.

## **Procedures**

**Baseline.** The baseline phase was the same as the condition identified by the FA with the highest percentage of intervals or rate of problem behavior for Benson and Ellie. Because Malcom had recently participated in another research study for which an FA had been conducted and had resulted in problem behavior maintained by access to adult attention, an FA was not conducted for him as part of this study. Instead, a non-contingent reinforcement (NCR) and contingent reinforcement (CR) baseline was conducted. During NCR, Malcom received attention every 30 s, had access to toys, and no demands were presented. All targeted and non-targeted problem behavior was ignored. During CR, contingent on the target problem behavior, attention was provided for 10 s. The conditions were alternated in a 2:1 ratio (two sessions of CR, one session of NCR). The data from the CR condition were used as baseline.

**Functional Communication Training.** Following the FAs, subjects were trained to either emit a vocal response (Benson) or exchange a white index functional communication card (Ellie and Malcom) for corresponding reinforcers (e.g., toys, attention), similar to the procedures described by Carr and Durand (1985). Sessions were 10 min and included a most-to-least prompting procedure (e.g., physical, gestural, and verbal) with a time delay that doubled (e.g., 0 s, 2 s, 4 s, 8 s, 16 s) across sessions. Contingent on the FCR the subjects gained access to the reinforcers for 30 s (Benson and Ellie) or 10 s (Malcom). Problem behavior was placed on extinction. The mastery criteria for the FCT was five consecutive sessions with 90% or more independent FCRs. Moreover, the rate of demands were adjusted to address reinforcement consumption time. To do this, we first subtracted the total reinforcement time from the total

session time and divided the result by 60. We then divided the total frequency of the FCRs by the result from the above equation.

**Multiple Schedule.** Following FCT, two multiple schedules of reinforcement modeling Hanley et al. (2001) were conducted using a multiple baseline across subjects with an embedded multielement design. In the multiple schedules, sessions were presented in an alternating sequence (e.g., static then dynamic signals). Sessions resembled the conditions from the FAs with the highest rates of problem behavior. For example, if problem behavior was maintained by access to attention, sessions were identical to the attention condition in the FA. Rates of FCRs were calculated for both components (i.e., FR 1 and EXT) during each session for both type of signals. The rates of FCRs and problem behavior were also adjusted to address reinforcement consumption time and duration of components. During the FR 1 components, all FCRs resulted in 30-s (Benson and Ellie) and 10-s (Malcom) access to the corresponding reinforcer. During the EXT components, all FCRs were placed on extinction. The initial durations in the multiple schedules phase were 45-s FR 1 and 15-s EXT and increased after visible discriminated responding between components and an average of 80% reduction of problem behavior from baseline in the last five sessions (i.e., for the first increment; 60-s FR 1, 15-s EXT) and last three sessions with discriminated responding and average of 80% reduction of problem behavior from baseline in all subsequent increments (i.e., 30-s, 45-s, and 60-s EXT, respectively).

Moreover, discrimination indexes based on Tiger, Hanley, and Heal (2006) were calculated to further evaluate the level of responding between reinforcement and extinction components in both static and dynamic signals. These calculations were completed by dividing the number of FCRs emitted in the FR 1 components by total number of FCRs emitted in both components (i.e., FR 1 and EXT). In a discrimination index, the closer the number is to 1, the

stronger the discrimination between the components (i.e., responses occurred only when reinforcement was available); the closer the number is to 0.5, the weaker the discrimination (i.e., responses occurred at an equal rate when reinforcement was available and when reinforcement was not available).

**Static Signals.** During the first multiple schedule arrangement, static visual stimuli were used in the form of white and red laminated index cards. The cards were correlated with alternating periods of FR 1 and EXT. During the FR 1 component (i.e.,  $S^D$ ), a white laminated index card was present to signal the availability of reinforcement and all FCRs resulted in reinforcement (i.e., attention or tangibles). During the EXT component (i.e.,  $S^\Delta$ ), a red laminated index card was used to signal that reinforcement was not available and all FCRs were placed on extinction. Problem behavior was placed on extinction during both components.

**Dynamic Signals.** The dynamic signals multiple schedule was introduced in the form of a Time Timer<sup>®</sup> displayed on a tablet. The timer was correlated with alternating periods of FR 1 and EXT. During the FR 1 component (i.e.,  $S^D$ ), a white portion of the Time Timer<sup>®</sup> was present signaling the availability of reinforcement and all FCRs resulted in reinforcement. During the EXT component (i.e.,  $S^\Delta$ ), a red portion of the Time Timer<sup>®</sup> was present signaling the unavailability of reinforcement and all FCRs were placed on extinction. Problem behavior was placed on extinction during both components.

## **Chapter 3:**

### **Results**

#### **Functional Analysis**

Figure 1 depicts the results from the FAs conducted for Benson and Ellie and the NCR/CR baseline conducted for Malcom. The results from the FAs suggested that problem behavior was maintained by social positive reinforcement in the form of access to tangibles for Ellie and Benson, with some problem behavior occurring during the escape condition for Ellie. The results from the NCR/CR baseline for Malcom showed that problem behavior was maintained by attention, as previously identified in the other research study. For Benson, highest percentage of intervals with problem behavior was obtained in the tangible condition ( $M = 53.25\%$ ), suggesting that tantrums were maintained by positive reinforcement in the form of access to toys. For Ellie, rates of problem behavior were highest in the tangible condition ( $M = 0.15$ ), suggesting that aggression was maintained by positive reinforcement in the form of access to toys. For Malcom, higher rates of problem behavior ( $M = 2.48$ ) were observed in the CR condition compared to the NCR condition, suggesting that aggression was maintained by access to adult attention.

#### **Functional Communication Training and Multiple Schedules**

Following the FAs, FCT was conducted and multiple schedules were introduced. Figure 2 depicts the percentage of intervals with problem behavior (Benson) and rates of problem behavior (Ellie and Malcom) during baseline, FCT, and multiple schedules. During baseline,

levels of problem behavior were high for all subjects. During FCT, all subjects were trained to emit a vocal response (Benson) or exchange a card (Ellie and Malcom) to request for their reinforcer while problem behavior decreased to zero (for Benson) or low levels ( $M = 0.01$ ) for Ellie, ( $M = 0.08$ ) for Malcom. Following FCT, the multiple schedules evaluations were completed for all subjects. For Benson and Ellie, zero levels of problem behavior were observed during most sessions during all treatment phases of the study. For Malcom, during the initial exposure of the multiple schedules evaluation, problem behavior increased to higher than baseline levels during static ( $M = 2.86$ ) and dynamic ( $M = 3.89$ ) signals in FR 1 and static ( $M = 3.69$ ) and dynamic ( $M = 4.13$ ) signals in EXT components. Therefore, FCT was reintroduced. During the second exposure to FCT, problem behavior decreased to low levels ( $M = 0.73$ ). Following the second FCT, a second exposure to the multiple schedules was introduced for both signals. In the initial phase, 45-s FR 1 and 15-s EXT, low rates of problem behavior were observed during static ( $M = 0.05$ ) and dynamic ( $M = 0.04$ ) signals in FR 1 and during static ( $M = 0.67$ ) and dynamic ( $M = 0.23$ ) signals in EXT. When the duration of components increased for both signals, problem behavior during FR 1 continued to occur at low rates for static ( $M = 0.14$ ) and dynamic ( $M = 0.30$ ) signals and at slightly higher rates during the EXT components for static ( $M = 1.32$ ) and dynamic ( $M = 1.90$ ) signals. When components increased to 60-s FR 1 and 45-s EXT, rates of problem behavior remained relatively low in FR 1 components for static ( $M = 0.04$ ) and dynamic ( $M = 0.05$ ) signals and in EXT components for static ( $M = 0.78$ ) and dynamic ( $M = 0.44$ ) signals. Finally, when the final duration was 60-s FR 1 and 60-s EXT, problem behavior remained low in FR 1 for static ( $M = 0.08$ ) and dynamic ( $M = 0.35$ ) signals and in EXT for static ( $M = 0.11$ ) and dynamic ( $M = 0.39$ ) signals.

Figure 3 depicts the FCRs during all phases of the study for all subjects. For Benson, zero FCRs were observed during baseline. After implementing FCT, high and stable rates of FCRs ( $M = 8.14$ ) were observed. During initial exposure to 45-s FR 1 and 15-s EXT of static signals, Benson showed high rates of FCRs ( $M = 10.80$ ) in the FR 1 component and initial high rates of FCRs in the extinction component that decreased to lower levels ( $M = 1.24$ ) after 5 sessions. The average discrimination index for Benson for static signals during this phase was 0.89. During the dynamic signals, high rates of FCRs were observed during the 45-s FR 1 ( $M = 7.82$ ) component and lower rates of FCRs ( $M = 0.38$ ) were observed during 15-s EXT components with an average discrimination index of 0.95. Following five sessions with discriminated responding, the components' durations were increased for both signals. During the 60-s FR 1 component and 30-s EXT phase, FCRs continued to occur at high rates for static ( $M = 13.14$ ) and dynamic ( $M = 11.94$ ) signals during reinforcement, and at zero levels during static and low levels ( $M = 0.13$ ) during dynamic signals in the extinction components. During the 60-s FR 1 and 45-s EXT phase, FCRs continued to occur at high rates for static ( $M = 13.94$ ) and dynamic ( $M = 12.93$ ) signals during reinforcement and at low rates for static ( $M = 0.30$ ) and zero rates during dynamic signals during the EXT components. During the last phase of the study, 60-s FR 1 and 60-s EXT, FCRs continued to occur at high rates for static ( $M = 8.65$ ) and dynamic ( $M = 11.06$ ) signals during reinforcement and low rates of FCRs during static ( $M = 0.09$ ) and zero rates of FCRs during dynamic signals during extinction. The average discrimination indexes for the last phase of the study for Benson were 0.96 during static signals and 1 during dynamic signals.

For Ellie, no data were collected on FCRs during baseline. Anecdotally, FCRs did not occur during the FA. During FCT, Ellie engaged in high and stable rates of FCRs ( $M = 3.91$ ).

Following FCT, 45-s FR 1 and 15-s EXT was introduced for both signals. In the FR 1

components, high and slightly variable rates of FCRs were observed during the static ( $M = 4.83$ ) and dynamic ( $M = 5.26$ ) signals. Rates of FCR during the EXT components were initially high during static ( $M = 3.42$ ) and dynamic ( $M = 1.12$ ) signals but decreased to lower levels during static and to zero levels in dynamic signals during the last sessions. During FR 1 and EXT components, discrimination indexes were calculated for dynamic ( $M = 0.87$ ) and static ( $M = 0.56$ ) signals. Following five sessions with discriminated responding, the durations for components were increased for both signals. During the 60-s FR 1 and 30-s EXT phase, FCRs during FR 1 occurred at relatively high rates for static ( $M = 6.31$ ) and dynamic ( $M = 6.45$ ) signals. FCRs during EXT occurred at lower rates for static ( $M = 2.78$ ) and dynamic ( $M = 0.64$ ) signals. Moreover, the 60-s FR 1 and 45-s EXT phase, FCRs during FR 1 occurred at relatively high rates for both static ( $M = 6.65$ ) and dynamic ( $M = 6.29$ ) signals. FCRs during EXT occurred at lower rates for static ( $M = 2.78$ ) and dynamic ( $M = 0.64$ ) signals. Finally, in the last phase, 60-s FR 1 and 60-s EXT, FCRs continued to occur at high rates for static ( $M = 3.92$ ) and dynamic ( $M = 3.39$ ) signals during the FR 1, and low rates for static ( $M = 1.99$ ) and dynamic ( $M = 0.67$ ) signals during EXT. The average discrimination indexes for the last phase of the study for Ellie were 0.56 during static signals and 0.78 during dynamic signals.

For Malcom, zero levels of FCRs were observed during baseline (i.e., he did not request for attention using the functional communication card). After implementing FCT, the multiple schedules were introduced with 45-s FR 1 and 15-s EXT for both signals. In the FR 1 components, high rates of FCRs were observed during the static ( $M = 3.53$ ) and dynamic ( $M = 3.18$ ) signals. In the EXT components, high rates of FCRs were also observed in static ( $M = 3.54$ ) and dynamic ( $M = 2.09$ ) signals. The discrimination indexes were on average 0.61 for static and 0.74 for dynamic. Recall that due to high rates of problem behavior, FCT was

reintroduced for Malcom. During this second FCT, we observed high and stable rates of FCRs ( $M = 6.17$ ). Thus, a second exposure to 45-s FR 1 and 15-s EXT was introduced for both signals. During the FR 1 components, relatively high and stable rates of FCRs were observed in static ( $M = 3.79$ ) and dynamic ( $M = 4.08$ ) signals. During EXT components, rates of FCRs were initially high but decreased to lower levels in static ( $M = 3.00$ ) and dynamic ( $M = 3.24$ ) signals. When the durations of components increased for both signals to 60-s FR 1 and 30-s EXT, FCRs during FR 1 occurred at relatively high rates for both static ( $M = 4.50$ ) and dynamic ( $M = 5.33$ ) signals. FCRs during EXT occurred at lower rates for static ( $M = 1.13$ ) and dynamic ( $M = 2.24$ ) signals. Moreover, during the 60-s FR 1 and 45-s EXT phase, FCRs during FR 1 continued to occur at relatively high rates for static ( $M = 4.70$ ) and dynamic ( $M = 3.43$ ) signals and occurred at lower rates during the EXT components in static ( $M = 0.34$ ) and dynamic ( $M = 0.09$ ) signals. Finally, in the last phase, 60-s FR 1 and 60-s EXT, FCRs occurred at high rates for static ( $M = 3.82$ ) and dynamic ( $M = 3.71$ ) signals during FR 1, and low rates for static ( $M = 0.84$ ) and dynamic ( $M = 1.16$ ) signals during EXT. The average discrimination indexes for the last phase of the study for Malcom were 0.79 during static signals and 0.79 during dynamic signals.

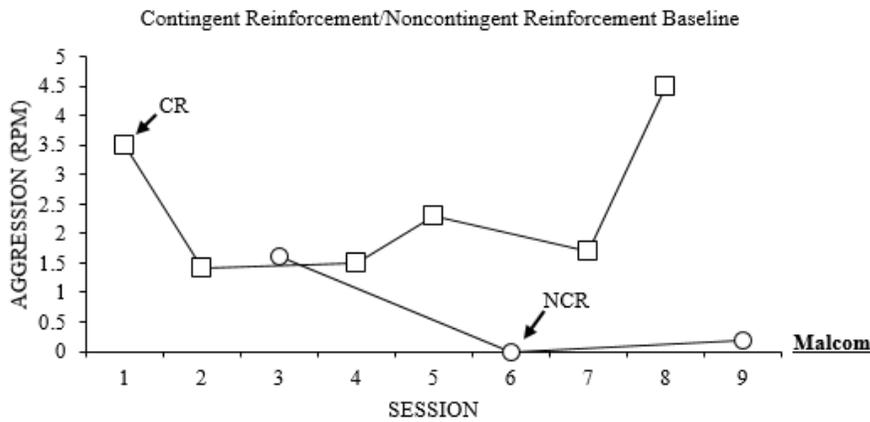
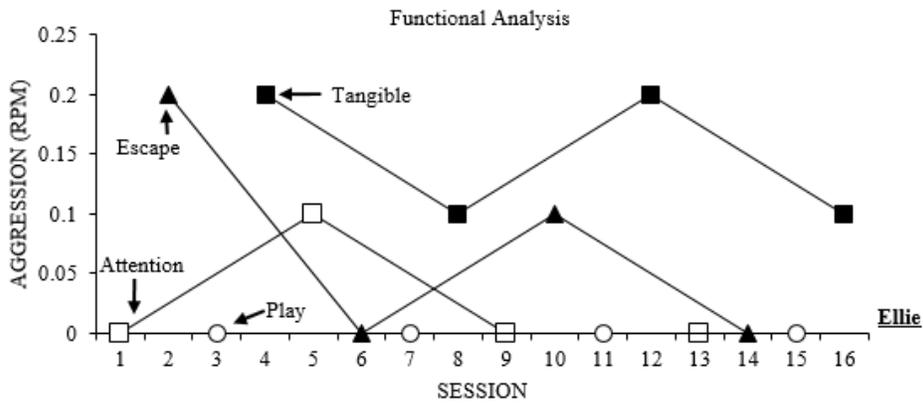
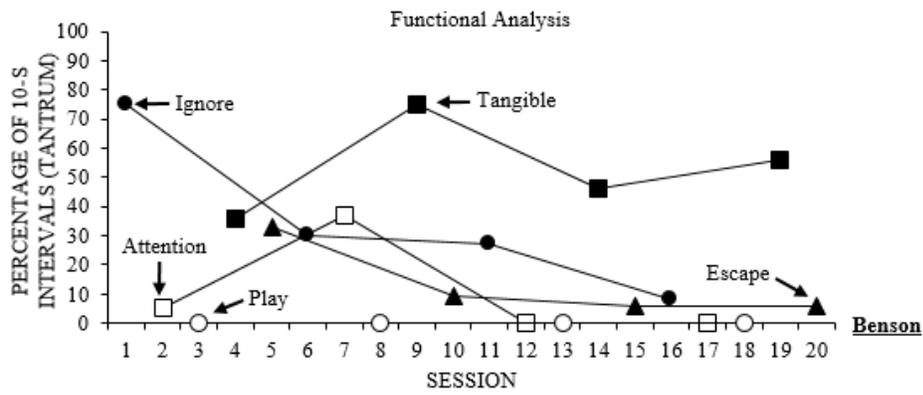


Figure 1. The top panel is the percentage of intervals with problem behavior for Benson during the FA. The middle panel Figure 1: Functional Analysis Graphs (Continued on Next Page)

represents rate of problem behavior for Ellie during the FA. The bottom panel is the NCR/CR  
Baseline for Malcom.

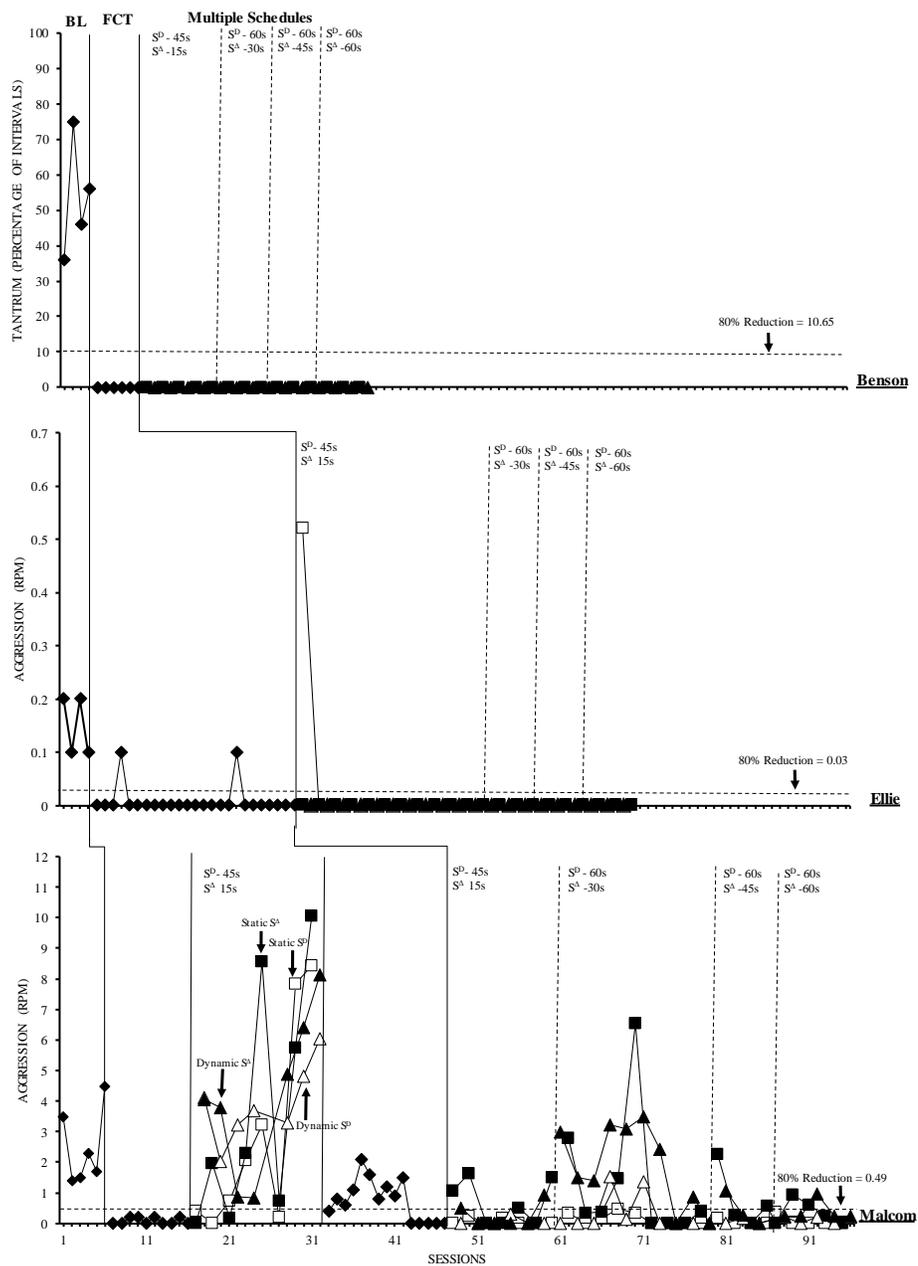


Figure 2. The percentage of intervals (Benson) with problem behavior and rates (Ellie and Malcom) of problem behavior during baseline, FCT, and the multiple schedules phase during static and dynamic signals. Figure 2: Problem Behavior Graphs (Continued on Next Page)

Open squares represent problem behavior during the reinforcement component in static signals.

Closed squares represent problem behavior during the extinction component in static signals.

Open triangles represent problem behavior during the reinforcement component in dynamic signals. Closed triangles represent problem behavior during the extinction component in static signals.

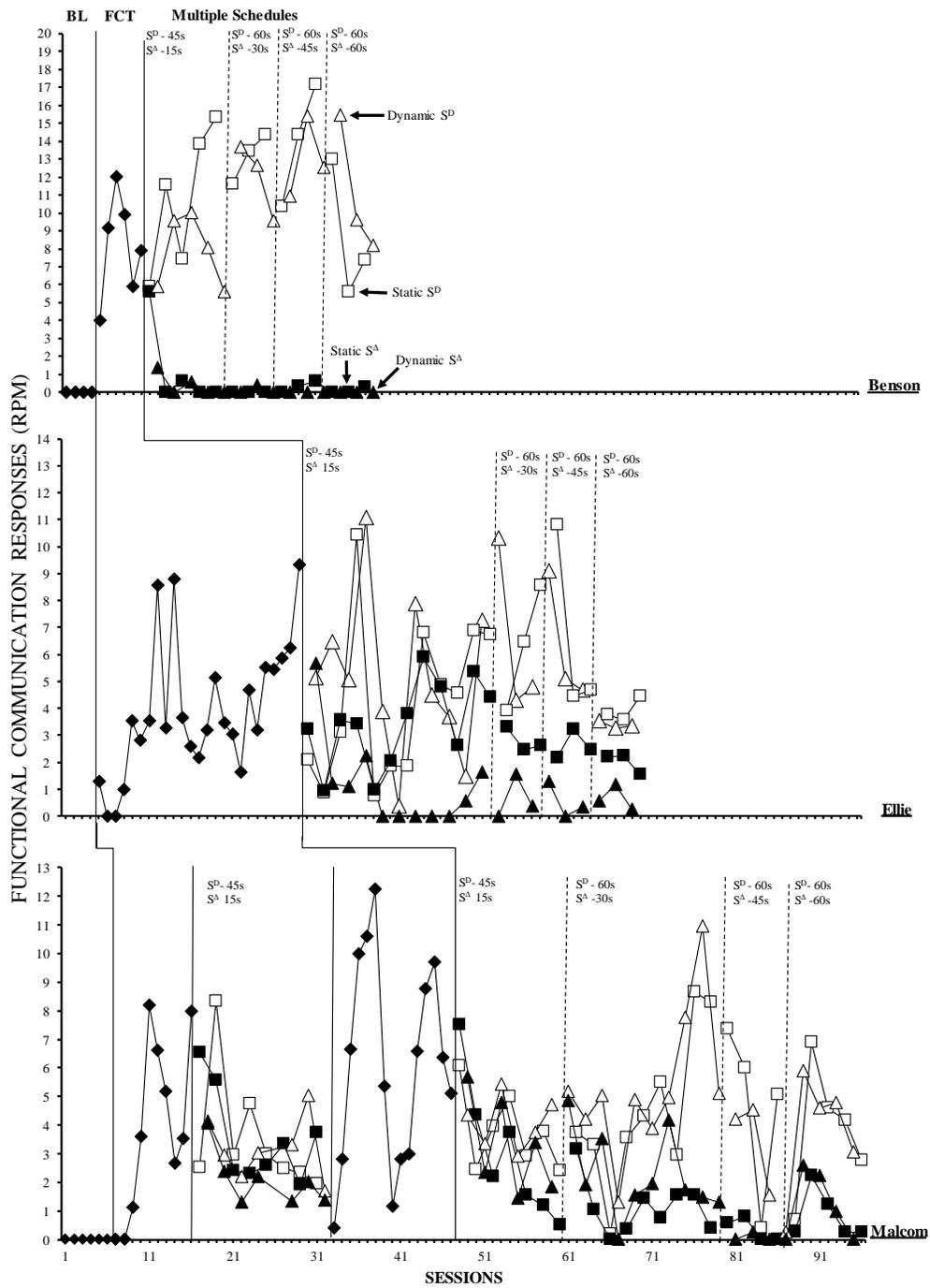


Figure 3. Rate of functional communication responses (FCRs) during baseline, Figure 3: Functional Communication Response Graphs (Continued on Next Page)

functional communication training (FCT), and the multiple schedules phase during static and dynamic signals. Closed diamonds represent FCRs during Baseline (Benson and Malcom only) and FCT phases. Open squares represent FCRs during the reinforcement component in static signals. Closed squares represent FCRs during the extinction component in static signals. Open triangles represent FCRs during the reinforcement component in dynamic signals. Closed triangles represent FCRs during the extinction component in static signals.

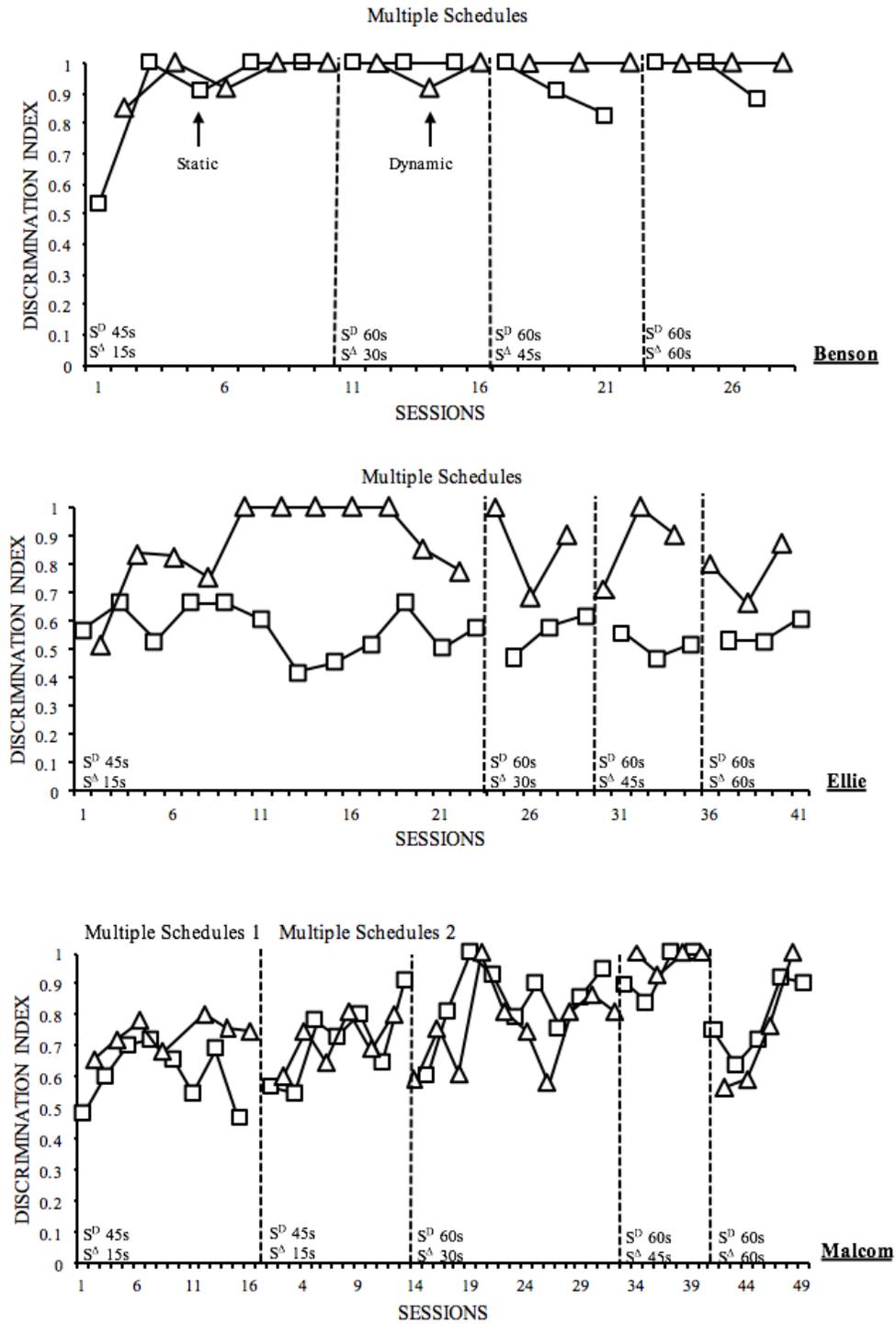


Figure 4. Discrimination indexes during the multiple schedules phases. Benson on the top panel, Ellie on the middle panel, Figure 4: Discrimination Index Graphs (Continued on Next Page)

Malcom on the bottom panel. Open squares represent discrimination indexes in the static signals.

Open triangles represent discrimination indexes in the dynamic signals.

## **Chapter 4:**

### **Discussion**

The current study compared the effectiveness of static (i.e., colored cards) and dynamic (i.e., Time Timer<sup>®</sup>) signals during multiple schedules consisting of reinforcement and extinction components for three subjects with ASD. The results suggest that both signals used in the multiple schedule arrangements were successful in producing discriminated manding while maintaining low to near zero levels of problem behavior. However, there were some differences in how discriminated manding was established using the different signals. For Benson, the discrimination indexes suggest that both signals produced similar discriminated manding throughout all phases of the study. However, during the last two phases, FR 1 60-s / EXT 45-s and FR 1 60-s / EXT 60-s, the discrimination index decreased during the last sessions for static signals while remaining at 1 during dynamic signals. Meaning, FCRs in the extinction component consistently remained at zero during dynamic signals while some FCRs occurred in the static signals. These results may suggest that if interested in increasing the duration of components to more practical durations for caregivers to reinforce, dynamic signals may result in more consistent zero levels of responding in extinction.

For Ellie, dynamic signals resulted in faster and more consistent discriminated manding. Discrimination indexes suggest that discrimination remained higher in dynamic than static signals during all phases of the multiple schedules. Moreover, for Malcom, dynamic signals initially resulted in faster discriminated responding. However, because of the increased rates of

problem behavior during the first exposure to the multiple schedule and the return to FCT to reduce problem behavior, Malcom was exposed to additional sessions of the multiple schedules arrangements. This extended exposure resulted in similar discriminated manding during both signals. It is possible that the longer exposure to both type of stimuli decreased the difference in discrimination that was initially observed in the first multiple schedule evaluation.

Overall, the results suggest that for two out of three subjects, dynamic signals resulted in faster and more consistent discriminated responding. For the other subject, both signals produced similar effects but dynamic signals produced slightly better discrimination during the last phases of the multiple schedules. It is possible that the visual signal indicating the passage of time presented by the Time Timer<sup>®</sup> accounts for these results. The Time Timer<sup>®</sup> provides information about the delay to reinforcement or waiting time. From the subjects' perspective, reinforcement is available when the rotating arm arrives at the desired duration (e.g., after 30 s are over), resulting in the absence of the red wedge signal and immediate appearance of the white timer face. In contrast, the static signals (e.g., red card) do not provide any information about the duration of the delay to reinforcement. Subjects are not presented with a visual signal indicating how long they must wait in the extinction component before the signal for the availability of reinforcement appears again.

The current study contributes to the limited research on the effects of different signals used during schedule thinning methods. Although multiple schedules have demonstrated to be effective during the reinforcement schedule thinning, it is unknown if certain signals work better than others or produce faster discriminated responding in some individuals. This study provides some evidence to suggest that for some individuals discriminated manding can occur faster when dynamic signals are used. Therefore, future research may continue to evaluate the effects of

different dynamic signals (e.g., electronic hourglass timers, red to yellow to green signals, countdown timers) on the acquisition of discriminated responding. Further, future research may evaluate a systemic procedure for identifying which signals can be used for different individuals when implementing multiple schedules as schedule thinning methods.

There are some limitations in the study that should be discussed. First, it is possible that dynamic signals produced higher discriminated manding in two subjects because of the potential subjects' history with electronics. However, we excluded subjects who engaged in problem behavior to receive access to electronics (e.g., tablets or iPads<sup>®</sup>) to avoid confounds due to preferences for electronic toys. Moreover, we asked the parents about their children's history with electronics and they reported that the children had little experience with electronics and no experience with the Time Timer<sup>®</sup>. Lastly, the final schedules of reinforcement in this study were 60-s FR 1 and 60-s extinction. This schedule of reinforcement can be difficult for caregivers to reinforce in the natural environment. Thus, further research should increase the duration of components to more practical durations during the evaluation of signals.

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