Increasing the Variability of Verbal Responding in Children and Adolescents with Autism Using a Conjunctive-Differential Reinforcement Schedule

by

Paul Argott

A dissertation submitted to the Graduate Faculty in Psychology in partial
Fulfillment of the requirements for the degree of Doctor of Philosophy,
The City University of New York

2010

This manuscript has been read and accepted for the
Graduate Faculty in Psychology in satisfaction of the
dissertation requirement for the Degree Doctor of Philosophy.

Nancy Hemmes

Date — Chair of Examining Committee

Maureen O'Connor

Date — Executive Officer

Bruce Brown .

Alicia Alvero .
Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

Abstract

INCREASING THE VARIABLITY OF VERBAL RESPONDING IN CHILDREN AND ADOLESCENTS WITH AUTISM USING A CONJUNCTIVE-DIFFERENTIAL REINFORCEMENT SCHEDULE

by

Paul Argott

Adviser: Doctor Nancy Hemmes

A procedure intended to teach variation in appropriate verbal responding to an antecedent stimulus was systematically manipulated for 5 individuals with autism. Four antecedent stimuli that include the clause, “else do you like to do” were presented in a varying order. Five responses that were appropriate to any of the antecedent stimuli were taught using a script-fading procedure. Percentage of varied verbal responses was studied under a conjunctive-differential reinforcement procedure using a multiple-baseline-across-subjects experimental design. Under a modified percentile requirement of the conjunctive schedule, responses were ranked according to their frequency of emission after every session and reinforcement was omitted for the 2 most frequent responses on the subsequent session. Under a lag-1 schedule requirement, reinforcement was omitted for consecutive occurrences of a given response within a given session. Data showed that the percentage of responses meeting the conjunctive schedule requirement increased with the systematic implementation of the schedule. A variability measure showed that responses were more stereotyped during baseline sessions in comparison to treatment sessions. Comparisons between the numbers of different statements emitted by

individuals with autism versus those of their typically developing peers suggest that further research is necessary to increase responding to a typical level. Nevertheless, responses by teachers and parents to a social validity questionnaire suggest that the procedure could be applied in clinical and home settings and used to increase varied verbal responding.

Acknowledgments

Much thanks and appreciation is extended to all those who have helped guide me.

To Dr. John Brown for starting me on my path toward this interest in behavior analysis.

To Dr. Nancy Hemmes for your continuous support in the development, running, and writing of this manuscript. You have provided me with so much support during the current and hopefully future research endeavors.

To Dr. Claire Poulson for your patience and mentorship throughout our time together.

To Drs. Bruce Brown and Alicia Alvero for your advisement during the past six years. You have kept my eyes opened to the various applications of applied behavior analysis and forced me to refrain from focusing on a single application.

To Dr. Dawn Buffington-Townsend for allowing me to run all of my graduate research in your school and for supporting me with your time and effort while I was there.

To the numerous families and staff that I have come to know and become affiliated with as a result of my research experiences. Your participation and support have been integral in this process.

To all of my friends at home and in the Learning Processes and Behavior Analysis subprogram. You have helped to push me toward this end. I am honored to call you my colleagues and friends.

A special thanks to my family and my wife, Brittani. You are the inspiration for all I do.

Table of Contents

List of Tables

List of Figures

Increasing the Variability of Verbal Responding in Children and Adolescents with Autism Using a Conjunctive-Differential Reinforcement Schedule

The content of one's speech is often a predictor of how s/he is viewed by his/her peers and can influence an individual's daily functioning level (Fiester & Gambria, 1972; Kernan, Sabsay, & Rein, 1986). This may pose a problem for children and adolescents with autism who typically have deficiencies in social communication and engage in repetitive behavior--two of the core deficits of autism (American Psychiatric Association, 2000). Stereotypic verbal responding--a characteristic of many individuals with autism--may be argued to be a result of a small vocal repertoire of appropriate responses; however, a pattern of stereotypic, non-variable responding may be seen even when an autistic individual has a sufficient verbal repertoire (Lee, McComas, & Jawor, 2002). Behavioral techniques have been used to reduce language deficiencies (e.g., Braam & Poling, 1983; Goldstein & Mousetis, 1989; Hart & Risley, 1975; Krantz & McClannahan, 1993) or stereotypic responding (e.g.,Cowdery, Iwata, & Pace, 1990; Goetz & Baer, 1973; Harding, Wacker, Berg, Rick, & Lee, 2004; Napolitano, Smith, Zarcone, Goodkin, & McAdam, 2010; Odum, Ward, Barnes, & Burke, 2006); however, if language skills are increased without simultaneously implementing contingencies for non-repetitive responding, stereotypic responding to social questions may still occur.

Typically, behavioral teaching procedures used to increase the use of language in individuals with autism focus on antecedent manipulations intended to increase the frequency with which individuals speak, rather than on the quality and variability of the content of those vocal productions (e.g., Odom, Chandler, Ostrosky, McConnell, & Reaney, 1992; Pierce & Schreibman, 1997; Sarakoff, Taylor, & Poulson, 2001).

Antecedent manipulations have been successful in increasing the frequency with which individuals with autism use language in the following categories: conversational speech (e.g., Sarakoff et al., 2001), empathic responses (e.g., Argott, Townsend, Sturmey, & Poulson, 2008; Buffington, Krantz, McClannahan, & Poulson, 1998), intraverbal responses (e.g., Ingvarsson, Tiger, Hanley, & Stephenson, 2007; Partington & Bailey, 1993), object, preposition, location word combinations (Goldstein & Mousetis, 1989), and reciprocal interactions (McGee, Almeida, Sulzer-Azaroff, & Feldman, 1992), among others.

A widely and successfully used antecedent manipulation is a script-fading procedure. Script-fading procedures involve presenting individuals with written or auditory scripts of appropriate verbal responses related to specific antecedent stimuli. When the individual reliably repeats the script in the presence of an antecedent stimulus, the scripts are faded from the end to the beginning until they are no longer presented. The goal is to transfer stimulus control from the scripts to the antecedent stimuli presented during the teaching procedure. Initially, individuals tend to respond to the antecedent stimulus with the scripted statements presented to them. Then, as scripts are faded, they begin responding with previously scripted statements or may respond with unscripted statements. Unscripted statements are generally defined as verbal responses that differ from the scripts by more than prepositions, conjunctions, articles, pronouns, or changes in verb tense (Krantz & McClannahan, 1993); whereas scripted statements are generally defined as those responses that differ from the current or previously presented script by no more than pronouns, conjunctions, articles, or prepositions (Krantz & McClannahan, 1993). For example, if a presented script had been “I like to go to the

movies" and the individual responds with the statement "I like to go to the park," the statement would be scored as unscripted; however, if the individual responds with "We like to go to the movies," the statement would be scored as scripted. The increase in unscripted statements has been shown to coincide with an increase in the use of novel language in individuals who can and cannot read (Krantz & McClannahan, 1993, 1998; Sarakoff, et al., 2001; Stevneson, Krantz, & McClannahan, 2000).

The successful use of script-fading procedures in building a repertoire of appropriate social responding suggests its use in increasing varied responding. To date, published reports on script fading have not presented data on the variability of successively emitted statements. It is possible that the individuals in those experiments emitted the same few unscripted statements repeatedly in the presence of specific antecedent stimuli. Therefore, we can conclude that script-fading procedures teach appropriate responses in the presence of the trained antecedent stimulus conditions, but cannot determine their usefulness in increasing the varied occurrence of those statements. The present study focused on the application of consequential manipulations once a verbal repertoire had been established using antecedent manipulations. Relatively few studies have specifically targeted varied responding in applied settings; however, the following techniques have been used effectively: extinction, lag schedules, and percentile schedules. Extinction has been used to increase functional manding while decreasing problem behavior in children with autism (Grow, Kelley, Roane, & Schillingsburg, 2008). Extinction is also incorporated into most consequential manipulations, and may contribute to their success by increasing the probability of the

emission of a reinforceable (i.e., varied) response while simultaneously decreasing the probability of a non-reinforceable response.

Several articles have described the use of lag schedules of reinforcement to increase varied verbal responding (Lee, 2006; Lee et al., 2002; Lee & Sturmey, 2006). Under lag schedules, reinforcement is contingent upon a response differing from the immediately preceding *n* responses within a session. Lee et al. (2002) used a lag-1 schedule of reinforcement to increase the variability among responses to the social questions, "What do you like to do" and "How are you?" Lee et al. compared the variability of responding during a condition in which differential reinforcement (DRA) was available for appropriate responding with a DRA plus lag-1 condition. During the DRA condition, all appropriate responding produced reinforcement, whereas reinforcement was contingent on appropriate and varied responding during the DRA plus lag-1 condition. The researchers found that varied responding was emitted when reinforcement was contingent on variability and more stereotypic responding was emitted when reinforcement was contingent on appropriate responses alone. Lee et al. (2002) noted that the effects may have been influenced by the number of preferred stimuli in the experimental environment because many of the responses referred to those stimuli. Lee and Sturmey (2006) extended the findings of Lee et al. (2002) and addressed that concern by manipulating the presence or absence of the lag schedule and the proportion of preferred stimuli in the environment. They found that the lag schedule of reinforcement increased variable responding to the social question "What do you like to do" regardless of the proportion of preferred stimuli present. Lee (2006) further extended the use of lag schedules to increase varied responding in a 3-step conversational exchange between

individuals with autism. Initially, individuals were taught three appropriate responses to each of three conversational statements made by the experimenter. Then, once the responses were learned, reinforcement for responding was placed on a lag-1 schedule of reinforcement. Under the lag procedure, varied responding during all parts of the conversational exchange increased.

Although lag schedules have been used successfully to increase varied verbal responding, it is possible that they do so by strengthening a sequence of responses that is $n + 1$ responses long, rather than generalized variability in responding. For example, if a lag 2 schedule is in effect, the subject can easily obtain all possible reinforcers by simply emitting 3 responses in a fixed sequence. Under this strategy, each of the responses will differ from the previous two. This sequence of responding, in which an individual emits a repetitive sequence of two or more responses that contains just enough variability to produce reinforcement, has been labeled higher-order stereotypy (Lee et al., 2002; Schwartz, 1982). Lee et al. (2002) and Lee and Sturmey (2006) discuss this potential limitation of lag schedules and suggest that it did occur for at least one of the participants in each of their studies.

In the present study, a conjunctive-differential reinforcement procedure that was based on the logic of the percentile schedule of reinforcement was implemented to evaluate its effects on varied responding. In general, a schedule of reinforcement indicates which responses within a class of responses will be reinforced (Catania, 2007). Under a percentile schedule, reinforcement of a particular response is determined by its percentile rank on a given dimension of responding among recently emitted responses. One of the features of a percentile schedule is that the criterion for reinforcement

continuously changes as the distribution of responding changes, thereby maintaining a constant overall density of reinforcement. The criterion is adjusted so that the number of responses expected to meet the criterion relative to the total number of expected responses equals the constant density of reinforcement. The number of responses expected to meet the criterion is determined by a distribution of the organism's recently-emitted responses. Accordingly, the recent behavior of an organism determines which responses in its behavioral repertoire will be reinforced. This type of reinforcement schedule can be used to systematically shape an organism's response repertoire (Galbicka, 1994). An illustration is a study conducted by Kuch and Platt (1976) where a percentile schedule was used to shape longer inter-response times (IRTs) between key pecks in pigeons by reinforcing only the longest IRTs. The IRTs that were reinforced varied as a function of the pigeons' emitted inter-response times: as the pigeons' IRTs became longer, the IRTs that met the criterion for reinforcement changed as well.

As with other schedules of reinforcement, there are variations on the percentile schedule; nevertheless, every variation requires that the experimenter be able to ordinally rank the response being measured on some response dimension (e.g., frequency, duration, rate, etc.). The typical percentile schedule employs the formula, $k = (m + 1)(1 - w)$ to determine the ordinal rank (k) necessary for reinforcement. In this formula, w represents the to-be-programmed probability of reinforcement (density of reinforcement) per response regardless of response topography, m represents the experimenter-defined fixed number of recently-emitted responses that will be used as a comparison distribution, and k represents the ordinal rank out of m that the current response must exceed in order to be considered criterial and reinforced.

Athens, Vollmer and Pipkin (2007) used this formula to help increase the duration of task engagement in children. The experimenters rank ordered the children's most recent durations of engagement in seconds and kept the overall density of reinforcement constant at .50. When the experimenters used the previous 20 observations as the comparison distribution (*m*), the resulting formula was $k = (20 + 1)(1 - .50)$. The result of this formula (10.5) was rounded to a whole number so that the current response had to exceed the duration of the 10^{th} longest response of the previous 20 to be reinforced. Therefore, as the experiment continued, the absolute duration of engagement necessary for reinforcement changed, while the percentile rank a given response was required to exceed remained constant. This procedure led to a significant increase in the duration of engagement in all school subjects. When using this formula, once the experimenter solves the formula and determines the *k* value necessary for reinforcement, no further calculations are necessary. Rather, the experimenter simply has to update the comparison distribution to include only the most recent responses by excluding the least recent response and replacing it with the most recent response (see Galbicka, 1994 for a complete description of percentile schedules).

The parameters of the conjunctive-differential reinforcement schedule used in the current study are based on the logic of the percentile schedule and are similar to those used by Duker and van Lent (1991) in which they omitted reinforcement for the 2 or 3 most frequently emitted gestures by severely retarded individuals. The authors found that when the frequently emitted gestures did not earn reinforcement, the use of the low rate gestures increased. The purpose of this type of schedule is to shape variability in a given response domain of the participants. In addition to the previously described studies, the

percentile schedule has been further used to increase the frequency of variable key press sequences in depressed students (Hopkinson & Neuringer, 2003), adolescents with autism (Miller and Neuringer, 2000), and rats (Wagner & Neuringer, 2006). Additionally, percentile schedules have been used to increase the rate of lever presses in rats (Galbick, Kautz, & Jagers, 1993), the duration of eye contact in children with Fragile X syndrome (Hall, Maynes, & Reiss, 2009), and joystick displacement by rats (Scott & Platt, 1985), among other responses (Arbuckle, & Lattal, 1992; Lamb, Morral, Galbicka, Kirby, & Iguchi, 2005; Lamb, Kirby, Morral, Galbicka, & Iguchi, 2004; Machado, 1989; Platt & Scott, 1981).

The percentile schedule has been described as a precise way of shaping behavior (Galbicka, 1994) that, like shaping, uses the principles of reinforcement and extinction. The basic premise of the percentile procedure is similar to that of shaping: a response must occur before it can be reinforced. Therefore, responding that meets the criterion for reinforcement must be within the organism's current behavioral repertoire (Athens et al., 2007) which may be expanded as a result of extinction-induced variability (Leslie, 1996). Additionally, as in shaping, successive approximations to a terminal response are reinforced under the percentile schedule. While shaping has been described as more of an art form than a science (Galbicka, 1994), percentile schedules systematically manipulate the parameters necessary for shaping a response and accommodating individual changes in behavior. Because the criterion for reinforcement is relative rather than absolute, as behavior changes and the comparison distribution contains different values, the requirement for reinforcement will change as well. While percentile schedules have been shown to be effective in a number of response domains, the

applicability of a percentile schedule in shaping varied verbal responding by individuals with autism has not been investigated.

The present study incorporated the logic of the percentile schedule by changing the criterion for reinforcement after every session, thereby requiring the individuals with autism to emit less probable verbal responses. This modification to the typical percentile schedule makes the procedure easier to apply in a clinical setting because clinicians do not have to re-rank language responses after every trial, a procedure that rarely would be possible. The present differential reinforcement procedure is similar to the schedule used by Duker and van Lent (1991) in which reinforcement was arranged based on ordinal ranking of response frequency for all appropriate responses to a given antecedent stimulus. Rather than calculating a criterion for reinforcement many times during a session, the reinforcement criterion was determined one time for each session. Prior to a given session, all emitted appropriate responses for the prior two sessions were ranked in order of frequency, and the two most frequently emitted responses were ineligible for reinforcement. As a result of this modification, the procedure did not maintain a constant density of reinforcement throughout sessions as the typical percentile schedule does. Although the criterion for reinforcement systematically changed, it did so one time prior to each session rather than prior to each trial. In addition to meeting the modified percentile requirement, responding was also subject to a lag-1 schedule of reinforcement under a conjunctive schedule of reinforcement. The lag schedule was used to prevent the repetitive emission of a single criterial response during sessions. Under the resulting conjunctive schedule, individuals were required to emit a minimum of two responses that were different from the most frequently emitted responses during a given session.

Method

Participants, Setting, and Materials

Participants included 5 children and adolescents between the ages of four and 14 years who had been diagnosed previously with autism by an independent agency. These children and adolescents attended a private school for individuals with autism in northern New Jersey. Individuals who were chosen to participate could tact items and mand for items in his/her environment, showed a history of repetitive responding to social questions, and engaged in minimal conversational skills. Each participant had either experience with script-fading or the prerequisite skills for script-fading to be successful. Theresa was a 4-year-old girl who engaged in minimal conversational exchanges consisting of 4-word utterances. She did not have experience with script-fading procedures; however, any verbal interactions were controlled by her full-day activity schedule or by an instructor's prompts. Theresa also engaged in some tantrum behavior consisting of crying when she was denied access to a preferred item or activity. Alex was a 7-year-old boy who had experience with script-fading procedures, but typically emitted stereotyped responses to antecedent stimuli and spoke in a low volume. Alex's verbal responses typically consisted of 3-5 word mands for earned reinforcers. Alex frequently became distracted by other children in his environment and required constant prompting to remain on task. Amanda was a 13-year-old adolescent girl who responded to questions with 2-4 word utterances and had experience with script-fading. Amanda's scripts typically consisted of 4-5 word phrases that would be used to answer social or personal information questions. She also engaged in aggressive and tantrum behavior that consisted of yelling and grabbing instructors. Theo was a 13-year-old adolescent boy

who had an extensive history with script-fading, but typically emitted stereotyped responses in the presence of verbal antecedent stimuli. This pattern of responding occurred to such an extent that he would emit age-inappropriate responses that he was taught years earlier. Theo could emit long sentences that included information about where he was going and what he was going to do. Jeff was a 14-year-old adolescent boy who frequently engaged in reciprocal conversational exchanges and had an extensive history with script fading. Although he engaged in conversation, his responses were often stereotyped and consisted of the same phrases organized in a varying order. Sessions took place in each participant's classroom at the school and the room was occupied by the child or adolescent, his/her teacher, the experimenter, and other students and their teachers. Other materials in the room included a table, chairs, shelving, and a Language Master® device.

Two other groups of subjects also participated. Eight (two for each participant) age-matched typically-developing peers provided data for a measure of social validity of the behavior change observed for the individuals. The peers attended public and private schools for typically developing children in New Jersey. In addition, parents and teachers of the children and adolescents with autism were asked to complete questionnaires designed to collect a measure of social validity related to the practicality of the teaching procedure that was used with their children/students. All participants were treated according to the ethical principles of the American Psychological Association.

Experimental Design

The presence or absence of a conjunctive-differential reinforcement schedule was manipulated under a multiple-baseline-across-subjects experimental design.

Antecedent Stimuli and Scripted Responses

On each trial during all conditions, an antecedent stimulus was presented to the participants and their responses were recorded. Five antecedent stimuli were presented in each session. One stimulus ("*What do you like to do?*") was presented on the first trial only. On the subsequent trials, one of four other antecedent stimuli that included the clause "*else do you like to do*?" were presented in a block-randomized order in 4-trial blocks, with a new random order used in each session. The following stimuli were used: "*What else do you like to do*?", "*Is there something else you like to do*?", "*Anything else you like to do*?", and "*Tell me something else you like to do*."

To ensure that each participant possessed a sufficient verbal repertoire for varied verbal responding to occur, prior to the experimental procedure, five auditory scripted responses to the four antecedent stimuli were taught to them under the script-fading procedures described below. The scripted responses were individualized to match the activities preferred by each individual with autism (see Appendix A). Parents and teachers were asked to complete a questionnaire by reporting five activities in which the child or adolescent typically engaged (see Appendix B). Parents' and teachers' responses were combined; if more than five activities were listed, five were randomly selected to be included as scripts. Stimulus presentation occurred in 5 four-trial blocks in which the scripted responses were randomly paired with each of the antecedent stimuli with the exception that each stimulus-response pair could not occur more than once.

Response Definitions

Participant responses to the antecedent stimuli were classified as follows. *Appropriate responses* were defined as a response that referred to a socially acceptable activity (Lee, McComas, & Jawor, 2002). *Varied responses* were defined as an appropriate response that referred to a different activity from those included in the two most frequently emitted responses during the previous two sessions, and from the response emitted in the previous trial. Responses were scored as *scripted responses* if they exactly matched any previously presented script or if they differed from any script only by conjunctions, articles, prepositions or pronouns (Krantz & McClannahan, 1993). Responses were scored as *unscripted responses* if they were grammatically correct, socially acceptable, and differed from any previously-presented script by more than conjunctions, articles, prepositions, or pronouns (Krantz & McClannahan, 1993). A *novel response* was defined as a response that referred to an activity that had never been named by the participant in the experimental context and had not been taught in script-fading sessions. The foregoing response categories were not mutually exclusive. For example, unscripted responses could also qualify as varied responses and novel responses, by definition, were also unscripted.

Procedure

General procedure. During all sessions, regardless of condition, the experimenter met the participants in his/her classroom and sat facing him/her at a distance of approximately 1.5 meters. The experimenter initiated trials by obtaining eye contact from the participant by orienting his or her face so that eye contact was obtained. Then, during the first trial, the experimenter presented the initial antecedent stimulus

(“*What do you like to do?*”). If the participant emitted an appropriate response (e.g., “*Ride my bike”*), the experimenter presented a typical verbal statement (e.g., *that’s a fun thing to do*). If no response occurred within 5s, the trial was terminated. After either of these outcomes, a new trial was presented. During all subsequent trials, one of the four remaining antecedent stimuli was presented based on the predetermined block randomization (see *Antecedent Stimuli and Scripted Responses*, above). After the participant responded, a consequence that depended on the experimental phase in effect was presented and the response was recorded. Consequences could include verbal praise consisting of 1 of 4 statements that may be emitted by individuals in the natural environment. These statements included “*That was something different!*”, *That’s an interesting thing to say!*”, “*It’s nice you said something different!*”, or *Good, you said something different!*” Other consequences were secondary reinforcers in the form of points or tokens (depending on the participant) that could be exchanged for preferred snacks or activities. During all experimental conditions, if the participant emitted a reinforceable appropriate response that was grammatically incorrect, the participant was corrected using a verbal prompt. When the grammatically correct verbal prompt was imitated (this was always the case), the response was reinforced. Next, the experimenter waited for a 10-s inter-trial interval (ITI) to elapse, and presented the next antecedent stimulus. The 10-s ITI was shortened to 0 s after session 24 for Amanda because she developed a chain of responding that prevented reinforcement of some varied responses (see *Conjunctive-differential reinforcement schedule procedure* for further explanation). Sessions consisted of 21 trials, lasted approximately 15 minutes, and were conducted 5 days per week.

Script-fading pre-training. Prior to the experimental procedures, five auditory scripted responses to the antecedent stimuli (described above) were taught to the participants using a Language Master device®. Each antecedent stimulus was followed, after 1 s, by one auditory script recorded on a Language Master ® card. Tokens and verbal praise/statements were presented contingent on emitting a scripted response. If no response was emitted within 5 s, the trial was terminated. Full scripts were presented until the participant responded with a scripted statement during 100% of all trials for 3 consecutive days. Then, script fading across 4 steps for all scripts began. The scripts were shortened by reducing the number of letters in the recorded script as follows: Step 1 involved shortening the script by removing 1/3 of the letters from the end of the script. In step 2, another 1/3 of the original letters from the end of the script were removed resulting in a script that had 2/3 of the letters removed. During step 3, a blank Language Master® card was presented, and in step 4 no Language Master ® card was presented, but the Language Master machine was present. For example, for the following script, "Go to the movies" would be reduced in step 1 to "Go to the mo", in step 2 to "Go to", and in step 3 to " ". In step 4, no card was presented. During script-fading, each participant remained on steps 1-3 until they responded with an appropriate statement during 80% of their opportunities to respond for 2 consecutive sessions. Participants remained on step 4 until they responded with an appropriate statement during 80% of their opportunities to respond for one session.

Baseline procedure. The first five trials of each experimental session were *script refresher trials*: the procedures for Step 2 of the script-fading procedure were used and scripts were randomly paired with the five antecedent stimuli (the initial antecedent

stimulus and the four stimuli containing the clause *"else do you like to do"*). No scripts were presented on subsequent trials. Following the script refresher trials, data collection began with the experimenter presenting antecedent stimuli that included the clause *"else do you like to do"* in block-random order for 16 trials, and recording the participants' responses. The experimenter presented tokens/points and verbal praise for all appropriate responses to the antecedent stimuli. An inappropriate response terminated the trial.

Conjunctive-differential reinforcement schedule procedure. Session structure under the conjunctive schedule procedure was identical to that of baseline, with the first five trials being refresher trials and the stimuli being block randomized. Prior to each session, the criterion for reinforcement was determined by ordinally ranking the responses emitted by each of the participants during the previous two sessions according to the frequency of response emission. Responses that referred to the same activity were treated as the same response regardless of the format of the statement (e.g., *watch a movie* and *watch movies at home*). Reinforcement in a given session was available for responses that were ordinally ranked 3 or lower in the prior sessions in accord with the modified percentile requirement; thus criterial responses could change between sessions. In accord with the lag-1 requirement, only responses that were different from the previous trial could be reinforced. Reinforcement included tokens/points and verbal praise. If the participant emitted a response that was ordinally ranked 1 or 2 or was repeated from the previous trial, the experimenter implemented a correction procedure by telling the participant, "you have to say something different", averted his gaze to score the data, and terminated the trial.

The experimenter was required to modify the procedure by decreasing the 10-s ITI to 0 s for Amanda. The modification was required because Amanda developed a chain of responding that occurred after the correction procedure was implemented. When the experimenter implemented the correction procedure after a non-criterial response, Amanda would immediately emit a varied response during the ITI. Because the response occurred during the ITI, it could not be reinforced. Therefore, the ITI was decreased to permit the reinforcement of all varied responding.

Pre- and post-test procedure. Two pre- and two post-test sessions were conducted immediately before baseline and after the final session of the conjunctive schedule conditions respectively. Procedures during these sessions were identical to those during baseline. During one of the pre- and post-test sessions, a novel adult presented the antecedent questions to the participants and recorded their responses. During the second of these sessions, the antecedent questions were presented by the experimenter in a novel setting within the school.

Follow-up. One month after participants met a performance criterion--at least seven days in the current intervention with either two ascending data points above baseline levels or 2 consecutive days above 80% of opportunities meeting the conjunctive schedule requirement--follow-up sessions were conducted to measure the maintenance of the newly-acquired skill over time. The performance criterion was established post hoc as it became apparent to the experimenter that although some of the participants showed improvement over baseline, the originally planned criterion of completion of training of 2 consecutive days with above 85% of opportunities meeting the conjunctive schedule criterion would not be met. The procedures for the follow-up sessions were identical to

baseline procedures where tokens and verbal praise were presented for appropriate responses regardless of their history of emission.

Social Validity

The effectiveness and practicality of the teaching procedure was assessed by a survey presented to the participants' teachers and parents. The survey included a brief description of the experimental procedures and questions regarding the usefulness of the procedure and the ease of its use in a school or home setting (see Appendix C). The social validity of the behavior change observed in the participants was assessed by comparing the number of different activities reported by typically developing individuals being presented with the same antecedent stimuli under baseline procedures during one session to the mean number of different activities per session emitted by individuals with autism averaged across the last five sessions from each experimental condition.

Procedural Integrity

During approximately 19% of sessions, an observer other than the experimenter recorded the following measures on the correct implementation of the independent variable: establishment of eye contact prior to the presentation of the antecedent stimulus, appropriate and correct presentation of the four antecedent stimuli, presentation of the script during script fading and refresher trials, correct presentation of reinforcement according to the reinforcement schedule in effect during the session, and the implementation of the correction procedure for grammatically incorrect responding. The mean percentage of correctly implemented measures was 99.98%. The mean percentages for each participant and each phase can be seen in Table 1.

Inter-Observer Agreement

Inter-observer agreement (IOA) was measured on a point-by-point basis during approximately 26% of all sessions within each experimental phase. Data were collected on the following measures: procedural integrity, as described above, verbatim responses emitted by the participants, scripted and unscripted responses, and variable responses. Inter-observer agreement was calculated as a percentage of observations in which the two observers agreed. The mean percentage agreement across all participants was 98.7% (range: 96%-100%). The data for each phase and for each participant are displayed in Table 1.

Results

The introduction of the conjunctive-differential reinforcement schedule increased the use of appropriate varied verbal responses to the antecedent social questions for all participants. Figure 1 displays the percentage of responses emitted by each participant that met the conjunctive schedule criterion. The functions show that for all participants, responding met the conjunctive schedule requirement at low levels during baseline sessions. Jeff and Theresa showed a descending baseline trend while Theo showed some variability during baseline sessions at a moderate level. With the successive introduction of the conjunctive schedule across participants, the percentage of responses that met the schedule requirement increased above baseline levels for each participant, while responding did not increase or increased inconsistently (Theo) for the untreated participants.

Amanda showed an initial increase in the percentage of responses that met the conjunctive schedule requirement; however, the percentage began decreasing after seven sessions and continued to decrease to low levels that were still above baseline levels. The decrease in responding coincided with Amanda immediately responding with a varied response after the correction procedure during the 10-s ITI. Therefore, the 10-s ITI was decreased to 0s and with the introduction of this change, the percentage of responses that met the schedule criterion steadily increased to a maximum of 69%.

The effect of the introduction of the conjunctive schedule was evaluated by a Mann Wald procedure comparing the percentage of responses meeting the conjunctive schedule requirement during the last 5 sessions of each condition for all participants. As shown in Table 2, the comparisons between baseline and the conjunctive schedule

conditions show a significant difference between the levels of responding in all participants except Theo, whose data will be discussed later. Additional comparisons were also conducted for Amanda during the conjunctive schedule with a 10-s ITI and a 0-s ITI and show a significant difference between the levels of responding.

Figure 1 also shows the percentage of responses meeting the conjunctive schedule criteria during pre- and post-test sessions conducted under baseline conditions with another adult and in another setting (squares and triangles respectively) for each participant. Jeff, Amanda, and Theo showed increases in the percentage of responses meeting the conjunctive schedule criterion to another adult and in another setting in a post-test when compared to their pre-tests in the same conditions. Theresa showed no change in the percentage of responses meeting the conjunctive schedule criterion to another person from a pre- to a post-test and showed a decrease in the percentage in another setting. Alex showed an increase in the percentage of responses between the pre- and post-tests with another adult, but showed no increase in another setting. Follow-up data collected under baseline conditions show that all of the participants except Theresa emitted responses that met the conjunctive schedule requirement above baseline levels after one month without practice.

Figure 2 shows a comparison between the percentage of responses meeting the conjunctive schedule requirement (closed circles) and the percentage of responses meeting the lag-1 requirement, but not the conjunctive requirement (open circles). Responding that met only the lag-1 requirement occurred when the participants did not repeat the same response during successive trials, but emitted one of the 2 most frequently emitted previous responses from the prior sessions. Responses that met only

the lag-1 requirement occurred at higher levels than those that met the conjunctive schedule requirement for 5 participants, with the exception of Alex's performance during baseline where he repetitively emitted a single response. The percentage of responses meeting the lag-1 requirement generally followed the same trend (decreasing, increasing, or stable) as those meeting the conjunctive schedule requirement during both baseline and treatment conditions.

The percentage of criterial and non-criterial responses scored as scripted (closed symbols) and unscripted (open symbols) per session is displayed for each subject in Figure 3. Some responses emitted by each of the particpants are not displayed because a response that was determined to be inappropriate was scored as neither scripted nor unscripted. As a result, scripted and unscripted data points plotted for a given session do not sum to 100% in all cases. Three of the 5 participants (Theresa, Amanda, and Theo) responded almost exclusively with scripted responses for the duration of the experiment. Once the conjunctive schedule was introduced, Jeff began responding with primarily unscripted responses and continued to do so for the duration of the study. Alex mainly responded with scripted statements during baseline sessions, but used both scripted and unscripted statements when the conjunctive schedule was in effect. This pattern of responding continued during the post-test in another setting, but reverted back to the baseline pattern of responding during the post-test with another adult.

Table 3 shows the mean variability scores and range of scores for all responses (criterial and non-criterial) during the last five sessions of each experimental condition for each participant. Variability scores were calculated for a given response by counting the number of consecutive trials that occurred since the last occurrence of that response,

either in the current or prior sessions. Responses that referred to the same activity were considered the same response. A response that had not occurred previously (novel response) was not given a variability score. The mean and range of variability scores across all responses during the last five sessions of each condition are presented. Across all the participants, the average variability scores during baseline were low and increased in all participants except Theo after the implementation of the conjunctive schedule. The average variability score for Theo decreased from baseline to treatment and will be discussed further below. The average variability score for Amanda increased further when the ITI was decreased to 0 s. Variability scores remained at or above baseline levels during follow-up sessions for all participants.

The level of the variability scores from the last five sessions of baseline and each treatment condition were compared using a Mann Wald procedure. The results can be seen in Table 4. Four of the 5 participants showed a significant difference in the average variability scores between baseline and treatment conditions. Amanda did not show a significant difference between baseline and the conjunctive schedule condition with a 10-s ITI, but did show a significant difference between baseline and the conjunctive schedule condition with a 0-s ITI. Again, Theo was the only participant who did not display a significant difference between conditions.

The participants' responses were analyzed to determine whether each response was sequentially dependent on any other response by calculating the probability that a given response was followed by any other possible response (Lyons & Cheney, 1984). Sequential probabilities for four participants can be seen on Tables 5-8. All responses emitted by a given participant were assigned a numeric value. The column on the left

side of each table displays all initial responses in a pair of responses, while the top row displays all possible subsequent responses. The intersection of the rows with the columns displays the probability that the initial response was followed by a given subsequent response. For example, Table 5 shows that Alex emitted a single response during baseline sessions; as can be seen by the obtained probability of 1.0 for response 1 followed by response 1. The sequential probabilities show that responding during baseline consisted primarily of each participant emitting responses in a relatively small number of high probability combination. For example, there was a .82 probability that response 1 was followed by response 2 during baseline for Amanda (Table 7). Conversely, the more even distribution of probabilities during the conjunctive schedule for all subjects suggests that responding became more varied with a wider variety of response combinations being emitted. For example, the initial 1 response was followed by responses 1, 2, 3, and 4 during the conjunctive schedule with probabilities of .37, .13, .32, and .18 respectively for Amanda (Table 7).

Table 9 displays the sequential probabilities for Jeff's responding in a different format from that use for the previous participants because Jeff emitted 34 different responses during the experimental conditions as opposed to five or six emitted by the other participants. The columns are labeled by condition (baseline or conj schedule), initial and subsequent response (R1/R2), and the frequencies of the subsequent and initial response (F2/F1). Responses are ordered based on condition and the frequency of emission. Therefore, the most frequently emitted response during baseline (response 3) is presented first with each subsequent response (1, 2, 3, 4, & 5) that occurred with it. The data show that responding during baseline was limited to a small array of responses and

response combinations. This pattern of responding can be seen in Table 9, which shows that response 3 occurred 61 times and was followed by either response 1 or 3 during 49 of those occurrences. On the other hand, responding during the conjunctive schedule was more varied and can be seen in Table 9 where response 3 occurred only 8 times and was followed by responses 12, 5, 3, 7, and 19.

Figure 4 displays the average number of different responses emitted during the last five sessions of baseline and treatment compared with the number of different responses emitted by a male and female typical peer under baseline conditions during one session. All participants except Theo, emitted an increased number of different statements during conjunctive schedule procedures compared to baseline procedures; however the increased number did not approach the number emitted by typical peers for any participant except Jeff. In comparison to individuals with autism, typically developing peers emitted a wider variety of responses under the baseline procedures.

The cumulative number of novel responses across all conditions for each of the participants is shown in Figure 5. During script-fading sessions, Jeff and Theresa did not emit any novel responses, while Amanda emitted two novel responses, Alex emitted one, and Theo emitted four novel responses. None of the participants emitted a novel response during baseline sessions. With the implementation of the conjunctive schedule, Jeff emitted 30 novel responses, Theresa and Alex emitted 1 novel response, Theo did not emit any novel responses, and Amanda emitted one novel response, but only after the ITI was decreased to 0 s. Altogether, Jeff emitted 34 novel responses, Theresa emitted 1 novel response, Amanda emitted 3 novel responses, and Alex and Theo each emitted 4 novel responses.

The results of the social validity survey presented to parents and teachers of the children and adolescents with autism suggest that the procedure would be useful and applicable in a school or home setting. All but one teacher out of four responded affirmatively to all of the questions on the survey. One teacher responded negatively to questions four and five regarding whether the teacher could implement the procedure in school and whether the procedure would increase the use of a variety of verbal responses. That same teacher commented that the procedure "was functional to teach varied language responses," but also increased frustration and/or confusion for the adolescent she observed. All but one parent out of five responded affirmatively to all of the questions. One parent did not respond to questions three and five commenting that she would need more information about the procedure to answer those questions.

Discussion

A conjunctive-differential reinforcement schedule was used to increase varied verbal responding to a class of antecedent stimuli in five individuals with autism. The results indicate that the schedule effectively increased the level of varied responding from baseline to intervention conditions in all participants only when the conjunctive schedule was introduced. The significant Mann Wald results provide further support for the effectiveness of the treatment procedure. The post-test data suggest that, for some students, responding was not sensitive to changes in experimenter or experimental setting, but endured across different settings and individuals. The maintenance of responding in all participants except Theresa and Theo during follow-up sessions suggests that varied responding to the antecedent stimuli presented in the study may have become part of their behavioral repertoires.

It has been suggested that individuals with autism will continue to respond repetitively even though they have a sufficient response repertoire to prevent repetition from occurring (Lee et al., 2002). Baseline results support this statement. Participants were taught a repertoire of appropriate responses to the antecedent stimuli before baseline conditions using script-fading procedures, but emitted repetitive responses during those sessions. This tendency can be seen in the analysis of sequential dependencies between responses (Tables 5-9), the percentage of responses meeting the conjunctive schedule requirement (Figure 1), and variability scores during baseline conditions (Table 3). Previous research (Lee, 2006; Lee et al., 2002; Lee & Sturmey, 2006) has shown that individuals with autism can learn to vary their responses under lag schedules of reinforcement; however, the authors of these studies suggested that the resulting

responses may have been a form of higher order stereotypy. The use of the conjunctive schedule increased varied responding while eliminating or reducing higher order stereotypy, as indicated by the more equal distribution of sequential probabilities across responses from baseline to conjunctive schedule conditions and increased variability scores. The use of the lag-1 requirement within sessions discouraged participants from emitting repetitive responses during sessions and combined with the modified percentile component, discouraged participants from learning patterns of responses that may have led to higher order stereotypic responding.

Although the current procedure effectively increased varied responding in 4 of the 5 participants, it may not have been effective with Theo. He is the only participant who showed a decreased variability score from baseline to treatment sessions. This decrease occurred because Theo developed a pattern of responding that can be described as higher order stereotypy. The pattern Theo developed during baseline included emitting the responses of the five refresher trials in the order they were presented during the subsequent trials. Then, when the conjunctive schedule was introduced, Theo initially emitted the five responses of the five refresher trials, and then omitted the two responses that were not reinforced. Had the refresher trials not been presented, this pattern of responding may not have emerged, and more varied responding and novel responses may have been emitted. The intended purpose of the refresher trials was to ensure that the participants possessed a repertoire of appropriate responses that would support varied responding. Alternatively, the refresher trials may have strengthened the five responses that were taught during script-fading sessions and reduced the tendency to respond with variable and/or novel statements.

In addition to increased varied responding, novel responses were observed during script-fading and the conjunctive schedule conditions. In contrast with some previous research (e.g., Sarakoff et al., 2001; Krantz & McClannahan, 1998), all participants did not emit novel responses during script-fading sessions, and the participants who did emit novel responses did not continue to use those responses once baseline sessions began. A possible basis for the present observations is that the participants were not taught a sufficient number of scripts. Krantz and McClannahan (1993) taught participants 10 scripts when they reported novel language. Conversely, participants did not emit novel responses when only two scripts were taught by Argott et al. (2008). Another possible rationale for the discrepancies noted is that verbal models of potential verbal responses are typically emitted by instructors after a scripted response is emitted by individuals with autism (Krantz & McClannahan, 1998). This did not occur during script-fading procedures in the current study. When instructors model alternative responses to scripted statements, children and adolescents may emit them alone or in combination with scripted statements to form novel responses. As the experimenter did not model alternative responses, participants did not have the opportunity to combine those statements to produce novel and/or varied responses. Extensions on the current research may manipulate the presence of the modeled responses to evaluate whether those changes may influence the percentage of variable and novel responses that are emitted by children and adolescents with autism.

Novel responding was also observed during the conjunctive schedule procedures in 4 of the 5 participants. Although 3 of the 4 participants who emitted novel responses during the schedule emitted only one or three, Jeff emitted 30 novel responses when the

schedule was in effect. It was noticed that Jeff appeared to use a mediating response to identify novel activities. The mediating responses consisted of visually scanning the room for stimuli he played with (e.g., Jenga) or identifying activities he had previously engaged in with his family (e.g., Ski in Colorado). Theresa and Alex also appeared to use the same mediating responses to a lesser extent as they emitted only one and three novel responses respectively. The strategy of scanning the room for stimuli was also reported by Lee et al. (2002). The authors suggested that the novel responses emitted in their study were actually mands for items in the environment; the participants in the study chose to exchange their tokens for the items included in their responses. Therefore, Lee et al. suggested that the lag schedule increased varied responding, but the environment led to novel responses. Conversely, the novel responses emitted in the current study are not believed to be mands as the participants did not exchange their tokens for the items included in their responses. The current observations suggest that the participants were actually responding to the antecedent stimuli rather than manding for preferred items.

Although post-test and follow-up data levels were typically higher than those during baseline sessions, there was a decrease in the percentage of criterial responses below intervention levels in all participants except Jeff. This decrease suggests that varied responding may have come under the stimulus control of the experimenter or setting as well as the programmed schedule of reinforcement. The observed pattern illustrates the necessity for a modification of the procedures for thinning the schedule of reinforcement in order to prevent participants from identifying when the differential reinforcement schedule is in effect. Future elaborations may experimentally fade the

schedule to determine how many steps are necessary to transfer stimulus control from the schedule of reinforcement to the natural contingencies in the environment.

The comparisons between the individuals with autism and their typically developing peers suggest that modifications are necessary to increase varied responding to typical levels. Although varied responding increased in individuals with autism, they did not compare to their typical peers. Interestingly, the differences between the numbers of different responses may have been due to the typical peers assuming that a different response was required for every trial when it was not. Once sessions were concluded, many of the typical peers stated that it was difficult to come up with different activities for all trials, even though the experimenter stated before the sessions began that they could repeat responses if they chose to do so. Based on these observations, it seems that typical peers may assume variability is required when they are repeatedly presented with a single class of antecedent stimuli. This is in contrast to individuals with autism who, during baseline, continuously emitted the same responses under the same procedures. The difference between the groups may be a characteristic of autism or one that is taught. Individuals with autism are routinely presented with massed trials in which a single response is always reinforced. The massed trials may teach individuals with autism to respond stereotypically to an antecedent stimulus rather than vary their responses. Practitioners may keep this idea in mind when teaching individuals with autism and possibly replace massed trials with interspersed trials of different programs.

As this is the first study to use a reinforcement schedule based on percentile schedule procedures to increase variability in language, the applicability of its use in applied settings remains to be determined. Modifications to the typical percentile

schedule, eliminating calculations and trial-by-trial re-ranking, make it more practical to use in a school or home setting compared to the typical percentile schedule. Responses provided by parents and teachers of the participants support this statement. The majority of parents and teachers indicated that they felt the procedure could be implemented in their typical setting and would successfully increase variability without much effort on their part. Nevertheless, one teacher did suggest that the procedure could not be implemented in school and would not increase varied verbal responding. This teacher also commented that the adolescent she observed seemed confused or frustrated. The level of frustration observed by the experimenter did not seem any greater than the level observed when an extinction procedure is implemented or reinforcement is not obtained for an incorrect response during daily academic programs. Therefore, responses suggesting frustration might be expected during this procedure, as it includes extinction of high-probability responses. Moreover, the data do not support the assertion that the procedure would not be effective; all participants showed an increase in varied responding with the implementation of the conjunctive schedule. Nevertheless, the correction procedure may be altered to ensure that the criteria for reinforcement are salient to all individuals, thereby reducing the potential for further frustration or confusion.

To further assess the effectiveness and/or necessity of the modified percentile component of the conjunctive-differential reinforcement schedule, future researchers may conduct a component analysis comparing the effects of a lag -1 schedule alone with the current conjunctive schedule. Additionally, researchers may compare the effects of a lag-2 or lag-3 schedule with the effects of the current conjunctive schedule. A limitation of

the current study is the post-hoc determination of the exit criterion. As a result, three participants encountered additional training trials after the criterion was met which may limit confidence in the follow-up data. Nevertheless, the follow-up data may not be compromised because the follow-up sessions for all participants were conducted one month after that final training session regardless of whether it coincided with the final data point. Further research may manipulate the ITI to determine whether the conjunctive schedule would be effective with a more natural delay between stimulus presentations. As this procedure proved effective in increasing varied responding in individuals with autism to a class of antecedent stimuli asking "What do you like to do," the applicability of this procedure to increase varied responding to different antecedent stimuli and in conversational exchanges seems a logical next step. These additions could be used to increase the social validity of the procedure by allowing researchers to teach a variety of responses to different classes of antecedent stimuli simultaneously. This change would allow the researchers to present a variety of stimuli during training trials making sessions more conversational.

Table 1

Inter-Observer Agreement (IOA) and Procedural Integrity Data during Experimental Conditions for all Participants

Participant	Condition	Mean IOA %	Procedural Integrity
Jeff	Baseline	97%	100%
	Conj	98%	99.8%
Theresa	Baseline	100%	100%
	Conj	100%	100%
Amanda	Baseline	100%	100%
	Conj	96%	100%
	0s ITI	99%	100%
Alex	Baseline	99%	100%
	Conj	97%	100%
Theo	Baseline	100%	100%
	Conj	100%	100%

Note. Conj= Conjunctive-differential reinforcement schedule;
0s ITI = conjunctive schedule with a 0s inter-trial interval

Table 2

Mann Wald Results Comparing the Percentage of Responses Meeting the Conjunctive Schedule Criteria across Conditions for all Participants.

Participant	Conditions Compared	F-value
Jeff	Baseline-Conj	7.54**
Theresa	Baseline-Conj	2.01*
Amanda	Baseline-Conj	12.77**
	Baseline-0s ITI	2.14*
	Conj-0s ITI	1.44*
Alex	Baseline-Conj	2.57**
Theo	Baseline-Conj	.54

Note. Conj = Conjunctive-differential reinforcement schedule; 0s ITI = Conjunctive schedule with a 0s inter-trial interval
* = $p<.05$; ** = $p<.01$

Table 3

Means and Range of Variability Scores Across Conditions for all Participants

Subject	Condition	Mean	Range	Number of Trials
Jeff	Baseline	3.98	0-32	80
	Conj	17.76	1-195	67
	Follow-up	44.08	8-175	12
Theresa	Baseline	1.91	0-25	79
	Conj	3.71	0-37	79
	Follow-up	3.56	0-37	16
Amanda	Baseline	.99	0-2	80
	Conj	2.66	0-45	80
	0s ITI	4.72	0-24	79
	Follow-up	5.31	1-40	16
Alex	Baseline	0	0	80
	Conj	2.65	0-29	78
	Follow-up	2.06	0-17	16
Theo	Baseline	4	0-11	80
	Conj	3.94	0-17	80
	Follow-up	4	1-6	16

Note. Conj = Conjunctive-differential reinforcement schedule;
0s ITI = Conjunctive schedule with a 0s inter-trial interval

Table 4

Mann Wald Results Comparing the Mean Variability Scores across Conditions for each Participant.

Participant	Conditions Compared	F value
Jeff	Baseline-Conj	.047**
Theresa	Baseline-Conj	.03*
Amanda	Baseline - Conj	.010
	Baseline – 0s ITI	.033*
	Conj – 0s ITI	.002
Alex	Baseline-Conj	.083**
Theo	Baseline-Conj	.0002

Note. Conj = Conjunctive-differential reinforcement schedule;
0s ITI = Conjunctive schedule with a 0s inter-trial interval
* = p<.05; ** = p<.01

Table 5

Sequential Probabilities between all Possible Response Combinations during Baseline and Conjunctive-differential reinforcement schedule Conditions for Alex. Initial response in rows and following response in columns.

Responses	1		2		3		4		5	
	BL	Conj	BL	Conj	BL	Conj	BL	Conj	BL	Conj
1	1.0	.49	0	.20	0	.16	0	.16	0	0
2	-	.22	-	.10	-	.49	-	.10	-	.10
3	-	.17	-	.54	-	.14	-	.11	-	.03
4	-	.59	-	.18	-	.18	-	.06	-	0
5	-	0	-	.63	-	0	-	0	-	.37

Note. BL=Baseline; Conj=Conjunctive-differential reinforcement schedule. Dashes were used when a given initial response did not occur.

Table 6

Sequential Probabilities between all Possible Response Combinations during Baseline and Conjunctive-differential reinforcement schedule Conditions for Theresa. Initial response in rows and following response in columns.

Responses	1		2		3		4		5		6	
	BL	Conj	BL	Conj	BL	Conj	BL	Conj	BL	Conj	BL	Conj
1	.44	.32	.17	.01	.03	.07	.30	.26	.06	.31	0	.02
2	.56	.11	.06	.11	.31	.11	.06	.67	0	0	0	0
3	.44	.14	0	.07	0	.11	.22	.32	.33	.21	0	.14
4	.43	.33	.04	.05	.02	.08	.48	.36	.04	.13	0	.06
5	.30	.31	.10	0	.10	.06	.40	.37	.10	.16	0	.09
6	-	.11	-	0	-	.22	-	.28	-	.33	-	.06

Note. BL=Baseline; Conj=Conjunctive-differential reinforcement schedule. Dashes were used when a given initial response did not occur.

Table 7

Sequential Probabilities between all Possible Response Combinations during Baseline and Conjunctive-differential reinforcement schedule Conditions for Amanda. Initial response in rows and following response in columns.

Responses	1			2			3			4			5			6		
	BL	10s	0s	BL	10s	0s	BL	10s	0s	BL	10s	0s	BL	10s	0s	BL	10s	0s
1	.17	.37	.15	.82	.13	.15	.01	.32	.08	0	.18	.43	0	0	.15	0	0	.02
2	1.0	.19	.13	0	.30	.33	0	.37	.22	0	.15	.20	0	0	.09	0	0	.02
3	1.0	.02	.14	0	.14	.14	0	.40	.19	0	.26	.50	0	0	.02	0	0	0
4	-	.10	.26	-	.10	.25	-	.49	.27	-	.32	.08	-	0	.15	-	0	.02
5	-	-	.30	-	-	.04	-	-	.07	-	-	.22	-	-	.19	-	-	.19
6	-	-	.18	-	-	.09	-	-	0	-	-	.27	-	-	.18	-	-	.27

Note. BL=Baseline; 10s=Conjunctive-differential reinforcement schedule; 0s=Conjunctive schedule with a 0s ITI. Dashes were used when a given initial response did not occur.

Table 8

Sequential Probabilities between all Possible Response Combinations during Baseline and Conjunctive-differential reinforcement schedule Conditions for Theo. Initial response in rows and following response in columns.

Responses	1		2		3		4		5	
	BL	Conj	BL	Conj	BL	Conj	BL	Conj	BL	Conj
1	.10	.05	.52	.82	.03	.14	.30	0	.05	0
2	.24	0	.10	0	.21	.62	.41	0	.04	.38
3	.03	.05	.14	0	.06	.05	.75	.91	.06	0
4	.20	.14	.34	.05	.02	0	.18	.10	.26	.71
5	.83	.67	.11	.08	0	.21	.04	0	.02	.04

Note. BL=Baseline; Conj=Conjunctive-differential reinforcement schedule

Table 9

Sequential Probabilities between Possible Response Combinations during Baseline and the Conjunctive-differential reinforcement schedule conditions for Jeff. Columns contain Experimental Conditions, Primary/Secondary Response, and Frequencies of Response 1 and Response 2. Responses that occurred fewer than 4 times in a condition are excluded.

Con	R1/R2	F2/F1	Con	R1/R2	F2/F1	Con	R1/R2	F2/F1	Con	R1/R2	F2/F1
BL	3/1	19/61	BL	4/5	1/6	Conj	1/3	1/8	Conj	14/12	1/5
BL	3/2	4/61	Conj	10/12	2/10	Conj	1/2	1/8	Conj	14/13	1/5
BL	3/3	30/61	Conj	10/28	2/10	Conj	1/20	1/8	Conj	14/15	1/5
BL	3/4	2/61	Conj	10/3	1/10	Conj	1/14	1/8	Conj	9/3	2/4
BL	3/5	6/61	Conj	10/14	1/10	Conj	1/22	1/8	Conj	9/10	1/4
BL	1/1	2/23	Conj	10/19	1/10	Conj	1/35	1/8	Conj	9/19	1/4
BL	1/2	5/23	Conj	10/33	1/10	Conj	1/10	1/8	Conj	13/1	1/4
BL	1/3	15/23	Conj	10/27	1/10	Conj	3/12	3/8	Conj	13/12	1/4
BL	1/4	1/23	Conj	10/34	1/10	Conj	3/5	2/8	Conj	13/14	1/4
BL	2/2	2/12	Conj	12/10	2/9	Conj	3/3	1/8	Conj	13/20	1/4
BL	2/3	7/12	Conj	12/13	1/9	Conj	3/7	1/8	Conj	20/2	1/4
BL	2/4	1/12	Conj	12/20	1/9	Conj	3/19	1/8	Conj	20/21	1/4
BL	2/5	2/12	Conj	12/23	1/9	Conj	2/12	2/5	Conj	20/24	1/4
BL	5/3	7/9	Conj	12/2	1/9	Conj	2/9	1/5	Conj	20/34	1/4
BL	5/4	2/9	Conj	12/22	1/9	Conj	2/11	1/5	Conj	28/24	1/4
BL	4/1	1/6	Conj	12/1	1/9	Conj	2/25	1/5	Conj	28/25	1/4
BL	4/2	1/6	Conj	12/32	1/9	Conj	14/1	1/5	Conj	28/29	1/4
BL	4/3	3/6	Conj	1/4	1/8	Conj	14/9	1/5	Conj	28/31	1/4

Note. BL=Baseline; Conj= Conjunctive-differential reinforcement schedule; Con=Experimental condition; R1/R2=Primary and secondary responses; F2/F1=frequencies of response 2 and response 1

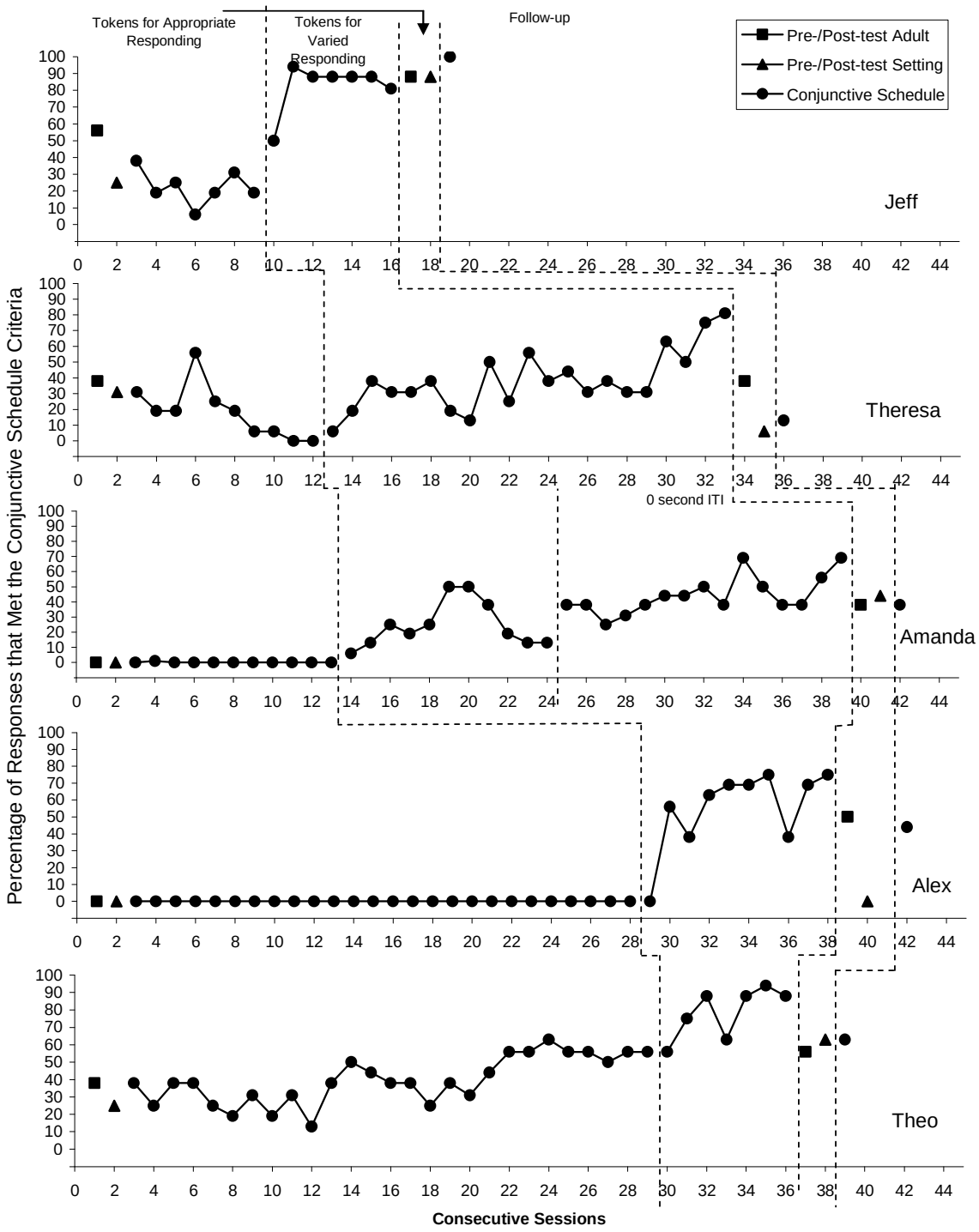

Figure 1. Percentage of responses that met the conjunctive schedule criteria for each participant. Squares represent pre- and post-tests with another adult and triangles represent pre- and post-tests in another setting.

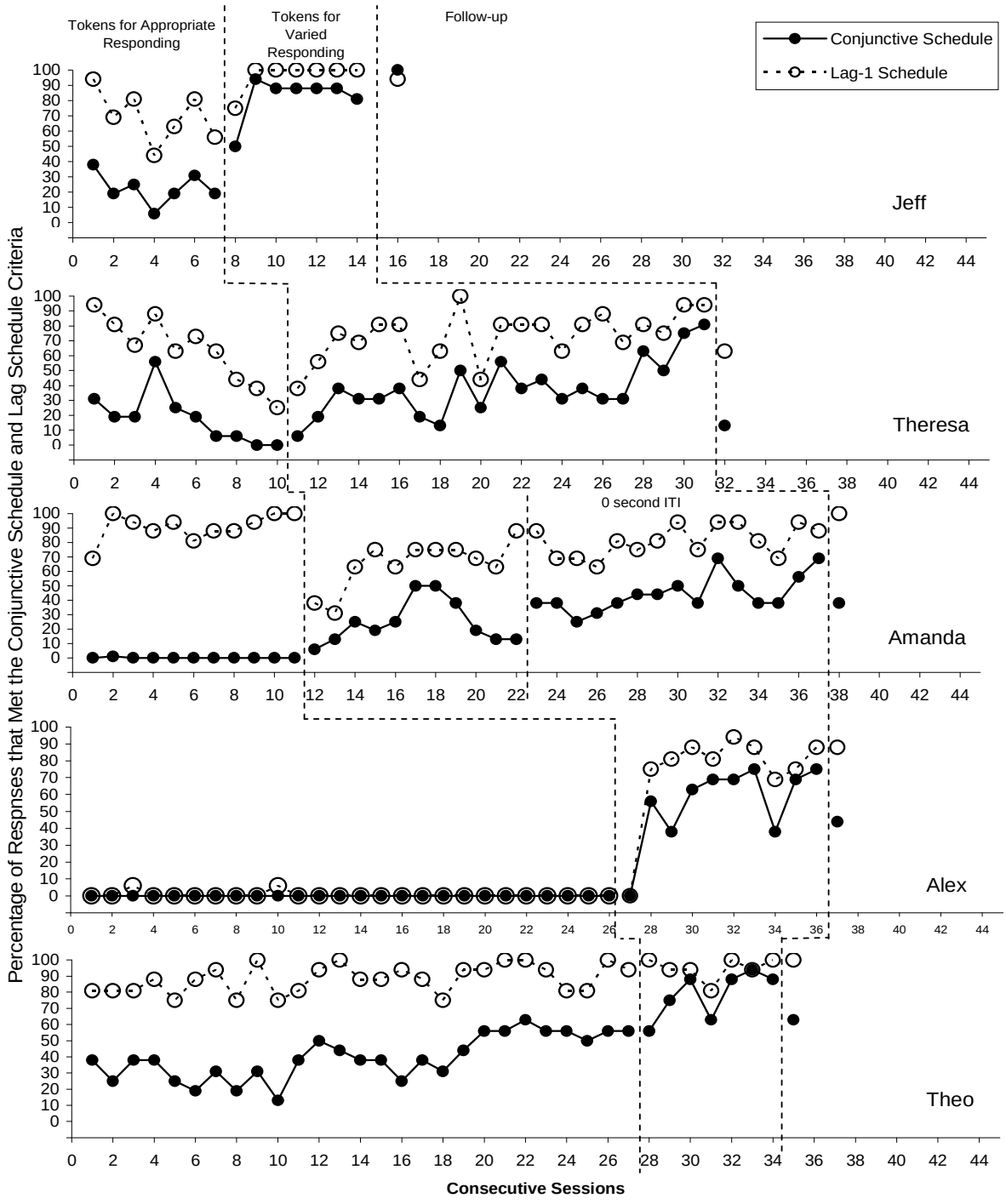

Figure 2. Percentage of responses that met the conjunctive schedule criteria and only the lag schedule criterion across consecutive sessions for each participant.

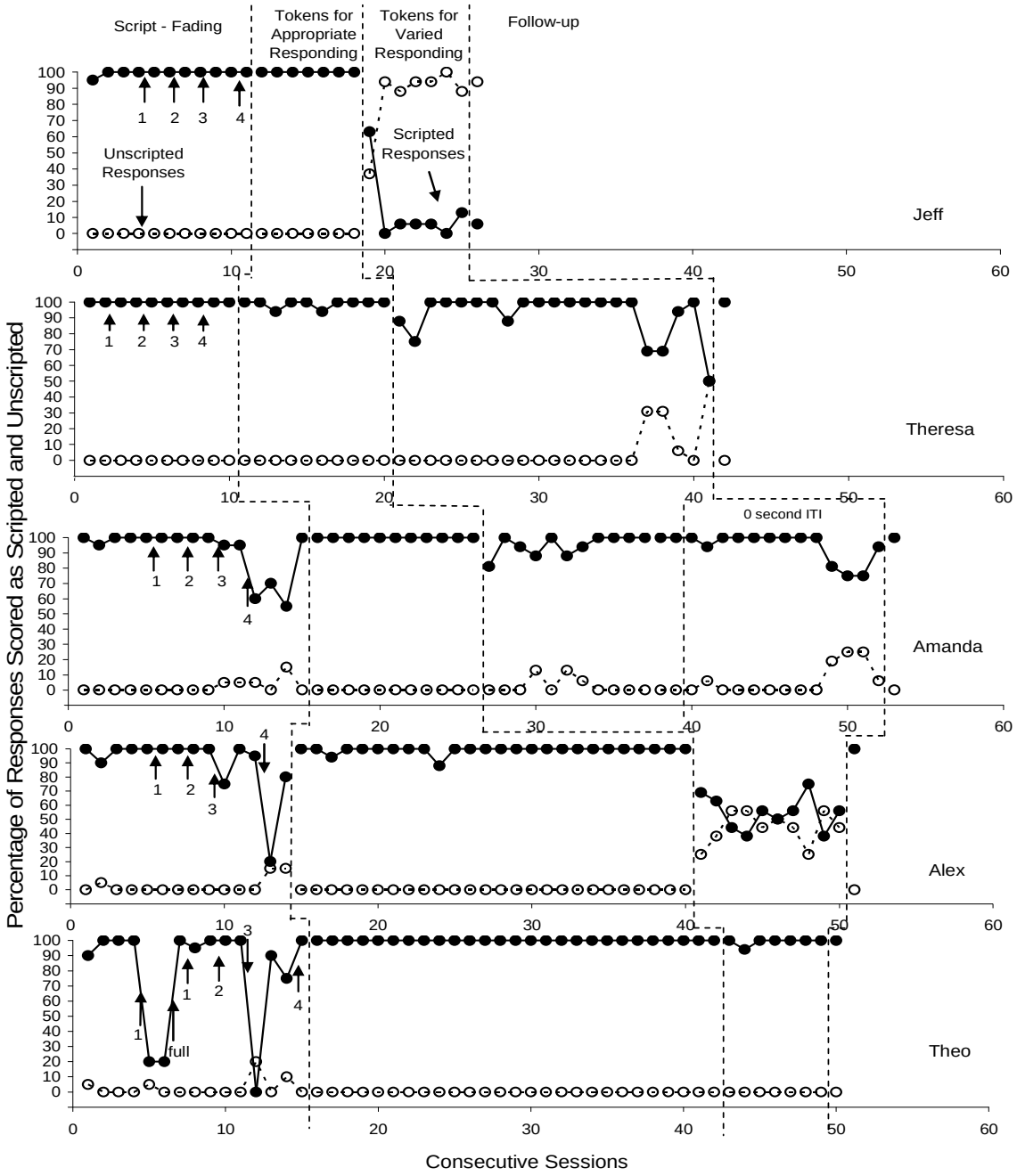

Figure 3. Percentage of criterial and non-criterial responses scored as scripted and unscripted across consecutive sessions for each participant. Numbers with arrows represent script-fading steps.

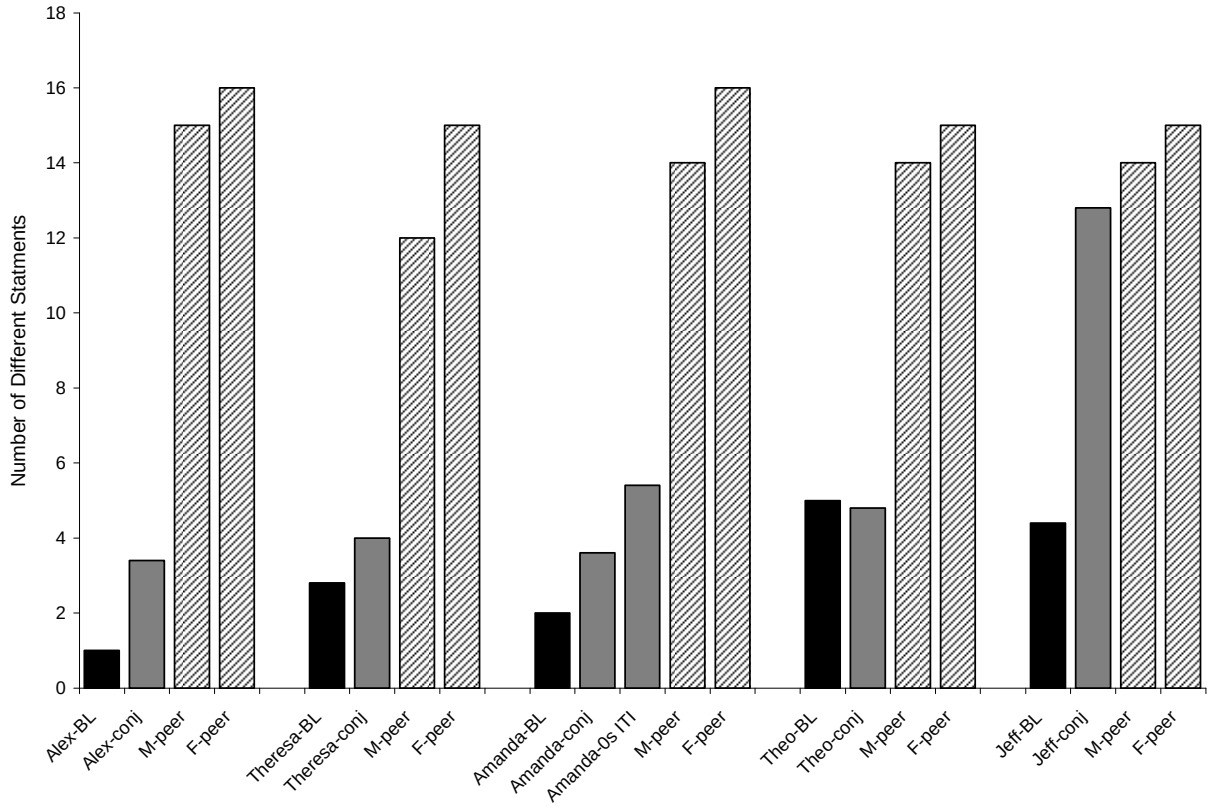

Figure 4. Number of different statements emitted by male and female typically developing peers under baseline conditions and the mean number of different statements emitted by individuals with autism averaged across the last five sessions of each condition. BL= baseline; conj=conjunctive-differential reinforcement schedule; 0s ITI = conj schedule with a 0 second inter-trial interval; M=male; F=female.

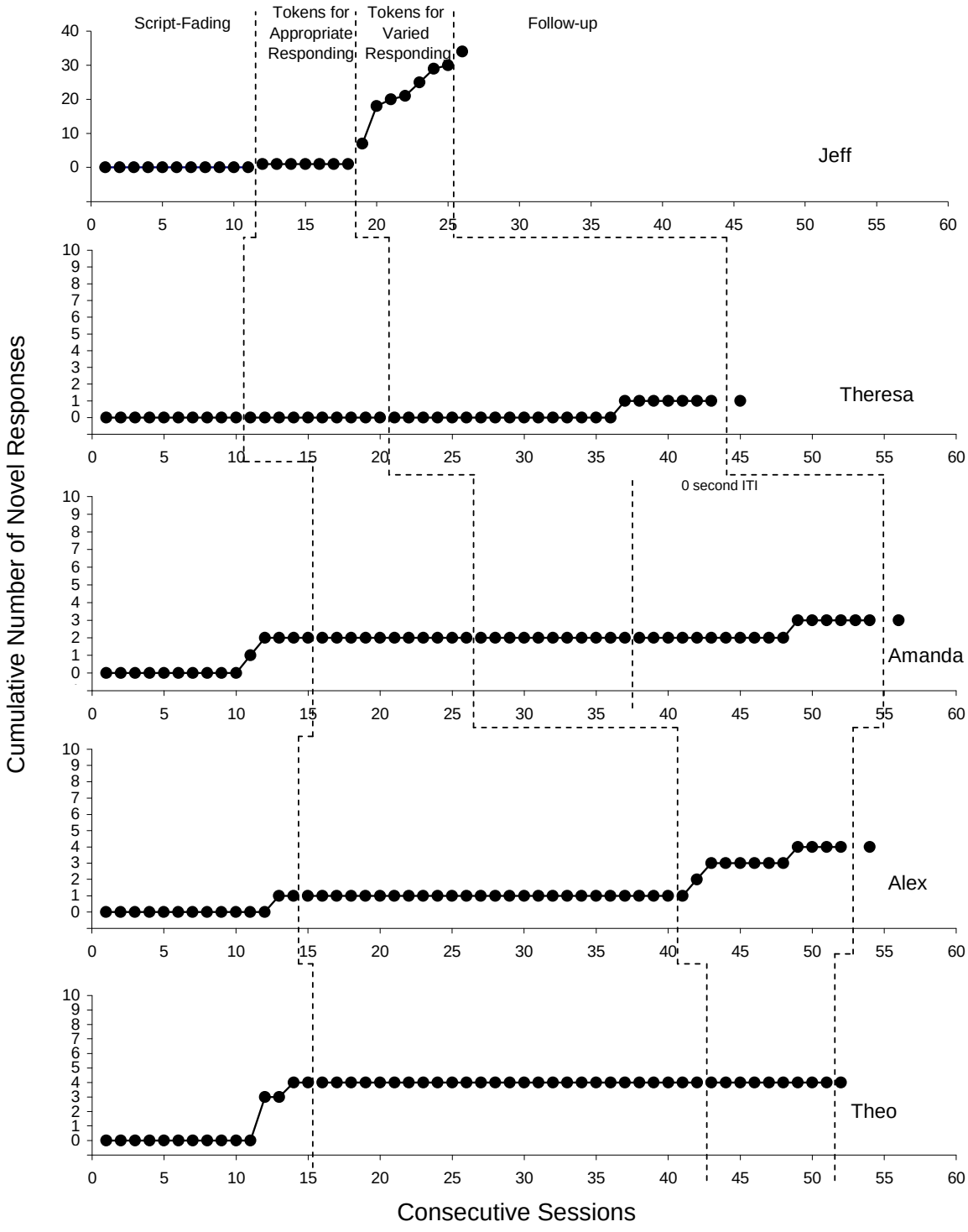

Figure 5. Cumulative number of novel responses across consecutive sessions for each participant. Note the different scale on Jeff's graph.

Appendix A

Individualized scripted responses taught to each participant

Learner	Responses	
Jeff	Play on the Playstation	Draw in art with Christine
	Swim in the pool	Use the computer
	Bowl with my friends	
Theresa	Look through books	Ballet at dance class
	Color and draw	Jump on the trampoline
	Park my cars	
Amanda	Go for a walk	Play guitar hero
	Swim in the pool	Use the computer
	Listen to my i pod	
Alex	Do my puzzles	Go on the playground
	Ride my bike	Play with Gavin
	Watch movies	
Theo	Walk with dad	Jump on the trampoline
	Play on my DS	Play on the wii
	Visit Natalie and Gracie	

Appendix B

Questionnaire given to parents and teachers

Please list five socially acceptable leisure activities in which your child regularly engages. These activities will be taught as responses to the social question, “What do you like to do?”

Please make your responses as short as possible as they will be used to create scripts that will be taught to your child.

1. _____

2. _____

3. _____

4. _____

5. _____

Appendix C

Survey given to parents and teachers about the validity of the teaching procedure

The current teaching procedure requires that a learner be taught at least five appropriate responses to a specific antecedent stimulus using a script-fading procedure. Once those responses are acquired, the learner's responses are to be recorded and the frequency of those responses is to be ranked from the most to least frequently emitted. Once the responses are ranked according to the frequency of their emission, reinforcement is omitted for the 2 most-frequently-emitted responses requiring the learner to emit other responses. After each session, the responses are re-ranked based on the previous 2 sessions.

Please answer the following questions regarding the previously described procedure.

1) Could you teach a variety of responses to a specific question using a script-fading procedure to your learner? Yes No
2) Could you record the responses emitted by a learner in your typical setting? Yes No
3) Could you rank the frequency of emission of those responses after your sessions with the learner? Yes No
4) Could you implement the current procedure in your typical setting with a learner? Yes No
5) Do you think the current procedure, as described, would increase the use of a variety of verbal responses with learners you know? Yes No
6) Please comment about the overall functionality and applicability of the teaching procedure._____

References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders (4th ed., text revision).* Washington, DC: Author.

Arbuckle, J. L. & Lattal, K. A. (1992). Molecular contingencies in schedules of intermittent punishment. *Journal of the Experimental Analysis of Behavior, 58,* 361-375.

Argott, P. J., Townsend, D. B., Sturmey, P., & Poulson, C. L. (2008). Increasing the use of empathic statements in the presence of a non-verbal affective stimulus in adolescents with autism. *Research in Autism Spectrum Disorders, 2*, 341-352.

Athens, E. S., Vollmer, T., R., & St. Peter-Pipkin, C. C. (2007). Shaping academic task engagement with percentile schedules. *Journal of Applied Behavior Analysis,* 40, 475-488.

Braam, S. J. & Poling, A. (1983). Development of intraverbal behavior in mentally retarded individuals through transfer of stimulus control procedures: Classification of verbal responses. *Applied Research in Mental Retardation, 4,* 279-302.

Buffington, D. M., Krantz, P. J., McClannahan, L. E., & Poulson, C. L. (1998). Procedures for teaching appropriate gestural communication skills to children with autism. *Journal of Autism and Developmental Disorders, 28,* 535-545.

Catania, A. C. (2007) *Leaning: Interim 4th Edition*. Cornwall-on-Hudson, NY: Sloan Publishing.

Cowdery, G. E., Iwata, B. A., & Pace, G. M. (1990). Effects and side effects of DRO as treatment for self-injurious behavior. *Journal of Applied Behavior Analysis, 23,* 497-506.

Duker, P. C. & van Lent, C. (1991). Inducing variability in communicative skills gestures used by severely retarded individuals. *Journal of Applied Behavior Analysis,* 24, 379-386.

Fiester, A. R. & Gambria, L. M. (1972). Language indices of vocational success in mentally retarded adults. *American Journal of Mental Deficiency, 77*, 332-337.

Galbicka, G. (1994). Shaping in the 21st century: Moving percentile schedules into applied settings. *Journal of Applied Behavior Analysis*, *27,* 739-760.

Galbicka, G., Kautz, M. A., & Jagers, T. (1993). Response acquisition under targeted percentile schedules: A continuing quandary for molar models of operant behavior. *Journal of the Experimental Analysis of Behavior*, *60*, 171-184.

Goetz, E. M. & Baer, D. M. (1973). Social control of form diversity and the emergence of new forms in children's blockbuilding. *Journal of Applied Behavior Analysis, 6,* 209-217.

Goldstein, H. & Mousetis, L. (1989). Generalized language learning by children with severe mental retardation. Effects of peers' expressive modeling. *Journal of Applied Behavior Analysis*, *22*, 245-259.

Grow, L. L., Kelley, M. E., Roane, H. S., & Shillingsburg, M. A. (2008). Utility of extinction induced response variability for the selection of mands. *Journal of Applied Behavior Analysis, 41,* 15-24.

Hall, S. S., Maynes, N. P., & Reiss, A L. (2009). Using percentile schedules to increase eye contact in children with fragile x syndrome. *Journal of Applied Behavior Analysis, 42,* 171-176.

Harding, J. W., Wacker, D. P., Berg, W. K., Rick, G., & Lee, J. F. (2004). Promoting response variability and stimulus generalization in martial arts training. *Journal of Applied Behavior Analysis, 37,* 185-195.

Hart, B. & Risley, T. R. (1975). Incidental teaching of language in the preschool. *Journal of Applied Behavior Analysis, 8,* 411-420.

Hopkinson, J. & Neuringer, A. (2003). Modifying behavioral variability in moderately depressed students. *Behavior Modification, 27,* 251-264.

Ingvarsson, E. T., Tiger, J. H., Hanley, G. P., & Stephenson, K. M. (2007). An evaluation of intraverbal training to generate socially appropriate responses to novel questions. *Journal of Applied Behavior Analysis, 40,* 411-429.

Kernan. K. T., Sabsay, S., & Rein, R. P. (1986). Aspects of verbal behavior cited by listeners in judging speakers as retarded or not retarded. *Mental Retardation & Learning Disability Bulletin, 14,* 24-43.

Krantz, P. J., & McClannahan, L. E. (1993). Teaching children with autism to initiate to peers: Effects of a script-fading procedure. *Journal of Applied Behavior Analysis, 26*, 121-132.

Krantz, P. J., & McClannahan, L. E. (1998). Social interaction skills for children with autism: A script-fading procedure for beginning readers. *Journal of Applied Behavior Analysis, 31*, 191-202.

Kuch, D. O. & Platt, J. R. (1976). Reinforcement rate and interresponse time differentiation. *Journal of the Experimental Analysis of Behavior, 26*, 471-486.

Lamb, R. J., Morral, A. R., Galbicka, G., Kirby, K.C., & Iguchi, M. Y. (2005). Shaping reduced smoking in smokers without cessation plans. *Experimental and Clinical Psychopharmacology, 13*, 83-92.

Lamb R. J., Kirby, K. C., Morral, A. R., Galbicka, G., & Iguchi, M. Y. (2004). Improving contingency management programs for addiction. *Addictive Behaviors, 29*, 507-523.

Lee, R. (2006). *The effects of script-fading and a lag-1 schedule on varied social responding in children with autism*. Unpublished doctoral dissertation, City University of New York.

Lee, R., McComas, J. J., & Jawor, J. (2002). The effects of differential and lag reinforcement schedules on varied verbal responding by individuals with autism. *Journal of Applied Behavior Analysis, 35*, 391-402.

Lee, R. & Sturmey, P. (2006). The effects of lag schedules and preferred materials on variable responding in students with autism. *Journal of Autism and Developmental Disorders, 36,* 421-428.

Leslie, J. C. (1996). *Principles of Behavioral Analysis*. Amsterdam, B. V.: Overseas Publishers Association.

Lyons, C. A. & Cheney, C. D. (1984). Time reallocation in a multiresponse environment: Effects of restricting response classes. *Journal of the Experimental Analysis of Behavior, 41,* 279-289.

Machado, A. (1989). Operant conditioning of behavioral variability using a percentile reinforcement schedule. *Journal of the Experimental Analysis of Behavior, 52,* 155-166.

McGee, G. G., Almeida, M. C., Sulzer-Azaroff, B., & Feldman, R. S. (1992). Promoting reciprocal interactions via peer incidental teaching. *Journal of Applied Behavior Analysis, 25,* 117-126.

Miller, N. & Neuringer, A. (2000). Reinforcing variability in adolescents with autism. *Journal of Applied Behavior Analysis, 33,* 151-165.

Napolitano, D. A., Smith, T., Zarcone, J. R., Goodkin, K., & McAdam, D. B. (2010). Increasing response diversity in children with autism. *Journal of Applied Behavior Analysis, 43,* 265-271.

Odom, S. L., Chandler, L. K., Ostrosky, M., McConnel, S. R., & Reany, S. (1992). Fading teacher prompts from peer-initiation interventions for young children with disabilities. *Journal of Applied Behavior Analysis, 25*, 307-317.

Odum, A. L., Ward, R. D., Barnes, C. A., & Burke, K. A. (2006). The effects of delayed reinforcement on variability and repetition of response sequences. *Journal of the Experimental Analysis of Behavior, 86*, 159-179.

Partington, J. W. & Bailey, J. S. (1993). Teaching intraverbal behavior to preschool children. *The Analysis of Verbal Behavior, 11*, 9-18.

Pierce, K. & Schreibman, L. (1997). Multiple peer use of pivotal response training to increase social behaviors of classmates with autism: Results from trained and untrained peers. *Journal of Applied Behavior Analysis, 30*, 157-160.

Platt, J. R. & Scott, G. K. (1981). Analysis of the superiority of discrete-trials over free-operant procedures in temporal response differentiation. *Journal of Experimental Psychology: Animal Behavior Processes, 7*, 269-277.

Sarokoff, R. A., Taylor, B. A., & Poulson, C. L. (2001). Teaching children with autism to engage in conversational exchanges: Script fading with embedded textual stimuli. *Journal of Applied Behavior Analysis, 34*, 81-84.

Schwartz, B. (1982). Reinforcement-induced behavioral stereotypy: How not to teach people to discover rules. *Journal of Experimental Psychology: General, 111*, 23-59.

Scott, G. K. & Platt, J. R. (1985). Model of response-reinforcer contingency. *Journal of Experimental Psychology: Animal Behavior Processes, 11*, 152-171.

Stevenson, C. L., Krantz, P. J., & McClannahan, L. E. (2000). Social interaction skills for children with autism: A script-fading procedure for nonreaders. *Behavioral Interventions, 15*, 1-20.

Wagner, K. & Neuringer, A. (2006). Operant variability when reinforcement is delayed. *Learning and Behavior, 34*, 111-123.