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Varied Treatment Response in Young Children with Autism: A Relative Comparison of Structured and Naturalistic Behavioral Approaches

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Abstract

Heterogeneity of treatment response is common for children with autism spectrum disorder (ASD). Thus, many providers vary which intervention is used based on child characteristics and learning domain. Improved understanding of how to match treatments to different children and domain areas may enhance efforts to individualize treatment and improve treatment response. This study evaluated the relative efficacy of discrete trial training (DTT) and pivotal response training (PRT) for teaching young children at risk for ASD receptive and expressive language, play, and imitation skills. Using a single-subject adapted alternating treatments design, children received both treatments for 12 weeks. Data were collected during treatment and at 3-month follow-up. All participants acquired target skills in both treatments and demonstrated some generalization, maintenance, and spontaneous skill use. PRT and DTT were each more effective for some children and domains. The results suggest that that early rates of learning may be predictive of longer-term treatment response and useful in informing treatment decisions.

Given the known heterogeneity and developmental nature of autism spectrum disorders, it is clear that no one instructional format will be best for all children with autism spectrum disorder (ASD), nor will work for any one child throughout the treatment course (Delmolino & Harris, 2012; National Autism Center, 2009; Stahmer, Schreibman & Cunningham, 2011; Wallace & Rogers, 2010). Research supports early interventions based on the principles of applied behavior analysis or a combination of developmentally-based and applied behavior analytic strategies (Wong et al., 2014; Schreibman et al., 2015). However, differential treatment response is common in that up to 50% of children fail to show substantial positive response (Dawson et al., 2010; Lovaas, 1987; Sallows & Graupner, 2005; Sandall et al., 2011; Sherer & Schreibman, 2005).

Moreover, evidence suggests that community-based providers do not select just one intervention for individual children and instead use a combination of approaches (Love, Carr, Almason, & Petursdottir, 2009; Stahmer, Collings, & Palinkas, 2005). Some have proposed a technical eclectic model, whereby multiple practices are integrated and tailored based on treatment goals, as well as individual child and setting variables (Odom, Hume, Boyd, & Stabel, 2012). Others have suggested that a combination of structured and

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naturalistic procedures may be most effective, which fall along the continuum of behavior analytic approaches sharing many common features (Smith, 2001; Steege, Mace, Perry, & Longenecker, 2007; Sundberg & Partington, 2010). Comprehensive models have been developed combining interventions in different ways (Arick, Loos, Falco, & Krug, 2004; Dawson et al., 2010; Stahmer & Ingersoll, 2004). One in particular, Strategies for Teaching Based on Autism Research (STAR; Arick et al., 2004) bases the use of various behavioral strategies on the target domain area. However, prescribed divisions such as these have been theoretically driven rather than based on data. Little data exist to inform decisions amongst interventions to determine a priori which instructional format is most likely to benefit individual children or be effective for teaching varied target skills (Humphrey & Parkinson, 2006; Stahmer, Schreibman et al., 2011; Yoder & Compton, 2004).

Two commonly used interventions for children with ASD are discrete trial training (DTT; Lovaas, 2002; Maurice, Green, & Luce, 1996; Smith, 2001) and pivotal response training (PRT; Koegel et al., 1989; Humphries, 2003). Both approaches are applied behavior analytic, accepted as evidence-based, and used in community settings (National Autism Center, 2009; Odom, Collet-Klingenberg, Rogers, & Hatton, 2010; Vismara & Rogers, 2010; Wong et al., 2014). DTT is a highly structured behavioral intervention and PRT is a naturalistic behavioral intervention. Although the instructional strategies have many commonalities, the context of delivery differs with PRT being embedded within motivating, naturally occurring situations and DTT being decontextualized. See Table 1 for a summary of the core differences.

Early studies comparing the component parts of these interventions found more rapid skill acquisition when natural, direct reinforcers (i.e. a direct relationship exists between the child's response and received reinforcer) were used compared to indirect reinforcers (i.e. the delivered reinforcer is not directly related to the child's response; Koegel & Williams, 1980; Williams & Koegel, 1981), as well as when goal-direct attempts were reinforced in comparison to shaping procedures (Koegel, O'Dell, & Dunlap, 1988). Studies comparing PRT and DTT found similar acquisition patterns (Koegel, Camarata, Koegel, Ben-Tall, & Smith, 1998) or superiority in PRT (Koegel, Koegel, & Surratt, 1992; Koegel, O'Dell, & Koegel, 1987). PRT has been found to facilitate greater generalization, maintenance, and spontaneity, and fewer challenging behaviors (Koegel et al., 1987, 1988, 1992, 1998; Sigafoos et al., 2006). Studies comparing DTT to other naturalistic behavioral interventions have found similar results (LeBlanc, Esch, Sidener, & Firth, 2006; McGee, Krantz, & McLannahan, 1985; Miranda-Linné & Melin, 1992; Neef & Walters, 1984). In a randomized clinical trial comparing PRT with a structured behavioral approach, greater improvements in mean length of utterance and reduced levels of disruptive behavior were found in children who received PRT (Mohammadzaheri et al., 2014, 2015).

A few investigators have examined whether these approaches might be most appropriate for different children. Variables that have been implicated in PRT responsivity include levels of stereotypy, toy play, approach, avoidance (Sherer & Schreibman, 2005; Ingersoll, Schreibman, & Stahmer, 2001). More recently, pre-treatment variables including cognitive ability, positive affect, and toy contact were found to predict PRT responsivity (Fossum, Williams, Garon, Bryson, & Smith, 2018). Follow up research has suggested some of these same variables may not be predictive of DTT response (Schreibman, Stahmer, Cestone Bartlett, & Dufek, 2009).

Notably, most of these studies have been conducted with children over the age of 3, whereas children often begin treatment at an earlier age (Dawson, 2008). Some have theorized that naturalistic interventions may be best suited for younger children (Stahmer, Brookman-Frazee, Lee, Searcy, & Reed, 2011; Wallace & Rogers, 2010). Similarly, naturalistic interventions are more consistent with foundational tenets of developmental science and early intervention, including an emphasis on learning within less restrictive, actively engaged, and socially-laden, play-based environments (Iovannone, Dunlap, Huber, & Kincaid, 2003; National Research Council, 2001; Schreibman et al., 2015).Studies examining the differential efficacy of structured and naturalistic intervention with children diagnosed at risk for ASD and at earlier ages is critical to informing intervention at its earliest start.

Additionally, comparison studies have focused on teaching expressive language, although these interventions are also commonly used to teach receptive language, play, imitation, and other social skills (e.g., Ingersoll & Schreibman, 2006; Koegel, Werner, Vismara, & Koegel, 2005; Pierce & Schreibman, 1995; Stahmer, 1999). It is unknown whether the same strengths and limitations of each approach extend to other domains and to younger children, or if the best practice method varies by child/skill area.

The specific aims of this study were:

1. To evaluate the relative efficacy of DTT versus PRT for teaching children with autism, or identified as at risk for autism, under age 3 in the areas of receptive and expressive language, object play skills, and imitation skills.
2. To identify how early in the treatment process patterns of responsivity emerge.

Methods

Participants

Four children at risk for ASD under the age of 3 (M = 23 months, SD = 4.2) participated in the study. Three children were male and one was female. All children were Caucasian. Participants were recruited from a pool of research subjects (n=49) receiving treatment through a comprehensive in-home program delivered by the university laboratory program where children received 6-12 hours per week of one-to-one, in-home intervention and parent training until 36 months of age. The Strategies for Teaching Based on Autism Research (STAR; Arick et al., 2004) and Teaching Social Communication to Children with Autism (Ingersoll & Dvortsak, 2010) curricula were used as the basis for the early intervention in-home programming (See Bacon et al., 2014 for a more detailed description of this study). Enrollment was consecutive based on space availability. Participants were invited to participate and all agreed.

Children met the following inclusion criteria: (a) chronological age of less than 30 months, (b) diagnosis of risk for autism or provisional autism diagnosis determined by the administration of the Toddler Module of the Autism Diagnostic Observation Schedule (ADOS-T; Lord, Luyster, Gotham, & Guthrie, 2012) and overall clinical judgment by research-reliable, doctoral-level research staff based on the Diagnostic and Statistical Manual of Mental Disorders—Fourth Edition, Text Revision (American Psychiatric Association, 2000), (c) no longer than one month of prior treatment, and (d) parent permission to modify treatment goals during intervention. All participants were diagnosed with ASD at age 3. See Table 2 for a summary of pre-treatment characteristics.

Procedure

Prior to the start of treatment, a series of assessments and observational behavioral measures were administered to assess eligibility and identify treatment targets. Next, an acquisition probe was conducted. An adapted alternating treatments design was used (AATD; Sindelar, Rosenberg, & Wilson, 1985) to compare the relative efficacy of PRT and DTT for teaching early skills in 6 domains: expressive actions and objects, receptive actions and objects, play, and imitation. The treatment phase was 12 weeks and consisted of three 90-minute treatment sessions per week, including 45 minutes each of DTT alone and PRT alone. Data were collected during treatment sessions, as well as acquisition and generalization probes. Maintenance of gains was assessed at a 3-month follow-up. During the study, caregivers and other treatment providers were asked to refrain from teaching the experimental targets.

This type of single subject study design offers a novel approach to addressing the question of treatment matching, as it allows for the evaluation of domain by intervention interactions within an individual child. In AATDs, a set of equivalent but functionally independent instructional items are randomly assigned to different treatment conditions. This is in contrast to the standard alternating treatments design (Barlow & Hayes, 1979), whereby the effects of two or more treatments are compared on the same behavior(s).

Setting

Pre-treatment acquisition probes were conducted in a 6 x 8-ft laboratory room with a one-way mirror. Treatment sessions were conducted in the child's home. Acquisition probes were conducted in the same room as treatment. During the treatment phase, generalization probes were conducted in a room of the house not used for treatment. The lab or home generalization setting was used for the post-treatment and follow-up generalization probes.

Materials

A small table and two chairs were available for treatment sessions and acquisition probes. Teaching and assessment materials consisted of developmentally-appropriate toys and snacks. Stimuli for generalization probes were kept separate from teaching stimuli, such that the generalization materials were novel from those used during treatment. Materials were added and rotated as new targets were introduced, and to increase the potency of potential reinforcers.

Assessments

Standardized measures.—An experienced assessment team administered several measures prior to the start of treatment to characterize the participants, including the ADOS-

T (ADOS-T; Lord et al., 2012), MSEL (Mullen, 1995), Vineland Adaptive Behavior Scales, 2nd Edition (VABS-II; Sparrow et al., 2005), and MacArthur-Bates Communicative Development Inventory (MCDI; Fenson et al., 1993).

Target selection.—The MCDI (Fenson et al., 1993) and Student Learning Profile-adapted (aSLP; Arick et al., 2004) were used to identify treatment targets. The MCDI is a standardized parent report instrument of early language competence used widely in research with infants and children up to 30 months. The aSLP is a curriculum-based assessment for determining student learning goals in receptive language, expressive language, spontaneous language, functional routines, preacademic concepts, and play and social interaction concepts (Arick et al., 2004). The aSLP has been found to be positively correlated with standardized assessments and indicative of treatment progress (Bacon et al., 2014).

A pool of potential targets were selected in the domains of expressive language, receptive language, imitation, and play based on non-mastery on these assessments. In particular, targets were selected in expressive labeling of objects and actions, receptive identification of objects or demonstration of actions (e.g., “Show me jumping”), functional play actions, and motor imitation with objects. Skills were selected that were at or just slightly above the child’s developmental level. Targets currently being taught by parents or other providers were excluded. An initial probe was conducted to confirm the child did not know the targets (See Acquisition Probe below). Target pairs were matched by domain area, difficulty and similarity of materials (e.g., animal names, play actions with pretend food, imitation with blocks), and developmental appropriateness. Matches were randomly assigned to treatment conditions, such that one target from each pair was assigned to PRT and DTT respectively. Specific target pairs are available from the author upon request.

Behavioral Measures

Session data.—Within-session responding was scored on a trial-by-trial basis by the therapist in vivo during DTT sessions, as is customary of this intervention procedure. Trial-by-trial data for PRT were scored by a second trained research assistant in vivo, due to difficulty of data collection while conducting a naturalistic intervention. These data provided a measure of within session learning and were used for determining mastery of target skills (i.e. 80% correct for discriminated responding). Total number of trials per session was collected for 33% of all sessions.

Acquisition probes.—Acquisition probes were administered prior to treatment, every three sessions, and at post-treatment and follow-up, by one of the child’s therapists. These included up to 5 randomly ordered presentations of representative stimuli for each of the introduced targets. Targets were scored correct if the child responded correctly at a rate of 80% or better. Probing was discontinued after four incorrect trials or two incorrect trials of a target. One-trial probes were conducted if the first trial was correct for skills demonstrated at mastery on the two prior consecutive probes. Data are reported as number of skills performed correctly.

Stimuli were selected from materials used during treatment sessions. Trials were preceded by a consistent *SD* (e.g., “Give me (object)” for receptive objects). For all acquisition and generalization probes, no prompts, reinforcers, praise, nor feedback were delivered contingently for correct or incorrect responding to the target presentations. Trials of known stimuli were interspersed on a variable ratio 5 schedule. Praise and access to materials was provided for correct responding to non-target stimuli and general attending behaviors.

Generalization probes and spontaneous skill use.—Weekly generalization probes were administered prior to treatment, during treatment, and at post-treatment and follow-up. The administrator did not have previous treatment experience with the child. Probes began with 5 minutes of a *spontaneous* generalization probe, followed by the *elicited* generalization probe, and 5 additional minutes of the *spontaneous-primed* generalization probe. Targets were included once acquisition was demonstrated in session or acquisition probe data for that week. Materials were different from those used during treatment and selected based on relevance to targets (e.g., if the target was *frog*, a variety of toys and materials representing frogs would be available).

In the *spontaneous* probe portions, the child could freely explore the environment. A range of potentially motivating materials were accessible with some inaccessible to encourage spontaneity (e.g., out of the child's reach, in a closed container). The administrator refrained from initiating interaction, but responded as usual to child initiations.

Spontaneous skill use was scored via video by trained observers, blind to the time point of the video, during the spontaneous portion of the generalization probe using 30-second partial interval scoring for domains where spontaneous use was feasible (i.e. receptive language and imitation require a cue from an adult). Consensus coding was utilized due to the rare nature of these behaviors. Two reliable coders watched each video independently and then met to compare items. For instances of disagreement, the coders convened, discussed, and came to a consensus. When the coders disagreed after discussion, a third reliable coder observed the video and a consensus was determined. Data are reported as number of different target skills used during probes.

The *elicited* probe consisted of up to 5 presentations of each target item with data reported as number of skills performed correctly. The administrator was instructed to create opportunities where the child was motivated for a particular object/activity. He/she presented a target-related cue while withholding access to the item. Targets were scored in the same manner as the acquisition trials.

Procedural fidelity.—Procedural fidelity was collected on 33% of all probes. The average number of items administered with fidelity for acquisition probes was 99.5% (range: 89-100%). For generalization probes, 100% of items were implemented with fidelity.

Treatment

Children received three 90-minute treatment sessions per week, including 45 minutes of DTT alone and 45 minutes of PRT alone, for 12 weeks. Order of treatment procedures was randomly determined on the first day of the study and counterbalanced across subjects. Randomization was restricted such that no more than 3 consecutive session sets began with the same intervention. Both interventions were implemented per the procedures described in their oft-cited treatment manuals (Koegel et al., 1989; Lovaas, 2002).

Therapists simultaneously taught one target from each of 6 categories in both treatments. At least 5 opportunities per acquisition target were presented per session. Once an item was acquired (i.e. 80% correct across two consecutive sessions), it was practiced in maintenance and generalization per the respective treatment manuals. Then, a new target in the relevant category was introduced. All sessions and assessments were video recorded.

Therapist training.—Therapists were undergraduate research assistants trained in both interventions by the first author, with oversight from two licensed clinical psychologists with extensive experience in early behavioral interventions for this population. Therapists received the published materials, *How to teach pivotal behaviors to children with autism: A training manual* (Koegel et al., 1989), and relevant excerpts of the manual, *Teaching individuals with developmental delays: Basic intervention techniques* (Lovaas, 2002), for PRT and DTT respectively. They listened to didactic lectures, observed trained therapists, and practiced treatment implementation with coaching and feedback until trained to fidelity. The experimenter provided ongoing supervision at least weekly.

Discrete trial training.—Discrete trial training (DTT) was implemented per manualized procedures (Lovaas, 2002). At the start of the session, the therapist selected a domain to target (e.g., expressive objects, play) and consistent materials for the current acquisition and/or maintenance targets. The therapist conducted reinforcement sampling to identify potential reinforcers. After gaining the child's attention, the therapist presented a clear, consistent discriminative stimulus (*SD*) or cue for the relevant domain (e.g., "Do this" + model action, "What is it?" + 3-D object). For new skills, a prompt was presented with the *SD* and systematically faded as the child progressed. For mastered skills, a prompt was presented after two consecutive incorrect responses. The therapist waited 3-5 seconds for a child response. He/she provided tangible reinforcement accompanied by social praise for correct responses. A neutral response was provided for incorrect responses or non-responses. A short pause followed where, if appropriate, the child could enjoy the reinforcer for a few seconds before the next trial.

Discrimination training for new targets followed the treatment manual. Once a target was acquired, the therapist varied the S^Ds presented and stimuli used to target generalization. Mastered items were maintained during random rotation with other targets. Play breaks were interspersed based on motivation and attention. These procedures were followed for each learning domain during the session.

Pivotal response training.—Pivotal response training (PRT) was implemented per manualized procedures (Koegel et al., 1989). Individual treatment targets were introduced one at a time due to the design of this study, which is a modification to how PRT was originally designed. At the start of the session, the therapist followed the child's lead to materials of interest, which were used for instructional materials and reinforcement. Trials for different experimental domains were interspersed throughout the session and materials were varied frequently. After gaining the child's attention, the therapist presented a clear and developmentally appropriate *SD* that was related to the activity and target. The *SD* was varied across trials (e.g., imitation trials might vary between “Do this” + action, “Watch me! Now you try,” “You do,” and “Copy me.”). Prompts were provided based on the child’s response pattern (e.g., prompts were faded following correct responding; prompt supportiveness was increased following incorrect responding). The therapist waited 3-5 seconds for a child response. He/she provided tangible, direct reinforcement accompanied by social praise for correct responses and some goal-directed attempts. For incorrect responses or non-responses, the therapist withheld reinforcement. A short pause followed where, if appropriate, the child could enjoy the reinforcer for a few seconds before the therapist prepared for the next learning opportunity.

To illustrate, PRT delivery for expressive object labeling involved the therapist presenting a preferred item and a relevant, varied cue (e.g., “What is this?”, presentation + expectant look, “It’s a…”). Delivery for imitation involved modeling the target action with preferred items while providing a relevant, varied cue (e.g., roll ball, flatten and stamp play-doh) followed by an opportunity for the child to model the same action and subsequent free access to play with the play-doh in a preferred manner contingent upon appropriate responding. PRT trials of receptive actions involved providing an instruction to engage in the target action (e.g., “Show me driving,” “Can you sweep?”) while presenting an array of appropriate, play-based items followed by free access to the preferred material for appropriate responding (e.g., child used play broom to run along his/her arm). Targeting receptive objects involved providing a cue to identify the object (e.g., “Show me (object)”, “Where is (object),” “Can you get the (object)”) while presenting an array of play-based items. For all targets, the child was given free access to the preferred item or array of items, or continuation of the preferred play scheme, for correct responding and goal-directed attempts.

Maintenance and acquisition tasks were interspersed throughout each session. The therapist took turns while playing with the child. Frequent reinforcement sampling occurred to maximize motivation and ensure that materials served as reinforcers.

Fidelity of implementation.—Fidelity of implementation (FI) probes were used for training therapists initially, as well as for validating the integrity of the independent variables during the study. Treatment FI probes were conducted on 10-minute video segments randomly selected from sessions. PRT or DTT implementation was rated on a scale of 1 (did not use or did not use competently during the segment) to 5 (used competently throughout the segment) for each item. Fidelity checklists and definitions are available from the author upon request. Criterion for passing FI was scoring 4-5 on all items on two consecutive probes. FI was collected throughout treatment on 33% of the sessions. Ninety-seven percent of PRT session probes and 100% of DTT session probes received a passing score. An average of 45 trials and 41 trials occurred during PRT and DTT sessions respectively. Therapists provided at least 5 target opportunities per session for 93% and 90% of PRT and DTT targets respectively.

Interobserver Agreement

Interobserver agreement was calculated on 33% of PRT and DTT fidelity of implementation, procedural fidelity for acquisition and generalization probes, and behavioral coding procedures. Interobserver agreement was 91% for PRT and 94% for DTT. Interobserver agreement was 90% for scoring of the acquisition probe trials and 100% overall for procedural fidelity of acquisition probe implementation. Agreement was 90% for scoring of the elicited generalization probe trials and 100% for procedural fidelity of the generalization probe.

Interobserver agreement was calculated for the total number of trials administered per target and total number of trials to criterion for experimental targets. Agreement for number of trials per target was 99% for PRT and 96% for DTT. Agreement for total number of trials to criterion was 99% in PRT and DTT.

Results

Relative Efficacy of DTT and PRT

The first aim of this study was to evaluate the relative efficacy of DTT compared to PRT for teaching children with autism in the areas of receptive and expressive language, play, and imitation. See Table 3 for a summary of the number of skills acquired and generalized by the end of the treatment phase. The number of skills acquired, generalized, and maintained in each domain are displayed for Jonah, Mario, Sally, and Leo in Figures 1, 3, 4, and 5 respectively. Solid data points reflect within-session data. Open data points reflect the respective probes.

Acquisition

Jonah.—Jonah demonstrated more rapid overall skill acquisition in PRT (Table 3). The superior upward trend emerged during the third week of treatment and was consistent throughout treatment. This relative benefit was primarily driven by expressive language (Figure 1). In all other domains, any mean differences were minor between treatment conditions.

Mario.—Data are presented for 8 weeks of treatment, as Mario discontinued participation due to scheduling difficulties. He demonstrated a modest superiority of PRT in overall skills acquired (Table 3). However, the paths overlapped throughout the first 5 weeks of treatment. Although Mario's data reflected a possible superiority of DTT for expressive language, interpretation is cautionary due to the small number of targets acquired in either treatment (Figure 3). Mario acquired receptive language skills more rapidly in PRT. This pattern emerged during the fourth week of treatment. There was a lack of differentiation in play and imitation acquisition.

Sally.—Sally demonstrated greater overall acquisition of targets in DTT (Table 3). This pattern emerged during the fourth week of treatment. Given the frequent overlap and small mean difference, no superiority of treatment was demonstrated for expressive language. Sally demonstrated a later emerging and slight superiority of DTT for the acquisition of receptive language. She acquired more play targets in PRT, but this difference emerged in the last sessions of the treatment phase and should be interpreted with caution. The bulk of DTT superiority of was driven by imitation.

Leo.—Leo demonstrated more rapid overall skill acquisition in DTT (Table 3). This trend emerged during the sixth week of treatment (Figure 5). As Leo did not acquire many expressive language targets, these results should be interpreted with caution. Acquisition of receptive language and play targets was superior in DTT. Acquisition was similar across treatments for imitation skills.

Generalization

Jonah.—Patterns of generalization generally mirrored acquisition. The greatest differentiation between the conditions was in expressive language (Figure 1). In the other domains, Jonah demonstrated similar patterns of generalization in both treatments.

Mario.—Generalization mirrored how Mario learned during treatment. He demonstrated superior generalization in PRT early in treatment, but this difference attenuated as treatment progressed (Figure 3).

Sally.—Sally demonstrated overall superior generalization in DTT (Table 3). She tended to generalize expressive targets better in PRT (Figure 3). There was an advantage of DTT in generalization of imitation and play.

Leo.—Leo's pattern of generalization was similar to acquisition (Table 3). Expressive language generalization was similar across treatments. In this domain, Leo initially demonstrated better generalization in DTT, which attenuated at the same time as in acquisition (Figure 5). Leo demonstrated superior generalization of receptive language and play targets in DTT. However, the superiority for receptive language was less clear and may not represent a clinically significant difference.

Maintenance

Jonah.—Jonah demonstrated strong skill maintenance (Figure 1). The relative benefit of PRT for expressive language was maintained. Receptive gains were maintained better in PRT during acquisition and in DTT for generalization.

Mario.—Maintenance data is not available for Mario, as he discontinued intervention after 8 weeks.

Sally.—Sally demonstrated a high degree of skill loss during follow-up (Figure 3). She maintained approximately half of the previously acquired targets, however the relative superiority of DTT remained. The superiority of PRT for expressive language and play did not sustain over time. She maintained the majority of imitation and receptive language targets in both conditions, and DTT remained superior in these domains.

Leo.—The overall superiority of DTT demonstrated during treatment did not maintain in follow-up (Figure 5). Overall, Leo demonstrated significant skill loss in DTT compared to minor loss in PRT. These patterns were consistent across acquisition and generalization. Leo lost all of prior learned receptive language skills in DTT compared to maintaining those learned in PRT. This same pattern occurred for play skills. For imitation, patterns demonstrated during treatment were similar at follow-up.

Spontaneity

Jonah.—Jonah demonstrated greater variability of spontaneous skill use in PRT compared to DTT. He used 7 different PRT actions and 4 different DTT actions (Figure 2). He did not use words spontaneously in either condition.

Mario.—Mario demonstrated a greater variability of spontaneous skill use in PRT, where he used 6 different actions and 2 words, compared to DTT, where he used 5 different actions (Figure 2).

Sally.—DTT was superior for Sally for spontaneous use of actions, whereas PRT was superior for spontaneous word use. She used 4 different PRT actions and 7 different DTT actions. She used 3 different words spontaneously in PRT and 1 word in DTT (Figure 2).

Leo.—There was a minor superiority of PRT for skills used spontaneously. Leo used 10 different actions in PRT compared to 9 in DTT (Figure 2). Overall, neither treatment emerged as superior for spontaneity.

Time to Responsivity

Aim two of the study was to identify how early patterns of treatment responsivity emerged in the interventions. For any domain where there was a clear differentiation in treatment response between PRT and DTT, patterns emerged by the first or second discrimination (i.e. when the child learned to differentiate 2-3 skills). The week during treatment varied between participants and domains. For Jonah, the PRT superiority emerged during weeks 2-3, whereas it emerged during weeks 3-4 for Mario. Sally demonstrated clear patterns in imitation during week 4 but patterns for expressive language and play did not emerge until weeks 9 and 11 respectively. Finally, the DTT superiority for Leo emerged during week 5 for play and week 9 for receptive language. In consideration of numbers of treatment hours, these time points equate to approximately 4 to 25 hours of treatment.

Discussion

This investigation involved providing both DTT and PRT to children at risk for ASD under the age of 3 for teaching expressive and receptive language, play, and imitation skills. All participants learned target skills across domains in both treatments, and demonstrated some generalization, maintenance, and spontaneous use of skills acquired during both interventions. This strengthens the evidence for both approaches and provides support for these treatments for children under 3, for which evidence is growing (Dawson et al., 2010; Estes et al., 2015; Stahmer, Akshoomoff et al., 2011). This study also provides support for the use of PRT for teaching a broader range of skills. PRT has been shown to be effective for teaching expressive language, joint attention, play, social interaction, and academic skills (e.g., Koegel et al., 1992, 1998; Koegel & Koegel, 2006; Pierce & Schreibman, 1997; Rocha, Schreibman, & Stahmer, 2007; Stahmer, 1999; Stahmer, Thorp & Schreibman, 1995), and this study extends the evidence supporting PRT for teaching other skills, such as receptive language and imitation.

Treatment response varied significantly across children and domain area. The findings suggest that individual children respond uniquely to PRT and DTT, and that the same child may respond differently depending on the skill or dimension. This emphasizes the apparently idiosyncratic and variable nature of ASD and treatment responsivity that has been referenced by many (Delmolino & Harris, 2012; Stahmer, Schreibman et al., 2011; Wallace & Rogers, 2010). It also introduces the possibility that varying treatment approach for a particular child by domain area or learning dimension may improve treatment response. Indeed, some have suggested that a combination of structured and naturalistic procedures may be most effective for some children (Smith, 2001; Steege et al., 2007; Sundberg & Partington, 2010) or have developed comprehensive models that combine the use of these interventions in different ways (Arick et al., 2003; Dawson et al., 2010; Stahmer & Ingersoll, 2004; Stahmer, Akshoomoff, & Cunningham, 2011). The results do not support the pre-determined prescription of specific approaches by domain across all children. Instead, they suggest the importance of future studies evaluating child variables that may inform these treatment by domain interactions. It has been proposed that an evidence-based approach to combining multiple practices may be beneficial (Odom et al., 2011) and these data support this notion.

In this study, two participants' response patterns tended to favor PRT. Jonah demonstrated a superiority of PRT for expressive language and Mario benefited more from PRT in receptive language. The patterns across domains were similar for the acquisition, generalization, and maintenance of gains. These findings corroborate previous reports of the benefits of PRT for the generalization and maintenance (Koegel et al., 1998, 1992, 1987, 1988; Sigafoos et al., 2006; Williams & Koegel, 1981). Both also demonstrated greater spontaneous skill use in PRT, replicating previous research comparing naturalistic and structured behavioral treatments (See Delprato, 2001 for review).

Alternatively, Sally and Leo tended to acquire more skills in DTT. However, there were dimensions and domains where performance was superior in PRT. Sally demonstrated greater gains in DTT for imitation, receptive language, and play, while Leo benefitted from DTT in receptive language and play. Both children demonstrated PRT superiority for expressive language and there were some benefits of PRT for spontaneous skill use for Sally. This suggests that a hybrid approach implementing both interventions may be optimal for some children. This notion echoes prior work suggesting a combination of structured and naturalistic procedures to be most effective for some (Smith, 2001; Steege et al., 2007; Sundberg & Partington, 2010) and suggests models that combine the use of these interventions in different ways (Arick et al., 2003; Dawson et al., 2010; Stahmer & Ingersoll, 2004; Stahmer, Schreibman et al., 2011) may be beneficial in some cases. Importantly, these arguments have been primarily theoretical and not based on systematic, comparative research. Future research investigating child characteristics related to both of these response profiles would be important.

Contrary to earlier research, patterns of generalization often mirrored patterns of acquisition in DTT. Highly structured interventions have been modified since many of the prior studies were conducted with some modifications designed to address known limitations such as generalization. This study followed manualized approaches that more closely match the way these interventions are implemented today (Lovaas, 2002; Smith, 2001). Alternatively, this finding may be related to the relatively contrived nature of the generalization assessments and may not reflect differences in the use of skills in more naturally occurring opportunities. Finally, it may be that younger children at risk for autism may possess different profiles than those children examined in earlier research.

Finally, despite the variability in time to responsivity, what was notable was the small number of discriminations that occurred prior to the establishment of a pattern. Across all participants, patterns of differentiation—should they occur—emerged around the time that the first few skills were acquired in the superior treatment. This equated to 4-25 hours of treatment, which in practice would be completed within the first few weeks of in-home intervention. These results suggest it might be effective to provide both PRT and DTT early on and observe the intervention where the child begins learning first. This may be one way to adapt “decision tree” approaches, which have often based treatment decisions on the lack of responsivity after a certain amount of time (Dawson et al., 2010). Even more, these data suggest the value of practitioners’ use of data-based decision make to determine the effectiveness of an intervention and how to proceed in the face of non-response to a particular approach. In several domains, participants in this study demonstrated limited responsivity to the tested interventions. It may be that other approaches, not included in this study, might have been more effective. This supports the proposition that different treatment strategies may be needed to meet the highly varied needs of children with ASD across the lifespan (e.g., Schreibman, Stahmer et al., 2011) and underscores the importance of adequate breadth of training across the continuum of evidence-based practices for ASD that is paramount to improving practitioner training programs.

There are several important limitations to this study. Pre-treatment and some post-treatment acquisition probes were conducted in a different setting from treatment, which may have impacted acquisition results. PRT was implemented in a relatively contrived manner, as was assessment for generalization. In particular, pre-determined targets were addressed in PRT sessions, which partially limited the extent of ‘child-led’ items of interest. Additionally, a minimum number of treatment targets were required in each session, which is not a necessary component of PRT. Generalization was assessed in a different room of the child’s home rather than a distinct setting (e.g., park, community). Thus, potential differences in generalization to more natural environments were not measured. Research staff who conducted observational coding were not blind to study condition, however, they were blind to phase of treatment. Finally, the small number of subjects inherent in single-subject design limits generalizability of these findings and the ability to identify child characteristics associated with the varied treatment response profiles. Some children learned very few skills in some domains, making it difficult to draw overall conclusions. Follow-up, larger-scale studies with a broader range of children would further enable investigations of these considerations. Importantly, it may be that other intervention approaches not tested in this study may result in greater child gains.

This study confirms that children respond in unique ways to PRT and DTT and suggests the most effective approach may depend on the child, domain, and dimension. Early response patterns may be predictive of longer-term responsivity, or may be used to inform adjustments to treatment approach. In a short period of time, practitioners may be able to identify which treatment would best fit the child and domain early on in treatment. Overall, the results of this study suggest the potential of tailoring treatments to individual child needs and begin to suggest specific methods for such efforts.

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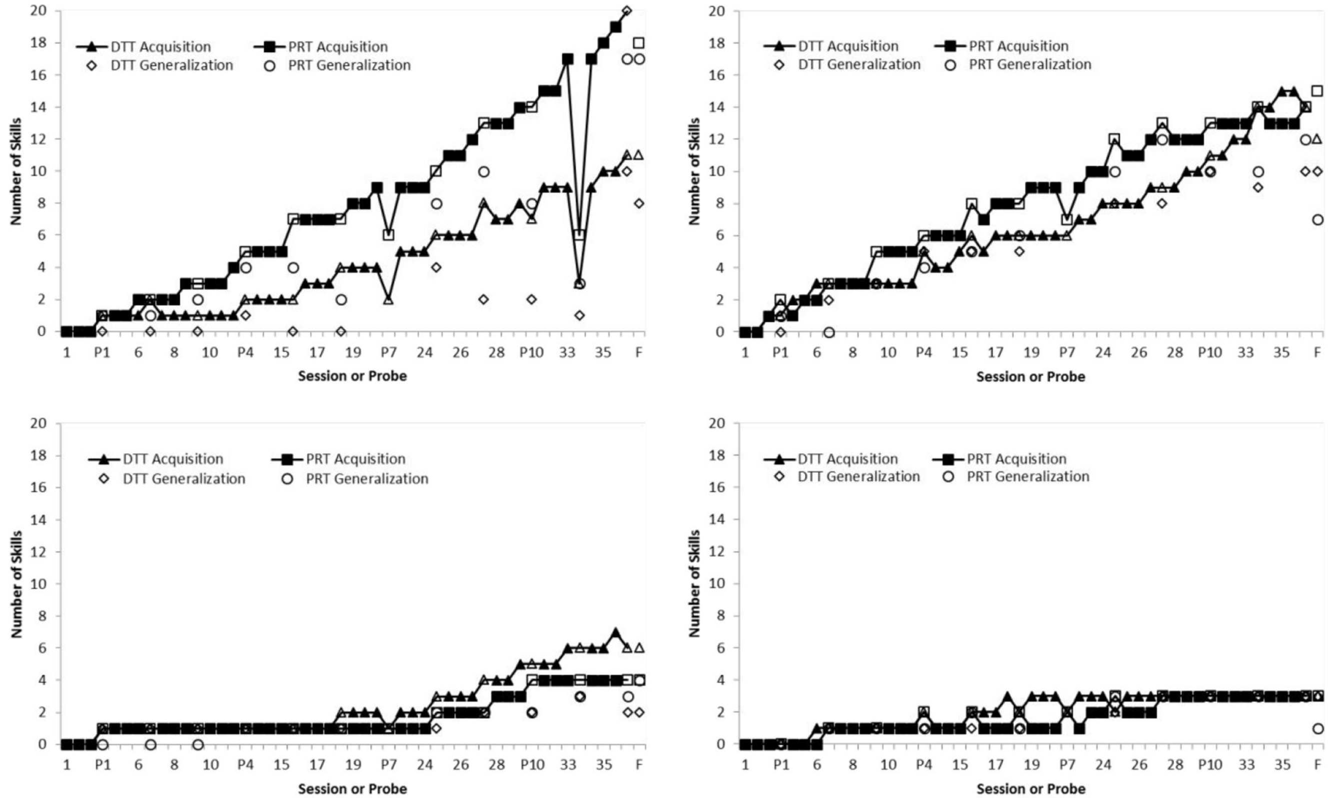

Figure 1.

Jonah: Number of Skills Acquired, Generalized, and Maintained in Expressive Language (top left), Receptive Language (top right), Play (bottom left), and Imitation (bottom right)

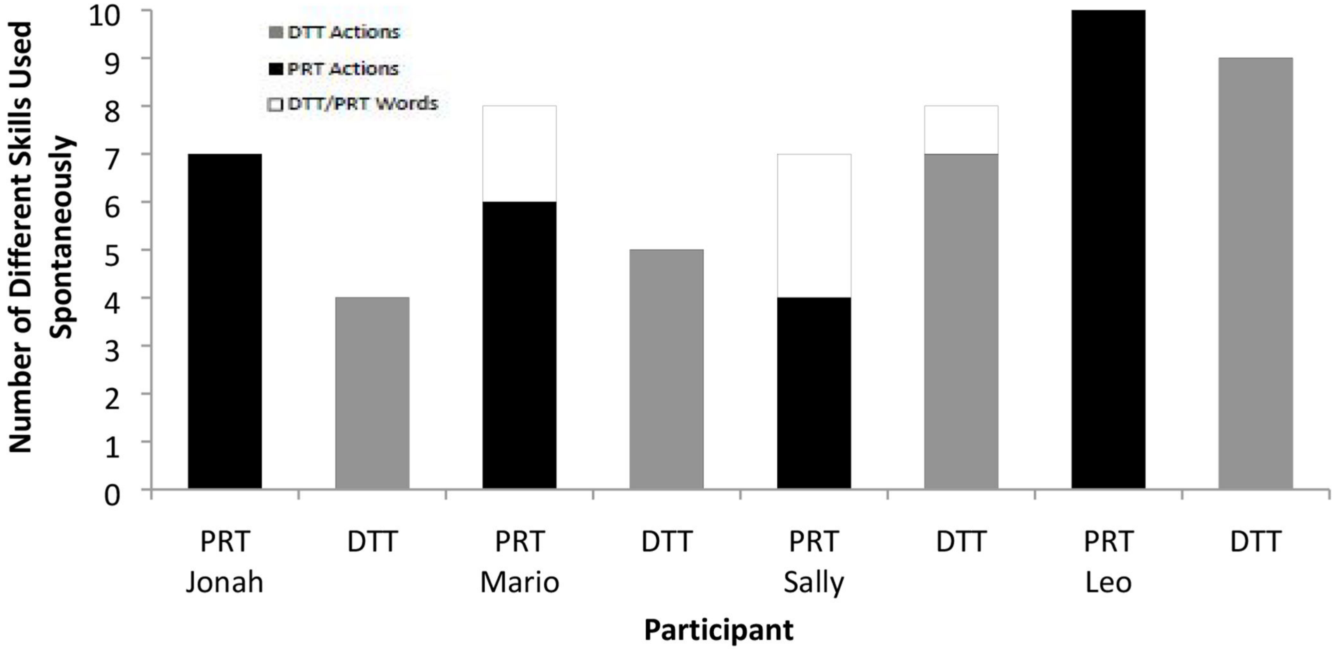

Figure 2.
Number of Different Target Skills Used Spontaneously During Generalization Probes

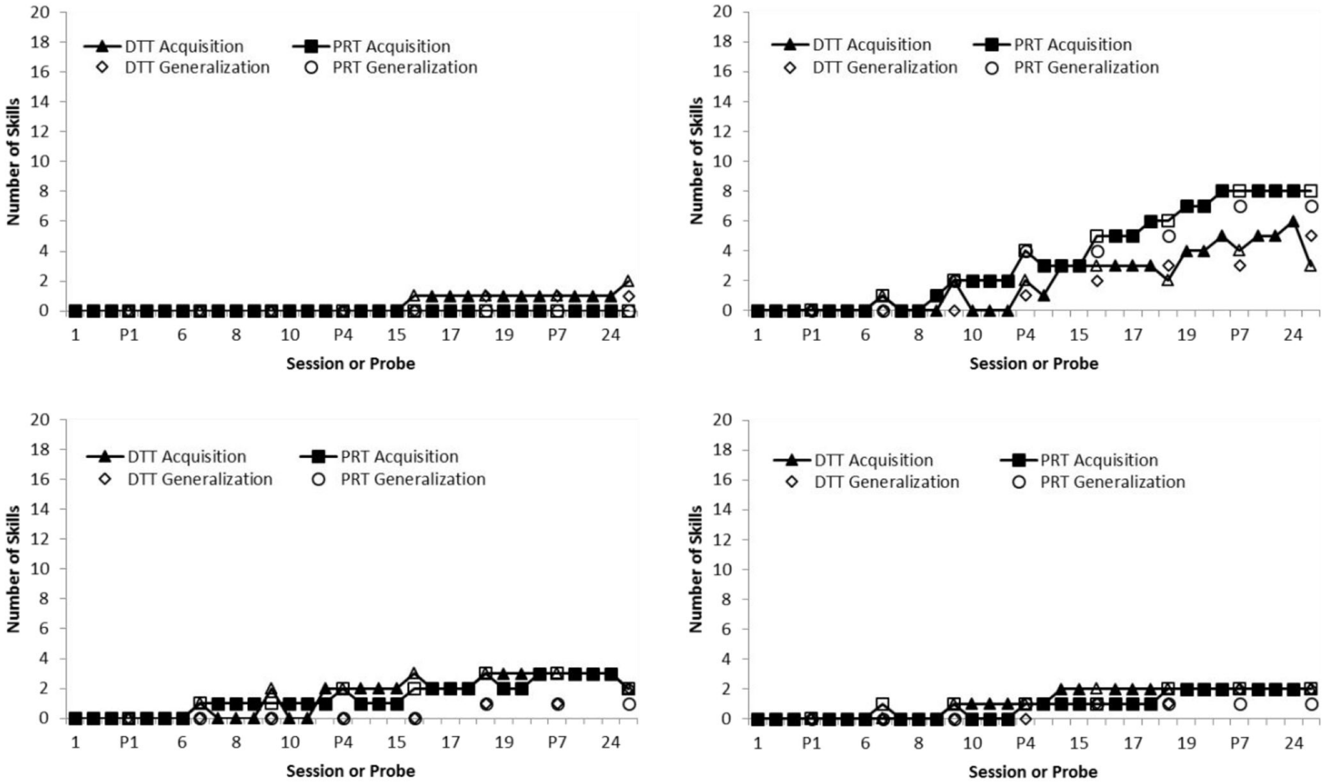

Figure 3.

Mario: Number of Skills Acquired, Generalized, and Maintained in Expressive Language (top left), Receptive Language (top right), Play (bottom left), and Imitation (bottom right)

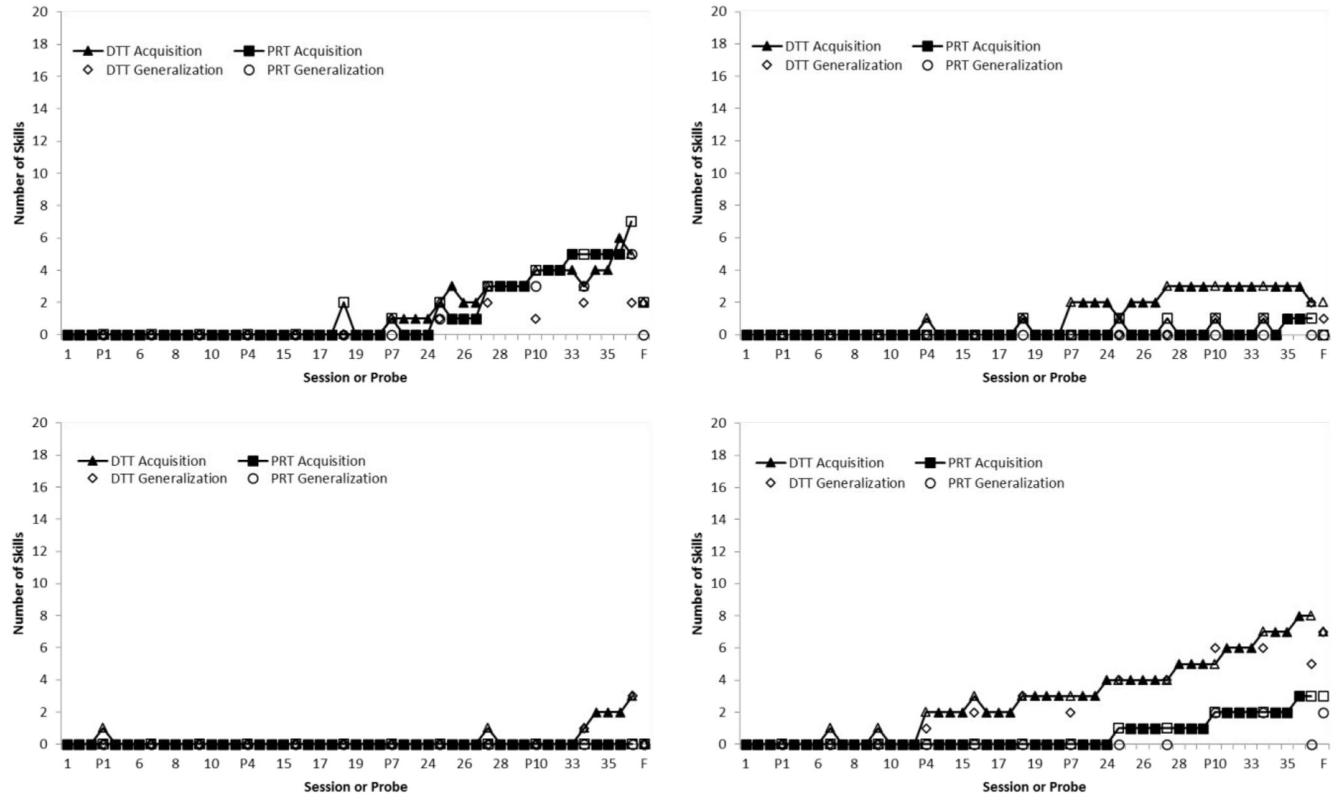

Figure 4.

Sally: Number of Skills Acquired, Generalized, and Maintained in Expressive Language (top left), Receptive Language (top right), Play (bottom left), and Imitation (bottom right)

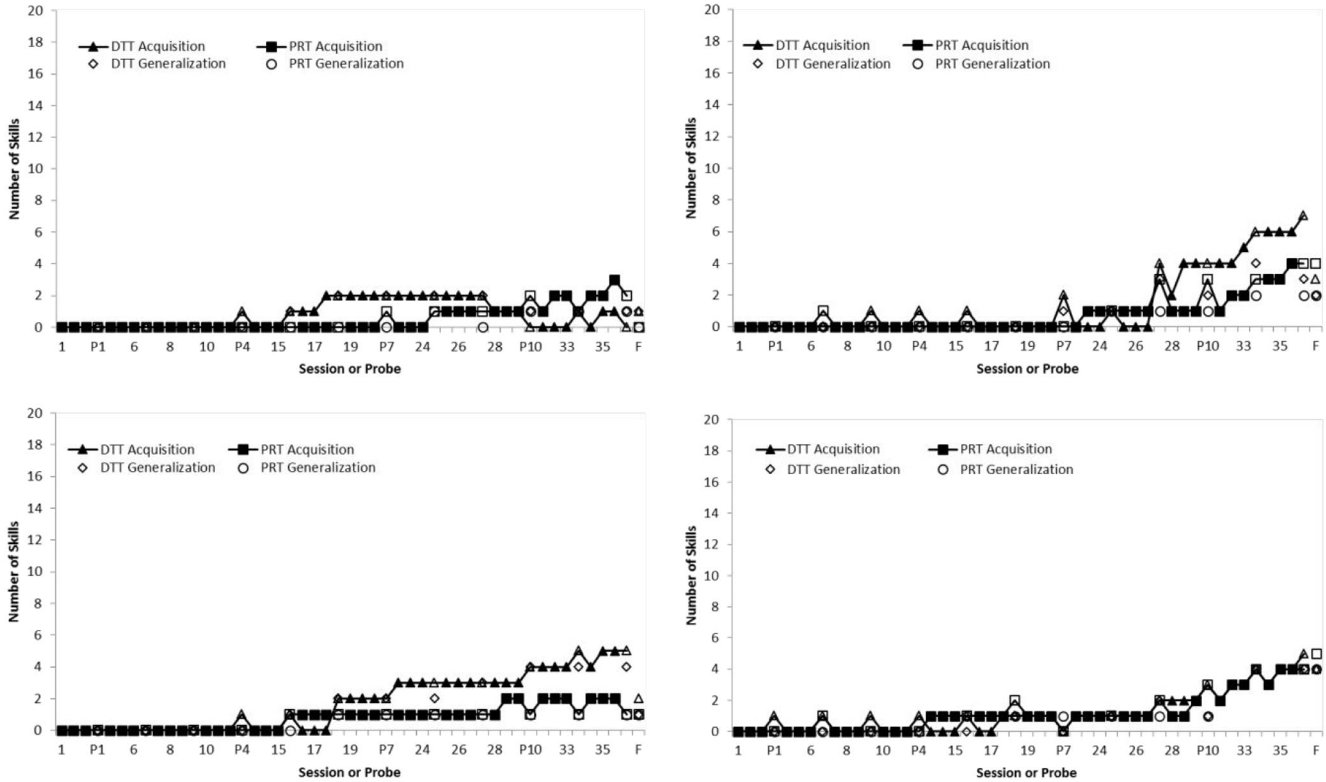

Figure 5.

Leo: Number of Skills Acquired, Generalized, and Maintained in Expressive Language (top left), Receptive Language (top right), Play (bottom left), and Imitation (bottom right)

Table 1.

Primary differences between DTT and PRT

	DTT	PRT
Instructional Materials & Task	Chosen by the therapist, not varied during acquisition	Chosen by child, varied frequently
Teaching Situation	Typically in a structured manner (e.g., child-sized table)	Typically in play-based manner (e.g., on floor, during daily routine, child-sized table)
Reinforcement Contingency[1]	Correct responses or successive approximations	Correct responses and good attempts
Consequences	Indirect reinforcement (reinforcers not directly related to the target response	Direct reinforcement (direct response-reinforcer relationship)
Generalization	Focus after acquisition	Focus throughout treatment

[1]Successive approximations involve reinforcing a narrow range of lower-level approximations and increasing systematically based on the child's consistent expression of the previous response (and subsequent extinction of earlier responses upon mastery). Reinforcing good attempts involves reinforcement of most reasonable, goal-directed attempts (i.e. wider and less systematic range of responses).

Table 2.

Child pre-treatment characteristics

	Jonah	Mario	Sally	Leo
Age (months)	27	22	29	26
Mullen Scales of Early Learning				
Early Learning Composite[a]	62	85	69	67
Vineland Adaptive Behavior Scales[a]				
Adaptive Behavior Composite	81	94	80	83
MacArthur Communicative Development Inventory				
Words Said	11	5	0	2
Non-animal Sounds said	8	1	0	0
Words Said and Understood	121	117	30	72

[a]Standard Score, *M*=100, *SD*=15;

[b]T-score, *M*=50, *SD*=10

Table 3.

Total Number of Skills Acquired and Generalized by Domain and Child

	Jonah		Mario		Sally		Leo	
	PRT	**DTT**	**PRT**	**DTT**	**PRT**	**DTT**	**PRT**	**DTT**
Acquisition								
All	41	34	12	9	11	18	11	17
Expressive Language	20	11	0	2	7	5	2	0
Receptive Language	14	14	8	3	1	2	4	7
Play	4	6	2	2	0	3	1	5
Imitation	3	3	2	2	3	8	4	5
Generalization								
All	35	25	9	10	5	12	8	12
Expressive Language	17	10	0	1	5	2	1	1
Receptive Language	12	10	7	5	0	2	2	3
Play	3	2	1	2	0	3	1	4
Imitation	3	3	1	2	0	5	4	4