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Research Article

ABA Curricula Effects on Toddler Language, Cognition and ASD Symptoms

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ABSTRACT

The effectiveness of Applied Behavior Analysis (ABA) to treat young children with Autism Spectrum Disorder (ASD) has long been established. Natural Environment Teaching (NET) is an effective adaptation to Discrete Trial Training (DTT). Children with ASD respond to ABA intervention differentially. Treatment with an optimal curriculum is crucial to treatment effectiveness and research on naturalistic treatments is under-researched in community-based settings. Three intervention approaches were compared: (1) DTT only; (2) DTT and NET combined; (3) NET only. This study predicts that differential effects of curricula provided to children with ASD less than three years-of age will result in different outcomes. All treatments led to improved language, cognitive outcomes, and a reduction in ASD symptoms. The NET only children improved most significantly with mean group scores in the normal range of cognitive and language development, and ASD symptoms in the non-autistic range. Adding NET to an ABA intervention for toddlers with ASD improves developmental outcomes demonstrating the benefit of using naturalistic behavioral intervention techniques in early intervention. This research extends the scope of naturalistic behavioral interventions by examining its benefits over traditional discrete trial interventions in a real-world community-based early intervention center for toddlers less than 3 years of age. Naturalistic behavioral interventions are under-researched in community-based early intervention settings although these setting are where most children receive intervention services. This research provides support for the use of NET and aids in the refinement of ABA curricula protocols for young children with ASD. The study also adds support to the effectiveness of using ABA in community-based early intervention programs for children on the autism spectrum.

Keywords: Intervention; Autism; Treatment; Verbal behavior therapy

INTRODUCTION

Lovaas (1987) demonstrated the effectiveness of applied behavior analysis (ABA) to increase learning for young children with a diagnosis of Autism Spectrum Disorder (ASD) [1]. He observed that it was difficult for children with ASD to learn in their natural environment. He reasoned, and others have more recently shown, that learning could occur more easily for these children by using effective reinforcement that leads to generalization in a structurally simplified environment [2-4]. Lovaas (1987) used Discrete Trial Training (DTT) to demonstrate gains in general developmental and other outcomes. It has also been demonstrated that the use of DTT is very effective when delivered by an instructor who creates a highly structured learning environment. This has become the most used and reported ABA approach [5-7]. Neidert et al. have shown that ABA is critical for improving communication and adaptive skills for children with ASD [8].

Children with ASD may not self-initiate properly; some naturalistic interventions have proven successful in both attainment and generalization of spontaneous language skills [9]. Behavioral interventions can be employed in natural settings and can also be implemented in a clinical setting [10]. The natural environment should encompass all aspects of daily life and experiences and be child-centered. It should also include the family and community in playing a role to provide integration and developmental opportunities for the child [11]. Children with autism receiving naturalistic behavioral interventions demonstrate gains in many areas. These include greater independence and more natural sounding and interactive exchanges between the child and typical peers [12,13].

Schreibman and colleagues have emphasized the importance of including the child as an "active" partner in learning. Advances in developmental science have led to revised methods to improve early intervention practices. These advances have led to the assumption that DTT should expand to incorporate developmentally appropriate learning strategies that also rely on incidental teaching. This recognition has led to the integration of both highly structured settings and developmental principles in early intensive intervention for children with ASD. As behavioral

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intervention and developmental fields matured, awareness of a need to assimilate the two approaches has grown. Interventions for children with ASD are increasingly offered in natural settings and incorporate key principles of ABA and developmental science thus allowing a child to assert more control over the environment.

Healy and Lydon (2013) [14] reported that researchers now refer to behavioral methods to treat young children with ASD as Early Intensive Behavioral Intervention (EIBI). EIBI programs use a hierarchically arranged and developmentally sequenced skill-based curriculum [15]. Gould and colleagues (2011) reviewed EIBI programs and report that there is general concordance among a variety of programs in assessment, treatment, and evaluation of outcomes [16]. This research identifies the most effective programs for meeting specific curricula criteria. However, Gould et al. concluded that no one approach was comprehensive enough to change the behavior of a child with delays in an array of skill areas, such as social, language, executive functioning, daily living, play, and cognition. They also report that none of the programs they reviewed provide specific treatment recommendations. This review leads to the assumption that there is no satisfactory "one-size fits all" approach to EIBI.

Prior to the development of DTT, normalized teaching interventions were examining the benefits of targeting skills in the learner's natural environment [17]. Hart and Risley (1975) [18] demonstrated that incidental teaching of language skills outside of formal group intervention increased spontaneous language in at risk youth and led to the generalization of these skills outside of the original learning environment. Normalized interventions have since evolved to include many effective methods of early intervention to children with ASD. These approaches include Verbal behavior therapy [19-21], Incidental teaching, Pivotal response treatment [22], and the Denver Early Start model [23-25]. These approaches are collectively known as Naturalistic Developmental Behavioral Interventions (NDBIs) being that they are informed by developmental psychology that provide the intervention in natural and least restrictive environments while employing the principles of ABA. Each approach assumes there is an advantage to learning in the child's natural environment ultimately encouraging the child to apply what is learned in a variety of settings allowing for maximum generalization.

The natural environment teaching (NET) approach used in the current study was introduced by Sundberg and Partington (1998) [26] and has evolved as an effective adaptation of DTT. NET is influenced by both Pivotal Response Training (PRT) and Natural Language Paradigm (NLP) [27]. Like DTT, it used the principles of ABA but is considered more humanistic and incorporates many of the principles of NDBIs. A natural environment is not a specific location but rather any place where children engage in everyday routines and practices (Raab and Dunst, 2004) [28]. Intervention begins with understanding intrinsically motivating stimuli in the child's environment and pairing the instructor with reinforcers [29]. NET also uses functionally related stimuli and reinforcers (Weiss, 2005). Instruction is based on the child's VB-MAPP scores at baseline and uses a developmental hierarchy of skills.

Children with ASD vary in their degree of responding to ABA interventions [30] thus placing the child in the right setting is crucial to treatment effectiveness. Researchers noted that specific treatment protocols were needed based on the responsiveness of the individual with ASD [31]. Although there are differences between highly structured treatment like DTT and naturalistic environment interventions, they both are based on ABA principles and the science of learning. This study examines differential effects of several early intervention curricula using the principles of ABA to young children with ASD in a community-based setting. Because there is ample evidence that ABA is effective for improving developmental outcomes in children with ASD, it is not ethically viable to withhold treatment [32-34]. Therefore, the approach used in this research compares a more traditional instructional method of delivering ABA, DTT, to a more ecologically valid instructional methodology, NET. The study examines effects of the three intervention approaches for children with ASD with low cognitive and language functioning. The purpose of the study is to determine which instructional modality is more effective for improving language and cognitive skills in young children with ASD. This effectiveness focus should be concurrent with reductions in ASD symptoms. We compared the following conditions: (1) NET instruction alone, (2) combination of DTT and NET, (3) DTT instruction alone.

Study hypothesis

Vietze and Lax (2018) reported in a previous study that providing ABA in a community early intervention program had several positive effects. It increased cognitive and language scores using the Bayley Scales of Infant and Toddler Development-III (BSID-3); decreased autism symptoms, based on the Childhood Autism Rating Scale-2; [35] and improved Milestones scores and Barrier scores based on the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) [36].

This study hypothesized that differential treatment will result in different outcomes for children diagnosed with ASD. Therefore several predictions are proposed based on this overall hypothesis: (1) Children receiving a NET intervention will have higher cognitive and language scores than children exposed to only a DTT intervention; (2) Children in a NET intervention will have lower CARS-2 scores compared to children exposed to only DTT; (3) Children in a NET classroom will have higher VB-MAPP Milestones scores than children in the DTT only intervention; and finally (4) Children exposed to a combination of DTT and NET intervention will have better VB-MAPP scores and BSID-III language and cognitive scores than both children exposed only to DTT and those exposed only to a NET intervention; (5) Children receiving both treatment modalities will have lower CARS-2 scores than children only receiving one of the two treatment modalities.

METHODOLOGY

Participants

Participants were 142 children referred to the New York City Early Intervention Program (EIP) with a presumed developmental delay. All had all been previously diagnosed with "autism," "pervasive developmental disorder, not otherwise specified," or with an "autism spectrum disorder," according to DSM IV criteria. There were 117 boys (82.4%) and 25 girls (17.6%). Children were from families that spoke primarily English (56%), Chinese (24%) or Spanish (16%). Children were instructed in their primary language for the three larger language groups. A very small number spoke another language (4%). In New York State, the EIP is available to children from any income level, at no cost to the family. Most of the children in this sample were from low-income families and receiving Medicaid. Children entered the early intervention

program between 20-40 months-of-age. The sample mean age was 26.97 months (sd=3.861). Children typically exit EIP on their 3rd birthday; however, if a child receives approval for preschool special education services prior to his or her 3rd birthday s/he is permitted to remain in the EIP until August 31st or December 31st following their 3rd birthday. Therefore, it was possible for a child to begin receiving ABA services at 40 months-of-age. Informed consent was obtained from parents or legal guardian for participation in treatment and research as shown in Table 1.

Table 1: Demographic characteristics of participants at baseline.

	Group			
Characteristics	**NET**	**DTT**	**NET+DTT**	**Full sample**
n	42	60	40	142
Gender (%)				
Male	88.1	53.6	54	55.6
Female	11.9	46.4	46	44.4
Ethnicity (%)				
Asian	37.5	35.3	40	37.1
Black	16.7	17.6	16.7	17.1
White	16.7	13.7	10	13.3
Hispanic/Latino	25	33.3	33.3	31.4
Other	0.4	0	0	0.9
Age (mean)	27.4	26.7	26.9	26.9

Note: Age is reported in months.

Assessment instruments

Bayley scales of infant development-third edition: The Bayley Scales of Infant and Toddler Development-Third edition [37] are derived from the Bayley Scales of Infant Development (Bayley, 1969) [38] and were revised as The Bayley Scales of Infant Development-Second Edition (BSID-II) [39]. This assessment instrument was developed from earlier versions designed by Nancy Bayley in 1933. The BSID-III evaluates infant and toddler cognitive, language and motor development by direct observation and probing with graded tasks. These scales show good predictive validity with the WPPSI-III [40]. In addition, the BSID-III includes parent-rating scales that a parent can use to rate an infant's social-emotional and adaptive behavior. The social-emotional scales are based on research and writing by Stanley Greenspan [41]. The current results are based on the Cognitive and Language scales. The Bayley Scales have been used consistently and effectively to assess language skills in very young children [42].

Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP): The VB-MAPP is an instrument that is used to assess language and related behavioral milestones using applied behavior analysis principles (Sundberg, 2008) [38]. It is widely used with children diagnosed with developmental disabilities and autism. The VB-MAPP is a criterion-referenced assessment that can generate quantitative data. Each child is tested on a variety of behavioral domains necessary for the acquisition of language and social skills. These include tacts, mands, echoic, imitation, and other skills. Each child is observed and queried, using this rating scale with several different prompts to assign a score. The VB-MAPP provides three summary scores: (1) Milestones, (2) Barriers and (3) Transitions. Milestones are the rating on each of the separate (behavioral) domains. It represents 170 language and social milestones across three developmental levels. The VB-MAPP tracks over 1,000 skills that support the milestones and is used to record and track a child's progress. Therefore, milestones can be measured quantitatively to document learning as an outcome for research purposes. The higher the Milestones score, the better the child's progress. It is expected that the child who is responsive to an intervention will have a Milestones score that increases as a result of intervention because the behavioral domains represent intervention targets. The current study only uses the Milestones subscale.

Childhood Autism Rating Scale-Second edition (CARS-2): The Childhood Autism Rating Scales-Second Edition is a revision of the Childhood Autism Rating Scale [43,44]. It is a 15-item rating scale used by the tester to determine whether the child has problems with sensory-motor, language, social, cognitive, and other skills specific to autism spectrum disorder. It was designed to help differentiate children with specific autism symptoms from children with other developmental disorders. Originally developed in 1971 it is the only instrument that is reliably used to identify children with autism. The CARS developers reported an excellent internal consistency reliability index of 0.94; good inter-rater reliability, 0.71; and reasonable test-retest reliability, 0.88. Clinical ratings during a CARS assessment were correlated with CARS scores to establish criterion validity indicator of 0.81, a reasonable validity index. A concurrent validity study reported high agreement between the CARS-2 and the Autism Diagnostic Observation Schedule-Generic, ADOS-G [45]. This research team reported Cohen's kappa of 0.62, substantial agreement between the ADOS-G and the CARS-2, [46] reported similar results.

Procedures

Children were referred to the early intervention center-based ABA program at the Hand In Hand Early Childhood Center in New York City, after admission to the New York State Early Intervention Program. Children were assigned to an ABA classroom program based on their Individualized Family Service Plan (IFSP). Each IFSP is developed with representation from the family, the evaluation team, and an Early Intervention Official Designee. The IFSP describes the frequency and authorized amount for each service mandated for an eligible child. Beginning with enrollment, each child was tested by a licensed psychologist or psychologist-trained certified special educator using the Bayley Scales of Infant Development-Third Edition and The Childhood Autism Rating Scale (CARS) or the revised CARS. The BSID-III subscales administered were the Cognitive, Receptive and Expressive Language, and the Fine and Gross Motor scales. The Social-Emotional and Adaptive Behavior scale were administered by interviewing the parent. The Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) was completed by the teaching staff after observing the child. Just prior to leaving the program they were again administered the Bayley Scales, CARS-2, and the VB-MAPP. Due to the diverse participant sample all assessments were delivered in the child's native language either by assessor or through a translator as required by New York state regulations. All assessors were blind to treatment conditions.

Treatment programs

Treatment programs are individually designed for each learner based on VB-MAPP scores. Each skills acquisition program is designed to manipulate the environment so that a learner increases verbal behavior in the skill areas of mands, tacts, intraverbals, and echoic. Listener responding, visual perceptual, social skills, imitation, functional play skills, and group skills are also targeted to increase these developmental skills.

Authorized treatment hours varied for each child as determined by the mandated IFSP. Most children did not receive the total number of prescribed hours because of child cancelations due to illnesses, availability of the family, and holidays. Age of entry into the ABA program depended on several factors including the age at which the child was first referred to the early intervention program and/or the age at which a child may have been diagnosed with autism. Each intervention session was approximately two hours for five days a week in a classroom with a maximum of 10 children. Participants received on average 279 hours of intervention in a group setting with a 1:1 teaching assistant ratio.

DTT classroom: The traditional instructional approach in the program uses the principles of DTT. This method isolates skills into smaller component sub-skills taught intensely with frequent delivery of reinforcement and the repetition of teaching trials. Children in the DTT classroom are taught essential foundation level skills such as: responding to one's name, attending to tasks, following simple instructions, and basic imitation skills. The approach assumes that students in the DTT classroom will benefit from intensive, structured, one-to-one instruction so most instruction takes place at a table with the child an instructor.

Criteria for NET classroom placement: Cutoff scores for Readiness for a child's transition to the NET class is governed by the VB-MAPP Milestones scale measuring the child's ability to attend to group instructions. Most instruction in the NET classroom takes place in a group setting, therefore eligibility criteria was measured by the VB-MAPP Classroom Routines and Group Skills Subscale with a required inclusion score of 1.

The NET classroom instruction is based on the Sundberg and Partington (1998) Teaching Language to Children with Autism or Other Developmental Disabilities. The NET classroom promotes group play and instruction in rooms that mimics a typical preschool classroom. The classroom is made up of a large group instructional carpet, imaginative play centers (e.g., kitchen, tool bench, dress up), blocks, train sets, animal/people figurines and fine motor toys (e.g., string beads, peg boards, puzzles).

Staff training and fidelity to treatment: A critical element of the Hand in Hand Early Childhood Center ABA program is the focus on intensive staff training and ongoing support to ensure implementation fidelity. An Intensive Behavioral Skills Training program is in place to train paraprofessionals to offer the program. The training process is divided into seven hierarchically related phases. During each phase of the training process, trainers provide didactic instruction with reviews of the targeted topics such as pairing, manding, and data collection with the trainee. Once the trainee masters the targeted concepts, training continues in the classroom setting where the trainer learns to model the targeted teaching procedure. Training next provides opportunities to rehearse the procedure as the trainer observes, provides feedback, and collects data on the trainee's performance of the skill. Modeling, rehearsal, and feedback are continuously provided until the trainee correctly applies the procedure. Mastery for each skill is achieved following a correct demonstration of the skill across two sessions for two children. A trainee is deemed able to independently provide direct ABA services following mastery of all seven phases and becomes a teaching assistant.

In addition to comprehensive teaching assistant training, observations of teaching assistants occur frequently, and performance assessments are routinely conducted to ensure treatment fidelity. Additionally, each classroom, consisting of no more than 10 children receiving 1:1 instruction by teaching assistants, is overseen at all times by a BCBA. BCBAs also directly supervise each instructor weekly and review trial by trial data collected for each child weekly. The supervising BCBAs are responsible for determining treatment goals and criteria for each child.

ABA data collection and assessment scoring for each treatment modality: Trial-by-trial is the method used to record data on skill acquisition of the children as described by Cummings and Carr (2009) [47]. Each child's behavior is recorded as correct, prompted, or incorrect. Collecting and using frequency data is a common method of collecting learner behaviors. Data were organized daily into a score for each skill by creating a ratio score based on the number correct divided by the total number of a child's responses. This number is multiplied by a factor of 100 to create a percentage correct score. Each occurrence of the target response is recorded and graphed as total number of occurrences per session. Sessions lasted for 120 minutes and children typically attend the program five days each week.

RESULTS AND DISCUSSION

Due to non-random assignment of participants the researchers tested for statistically significant differences in scores on dependent measures at baseline among the three treatment groups. BSID-III Cognitive baseline scores ($F=22.454$, $p<.001$), BSID-III Language baseline scores ($F=35.864$, $p<.001$), CARS baseline scores ($F=19.503$, $p<.001$), and VB-MAPP Milestones baseline scores ($F=51.857$, $p<.001$) all showed statistically significant differences at baseline among the three treatment groups. Additionally, age of entry into the program was tested and found to not be significant ($F=.156$, $p=.856$), nor was quantity of treatment received found to be significant ($F=2.007$, $p=.143$).

In order to control for differences in pretest scores among the three groups a one-way ANCOVA controlling pre-test scores was used to test the study's hypotheses. All assumptions were met to run an ANCOVA. It was hypothesized that children receiving an NET intervention (NET alone or DTT+NET) will have higher cognitive and language scores, fewer ASD symptoms, and higher VB-MAPP Milestones than children exposed to the DTT intervention. Outcome measures consisted of the BSID-III Cognitive composite score, BSID-III Language composite scores, the CARS-2 score, and VB-MAPP Milestones and Barriers pretest and post-test scores.

Impact of the intervention on BSID-III scores

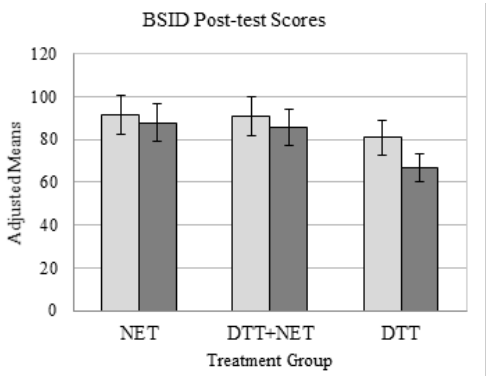
There was a significant difference in post-test mean for the BSID-III Cognitive scores ($F\ (2, 138)=16.413$, $p=.000$, $\eta 2=.192$) when adjusting for baseline scores with a small effect size. Similarly, the ANCOVA showed a significant mean difference on the BSID-III Language post-test scores ($F\ (2, 135)=38.743$, $p=.000$, $\eta 2=.365$) adjusting for BSID-III Language pre-test with a small to moderate effect size.

Bonferroni post-hoc test on both the BSID-III Cognitive and Language post-test scores revealed that mean differences between the DTT group and two other treatment groups were statistically significant ($p<.001$). While differences between NET and DTT+NET were not significant for either outcome variables ($p=1.00$).

Adjusted post-test means for both BSID-III post-test measures

demonstrated the NET group scored highest followed by the DTT+NET group. These results supported the hypothesis that NET when added to the DTT curriculum led to significant increases in scores on the BSID-III Cognitive and Language subscale shown in Figure 1.

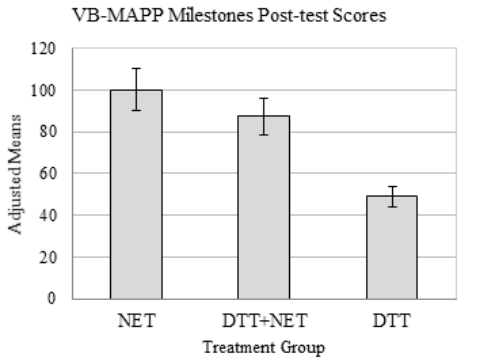
Figure 1: BSID-III adjusted post-test means. **Note:** Error bars represent a 95% confidence interval. (▒) BSID COG; (■) BSID LANG.



Impact of the intervention on VB-MAPP scores

The VB-MAPP is a criterion-referenced instrument that yields scores on a variety of language related behavioral milestones [48]. The Milestones score is a summary measure that includes all the scales in the instrument. There was a significant difference in mean on the VB-MAPP Milestones Assessment post-test scores (F (2, 136)=35.406, p=.000, $\eta 2$=.342) when adjusting for VB-MAPP Milestones pre-test scores with a small to moderate effect size. Post-hoc tests indicated that only differences in the DTT two other treatment groups were significant (p<.000). Overall, the NET group scored the highest on the Milestones Assessment followed by the DTT+NET curriculum group supporting the hypothesis that NET will lead to higher VB-MAPP scores shown in Figure 2.

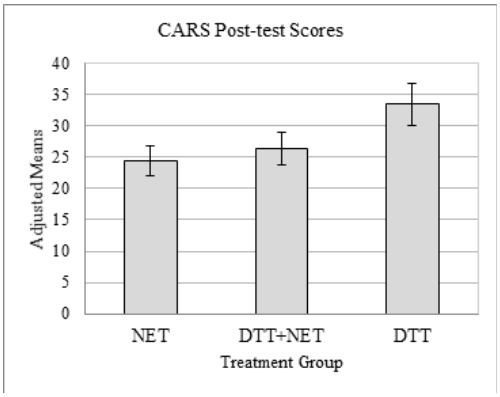
Figure 2: VB-MAPP milestones adjusted post-test means. **Note:** Error bars represent a 95% confidence interval.



Reduction in ASD symptoms: Changes in childhood autism rating scale-2 scores

It was hypothesized that children receiving both treatment modalities will have lower CARS-2 scores than children only receiving one of the two treatment modalities. There was a significant difference in mean on the CARS-2 post-test scores (F (2, 138)=30.519, p=.000, $\eta 2$=.307) when adjusting for CARS-2 pre-test scores with a small effect size. Bonferroni post-hoc test demonstrated that only differences between the DTT and both NET and DTT+NET groups were significant (p<.000). Children in the NET treatment group displayed fewest ASD symptoms as measured by the CARS-2 (Figure 3).

Figure 3: CARS-2 adjusted post-test means. **Note:** Error bars represent a 95% confidence interval.



The evidence base for the effectiveness of ABA for treatment of young children with ASD continues to grow since its inception by Ivar Lovaas in a randomized trial [49]. A number of ABA variations have been developed and evaluated for their effectiveness since its inception [50]. Most of these studies are described as experimental evaluation studies and call ABA with young children EIBI [51]. Vietze and Lax (2018) demonstrated that after an average of 292.7 hours, toddlers with ASD showed improvement in both language and cognitive development on the Bayley Scales of Infant and Toddler Development in a community early intervention program using only DTT. Few studies have compared the effectiveness of adding a natural environment intervention to traditional DTT, and no studies, to our knowledge, have compared these approaches using a large sample of children in a community based early intervention setting.

Effectiveness of the NET approach

This study investigated the impact of adding Natural Environment Training (NET) to DTT on language, cognitive development, learning milestones, and ASD symptoms among toddlers in a community early intervention program. Three intervention groups were compared. One group received only DTT; a second group received DTT plus NET (DTT+NET); a third group received only NET.

Examination of results showed improvements in language, cognitive development, learning milestones, and ASD symptoms for all three groups. However, because there were differences in pretest scores, it was necessary to control for the differences by using ANCOVA for all four dependent measures. This revealed significant main effects for all four dependent measures. When post-hoc tests were conducted to examine the nature of the differences between the three groups, the patterns were all the same. For all four dependent measures the DTT group only showed significant differences in adjusted mean scores from the other two groups, which were not statistically different from each other. Children receiving NET with or without DTT showed greater increases in cognitive, language, milestone, and reductions in ASD symptoms than children receiving DTT alone. Post-test language and cognitive scores placed children in the NET and the DTT+NET groups into the normal range of language development and cognitive development with mean scores in the normal range of 85-115 on the BSID-III following receipt of the

Hand in Hand Early Childhood Center ABA approach.

While the Bayley Scales of Infant and Toddler Development-III is a norm-referenced test the VB-MAPP is criterion referenced. Children were rated using the VB-MAPP on how many skills they mastered each time they were examined. The VB-MAPP includes a variety of skills including verbal and procedural imitation, specific language skills as well as play and social skills. The NET curriculum was superior to the DTT alone intervention. Both groups receiving NET had VB-MAPP scores higher than the DTT group's scores. This finding supports the efficacy of NET as a method to increase overall developmental functioning for children with ASD. This demonstrates that the NET approach, when incorporated into an ABA based classroom program, is more effective than DTT alone for children with ASD.

A similar pattern of improvement occurred for CARS-2 scores. DTT scores were statistically higher than the NET and the DTT+NET groups. Children receiving NET only or those who received DTT plus NET had significantly fewer ASD symptoms than those receiving DTT alone. The group mean for the NET group was 24.425 and 26.295 falling in the non-autistic range, while the mean score for the DTT group (m=33.462) still fell in the mild to moderate autism range after intervention. Improvements were such that ASD symptoms for children receiving NET decreased post intervention to CARS-2 scores that fell outside of the ASD diagnostic range.

The current study presented an opportunity to holistically examine the scope of impact NET has on key developmental measures in young children with ASD. Children in the NET classrooms showed significantly less symptoms of ASD and significantly higher language and cognitive skills after treatment. It seems that the features of NET are amenable to the development of skills such that they no longer meet criteria for ASD. This is indicated by the reduction of CARS scores to below the threshold for which a diagnosis of ASD can be made and BSID-III cognitive and language score within the normal range. These results may indicate that NET is imperative to changing the trajectory of development for children with ASD and a vital component of early intervention curricula.

Comparison with previous research and future directions

These results are similar to those reported for other naturalistic developmental behavioral interventions. Future research should help to discern more precisely what features of NDBIs exhibited in NET lead to increases in language skill, overall achievement of developmental milestones, and decreases in ASD symptoms. There are probably differential effects of NET approaches on different behavioral domains. NET incorporates similar techniques from PRT and from IT and delivers these methods in the natural environment [52,53]. The "pivotal skills" of PRT that lead to improvement in social communication skills include motivation, self-initiation, and self-management. Lei and Ventola (2017) [54] have suggested that improvement in these skills leads to improvement in other aspects of overall social and language functioning. Therefore, it appears that PRT for children with ASD may result in future overall improvement in developmental functioning because it focuses on crucial basic communication and social skills. Understanding the techniques used in NET that led to specific developmental outcomes will help tailor treatment to the specific needs of the child increasing its efficacy.

CONCLUSION

In a previous study, DTT effectiveness was shown to improve language, cognitive skills, and behavioral milestones for children with ASD receiving services in a community based early intervention program. It demonstrated that DTT reduced symptoms of ASD in children less than three years of age. The current study extends the findings of the previous research by varying the curriculum to compare a DTT intervention to NET alone and a DTT plus NET intervention. A distinctive feature of this study is that a NET intervention was provided for toddlers diagnosed with ASD. Most of the studies that utilize natural environment teaching methods have done so with children older than toddler age. The present study demonstrates the benefits of NET for children as young as 20 months providing support for incorporating techniques of naturalistic approaches in treatments for toddlers with ASD. Furthermore, the study utilized a relatively large sample of toddlers in a community early intervention program. The community-based setting did not allow for a true experimental design utilizing a control group. Withholding treatment would be unethical during this vital period of development. However, this experimental design adds valuable information to how ABA interventions function in real world settings. Even in a community-based setting, reduction in core ASD symptoms were demonstrated with both norms referenced (Bayley Scales of Infant Development-III) and criterion-referenced (VB-MAPP) measures for children receiving NET. Overall, these findings lend evidence to the scope of benefits NET interventions have on toddlers with ASD in a community treatment setting and add support for increased use of naturalistic intervention approaches in early intervention programs.

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