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Effect of Natural Environment Training and Discrete Trial Training on Adaptive Behaviors

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Abstract

Rising numbers in Autism Spectrum Disorder (ASD) diagnoses lead to concerns about resources and personnel to support these children in home and school settings. Early intervention and ABA therapy has been demonstrated to show the most beneficial outcomes for children diagnosed with ASD (Peters-Scheffer et al., 2011, Eikeseth et al., 2007). The literature has yet to review the differential effects Natural Environment Training (NET) and Discrete Trial Training (DTT) on adaptive skills. A sample of 110 children diagnosed with ASD or a Developmental Disorder between the ages of 16 and 35 months was collected. The participants either received DTT, NET, or both interventions (NET+ DTT). All participants received the Bayley Scales of Infant and Toddler Development™, Third Edition (Bayley™-3) Adaptive Subscale and the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) Barriers Assessment at intake to be used as baseline measures and again when discharged from the program. Analysis of covariance with pretest scores as the covariate was conducted. A main effect for group for barriers and adaptive behaviors controlling for pretest scores was found ($p = .001, p= .001$). NET and NET+DTT conditions showed statistically significant improvements compared to the DTT condition ($p=.000, p=.000$). These results show that NET can increase adaptive skills in young children with ASD. These findings lay the groundwork for further research and refinement of behavioral interventions in young children in the area of Applied Behavior Analysis and early intervention, and protocols for teaching adaptive skills to toddlers.

Keywords: Autism, Discrete Trial Training, Natural Environment Training, adaptive behaviors

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Effect of Natural Environment Training and Discrete Trial Training on Adaptive Behaviors

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Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder marked by deficits in social communication, social interactions, and restricted repetitive patterns of behaviors or interests (American Psychiatric Association, 2013). Additionally, 33% of children diagnosis with ASD also have an intellectual disability (Maenner et al., 2020). Based on data collected through the Autism and Developmental Disabilities Monitoring Network on 8 years old's throughout the United States, the CDC reports that, as of 2017, 1 in 54 children are diagnosed with Autism Spectrum Disorder (Maenner et al., 2020). Rising numbers in ASD diagnoses lead to concerns about resources and personnel to support these children in home and school settings.

ASD and Adaptive Behaviors

Adaptive behaviors refer to a set of skills that allow an individual to function independently usually referring to the domains of socialization, daily living skills, and communication skills (Pugaliese et al. 2016; Fenton et al. 2003).The relationship between ASD and deficits in adaptive behaviors has been repeatedly demonstrated although the causation of adaptive behavior and ASD remains debated.

Kanne et al. (2011**)** demonstrated in a sample of 1,089 verbal children diagnosed with ASD that IQ was the strongest predictor of adaptive behaviors, and the discrepancy between adaptive behavior and IQ became more severe with age. Overall IQ was most strongly correlated with expressive communication skills and play/ leisure skills. The researchers concluded that severity of ASD symptoms is not correlated with adaptive skill deficits. The external validity of these findings may be limited due to the narrow inclusion criteria of the sample (necessary verbal skills and relatively high mean IQ), suggesting further research should include a more diverse sample of ASD symptomology.

Although it is theorized that adaptive skill deficits are strongly correlated to low IQ or an intellectual disability, ASD alone has been shown to lead to adaptive skill deficits. In a longitudinal study, Pugaliese et al. (2016) studies a sample of 64 children between the ages of 3 and 14 for an average of 3.4 years. Participants had received a diagnosis of ASD, but did not have a comorbid intellectual disability. Baseline measures of IQ, ASD, adaptive skills, and executive functioning were measured. The Vineland Adaptive Behavior Scales was administered again 2-5 times with at least 6 months between administrations. The researchers found that ASD leads to deficits in socialization, daily living skills, and communication skills even in individuals without a comorbid intellectual disability. Executive Functioning was a more accurate predictor of adaptive behavior development than IQ suggesting that ASD alone leads to adaptive skill deficits.

Gabriels et al. (2007) similarly found that middle schoolers diagnosed with ASD all showed delays in adaptive skills, while participants with an intellectual disability and ASD had the most severe deficits. For the participants with a low IQ adaptive skill weaknesses were relatively stable over time. A five year follow up assessment showed little change in adaptive skill acquisition for the low IQ groups while the high IQ group showed increases in adaptive behavior, though both groups were still performing significantly below typically developing peers. Adaptive skill weaknesses are more present in children with ASD than other developmental disorders and remain stable over time.

Neidert, Dozier, Iwata, and Hafen (2010) theorize that ASD possess many challenges to the normal acquisition of adaptive behaviors. Weak intrinsic and extrinsic motivation may be among the most salient challenge in the ASD population. Individuals with ASD may not be reinforced by the same activities as the typical population. Social interactions may actually be

aversive for those with ASD and attention or verbal praise will not have the same reinforcing value leading to limited adaptive skills. Neidert et al. (2010) also suggest that behavioral challenges are more prevalent in the ASD population preventing or delaying adaptive skill instruction compounding the adaptive skills deficits.

Adaptive Behavior Deficits in Early Childhood Population

Adaptive skills are, many times, conceptualized as skills that only apply to older adolescence and adults due to their focus on independent living, but adaptive skill deficits have been repeatedly demonstrated in toddlers and young children under 3 years of age.

Ray-Subramanian et al. (2010) examines adaptive skills and ASD symptoms in 125 toddlers with mean age of 31 months. All children either received a diagnosis of ASD or PDD-NOS. Even under 2 years of age, delays in Vineland-II subscales of receptive communication, expressive communication, personal skills, interpersonal relationships, and play and leisure time were reported. The greatest delays were seen in socialization and communication subscales. Significant correlations were also found between cognitive skills and adaptive behavior again questioning if ASD alone results in adaptive behavior deficits or if low IQ results in these deficits.

Paul, Loomis, and Chawarska (2011) conducted a similar analysis, but also included a matched sample of children diagnosed with a developmental delay (DD). Vineland Adaptive Behavior Scale was administered to 54 children under the age of 2 diagnosed with ASD. The children diagnosed with ASD showed greater global delays in adaptive skills than the DD matched sample. Socialization skills showed to be the largest difference between the ASD sample and DD sample which is expected considering social skills deficits are among the diagnostic criteria for ASD. Interestingly, when controlling for baseline verbal skills, the ASD

sample only showed significant delays in the areas of receptive communication and daily living skills. Ventola et al. (2011) found comparable results when matching children with ASD and DD on verbal skills at baseline. The researchers conducted an item analysis of responses on the Vineland-II finding that deficits in socialization may be present as early as 12 months old in children with ASD. Both Paul, Loomis, and Chawarska (2011) and Ventola et al. (2011) call for adaptive skills to be assessed and directly taught in early intervention ABA programs.

Regardless of the specific cause for adaptive skills deficits in young children with ASD, these skill deficits have been repeatedly shown to be present in children under the age of 3. Early intervention programs should be measuring changes in adaptive skills in order to inform treatment plans and set up children from long term success.

Early Intervention

Early intervention and ABA therapy has been demonstrated to show the most beneficial outcomes for children diagnosed with ASD. Peters-Scheffer, Didden, Korzilius, and Sturmey (2011) conducted a meta-analysis on early intervention ABA treatments demonstrating improved scores on the Vineland Adaptive Behavior Scales (VABS: Sparrow, Cicchetti, & Balla, 2005), and the Childhood Autism Rating Scale (CARS: Schopler, Reichler, & Renner, 1986) assessments after just one year of ABA treatment in children ages 33.6 to 65.7 months.

Similarly, Eikeseth, Smith, Jahr, and Eldevik (2007) compared intensive ABA treatment with eclectic, non-behavior analytic treatment in a small sample of 4-7 year old's diagnosed with ASD. Follow up measures were taken after one year of treatment. The ABA treatment group showed greater improvements in adaptive behavior than the eclectic treatment group leading to increased scores in communication, daily living skills, and socialization skills as measured by the Vineland Adaptive Behavior Scales (VABS: Sparrow, Cicchetti, & Balla, 2005).

Woodman et al. (2018) examined the long term benefits of early intervention ABA therapy on adaptive skills using longitudinal data from the Early Intervention Collaborative Study. Children were followed from the age of 3 when early intervention began to the age of 18. Participants who received high dosage levels of early intervention still had greater daily living skills, communication skills, and socialization skills at 18 years old than participants who received low dosage levels of early intervention. Intensive early intervention does have long term benefits on adaptive skills.

Applied Behavior Analysis: Treatment Types

The principles of Applied Behavior Analysis come from B.F. Skinner's original research on operant conditioning and schedules of reinforcement (Skinner, 1938; Skinner, 1958) and have since been applied to teaching children and adults with developmental disorders.

Lovaas (1987) introduced a method for using the principles of ABA to teach skills to children with ASD called Discrete Trial Training (DTT). DTT usually takes place in a one on one contrived setting with the therapist and child. The procedure of DTT consists of a discriminative stimulus, target behavior, prompt, and reinforcement all in a short interval called a trial. Initially, the instructor uses more invasive prompts to ensure a correct responding before fading prompts out to independence (Lerman, Valentino, LeBlanc, 2016). Repeated trials ensure fluency and conditioned responses. DTT relies on teaching skills in a hierarchy where mastery of one skill is required before moving onto the next. Since its origin DTT has become one of the most popular and widely used methods of ABA therapy (Smith, 2001).

Lovaas (1987) demonstrated that DTT can be used to target specific behaviors such as play, speech, and self-stimulatory behaviors. Almost half of the children in the treatment group (47%) were able to attend general education first grade and scored in the average range on follow

up IQ tests, compared to only 2% in the control group. DTT has since been used to teach a wide variety of skills including adaptive skills.

Natural Environment Training (NET) is considered an application of applied behavior analysis and veers away from the rigid structure of DTT. Sundberg and Partington (1998, 1999) introduced NET based on Skinnerian principles of verbal behavior (Skinner, 1957). Weiss (2001) suggests that NET builds rapport with the instructor because the instructor acts as the primary facilitator of reinforcement. Unlike DTT, NET takes place in the child's natural environment focusing first on mand training (requesting). Frequent mand opportunities are set up in the environment using establishing operations and environmental arrangements to increase intrinsic motivation. This process is meant to increase spontaneity and independence. Over time instruction is faded to the natural context with natural levels of reinforcement (Weiss, 2001). NET is was originally developed to teach verbal behaviors and had a heavy emphasis on communication skill acquisition.

Limitations of the Current Literature

ABA treatment type may play a greater role in treatment effectiveness than current practice assents to. Schuetze et al. (2017) demonstrates that efficacy of ABA treatment does vary, hypothesizing this variability is due to the reliance on operant condition in ABA therapy and neurological differences present in ASD. The substantial neurological processing differences in individuals with ASD may lead to reinforcement patterns that are atypical and maladaptive. Odom et al. (2012) calls for a move beyond the outdated "behavioral treatment" vs "eclectic treatment" dichotomy calling for the need to elucidate specific benefits and weakness of individual treatment phenotypes. It is reasonable to think that certain treatment types may be more of less effective at targeting specific skill areas. Sundberg and Partington (1999) suggests

that DTT may be more beneficial when teaching academic skills and NET beneficial when targeting emerging language skills and group instruction skills. The literature has yet to qualitatively compare the differential effects of NET and DTT on adaptive behavior.

The current study hypothesizes that deficits in adaptive behaviors are present in toddlers as young as 35 months old in children diagnosed with ASD/PDD-NOS. An aim of this research is to add to the body of literature demonstrating that deficits in adaptive behaviors are present in toddlers as young as 35 months old in children diagnosed with ASD/PDD-NOS

Additionally, this study hypothesizes participants who receive both NET and DTT treatment condition will lead to greater improvements in adaptive behavior and a decrease in maladaptive behaviors compared with children who received NET or DTT treatment condition alone. It is reasonable to believe that the NET and DTT combined condition will allow for a more comprehensive treatment leading to the most beneficial outcomes in adaptive and maladaptive behaviors. An additional aim of this research is to add to the body of literature demonstrating that deficits in adaptive behaviors are present in toddlers as young as 35 months old in children diagnosed with ASD/PDD-NOS.

Methods

Participants

Participants consisted of 142 children (25% female) receiving early intervention through Hand In Hand Early Childhood Center in New York City. Participants were referred to the program by NYS Early Intervention Program due to signs of a developmental delay. Participants were between the ages of 16 and 35 months ($m = 26.97$, $sd = 3.86$) at intake and received a diagnosis of ASD or a Pervasive Developmental Disorder, Not Otherwise Specified (PDD-NOS) by a licensed psychologist before entering the program. The participant sample was

representative of a typical racial and ethnic sample found in large urban cities with the primary languages of Chinese (26.8 %), English (53.5%), Spanish (18.3%), and other (1.4%), and representative of the typical gender ratio of ASD diagnoses with 1 female receiving a diagnosis of ASD for every 4 males (Fombonne, 2009).

Assessments

The assessments chosen for this study attempt to mirror the theory of Neidert et al. (2010) that adaptive skills deficits are cause by both limited social reinforcement and an increase of maladaptive behaviors that inhibit instruction and typical adaptive skills development.

Bayley Scale of Infant and Toddler Development

At intake, all participants received the Bayley Scales of Infant and Toddler Development, Third Edition (Bayley, 2003). The Bayley Scale was developed to measure infant and toddler development from 1 month to 42 months of age, and is appropriate to use to both identify areas of developmental delay and track improvement over time (Albers & Grieve, 2007). Bayley-3 shows good predictive validity on the Vineland-II (VABS: Sparrow, Cicchetti, & Balla, 2005) standard scores and the WPPSI-III (Scattone, Raggio, & May, 2011; Wechler, 2002). Assessment is delivered through direct observation, parent report, and direct probes.

The Bayley Scale is designed to assess five areas of development: cognitive, communication, physical, socio-emotional, and adaptive. The Bayley Adaptive Behavior Subscale is administered through parent report and assesses skills such as communication, self-care, leisure, health and self-direction, home living, etc (Bayley, 2003). Scores on the Adaptive Subscale standardized scores based on pass/ fail criteria with an average mean score of 100 and a standard deviation of 15. The Bayley Scales of Infant and Toddler Development, Fourth Edition (Bayley-4) has since been released, but data were collected prior to its publication in 2019.

Verbal Behavior Milestones Assessment and Placement Program

The Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) is based on the principles of B.F. Skinner's analysis of verbal behavior and is designed to assessed verbal and related skills that are required to develop normal communication (Skinner, 1957; Sundberg, 2008). The VB-MAPP is a criterion-referenced instrument comprised of the Milestones Assessment, the Barriers Assessment, and the Transition Assessment. Sundberg (2008) states that the main goal of the VB-MAPP is to assesses baseline skill levels and areas of deficit in comparison to a typically developing child in order to inform treatment programming and analyze improvements over time. Assessment data is collected through observational data collection and direct probing of skills. The VB-MAPP has shown high to moderate interrater reliability with the highest interrater reliability demonstrated for the Milestones Assessment Subscale and lowest interrater reliability for the Barriers Assessment (Montallana, Gard, Lotfizadeh, & Poling, 2019; Sundberg & Sundberg, 2011). While the content validity for both the Milestones Assessment and Barriers Assessment is moderate to strong (Padilla & Akers, 2021). The VB-MAPP is the most commonly used assessment among ABA practitioners with 76% reporting using the VB-MAPP alone or in conjunction with other assessments (Padilla, 2020b).

The Barriers Assessment measures 24 learning and language acquisition barriers common to children with ASD or a developmental delay that inhibit learning or teaching. The skills assessed include behavior problems, reinforcer dependence, self-stimulation, obsessive-compulsive behavior, sensory defensiveness, failure to generalize, weak motivators, etc. The Barriers Assessment is a criteria referenced assessment and gives a sum score between 0-96. The lower the score the fewer barriers to learning and instruction are being exhibited by the child.

The Barriers Assessment is meant to complement the Milestones Assessment by identifying specific barriers impeding the development of a specific skill (Sundberg, 2008).

Procedures

Participants were referred to Hand In Hand Early Childhood Center due to suspected ASD or developmental delay to receive an evaluation and ABA therapy. Treatment type decisions (NET or DTT) were made based on intake scores. Three experimental groups were identified: NET group (*n=41*), DTT group (*n= 57*), and children who received both NET and DTT (NET+DTT) (*n=38*). Participants received an average of 260 sessions in their respective experimental treatment group. One session is consists of 2 hours of ABA therapy.

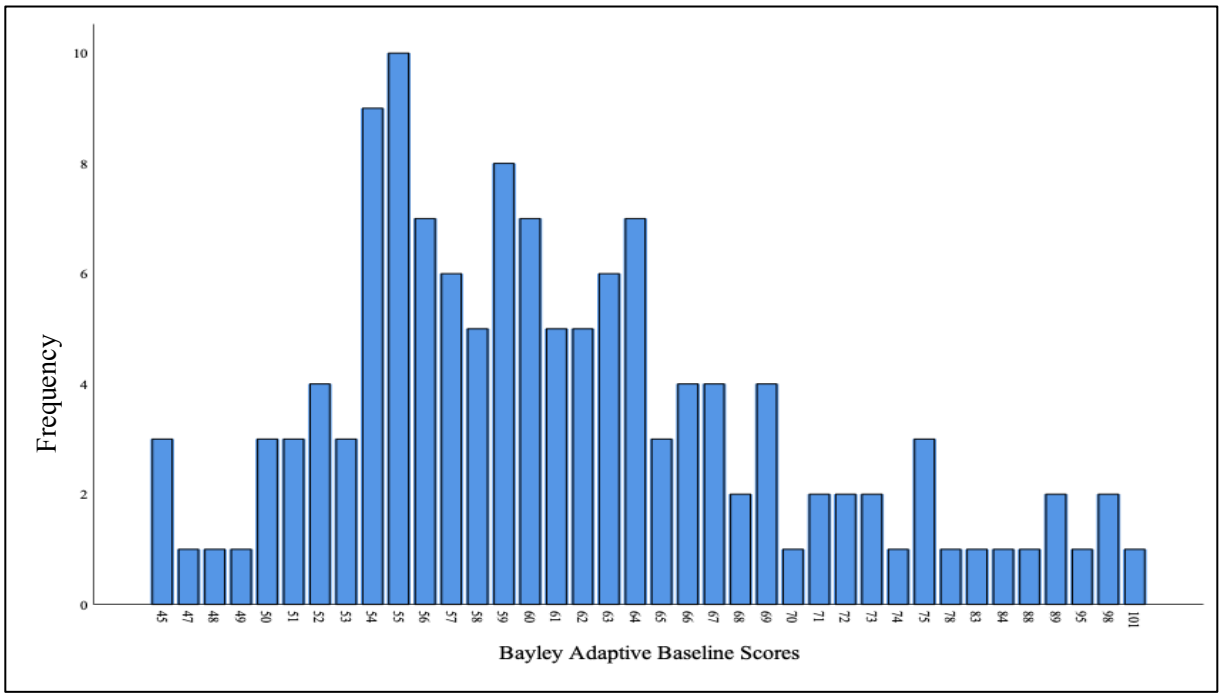
At intake, children were given the Bayley Scales of Infant Development-Third Edition (2003) by a licensed psychologist or educator trained to give the assessment. The Bayley Adaptive Behavior subscale was administered through parent interview. The VB-MAPP was also delivered at intake by the special educator or licensed psychologist. The Barriers Assessment subscale is administered through observational data collection.

Results

Deficits in adaptive behaviors at baseline were measured supporting the hypothesis that children under 36 months of age diagnosed with ASD show delays in adaptive behavior skill acquisition. Toddlers as young as 16 months to 35 month old were already displaying significant deficits in adaptive behaviors (*m = 62.01 sd = 10.66*) (Figure 1) as measured through the Bayley Adaptive Behavior Subscale. An increase in maladaptive behaviors and barriers to learning were also demonstrated by the VB-MAPP Barriers Assessment (*m = 51.83, sd = 18.25*) although a large range in scores was observed (Table 1).

Figure 1

Bayley Adaptive Subscale Score Distribution



Note: Baseline scores on Bayley-3 Adaptive Subscale

Table 1

Descriptive Statistics

VB-MAPP Barriers Baseline		Bayley Adaptive Baseline	
N	139	N	132
Mean	51.853	Mean	62.01
Std. Deviation	18.2555	Std. Deviation	10.657
Range	86.5	Range	56

Data were collected from a community sample where random assignment was not possible. ABA treatment is one of the accepted effective treatments available even a "wait list control group" would interfere with the child's developmental progress. Quantity of treatment received was not found to be statistically significant between three treatment groups *($p = .68$)* nor was age at intake found to be statistically significant between three treatment groups *($p = .8$)*.

Analysis of pretest scores did show statistically significant differences among three treatment groups for both dependent variables at baseline (*p=.01*). Therefore, an analysis of covariance with pretest scores as the covariate was conducted. A main effect of group for Bayley-3 Adaptive subscale was found controlling for pretest scores [$F(3,109) = 33.86$, $p < 0.001$, $\eta^2 = .475$)] (Table 6, Appendix A), and a main effect for VB-MAPP Barriers Assessment was found controlling for pretest scores [$F(3,135) = 109.78$, $p < 0.001$, $\eta^2 = .707$)] was found (Table 7, Appendix A). A large effect size was found for VB-MAPP Barriers and a moderate effect size was seen for the Bayley-3 Adaptive subscale. Fewer children were available for the post Bayley than for the VB-MAPP hence the difference in sample size.

Bonferroni post hoc tests showed that there was no statistically significant difference between the NET group and the NET+DTT groups on both the and the Bayley-3 Adaptive subscale (*p = .877*) and the VB-MAPP Barriers Assessment (*p = .398*). Post hoc tests between DTT only and the other two treatment groups (NET alone and NET+DTT) were significant (Table 2, Table 3).

Table 2

Pairwise Comparisons Bayley-3 Adaptive

Dependent Variable: Bayley Adaptive Post-Test						
					95% Confidence Interval for Difference[b]	
(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
NET	NET+DTT	3.100	2.930	.877	-4.026	10.227
	DTT	17.647*	2.948	.000	10.475	24.819
NET+DTT	NET	-3.100	2.930	.877	-10.227	4.026
	DTT	14.547*	2.755	.000	7.845	21.249
DTT	NET	-17.647*	2.948	.000	-24.819	-10.475
	NET+DTT	-14.547*	2.755	.000	-21.249	-7.845

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 3

Pairwise Comparisons VB-MAPP Barriers

Dependent Variable: VB-MAPP Barriers Post-Test						
					95% Confidence Interval for Difference[b]	
(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.[b]	Lower Bound	Upper Bound
NET	NET+DTT	-3.723	2.461	.398	-9.691	2.244
	DTT	-17.652*	2.781	.000	-24.395	-10.908
NET+DTT	NET	3.723	2.461	.398	-2.244	9.691
	DTT	-13.928*	2.537	.000	-20.079	-7.778
DTT	NET	17.652*	2.781	.000	10.908	24.395
	NET+DTT	13.928*	2.537	.000	7.778	20.079

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

The adjusted means show that NET treatment group had the greatest improvements controlling for pretest on both Bayley- 3 Adaptive subscale (*m = 78.82, sem = 2.108*) (Table 4) and VB-MAPP Barriers Assessment to learning (*m = 14.93, sem = 2.108*) (Table 5) followed by the NET+DTT group (Figure 2).

Table 4

Adjusted Means Bayley- 3 Adaptive Subscale

Dependent Variable: Bayley Adaptive Post-Test				
			95% Confidence Interval	
GROUP	Mean	Std. Error	Lower Bound	Upper Bound
NET	78.820[a]	2.108	74.641	83.000
NET+DTT	75.720[a]	2.056	71.644	79.796
DTT	61.173[a]	1.815	57.575	64.772

a. Covariates appearing in the model are evaluated at the following values: Bayley Adaptive Baseline = 62.26.

Table 5

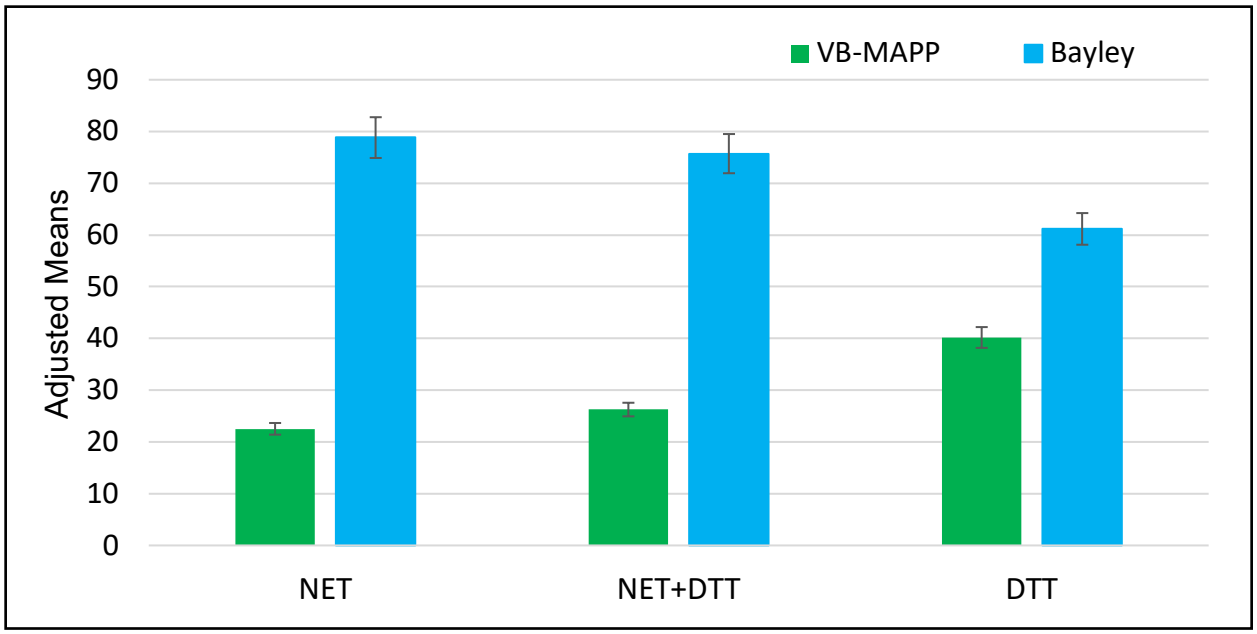
Adjusted Means VB-MAPP Barriers Assessment

Dependent Variable: VB-MAPP Barriers Post-Test				
			95% Confidence Interval	
GROUP	Mean	Std. Error	Lower Bound	Upper Bound
NET	22.539[a]	1.879	18.822	26.257
NET+DTT	26.263[a]	1.766	22.769	29.757
DTT	40.191[a]	1.651	36.924	43.458

a. Covariates appearing in the model are evaluated at the following values: Barriers Baseline = 52.070.

Figure 2

Adjusted Means Post-Tests



Note: Post-test estimated mean adjusted for baseline scores displaying 95% confidence interval

Discussion

This study demonstrates the value of measuring adaptive behaviors in young children. Toddlers under 36 months of age were displaying significant deficits in adaptive behaviors. These findings support existing literature that adaptive behavior interventions are necessary for children under the age of 3 diagnosed with ASD due to delays in adaptive behaviors in comparison to typical peers already emerging (Ray-Subramanian et al., 2010; Paul et al, 2011; Ventola et al. 2011). The theory by Neidert et al. (2010) that children with ASD may demonstrate more barriers to learning was also supported with the participants showing high levels of behaviors inhibiting learning at baseline. Treatment approaches to teaching adaptive behaviors need to take into account both direct instruction of adaptive behaviors such as

communication, play, and daily living skills and work on decreasing maladaptive behaviors that prevent learning and teaching.

This study is also one of the first to demonstrate differential effectiveness of treatment types under the umbrella of ABA therapy. Few studies use standardized baseline and post-test measurements to analyze the effectiveness of treatment. Additionally, few studies focus on the acquisition of adaptive behaviors in the early childhood population. This research did not demonstrate a statistically significant difference between NET and NET+DTT conditions, but does demonstrate significant differences between DTT and both other conditions. These results support the hypothesis that NET+DTT condition will lead to the most beneficial outcomes on adaptive behavior. Children who received NET alone and NET+DTT demonstrated a statistically significant improvement on Bayley Scales of Infant Development-III Adaptive Behavior Subscale and the VB-MAPP Barriers Assessment compared to the DTT alone condition after an average of 260 sessions.

Previous literature has hypothesized the need to take into account the benefits of NET and DTT in order to tailor treatment to meet the educational and behavioral needs of the individual child. Sundberg and Partington (1999) theorize that a combination of both NET and DTT may show the most beneficial outcome. This study lends quantitative evidence to the theory that NET and DTT do have differential effects on skill acquisition. NET was developed with a focus on teaching verbal and pre-verbal behaviors so these findings broaden the scope of the benefits of NET. Assessing adaptive behaviors using both the Bayley-3 and the Barriers Assessment ensures results are not biased by assessor expectations because the VB-MAPP is developed to be used along with NET.

The number of children being diagnosed with ASD are increasing every year (Maenner et al., 2020) making ABA therapy highly in demand. Research based decisions on how to use limited personnel and resources in providing effective treatment is imperative. Limited resources must be used efficiently and sparingly. Mastery of adaptive skills also benefits the individual with ASD. Adaptive skills are foundational to long term independent living, job acquisition, and interpersonal relationships. These findings lay the groundwork for further research and refinement of behavioral interventions in young children in the area of Applied Behavior Analysis and early intervention when targeting adaptive behaviors.

Limitations

Although this study contributed valuable information to the field of ASD and early intervention, there are a few limitations. The study is limited in experimental design do to the community based data sample. Random assignment of participants to each experimental group was not possible, but a covariate was used in the statistical analysis to account for baseline differences. These procedures are commonly used in educational settings and community based data samples.

Current Body of Literature

This study is also limited by the current body of literature analyzing NET and DTT. It is well documented that intensive early intervention that uses the principles of ABA increases adaptive skills (Woodman et al., 2018; Peters-Scheffer et al. 2011; Eikeseth et al. 2007). Some have also theorized that multiple treatment types would be needed to provide wholistic interventions (Sundberg & Partington, 1998; Cummings, 1998), but there is no empirical evidence favoring one ABA treatment type over another. In practice, children usually receive the

treatment time that is most readily available to due to them due to popularity in a certain geographic location or time period.

Future Research Directions

Applied Behavior Analysis, in general, focuses on individual changes over time tracking progress data for a single child and using single subject experimental designs. While valuable in a clinical setting, broader research identifying group differences in treatment modalities is necessary. Additional outcome variables should be studied in addition to adaptive behaviors to identify which domains of development benefit the most from NET or DTT. As previously mentioned, Sundberg and Partington (1999) predict that NET will be more beneficial for teaching some domains while DTT will be more beneficial for others. Future studies should also look at dosing recommendations for NET and DTT. NET and DTT may be more or less effective at different dose levels or may experience an plateau of effectiveness. A further analysis of the NET+DTT treatment condition could contribute to elucidating the dosing of NET necessary to see improvements in adaptive skills. Cummings (1999) calls for this very research and reminds us that, in practice, treatment modality is eclectic and varies due to the individual's acute needs. Targeting intervention type and dose to identified deficits will allow the child to progress more quickly. The goal with ASD interventions should always be treating areas of developmental delay efficiently and sustainably creating lasting, meaningful changes over time.

Conclusion

In summary, the current study demonstrates differential effects of types of ABA therapies. NET showed greater improvement in adaptive behavior and reduction in barriers to learning than DTT alone or in conjunction with DTT. Further research should be conducted on additional outcome measures such as verbal skills, cognitive skills, and social skills to determine

the scope of the improvement of skills attributed NET. Also, refinement of dosing recommendations is needed to understand the quantity of NET needed to sustain skill acquisition. Treatment decisions should always be research based and data driven. The finding of the current study inform best practice for increasing adaptive skills in early childhood aged children diagnosed with ASD.

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Appendix A

Table 6

Tests of Between-Subjects Effects Bayley-3 Adaptive

Dependent Variable: Bayley Adaptive Post-Test						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	13299.837[a]	3	4433.279	33.861	.000	.489
Intercept	4483.346	1	4483.346	34.244	.000	.244
Bayley Adaptive	1915.208	1	1915.208	14.628	.000	.121
GROUP	5697.795	2	2848.898	21.760	.000	.291
Error	13877.981	106	130.924			
Total	577436.000	110				
Corrected Total	27177.818	109				

a. R Squared = .489 (Adjusted R Squared = .475)

Table 7

Tests of Between-Subjects Effects VB-MAPP Barriers

Dependent Variable: VB-MAPP Barriers Post-Test						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	37569.715[a]	3	12523.238	109.786	.000	.714
Intercept	.007	1	.007	.000	.994	.000
Barriers	8820.746	1	8820.746	77.328	.000	.369
GROUP	5173.373	2	2586.687	22.676	.000	.256
Error	15057.219	132	114.070			
Total	183137.000	136				
Corrected Total	52626.934	135				

a. R Squared = .714 (Adjusted R Squared = .707)