3-14-2018

Early Intervention ABA for Toddlers with ASD: Effect of Age and Amount

Peter Vietze
Montclair State University, vietzep@mail.montclair.edu

Leah Esther Lax
Montclair State University

Current Psychology (2020) 39:1234–1244
https://doi.org/10.1007/s12144-018-9812-z

Early Intervention ABA for Toddlers with ASD: Effect of Age and Amount

Peter Vietze[1,2] · Leah Esther Lax[1]

Published online: 14 March 2018

Abstract
Autism Spectrum Disorder (ASD) is a developmental disability manifested early in life. About 26–40% of young children with ASD have intellectual disability (ID). Applied Behavior Analysis (ABA) has been shown to be effective in reducing symptoms of ASD and improving cognitive and language function. The purpose of this study was to examine the optimal age, number of treatment hours and domains, for which ABA was effective in a community based early intervention program. An ABA program was implemented with 106 toddlers under 40 months, many of whom were from immigrant families with limited English proficiency. Bayley Scales, VBMAPP and CARS-2 were administered as Pre-and Post-intervention program measures. The children showed significant improvement in all Bayley and VBMAPP measures as well as reduction in symptoms of ASD. The current study shows that ABA early intervention in a community setting provides statistically significant improvement in cognitive, communication, motor, socio-emotional, adaptive and criterion referenced behavior as well as a reduction in symptoms of ASD and barriers to learning.

Keywords Early intervention · ABA · Autism spectrum disorder · Ethnic minorities · Immigrant families

Introduction

Autism Spectrum Disorder (ASD) is a developmental disability manifested at an early age in children. It is characterized by communication deficits, difficulty building friendships appropriate for the children's age with stereotyped or repetitive behavior and high sensitivity to environmental stimuli (American Psychiatric Association 2013). About 26–40% of young children with ASD also have intellectual disability (ID) (Baird et al. 2000; Chakrabarti and Fombonne 2001). Problematic behavior patterns are often present including self-injury, anxiety, compulsions, withdrawal, uncooperative behavior, aggression, and destruction of property (Lecavalier 2006; McClintock et al. 2003). Nevertheless, some individuals with ASD are particularly adept at certain skills and tasks which surpass those skills of neurotypical individuals. These special skills may include exceptional memory, math skills, artistic and musical ability and the ability to focus intensely on something that interests the individual.

✉ Peter Vietze
vietzep@montclair.edu

[1] CARES, New York, NY, USA

[2] Montclair State University, Montclair, NJ, USA

Prevalence of ASD

In 2002, it was reported that the rate of ASD was as high as 66 per 10,000 (Fombonne, 2002; Yeargin-Allsopp et al. 2003). In 2016, the CDC raised the rate to 1 in 68 (Christensen et al. 2016). It should be noted, however, that the CDC report is based on their autism surveillance monitoring study of 8-year olds in 11 states. Currently, there are no prevalence data on children younger than 5. Since children are still being diagnosed for the first time after they get to school, prevalence data are only reliable for school-age children (Christensen et al. 2016).

Intervention Programs for ASD

The effectiveness of ABA therapy for the population with ASD has been demonstrated in numerous experimental and randomized controlled trials and has shown beneficial effects for cognitive, language and social skills (e.g. Fox, 2008, Lovaas 1987; Smith et al. 1997; Smith, Groen & Wynn, 2000). Nevertheless, examining the effects of ABA in community-based early intervention programs has yet to be demonstrated. In addition, the optimal age to commence treatment and the number of treatment hours has still to be determined for effective treatment in early intervention programs.

Applied Behavior Analysis (ABA) has been reported to deliver successful outcomes for children diagnosed with ASD. Since Lovaas (1987) first demonstrated the effectiveness of ABA (ABA) with young children with diagnoses of ASDs, there have been a number of replications or partial replications of his study (e.g. Smith et al. 1997; Smith, Groen, & Wynn, 2000, Matson and Konst 2014). Based on the results of some of these early-randomized clinical trials demonstrating that ABA was the only treatment that produced significant improvement in developmental level and associated reduction in symptoms, New York State (NYS) approved the use of ABA in its Early Intervention Program for children diagnosed with an AASD (New York State Department of Health 1999).

Furthermore, it has long been held that "earlier is better" when implementing early intervention programs (Shonkoff and Phillips 2000; Shonkoff 2003). Nevertheless, this has not been clearly demonstrated for ABA applied to young children with ASD. Currently, ASD cannot be easily identified before 18 months of age, for the most part. Therefore, if a child is diagnosed with ASD by 18 months, that child can only receive ABA in early intervention for approximately 18 months until the child transitions to a special education preschool program, in NYS. It is generally assumed that children, who begin ABA as early as possible, will show improvement in language and reduction in symptoms, as compared to those who begin later. It has also been assumed that the child who receives more ABA will benefit more than the child who receives fewer hours. However, there is no finite number of hours that has been demonstrated to effectively reduce the child's symptoms of ASD or to induce fluent language.

Early Identification of ASD

Early identification of ASD in children has increased in importance. There has been evidence that children with ASD can be reliably diagnosed at 2 years of age or younger (Stenberg et al. 2014). Many studies have found that children with ASD who receive services prior to 48 months of age make greater improvements than those who enter programs after 48 months of age (Fenske et al. 1985; Lovaas and Smith 1988; Lovaas 1987; Luiselli et al. 2000; Sheinkopf and Siegel 1998; Turner and Stone 2007). However, this has not been clearly demonstrated for ABA applied to young children (under the age of two) with ASD. Two comparable programs are the Walden Toddler Program (McGee et al. 2001) which is based on a typical daycare model, with the focus on using incidental teaching and social inclusion and the Early Start Denver Model which combines ABA with developmental approaches (Dawson et al. 2010). The ideal way to treat children with ASD is to identity their symptoms and begin treatment as early as possible. However, ASD cannot yet be easily identified before 18 months of age. In NYS if a child is diagnosed with ASD at 18 months, the child can only receive ABA in early intervention until the child transitions to special education preschool after the age of three. Studies have shown children may benefit most from entering intervention early (Fenske et al. 1985; Lovaas and Smith 1988; Lovaas 1987; Luiselli et al. 2000; Sheinkopf and Siegel 1998; Turner and Stone 2007).

Limitations of Existing Literature

Logically, it is assumed that the more ABA hours a child receives, the more likely it is that that child will benefit as compared with the child who receives fewer hours. Lovaas (1987) compared children who received ABA for 40 h a week to children who received only 10 h a week and found better results for the former group. In fact, the children who received only 10 h or less a week showed little improvement in symptoms or cognitive test scores. Nevertheless, there is no definitive empirical support on the finite number of hours that is prescribed to effectively reduce the symptoms of ASD and improve functioning.

The general hypotheses that were investigated in the current study predict that ABA leads to improved performance in Cognitive, Language, Motor and Social Emotional scores on the Bayley Scales (Bayley 1993), reduced symptoms of ASD and improved performance on the summary measures of the Verbal Behavior Milestones and Placement Program (VBMAPP) (Sundberg 2008). In addition, it was predicted that children who begin the program prior to 28 months will show more improvement on these measures than those older than 29 months and that children who received more intervention hours will show greater improvement in these measures than those who received fewer intervention hours.

Methods

Participants

Participants included 106 children who had been referred to Early Intervention due to a presumed developmental delay. They had all been diagnosed with ASD or Pervasive Developmental Disorder, Not Otherwise Specified according to DSM IV criteria or with an ASD according to DSM V criteria by licensed psychologists prior to entering the program. The children in the current report consisted of 90 males (85%) and 16 females (15%) females. The age range of the participants when they commenced ABA was 20–40 months with a mean age of 28.68 months. Typically, children exit the NYS Early Intervention Program on their 3rd birthday or, if they receive approval for preschool special education prior to their 3rd birthday, they are permitted to remain in the Early Intervention Program until August 31st or December 31st following their 3rd birthday. Hence it is possible for a child to begin receiving ABA at 40 months. Children were from

families who speak a variety of languages including Spanish (16%), Chinese (24%) and English (56%) with a small number speaking other languages (4%). The children were tested in their native language, as mandated by the New York State Early Intervention Program. Children from families whose primary language was other than English were tested by an examiner fluent in that language or with a trained interpreter in that language. After their admission to the NYS Early Intervention Program, having been diagnosed with ASD, they were referred to the Early Intervention ABA program at the Hand In Hand Early Childhood Center in New York City.

Participants actually received a mean of 292.74 h of intervention in a group setting with a 1:1 aide. In accordance with the Regulations of the NYS Early Intervention Program, an Individualized Family Service Plan or IFSP is established for each child, with representation from the evaluation team and the family, in concert with an Early Intervention Official Designee (EIO/D). This plan indicates the services, frequency and amount, which are authorized for a child who is deemed eligible by the Early Intervention program. In addition, the actual number of hours attended were a function of differential authorizations and depended on family availability, illnesses and holidays. Attrition is less than 10% as every effort is made to ensure that completion of the program is maintained. Children are provided bus transportation if they live beyond walking distance from the Center, in which case the parent brings the child and waits in a waiting room. Providing bus transportation from the home to the center for the child and parent, if desired, removed the major barriers to consistent attendance frequently experienced by out of home programs. Each session lasted for 2 h and the children typically attended 5 days a week. Age of Entry into the ABA program depended on a number of factors including the age at which the child was first referred to the Early Intervention Program and/or the age at which children may have been diagnosed with ASD. The mean age at which children entered the ABA intervention program was 28.67 months of age (Age of Entry) with a range of 19.9 to 39.7 months of age. Although Early Intervention is available to children from any income level at no cost to the family, most of the children were receiving Medicaid, indicating that this was a largely low-income sample. Table 1 shows summary information describing the participants in the study.

In order to test the hypotheses about Age of Entry, participants were divided at the median age into Older (children who began treatment at 29 months or older) and Younger (children who began treatment at 28 months or below). In the Younger group children ranged from 20 to 28 months with a Mean age of 25 months for Age of Entry. In the Older group children ranged from 28 to 40 months with a Mean age of 31 months for Age of Entry. Furthermore, the participants were also divided at the median Amount of Intervention received (291 h) into two subgroups with one representing those who received More intervention (>292 h) and the other representing those who received Less intervention (<291 h) in order to test the hypotheses about Amount of Intervention received.

Assessment Instruments

Bayley Scales of Infant Development- Third Edition

The Bayley Scales of Infant and Toddler Development-Third edition (Bayley 2003) are derived from the Bayley Scales of Infant Development (Bayley 1969) and were revised as the Bayley Scales of Infant Development-Second Edition (BSID-II; Bayley 1993). These descended from earlier versions designed by Nancy Bayley in 1933. Although children with ASD were not identified in the standardization, given the 2016 CDC estimates for ASD prevalence of 1 in 68, it is likely that children with ASD were represented in the sample, especially in the age range studied. Most with ASD children are still not identified until school age (Christensen et al. 2016). The Bayley-III (Bayley 2003) 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 (Wechsler 2002). In addition, the Bayley-III includes parent-rating scales on which the parent can rate the infant's social-emotional behavior. The social-emotional scales are based on research and writing by Stanley Greenspan and colleagues (Greenspan 2004). In the

Table 1 Characteristics of children in the sample ($N = 106$)

	Mean	S.D.	Minimum	Maximum
Age of Entry (Months)	28.67	3.61	19.9	39.7
Ending Age (Months)	38.35	3.23	27.6	43.9
Starting age of Younger Children (Months)	25.26	1.80	19.9	27.5
Starting age of Older Children (Months)	31.05	2.25	27.7	39.6
Number of hours	292.74	131.95	78	858
Less Intervention: Hours	191.08	63.00	78	291
More Intervention: Hours	390.63	103.77	292	858
% Males	85			

current study, the Bayley Scales were used as an evaluative tool so the fact that the norms do not specifically identify a group of children with ASD is not relevant.

Childhood Autism Rating Scale-Second Edition (CARS-2)

The Childhood Autism Rating Scales-Second Edition (Schopler et al. 2010) is a revision of the Childhood Autism Rating Scale (Schopler et al. 1986). The new version is norm referenced. It is a 15-item rating scale developed to evaluate children suspected of having ASD. It was designed to differentiate children with ASD from children with other developmental disorders. Originally developed in 1971 (Reichler and Schopler 1971), it was the only instrument that could be used to reliably identify children with ASD. The CARS has high reliability with an internal consistency rating of .94. Inter-rater reliability was originally estimated to be .71 and test-retest reliability was .88. Validity is also estimated to be high with criterion related validity (with the criterion being clinical ratings during the same session) estimated at .84. One study has reported high agreement between the CARS-2 and the Autism Diagnostic Observation Schedule- Generic, ADOS-G (Ventola et al. 2006). Ventola et al. (2006) reported Cohen's kappa of .619 between the ADOS-G and the CARS-2. Similar results were obtained by Chlebowski et al. 2010. Inter-rater reliability n the latter report was measured at both pretest and posttest occasions and showed Cohen's Kappa of .69.

Verbal Behavior Milestones Assessment and Placement Program (VBMAPP)

The Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) is an instrument that can be used to assess and track language and related behavioral milestones using ABA principles (Sundberg 2008). It is widely used with children who have developmental disabilities and ASD. The VBMAPP is a criterion-referenced assessment that can also generate quantitative data. Each child is tested on a variety of behavioral domains including such as Tacts, Mands, Echoic (imitation), (motor) Imitation, and other skills necessary for the acquisition of language and social skills. Each item scales the number of tasks completed by the child at the time. Most items are specific and not subjectively rated by observers. It is used to measure progress and the effect of intervention in the current research. Each child is observed and probed with a variety of prompts in order to assign a rating on the individual behaviors by the supervising teacher or a licensed clinical psychologist. Validity for the VBMAPP has been reported by Dixon et al. (2015). Reliability data have been reported for the VBMAPP by Barnes et al. (2014), Sundberg and Sundberg (2011) and Kisamore et al. (2016). The VBMAPP produces 3 summary scores: Milestones, Barriers and Transitions. Milestones refer to the rating on each of the behavioral domains. It represents 170 language and social milestones across 3 developmental levels. The Skills Task Analysis and Tracking System contains over 1000 skills that support the milestones, and can be used to record and track progress. The milestones are thus quantifiable and measurable and can be used to document learning, or used for outcome research. The higher the Milestones measure, the better the child's progress. Since the behavioral domains represent intervention targets, it is expected that the child who is responsive to intervention will have a Milestone score that increases as a result of intervention. A scoring manual serves to guide the observer who evaluates the child at the beginning of the program and upon exiting after aging out. The Barriers Assessment of 24 language and learning barriers is based on rating the child's behaviors that interfere or challenge the child's ability to achieve milestones. The Barriers score is expected to decline as a result of intervention if the child is responsive to the intervention. The Transition Assessment identifies the skills needed for successful transition to less restrictive learning environments. It is expected that the Transition score will increase if intervention is successful. The summary scores for Milestones, Barriers and Transitions are used as dependent variables for both pretest and posttest. VBMAPP pretest and posttest evaluations were conducted by licensed psychologists or special educators and a sample of scores were examined for inter-rater reliability. The percent of agreement was .84 for the pretest scores and .86 for the posttest scores, averaged across the three measures.

Procedures

Children were assigned to an ABA classroom program when they were referred by the Early Intervention Program. Prior to beginning, they were administered the Bayley Scales of Infant Development-Third Edition (2003) by a licensed psychologist or certified special educator, who was trained by a licensed psychologist, and evaluated with the Childhood Autism Ratings Scale-Second Edition (Schopler et al. 1986) by a licensed psychologist. The five administered Bayley-III subscales were the Cognitive Scale, Receptive and Expressive Language Scales, and Fine and Gross Motor Scales. The Receptive and Expressive Language Scales were combined to form the Composite Language Score and the two motor scales were similarly combined to form the Composite Motor Score. The Social-Emotional Scales and Adaptive Behavior Scales were administered by interviewing the parent. The VBMAPP was completed upon the children's entry into the program, based on observation by the supervising teacher or a licensed psychologist. When the children were ready to leave the program, either because they had reached their third birthday or reached the end of their eligibility to receive early intervention services, which in NYS is the 31st of August or December following of the year in which they

reached their 3rd birthday, they were again administered the Bayley Scales, CARS-2 and the VBMAPP to establish a post-score. A trained interpreter was utilized for the children whose primary language was other than English.

Early Intervention Program

Hand in Hand Early Childhood Center is an Early Intervention Center-based program that serves children, with ASD, ranging from 18 months to 3 years of age. The program follows a least restrictive environment model, which means that it offers many learning opportunities in a variety of settings (e.g., classroom, local community, individual instruction, group activities, etc.) and provides children with the least restrictive type of support necessary to learn. The *Hand in Hand Early Childhood Center* utilizes applied behavior analytic procedures (Baer et al. 1968) in training paraprofessionals to implement teaching procedures with procedural integrity. Additionally, the principles of behavior guide the process of assessing, designing, and implementing skill acquisition and behavior reduction procedures; as an integral part of the treatment plan for the learners enrolled at the center.

Staff Training An Intensive Behavioral Skills Training program has been developed to train new teacher assistants. The training process is divided into a hierarchy of 7 phases. During each phase of the training process, a trainer reviews the targeted topics (i.e. pairing, manding, data collection) with the trainee. Following mastery of the targeted concept, the training is conducted in the classroom, where the trainer models the targeted teaching procedure. Next, the trainee is provided with opportunities to rehearse the procedure as the trainer observes and collects data on the trainee's performance of the skill. Feedback is provided on the trainee's performance. A written quiz is required for the trainee to pass each level with a minimum score of 80% correct. Modeling, rehearsal, and feedback are continuously provided until the trainee correctly applies the procedure. Mastery criteria for each skill are achieved following correct demonstration of the skill across two sessions, for two different individuals, with experience in ABA. Following mastery of each of the seven phases, the trainee is able to provide direct ABA services. The trainer or supervisor are always in the room. Performance assessments are conducted on a quarterly basis at least. Furthermore, the fidelity of the program is tested periodically using the same criteria employed during training.

Skill Acquisition The Verbal Behavior Milestones Assessment and Placement Program (VBMAPP) is the primary tool utilized in assessing skill acquisition deficits and barriers for each student (Sundberg 2008). The classroom teacher, an individual with a graduate level degree in special education as well as advanced training in behavior analysis, administers the VB-MAPP.

Functional behavior assessment (FBA) Functional Behavior Assessment, in the form of ABC narrative recording (Bijou et al. 1968), is the first step in addressing behaviors that interfere with a learner's ability to attend to instruction and join in routine classroom activities; data is collected by the teachers and paraprofessionals. A pattern analysis is employed to formulate a hypothesis regarding the function. A behavior intervention plan (BIP) is implemented as the last step of the functional behavior assessment. The primary components of the BIP include: antecedent interventions intended to function as an abolishing operation for the behavior; skill acquisition programs to shape replacement behaviors; as well as extinction, and differential reinforcement components. Procedures and proper implementation are reviewed, modeled, and observed with student's paraprofessional on an ongoing basis by a Board-Certified Behavior Analyst (BCBA) and classroom teacher.

FBA Data Collection Baseline and treatment levels of interfering behavior are recorded via duration and rate measures. Duration data is graphed as the total duration of target behavior per session. Rate is graphed as total number of occurrences/recording time/120 min.

Treatment Programs Treatment programs are individually designed for each learner based on VB-MAPP scores and informed clinical opinion. Specifically, skills acquisition programs are designed to manipulate the environment so that the learners will increase verbal behavior in the area of mands, tact, intraverbal and echoic. Listener responding, visual perceptual, social skills, imitation, functional play skills, and group skills are targeted for increase, as well.

Data Collection and Measurement Trial by trial (Cummings and Carr 2009) is the method selected to record data on the skill acquisition programs of the learners (with the occasional exclusion of mand data; see below). Each response is recorded as prompted, correct, or incorrect. Data is graphed as percent correct; calculated by dividing responses correct by total number of responses multiplied by 100.

Frequency data is periodically selected as a method of collecting data on learner mands. Each occurrence of the target response is recorded and graphed as total number of occurrences per session. Sessions lasted for 120 min and children typically attended 5 days a week.

Analysis

In order to test the hypotheses predicting improvement as a result of the Hand in Hand ABA program, the Bayley Cognitive, Bayley Language Composite, Socio-Emotional, CARS-2, VBMAPP Milestones and VBMAPP Barriers, pretest and posttest scores were each analyzed using repeated measures ANOVAs with Pretest and Posttest as the Repeated factor and

Age of Entry and Amount of Intervention as the Between group factors. To test the prediction that children who entered the program at 28 months or before would show more progress than those who were 29 months or older, the sample was divided at the median age of 28 months. Furthermore, since we were interested in the effect of Amount of Intervention the participants were also divided in two groups at the median for number of hours. Thus, we were also able to test the hypothesis that more ABA intervention leads to more improvement on all of the dependent variables as well. The sample was divided into two subgroups according to the number of hours the children actually attended. The group that received 292 or more hours of ABA intervention was called the More group with the group having received 291 h of intervention or less being called the Less group. Furthermore, we were able to test the joint effects of age of entry and Amount of Intervention on the dependent variables.

Results

Results of the ANOVAs revealed significant Main Effects for the Pre-Post Repeated Measure Testing Factor for all the dependent variables. These results are presented in Table 2. The analysis for the Pre-Post Cognitive test yielded a statistically significant main effect for the repeated measure factor ($F_{1, 102} = 64.50$, $p < .001$). The mean Cognitive score for the pretest was 76.70 and the mean posttest was 87.08. The analysis for the Pre-Post Language test revealed a statistically significant main effect for the repeated measure factor ($F_{1, 101} = 173.2$, $p < .001$). The mean Language score for the pretest was 62.46 and the mean posttest was 79.65. Repeated measures ANOVA for the Pre-Post Motor Scale was significant for the repeated factor ($F_{1, 102} = 29.32$, $p < .001$). The mean Motor Score for the pretest was 74.81 and the mean posttest score was 83.28. The repeated measures ANOVA for the Social-Emotional score yielded significant main effects for the Pre-Post testing factor ($F_{1, 77} = 34.76$, $p < .001$). The mean pretest score for the Social-Emotional subtest was 70.54 while the mean posttest score was 81.23. Repeated measures ANOVA for the Adaptive Behavior score was significant for the repeated factor ($F_{1, 71} = 25.96$, $p < .001$). The mean pretest score for the Adaptive behavior subtest was 62.53 while the mean posttest score was 71.32. The analysis for the CARS-2 score also yielded a statistically significant main effect for the repeated measure factor ($F_{1, 99} = 52.68$, $p < .001$). The mean pretest score for the CARS-2 was 32.61 and the mean posttest score was 28.16. Results for the VBMAPP Milestones measures yielded a statistically significant main effect for the repeated measure factor ($F_{1, 101} = 217.13$, $p < .001$). The mean pretest score for VBMAPP Milestones was 28.31 and the mean posttest score was 73.14. The analysis for the VBMAPP Barriers showed that there was a significant main effect for the Pre-Post repeated measure factor ($F_{1, 100} = 318.86$, $p < .001$).

Results of the two-way repeated measures interactions for Age of Entry and Time of Testing (Pre-Post Measures) yielded only one statistically significant effect—the one for VBMAPP Barriers ($F_{1, 100} = 7.77$, $p < .006$). This outcome showed that the children who began at a younger age showed a larger reduction in Barriers. The Younger group showed a slightly higher level of Barriers (54.37) than the Older group (44.94) on the Pretest. The mean Barrier scores of the Younger group dropped from the mean pretest level of 54.37 to a mean score of 30.40. Two other two-way repeated measures interactions for Age of Entry and Time of Testing were marginally significant,

Table 2 Pretest and posttest for all measures (N = 106)

	Pretest			Posttest			p
	Mean (SD)	Minimum	Maximum	Mean (SD)	Minimum	Maximum	
BSID Cognitive	76.70 (14.75)	54	110	87.08 (12.79)	55	140	< .001
BSID-Communication	62.46 (16.32)	26	106	79.65 (19.76)	47	118	< .001
BSID-Motor	74.81 (14.85)	29	118	83.28 (16.74)	46	124	< .001
BSID-Socioemotional	70.54 (12.33)	51	120	81.23 (15.81)	55	140	< .001
BSID-Adaptive	62.53 (11.57)	40	98	71.32 (16.84)	43	112	< .001
CARS-2	32.61 (6.70)	15.5	48	28.16 (8.02)	15	52	< .001
VBMAPP-Milestones	28.31 (21.81)	13	98.5	77.16 (41.80)	13	158	< .001
VBMAPP-Barriers	49.52 (18.75)	10	91	29.37 (19.50)	0	73	< .001
VBMAPP -Transitions	30.09 (12.49)	0	64	50.71 (17.52)	17	86	< .001

those for the BSID Communication scale ($P < .087$) and that for VBMAPP Milestones (<.07). In both cases, the scores of the children who began at the younger age increased more than those who began at the older age. None of the other two-way interactions for Age of Entry and Time of Testing were significant. The results of these interactions are shown in Table 3.

The two-way repeated measures interactions for Amount of Intervention and the Time of Testing was significant for BSID Adaptive Behavior ($F_{1, 71} = 5.25, p < .02$). This result indicates that the group that received fewer than 291 sessions increased their BSID Adaptive Behavior (Pretest 62.39, Posttest = 75.97) more than the group that received more than 292 sessions (Pretest = 66.02, Posttest = 71.17). None of the other two-way interactions for Amount of Intervention and Time of Testing were significant. These results are shown in Table 4.

There were several statistically significant three way interactions. The results for the Bayley Communication scores showed a statistically significant interaction for Amount of Intervention, Age of Entry and Pre-Post changes ($F_{1101} = 12.32, p < .001$). This interaction indicated that in the group of children who received 291 or fewer hours of intervention, those who began ABA at 28 months or before showed a larger increase than those who started after 29 months. In the group who received 292 or more hours there was no difference in the two groups. Results for the CARS 2 analyses also showed a statistically significant three-way interaction for pre-post changes by age of entry and Amount of Intervention ($F_{1, 99} = 8.43, p < .01$). This interaction showed that for the children who received 291 or fewer hours of intervention, the younger children improved more than the older children. This did not hold for the children who received 292 or more hours of intervention. Similar results were found for the BSID Adaptive Behavior, VBMAPP Milestones, Barriers and Transitions ($F_{1, 71} = 7.72$, $p < .01$), ($F_{1, 101} = 3.99$, $p < .050$), ($F_{1, 100} = 20.51$, $p < .001$) and ($F_{1, 99} = 9.54$, $p < .01$) respectively. See Table 5 for results of these analyses.

It should be noted that the criterion set for statistical significance was $p < .05$. There was concern that the number of tests conducted might lead to inflated p values but as can be seen, the values obtained for all statistically significant results were well beyond the .05 criterion.

Discussion

The current research is among the first few studies to examine the effects of ABA in a community early intervention program with a highly diverse population. Compared to the baseline (Pretest) measure, children who received ABA in a classroom setting showed significant improvement on the cognitive, communication, motor, social-emotional and adaptive scales of the Bayley Scales of Infant Development-III. In addition, these children also scored significantly lower on the CARS-2 (Childhood Autism Rating Scale-Second edition) after they aged out of the Hand In Hand early intervention program than they did on the Pretest. The group as a whole increased a standard deviation on the Communication scale and 2/3 of a standard deviation on the Cognitive scale of the Bayley Scales. These are large improvements given the relatively short intervention duration. Of course, the absence of a control group makes it difficult to draw

Table 3 Pretest and posttest scores of all measures for younger and older toddlers (N = 106)

Measure	Younger Starting Age < 28 M ($N = 52$)		Older Starting Age > 27 M ($N = 54$)		Age by Test Interaction
	Pretest Mean (SD)	Posttest Mean (SD)	Pretest Mean (SD)	Posttest Mean (SD)	p
BSID Cognitive	75.94 (16.08)	88.38 (14.20)	77.43 (13.45)	85.81 (11.26)	NS
BSID-Communication	61.80 (15.03)	81.75 (21.60)	63.07 (17.57)	77.63 (17.78)	< .087
BSID-Motor	74.55 (13.13)	84.80 (18.05)	75.06 (16.49)	81.87 (15.47)	NS
BSID-Socioemotional	71.34 (12.70)	80.77 (15.62)	69.71 (12.01)	81.73 (16.20)	NS
BSID Adaptive	62.88 (10.91)	71.29 17.89	62.27 (12.13)	71.34 (16.18)	NS
CARS-2	32.66 (6.33)	28.48 (8.47)	32.58 (7.11)	27.85 (7.63)	NS
VBMAPP-Milestones	22.77 (17.50)	78.40 (44.72)	33.64 (24.26)	75.93 (39.12)	< .07
VBMAPP-Barriers	54.37 (14.80)	30.40 (20.33)	44.94 (20.96)	28.36 (18.79)	< .006
VBMAPP -Transitions	27.98 (11.59)	50.48 (18.38)	32.04 (13.07)	50.94 (16.81)	NS

Table 4 Pretest and posttest for all measures by amount of intervention (N = 106)

	Less Intervention Hours <291 (*N* = 53)		More Intervention Hours >291 (N = 53)		Amount by Test Interaction p
	Pretest Mean (SD)	Posttest Mean (SD)	Pretest Mean (SD)	Posttest Mean (SD)	
BSID Cognitive	77.23 (13.53)	87.00 (9.02)	76.15 (15.94)	87.15 (15.68)	NS
BSID-Communication	63.04 (14.99)	81.00 (16.98)	61.91 (17.61)	78.35 (22.19)	<.094
BSID-Motor	75.94 (12.02)	83.92 (14.08)	73.78 (17.07)	82.66 (19.07)	NS
BSID-Socioemotional	70.38 (10.07)	80.93 (11.98)	71.16 (1.38)	79.48 (1.63)	NS
BSID Adaptive	62.39 (9.28)	75.97 (16.01)	66.02 (13.29)	71.17 (17.86)	<.03
CARS-2	31.87 (5.89)	26.56 (7.36)	34.33 0.78)	29.74 (0.89)	NS
VBMAPP-Milestones	31.12 (21.78)	76.85 (33.54)	24.74 (2.29)	79.90 (4.41)	NS
VBMAPP-Barriers	44.75 (18.19)	25.65 (17.26)	55.37 (1.96)	31.90 (2.12)	NS
VBMAPP -Transitions	32.50 (11.74)	52.12 (14.61)	28.04 (1.32)	51.96 (1.91)	NS

definitive conclusions but it is not ethical to withhold or delay treatment in a community setting. Nevertheless, it cannot be stated that the ABA intervention was solely responsible to the changes observed since there was no comparison group. It is not possible to have a comparison group of children with ASD who do not receive ABA in intervention since, in New York State it is considered best practice to provide ABA to toddlers diagnosed with ASD. In accordance with New York State's Clinical Practice Guidelines for Autism/Pervasive Developmental Disabilities, "No adequate evidence has been found that supports the effectiveness for treating autism" for treatment modalities other than ABA (New York State Department of Health 1999, pp. 39–43). Parents who refuse ABA treatment may receive alternative therapeutic interventions, not judged to be effective. As this group represents a small proportion of the children with ASD diagnoses who receive early intervention services in New York State, they are not considered representative of the toddlers with ASD and thus were not included as a comparison group. In the future, a subsequent study will include toddlers who received home-based ABA only as a comparison group.

It is noteworthy that the results obtained for age at the start of intervention showed significant improvement in VBMAPP Barriers and borderline significant improvement in Communication and VBMAPP Milestones for the children who started at a younger age as compared to the children who started at older ages. This underscores the importance of very early identification and starting intervention very early in order to maximize therapeutic outcomes for children with ASD.

The results comparing length of intervention across Age of Entry did not yield significant differences in any measures other than the BSID Adaptive Behavior Scales and a marginal difference for the Communication Scales. This was somewhat

Table 5 Results of significant three-way interactions

Measure	F	p	Effect
BSID Cognitive	F (1, 102) =0.13	NS	
BSID-Communication	F (1, 101) =12.32	<.001	Children who received less intervention increased more if they began earlier.
BSID-Motor	F (1, 97) = 0.44	NS	
BSID-Socioemotional	F (1, 77) =1.17	NS	
BSID-Adaptive	F (1, 71) =7.72	<.01	Children who received less intervention increased more if they began earlier.
CARS-2	F (1, 99) = 8.43	<.01	Children who received less intervention decrease more if they began earlier.
VBMAPP-Milestones	F (1, 101) = 3.99	<.05	Children who received less intervention increased more if they began intervention earlier.
VBMAPP-Barriers	F (1, 100) =20.51	<.001	Children who received less intervention decreased more if they began intervention earlier.
VBMAPP -Transitions	F (1, 99) =9.54	<.01	Children who received less intervention increased more if they began intervention earlier.

disappointing but maybe not surprising since the differences in length of intervention between the two groups were not large enough (19 vs. 39 weeks). It has been suggested that a minimum of two years at 30 h a week is necessary for the success of an ABA program (Gould et al. 2011). However, our results show significant changes in all measures employed after an average of 28 weeks at 10 h per week in the classroom for toddlers diagnosed with ASD. It is not known if or for how long these gains can be sustained. Both groups increased at least one standard deviation on the Communication scale of the Bayley Scales of Infant Development. When both Age of Entry and Amount of Intervention are taken into effect, the analyses showed that the children who began at or below 28 months improved more than those who started later if they had at least 191 sessions. It should be noted that these children may have received additional services outside the classroom but that information was not readily available to the authors due to HIPAA and FERPA restrictions.

These results illustrate that children with ASD benefited developmentally from ABA intervention in a community based program. More importantly, the study supports previous findings that children may benefit more from entering intervention earlier than 48 months (Fenske et al. 1985; Lovaas and Smith 1988; Lovaas 1987; Luiselli et al. 2000; Sheinkopf and Siegel 1998; Turner and Stone 2007). The present findings demonstrate that children benefit from beginning ABA intervention at 28 months or earlier. Furthermore, it was found that children's communication and adaptive behavior (measured by the Bayley Scales of Infant and Toddler Development) and learning and language milestones (measured by the VB-MAPP; Sundberg 2008), appear to be age related; children showed greater improvement when they entered intervention early and received an average of 191 ABA sessions. In addition, children who began intervention earlier and received an average of 191 sessions also significantly reduced more learning and language acquisition barriers and ASD symptoms compared to their older counterparts. It is noteworthy that there were dramatic increases in language skills as a result of the current ABA program which are due to the emphasis placed on communication in this ABA program. The increase in all other measured skills and the reduction in symptoms of ASD for the sample as a whole is also noteworthy. These results stress the importance of early and consistent ABA programming for improvement of the developmental progress in young children with ASD.

It should be noted that all children in this study received ABA early intervention services and that no comparison group was studied. It might be suggested that the improvement shown is merely due to maturation. However, it should be acknowledged that the Bayley Scales of Infant and Toddler Development are norm referenced and adjusted to the age of the child at testing. Thus, maturation is controlled by the measurement instrument. The fact that the starting scores for Younger and Older groups were not significantly different attests to the fact that without intervention there would be no improvement in scores.

Previous research has demonstrated that when children with ASD are randomly assigned to an Intensive Behavioral Treatment Program (ABA) vs. an alternative educational or treatment program, the children improve in developmental level, language performance and display reduced symptoms of ASD (e.g. Lovaas 1987). A review by Matson and Konst (2014) reported on 30 studies that utilized ABA showed overall improvement. Among the most recent randomized clinical trials, (e.g. Landa and Kalb 2012; Dawson et al. 2010) it has been clearly demonstrated that interventions that include ABA in the treatment protocol are very successful in improving developmental performance. What has been missing from these studies is information addressing how the Amount of Intervention and age of intervention commencement affected outcome. It has long been a principle in the Early Intervention field that "earlier is better" and more intervention leads to larger gains. Much of the early ABA intervention research tested programs in which children were given intervention for 20–40 h a week. In Lovaas (1987) ABA regimens of 40 h a week and 10 h a week were compared. Children in the Lovaas study were given 2 or more years of intervention. Similarly, the children in the Early Start Denver Model research also were given 2 years of treatment (Dawson et al. 2010). In the current study, the children received an average of 292.74 h at 10 h a week delivered in the classroom. Furthermore, it should be noted that in the present study, the children ranged in age from 19.9 months to 43 months. The current study took place in a community program as part of the NYS Early Intervention Program in which there is little control over how early or for how long children receive early intervention. The length of treatment is thus determined by how early the ASD diagnosis is made and limited by the number of sessions missed due to illness, holidays or other family considerations. The results obtained are impressive given the relatively short amount of exposure to treatment in the classroom. In a community-based program, it may be only possible to provide 6–8 months of intervention prior to age 3, given the current difficulty in reliably identifying ASD in children prior to 18 months. If early identification could be improved by better informing parents, physicians and day care providers, perhaps more children would begin intervention earlier than is currently the case. Similarly, improved methods for early identification would also allow more intervention sessions. It is also possible that community intervention programs might be authorized to provide more sessions per week in the interest of obtaining greater gains.

The current study was made possible by the authors' commitment to providing continual assessment in order to ensure quality and consistency and also to allow for quality improvement by monitoring the outcomes of the children in the program. No external funding was provided for the current research, with the costs of continuing assessment absorbed by the program in the interest of quality assurance and quality improvement.

Of course, further study of the effects of community ABA intervention is needed. It is especially important to learn how long the gains made during the early intervention program are maintained and whether continuing ABA intervention is necessary during the preschool programs attended by most of these children following early intervention. It is also of interest to learn how the current results compare with the outcomes for home based intervention alone or home-based intervention provided in addition to center group based interventions. Furthermore, the effects of variations in intervention such as Natural Environment Training are also of interest. Comparisons of Natural Environment Teaching and Discrete Trial Training should also be conducted in order to determine the best course of treatment for toddlers with ASD. Finally, it is of great interest to match the intervention to the specific behavioral characteristics the child presents. In the current intervention program, the specific targets of intervention are determined by the child's initial performance on the VBMAPP. Other approaches to early intervention such as DIR are not known for precise early assessment in order to determine the best intervention targets (Solomon et al. (2014).

In summary, the current study shows that ABA early intervention in a community setting provides statistically significant gains in cognitive, communication, motor, socio-emotional, adaptive and criterion referenced behavior as well as a significant reduction in symptoms of ASD and barriers to learning. Furthermore, for some outcome variables, the joint effect of age of entry and amount of early intervention can have important differential effects. These results support the conclusions of Matson and Konst (2014) while providing more detailed outcomes for very young children.

Compliance with Ethical Standards

The relevant University IRB reviewed this study and "it was found to not fall under the description of research that requires IRB approval" and no external funding was received for the research.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington: American Psychiatric Association.

Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 1*(1), 91–97.

Baird, G., Charman, T., Baron-Cohen, S., Cox, A., Swettenham, J., Wheelwright, S., & Drew, A. (2000). A screening instrument for autism at 18 months of age: A 6-year follow-up study. *Journal of the American Academy of Child & Adolescent Psychiatry, 39*(6), 694–702.

Barnes, C. S., Mellor, J. R., & Rehfeldt, R. A. (2014). Implementing the verbal behavior milestones assessment and placement program (VB-MAPP): Teaching assessment techniques. *The Analysis of verbal behavior, 30*(1), 36–47.

Bayley, N. (1969). *Scales of infant development: manual*. New York: The psychological Corporation.

Bayley, N. (1993). *Bayley scales of infant development-II: Manual*. San Antonio: Psychological Corporation.

Bayley, N. (2003). *Bayley scales of infant development- III: Manual*. San Antonio: Psychological Corporation.

Bijou, S. W., Peterson, R. F., & Ault, M. H. (1968). A method to integrate descriptive and experimental field studies at the level of data and empirical concepts. *Journal of Applied Behavior Analysis, 1*, 175–191.

Chakrabarti, S., & Fombonne, E. (2001). Pervasive developmental disorders in preschool children. Journal of American Medical Association, 285(24), 3093–3099.

Chlebowski, C., Green, J. A., Barton, M. L., & Fein, D. (2010). Using the childhood autism rating scale to diagnose autism Spectrum disorders. *Journal of Autism and Developmental Disorders, 40*, 787–799.

Christensen, D. L., Baio, J., Braun, K. V., Bilder, D., Charles, J., Constantino, J. N., Daniels, J., … Yeargin-Allsopp, M. (2016) Prevalence and characteristics of autism Spectrum disorder among children aged 8 years–autism and developmental disabilities monitoring network, 11 sites, United States. Morbidity and Mortality Weekly Report Surveillance Summaries, 65 (no. SS-3) 1-23.

Cummings, A. R., & Carr, J. E. (2009). Evaluating progress in behavioral programs for children with autism spectrum disorders via continuous and discontinuous measure. *Journal of Applied Behavior Analysis, 42*, 57–71.

Dawson, G., Rogers, S., Munson, J., Smith, M., Winter, J., Greenson, J., & Varely, J. (2010). Randomized, controlled trial of an intervention for toddlers with autism: The early start Denver model. *Pediatrics, 125*, 17–23.

Dixon, M. R., Belisle, J., Stanley, C., Rowsey, K., Daar, J. H., & Szekely, S. (2015). Toward a behavior analysis of complex language for children with autism: Evaluating the relationship between PEAK and the VB-MAPP. *Journal of Developmental and Physical Disabilities, 27*(2), 223–233.

Fenske, E. C., Zalenski, S., Krantz, P. J., & McClannahan, L. E. (1985). Age at intervention and treatment outcome for autistic children in a comprehensive intervention program. *Analysis and Intervention in Developmental Disabilities, 5*(1), 4958.

Fombonne, E. (2002). Epidemiological trends in rates of autism. Molecular Psychiatry, 7(SUPPL. 2). https://doi.org/10.1038/sj.mp.4001162

Foxx, R. M. (2008). Applied behavior analysis treatment of autism: The state of art. *Child and Adolescent Psychiatric Clinics of North America, 17*(4), 821834.

Gadow, K. D., DeVincent, C. J., Pomeroy, J., & Azizian, A. (2004). Psychiatric symptoms in preschool children with PDD and clinic and comparison samples. *Journal of Autism and Developmental Disorders, 34*(4), 379393.

Gould, E., Dixon, D. R., Najdowski, A. C., Smith, M. N., & Tarbox, J. (2011). A review of assessments for determining the content of early intensive behavioral intervention programs for autism spectrum disorders. *Research in Autism Spectrum Disorders, 5*, 990–1002.

Greenspan, S. I. (2004). *Greenspan social-emotional growth chart: A screening questionnaire for infants and young children*. San Antonio: Psych Corp.

Kisamore, A. N., Karsten, A. M., & Mann, C. C. (2016). Teaching multiply controlled intraverbals to children and adolescents with autism spectrum disorders. *Journal of Applied Behavior Analysis, 49*(4), 826–847.

Landa, R. J., & Kalb, L. G. (2012). Long-term outcomes of toddlers with autism spectrum disorders exposed to short-term intervention. *Pediatrics, 130*(Supplement 2), S186–S190.

Lecavalier, L. (2006). Behavioral and emotional problems in young people with pervasive developmental disorders: Relative prevalence, effects of subject characteristics, and empirical classification. *Journal of Autism and Developmental Disorders, 36*(8), 11011114.

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*(1), 39.

Lovaas, O. I., & Smith, T. (1988). Intensive behavioral treatment for young autistic children. In B. B. Lahey & A. E. Kazdin (Eds.), *Advances in clinical child psychology* (Vol. 2). New York: Plenum Press.

Luiselli, J. K., Cannon, B. O., Ellis, J. T., & Sisson, R. W. (2000). Homebased behavioral intervention for young children with autism/pervasive developmental disorder. *Autism, 4*(4), 427–437.

Matson, J. L., & Konst, M. J. (2014). Early intervention for autism: Who provides treatment and in what settings. *Research in Autism Spectrum Disorders, 8*(11), 1585–1590.

McClintock, K., Hall, S., & Oliver, C. (2003). Risk markers associated with challenging behaviors in people with intellectual disabilities: A metaanalytic study. *Journal of Intellectual Disability Research, 47*(6), 405416.

McGee, G. G., Morrier, M. J., & Daly, T. (2001). The Walden early childhood programs. In J. S. Handleman & S. L. Harris (Eds.), *Preschool education programs for children with autism* (2nd ed., pp. 157–190). Austin: Pro-Ed.

New York State Department of Health. (1999). Clinical *Practice Guideline: Report of the Recommendations.* Autism/Pervasive Developmental Disorders, Assessment and Intervention for Young Children (Age 0–3 Years). Publication No. 4215.

Reichler, R. J. & Schopler, E. (1971). Journal of Autism & Childhood Schizophrenia, 1, 283–296.

Schopler, E., Reichler, R. J., & Rochen Renner, B. R. (1986). *The childhood autism rating scale for diagnostic screening and classification of autism*. New York: Irvington.

Schopler, E., Bourgondien, M. E., Wellman, G. J., & Love, S. R. (2010). *Childhood autism rating scale* (Second ed.). Torrance: Western Psychological Services.

Sheinkopf, S. J., & Siegel, B. (1998). Homebased behavioral treatment of young children with autism. *Journal of Autism and Developmental Disorders, 28*(1), 15–23.

Shonkoff, J. P. (2003). From neurons to neighborhoods: Old and new challenges for developmental and behavioral pediatrics. *Journal of Developmental & Behavioral Pediatrics, 24*(1), 70–76.

Shonkoff J. & Phillips, D. (Eds) (2000). From neurons to neighborhoods: The science of early childhood. Committee on integrating the science of early childhood development, board on children, youth, and families, commission on behavioral and social sciences and education, National Research Council and Institute of Medicine. Washington, DC, National Academy Press.

Smith, T., Eikeseth, S., Klevstrand, M., & Lovaas, O. I. (1997). Intensive behavioral treatment for preschoolers with severe mental retardation and pervasive developmental disorder. *American Journal on Mental Retardation, 105*(4), 238–249.

Smith, T., Groen, A. D., & Wynn, J. W. (2000). Randomized trial of intensive early intervention for children with pervasive developmental disorder. American Journal on Mental Retardation, 105(4), 269-285

Solomon, R., Van Egeren, L. A., Mahoney, G., Huber, M. S. Q., & Zimmerman, P. (2014). PLAY project home consultation intervention program for young children with autism spectrum disorders: A randomized controlled trial. *Journal of Developmental and Behavioral Pediatrics, 35*(8), 475.

Stenberg, N., Bresnahan, M., Gunnes, N., Hirtz, D., Hornig, M., Lie, K. K., et al. (2014). Identifying children with autism spectrum disorder at 18 months in a general population sample. *Paediatric and Perinatal Epidemiology, 28*(3), 255–262.

Sundberg, M. L. (2008). *Verbal behavior milestones assessment and placement program: The VB-MAPP.* Concord: AVB Press.

Sundberg, M. L., & Sundberg, C. A. (2011). Intraverbal behavior and verbal conditional discriminations in typically developing children and children with autism. *The Analysis of Verbal Behavior, 27*(1), 23–44.

Turner, L. M., & Stone, W. L. (2007). Variability in outcome for children with an ASD diagnosis at age 2. *Journal of Child Psychology and Psychiatry, 48*(8), 793–802.

Ventola, P. E., Kleinman, J., Pandey, J., Barton, M., Allen, S., Green, J., Robins, D., & Fein, D. (2006). Agreement among four diagnostic instruments for autism spectrum disorders in toddlers. *Journal of Autism and Developmental Disorders, 36*(7), 839–847.

Wechsler, D. (2002). *WPPSI-III administration and scoring manual*. San Antonio: Psychological Corporation.

Yeargin-Allsopp, M., Rice, C., Karapurkar, T., Doemberg, N., Coyle, C., & Murphy, C. (2003). Prevalence of autism in a U.S. metropolitan area. *Journal of the American Medical Association, 289*(1), 49–55.