Intensity of Early Behavioral Intervention for Children with Autism Spectrum Disorder: A Retrospective Evaluation

by

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Abstract

Early intensive behavioral intervention (EIBI) is currently the most studied and most practiced intervention for children with autism spectrum disorder. There has been increasing evidence over the past few decades supporting the use of EIBI for improving cognitive and adaptive functioning and reducing autism severity. However, there have been limited evaluations of the effectiveness of EIBI service intensity in the context of a government-funded service program. The current study addressed this gap in the literature using archival data obtained from St.Amant Autism Services, a government-funded EIBI service for children with autism spectrum disorder in Manitoba, Canada. This study compared children who have received an average of 22 hours per week and an average of 30 hours per week of EIBI for a period of one year. Standardized measures in cognitive functioning, adaptive behavior, and autism symptoms were examined using a 2 x 2 repeated measures ANOVA, with intensity (lower versus higher) as the between-group variable and time (Intake and Year 1) as the within-group variable. Communication subscales were examined for changes in language outcomes. Significant main effects for time were found for cognitive functioning, adaptive functioning, and autism severity. Data from communication subscales yielded significant main effects of time for both expressive communication and general language skills, but not for verbal performance. These results suggest the importance of both treatment intensity and duration for improvement on outcome measures. Future research should aim to address our research questions with a larger sample size and a low-intensity control group.

Keywords: autism spectrum disorder, early intensive behavioral intervention, applied behavior analysis, treatment intensity

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Intensity of Early Behavioral Intervention for Children with Autism Spectrum Disorder: A Retrospective Evaluation

Introduction

Autism Spectrum Disorder or ASD is an early-onset neurodevelopmental disorder marked by severe social and communication difficulties, and a restricted repertoire of interests (American Psychiatric Association, 2013). The prevalence of ASD has been rising rapidly in recent years (e.g., Fombonne, 2003; Ouellette-Kuntz et al., 2014). Although the etiology of ASD is still unclear, considerable research has shown that early intensive behavioral intervention (EIBI), based on the principles and procedures of applied behavior analysis, has produced significant and meaningful gains for children with ASD (Peters-Scheffer, Didden, Korzilius, & Sturmey, 2011). Given that there is now ample evidence supporting the efficacy of EIBI, recent systematic reviews have called for further research in a number of areas such as evaluations of EIBI effectiveness in service settings (as opposed to tightly controlled experiments) and when delivered at different levels of program intensities (e.g., Eikeseth, 2009). The current study sought to evaluate the effects of different program intensities of an EIBI program in a service setting using archival data.

Autism Spectrum Disorder and Prevalence

In order to meet the diagnostic criteria for ASD, The *Diagnostic and Statistical Manual of Mental Disorders, 4th edition – Text Revision* (DSM-IV-TR) included the term autistic disorder, which was one of five pervasive developmental disorders. Pervasive developmental disorder was used as an umbrella term that included autistic disorder, Asperger disorder, childhood disintegrative disorder, Rett disorder, and pervasive developmental disorder not otherwise specified (PDD-NOS) (American Psychiatric Association, 2000). However, these diagnostic criteria have since been modified, and the 5th edition of DSM (DSM-5, American Psychiatric

Association, 2013) now uses the term autism spectrum disorder as one classification. The DSM-5 requires that a number of deficits be present. Included in these are: (a) persistent difficulty in social communication and social interaction across multiple contexts; (b) restricted or repetitive patterns of behavior, interests, or activities; and (c) impairment in social or occupational functioning as a result of these symptoms. Symptoms must be present during the early developmental period and must not be better explained by intellectual disability or developmental delay.

Several decades ago, autism was considered extremely rare and typically assumed to be associated with severe intellectual disabilities (Lotter, 1966). Prevalence of autism, however, has been increasing over the last two decades (Fombonne, 2003; 2009). In 2003, ASD has an estimated prevalence of approximately 60 per 10,000 and occurs about four times more often in boys than girls (Fombonne, 2003). A recent Canadian epidemiologic study (Ouellette-Kuntz et al., 2014) reported that the overall prevalence of ASD for children 2-14 years of age were approximately 83 per 10,000 (1 in 120) in Newfoundland and Labrador in 2008, 91 per 10,000 (1 in 110) in Prince Edward Island in 2010, and 129 per 10,000 (1 in 78) in Southeastern Ontario in 2010. In Manitoba, the prevalence of ASD in children aged five to nine years old increased from 0.49% in 1996-2001, to 0.88% in 2001-2006 (Brownell et al., 2008). Moreover, prevalence rates have been rising steadily in each region since 2003. Studies with Montreal elementary and secondary school students showed that prevalence of ASD also increased from approximately 65 per 10,000 (1 in 153) (Fombonne, Zakarian, Bennett, Meng, & McLean-Heywood, 2006) to 79 per 10,000 (1 in 126) (Lazoff, Zhong, Piperni, & Fombonne, 2010). The exact cause of the increase is unknown, although a number of factors may have contributed to the rising prevalence of ASD such as changes in diagnostic criteria, incidence (Fombonne, 2003, 2006; Lazoff et al., 2010; Ouellette-Kuntz et al., 2014) and diagnostic substitution (Coo et al., 2008).

The cost for supporting a person with ASD has been estimated to be more than $3 million U.S. dollars beyond the normative lifetime costs of raising a child in North America, and 60% more in medical costs than that of typical North Americans (Ganz, 2007). However, the net savings throughout his or her life for a child who receives an intensive behavioral intervention is roughly $1 million U.S. dollars, even if that child achieves only partial effects from the intervention (Jacobson & Mullick, 2000). This suggests that early intervention might aide in cutting long-term costs for families over the child's lifetime, when considering the reduced need for support in adult life.

Characteristics of Early Intensive Behavioral Intervention

EIBI is a behavioral treatment program based on the principles and procedures of applied behavioral analysis, and it is typically delivered through an intensive program (e.g., up to 40 hours of one-to-one intervention per week) for two or more years (Lovaas, 1987). An autism tutor works individually with the child by implementing programs that the autism consultant has developed based on the child's skill deficits. The autism consultant conducts an initial assessment with the child using a number of curricula, one being the Assessment of Basic Language and Learning Skills – Revised (ABLLS-R) (Partington, 2008), to identify a child's skills. The ABLLS-R is divided into four domains: (a) basic learner skills (e.g., receptive language, group instruction), (b) academic skills (e.g., reading, math), (c) self-help skills (e.g., grooming, toileting), and (d) motor skills (e.g., gross motor, fine motor). The autism consultant creates individualized programs for the child based on the areas needing improvement and the autism tutor implements the programs using a combination of discrete-trials teaching (DTT), behavior chaining, and incidental teaching. DTT is a procedure that involves presenting trials in a fairly rapid succession during teaching sessions (Fazzio & Martin, 2011). Behavior chaining involves breaking down a complex behavior into small steps known as task analysis, and teaching and linking the steps together to form the final behavior (Martin & Pear, 2015). Incidental teaching is a naturalistic approach that involves incorporating teaching opportunities in the midst of a child's daily activities. The autism consultant decides which method is most appropriate for teaching a given skill for a child, and then designs a behavioral program based on it.

In addition to the one-to-one hours that the autism tutor spends working with the child, meta-analysis of 12 studies has suggested that involvement of the child's parents is an important factor for the child's success in an EIBI program (McConachie & Diggle, 2007). For example, the St.Amant Autism Program, the setting in which the current study was conducted, recommends that parents be given an average of five hours per week of parent programs to work on with their child. The consultant develops these programs depending on what the parent's most immediate concerns for their child are. For example, if a child is not toilet trained, a consultant might train a parent to implement an ABA-based toileting program in addition to the toileting program that the tutor is running with the child. Parent programs not only provide the child with additional learning opportunities, but also promote the generalization of skills to new people and potentially new environments. If the child engages in challenging behaviors (e.g., aggressive or self-injurious behaviors), the consultant can attempt to identify the cause of the behavior and develop interventions to decrease its frequency.

Efficacy of Early Intensive Behavioral Intervention

Efficacy refers to whether or not a treatment works to reduce the symptoms associated with a disorder, and is typically conducted under tightly controlled conditions (e.g., random assignment, control groups, etc.). Effectiveness, on the other hand, examines how well the result of a treatment can be generalized to the applied or clinical settings in which the treatment is offered (Lonigan, Elbert, & Johnson, 1998). In other words, efficacy allows investigators to make clear conclusions about a given treatment's ability to reduce symptoms, while effectiveness demonstrates the effect of a treatment in its day-to-day environment.

Over the years, there has been a rapid increase in research evidence that supports the efficacy of EIBI for persons with ASD. The first encouraging results were published by Lovaas (1987). In that study, 47% of children with autism who received EIBI successfully completed first grade in a general education classroom and had post-treatment IQs above 80. However, this study sparked much methodological criticisms and debate (e.g., Schopler, Short, & Mesibov, 1989; Lovaas, Smith, & McEachin, 1989). Since then, numerous experimental and quasi-experimental studies have examined EIBI as a primary treatment for children with ASD, including two randomized control studies (Sallows & Graupner, 2005; Smith, Groen, & Wynn, 2000). The growing number of programmatic evaluations of EIBI has also resulted in a number of systematic reviews and meta-analyses that supported the efficacy of EIBI (e.g., Eldevik et al., 2009; Kuppens & Onghena, 2012; Makrygianni & Reed, 2010; Peter-Scheffer et al., 2011). For example, in a sequential meta-analysis of 15 studies examining the efficacy of EIBI for children with ASD, Kuppens and Onghena (2012) concluded that EIBI programs are, overall, more effective than eclectic treatment programs.

Although EIBI may be considered established evidence-based practice (Reichow, Volkmar, & Cicchetti, 2008), continued research is much needed in a number of areas. For example, Eikeseth (2009) identified establishing the effectiveness of EIBI and examining the effects of different program intensities as important areas for future research.

What We Know about Treatment Intensity

EIBI that provided fewer hours of service per week compared to the original Lovaas study (1987) have reported gains that were more modest. For example, Eldevik, Eikeseth, Jahr, and Smith (2006) compared the effects between a behavioral treatment, based on the Lovaas model

(1981) and an eclectic treatment for children with ASD, with both interventions averaging 12 hours per week. After 2 years of intervention, the behavioral group made significantly larger gains than the eclectic group on intellectual functioning, behavioral deficits (i.e., no toy play, no affection, etc.), receptive language, and expressive language, suggesting that EIBI was superior to an eclectic treatment, even at only 12 hours per week. However, these gains were more modest than those reported in more intensive (e.g., 40 hours per week) behavioral programs. Eldevik et al. (2006) recommended that future research should investigate treatment intensity as an independent variable.

Reichow and Worley (2009) conducted a meta-analysis of EIBI for young children with autism. To be included in their synthesis, studies had to meet several inclusion criteria: (a) EIBI was based on the UCLA Lovaas model; (b) participants had been diagnosed with ASD; (c) participants had a mean chronological age less than 84 months at the beginning of treatment; (d) the mean duration of EIBI was longer than one year; (e) at least one child outcome measure was reported; (f) experimental or quasi-experimental research designs were used; and (g) publication in an English peer-reviewed journal. Upon conducting a literature search based on these inclusion criteria, 13 studies were analyzed. The findings showed that the largest IQ changes were seen when duration of intervention was long (i.e., two or more years) and total hours of therapy were high (i.e., mean of 18 to 40 hours per week), suggesting the importance of both treatment duration and intensity. Based on their analyses of the 13 research reports, the authors concluded that EIBI is an effective treatment, on average, for children with autism. However, they noted that future research must compare EIBI with other recognized treatment programs in order to determine if EIBI is more or less effective than other interventions. In other words, if we do not compare EIBI with other empirically validated treatments, we cannot make conclusions based on its effectiveness in regards to other treatment options (Riechow & Worley, 2009). Unfortunately, evidence for the efficacy of alternative treatments appears limited (Eikeseth, 2009; Virués-Ortega, Julio, & Pastor-Barriuso, 2013).

A more recent meta-analysis (Virués-Ortega, 2010) examined applied behavioral analytic intervention for children with autism in early childhood. Virués-Ortega conducted a meta-analysis, meta-regression, and dose-response meta-analysis of multiple outcomes. The dose response meta-analysis operationally defined dose (or intensity) as the number of treatment hours that the child received per week. Studies were not reviewed if they contained any of the following exclusion criteria: (1) the study was not peer-reviewed, non-empirical, or unpublished; (2) the intervention groups did not implement ABA intervention for autism; (3) the focus of the intervention was restricted to specific areas of behavior; (4) intervention did not meet ABA standards of >10 hours of intervention per week; (5) participants did not have a formal diagnosis of autism; (6) the study contained an intervention group with less than five subjects; (7) the study was epidemiological; (8) the study used reports based on anecdotal or other non-standardized outcome measures; (9) there were no pre-treatment measures; (10) the study biased subject selection, and (11) means and standard deviations were not available. Twenty-two research reports were included in the meta-analysis. Outcome measures included full scale IQ, nonverbal IQ, receptive language, expressive language, language composite, adaptive behavior-communication, adaptive behavior-daily living skills, adaptive behavior-socialization, adaptive behavior-motor skills, and overall composite adaptive behavior scores. Results showed that although intervention duration appeared to be of greatest importance for language skills, functional and psychosocial adaptive behaviors benefited most from intervention intensity. When examining levels of total intervention duration, the meta-analysis showed that intensity related effects were most evident for language performance and functional adaptive behaviors, and the highest dose-response effects were found for receptive and expressive language. However, treatment intensity was not as critical for areas such as intellectual functioning and psychosocial repertoires. These findings suggest that language-related outcomes have a great potential for gains when treatment is delivered at higher intensities. A treatment is typically considered high-intensity if it includes anywhere from 20 to 40 hours of one-to-one intervention per week (Maurice, Green, & Foxx, 2001) and low-intensity if it involves anything less than that. Virués-Ortega suggested that future research examine treatment intensity and duration across groups receiving ABA treatment.

Although treatment intensity has been compared across studies in the above reviews, it would be beneficial to examine treatment intensity as an independent variable for groups receiving the exact same intervention but in different doses. There is a scarcity of studies published in the literature that directly examine different intensities of behavioral intervention on outcome measures for children with ASD.

Direct Comparisons of Treatment Intensity

Sallows and Graupner (2005) compared intensity in a randomized trial by assigning twenty-four children with autism to either a clinic-directed group or a parent-directed group. The clinic-directed group was a replication of the UCLA model (Lovaas, 1987), and children in this group received an average of 39 hours per week of direct treatment. The parent-directed group received slightly less intensive treatment hours ($M = 32$) and less supervision by therapists that were equally well-trained as those in the clinic-directed group. Children were matched on pre-treatment IQ and then randomly assigned to either the clinic-directed group ($n = 13$) or to the parent-directed group ($n = 10$). After one year of treatment, eight children achieved IQs of 85 or higher (5 clinic directed and 3 parent directed), demonstrating a small difference in favor of the slightly higher intensity, clinic-directed group. After four years of treatment, outcomes for cognitive, language, social, adaptive, and academic measures were fairly similar across both groups. Upon combining the two groups, 48% of children in both groups were succeeding in regular education classrooms and showed rapid learning and average post-treatment scores. The authors concluded that the number of treatment hours in this study came closer to replicating the intensity of hours in the UCLA study (Lovaas, 1987) than any previous replication. With an average of 39 and 32 hours per week for the clinic-directed and parent directed groups, respectively, the authors noted that the findings were also the most comparable to those of the Lovaas (1987) study, with 48% of children in the two intensity groups succeeding in regular education classrooms (Sallows & Graupner, 2005), similar to 47% in the Lovaas experimental group (Lovaas, 1987). Results of this study suggest that treatment intensity could have an impact on a child's outcome measures; however, the difference in hours of service between group was relatively small in this study (Sallows & Graupner, 2005).

Similar to Sallows and Graupner (2005), Reed, Osborne, and Corness (2007) addressed the topic of treatment intensity. They compared outcome measures for children that received either a low intensity (12 hours per week) behavioral treatment to those of children who received a high intensity (30 hours per week) behavioral treatment for 9 months. They found that the higher intensity group made significantly larger gains on intellectual functioning and educational functioning when compared to the lower intensity group. However, 9 months was a fairly short duration of treatment, so we do not know if there would have been differences across the two groups after one or two years (Reed, Osborne & Corness, 2007). Given the short duration of treatment, nonrandom assignment to groups, and small sample in the study, this study should be replicated with higher methodological criteria.

Granpeesheh, Dixon, Tarbox, Kaplan, and Wilke (2009) also examined treatment intensity as a main independent variable for children with autism spectrum disorder. Their sample consisted of 245 children between the ages of 16 months and 12 years who were diagnosed with either Autistic Disorder (n = 227) or PDD-NOS (n = 18). All children in their sample were receiving behavioral intervention services from a community-based service provision agency at the time of the study.

After four months of data collection, Granpeesheh et al. (2009) found that overall, the number of one-to-one treatment hours was significantly correlated with the number of behavioral objectives mastered each month. In addition, they divided their sample into three separate groups based on participant age in order to conduct an analysis of age as a predictor variable. They found that Groups 1 and 2 (children ages 2 to 5.15 years and 5.16 to 7.24 years, respectively) showed a positive linear relationship between the number of treatment hours and monthly mastered materials, but children in Group 3 (age 7.15 to 12 years) did not, suggesting the importance of intervention at an earlier age.

Although Granpeesheh et al. (2009) showed that increased treatment hours are associated with an increase in the number of behavioral objectives mastered per month, they did not use any standardized measures to assess the children's outcomes. Since some behavioral objectives are more difficult to master than others, we may speculate that children who mastered more monthly objectives may have simply been mastering easier behavioral objectives. In order to truly examine the effect of treatment intensity on a child's outcome measures, we would need to have two or more groups of children receiving the same treatment and being tested on the same standardized outcome measures at each assessment period.

Statement of the Problem

Although the efficacy of EIBI is now well established (e.g., Eldevik et al., 2009; Kuppens & Onghena, 2012; Makrygianni & Reed, 2010; Peter-Scheffer et al., 2011), research on treatment intensity has been identified as a research need because it has important implications for service cost and delivery. Meta-analyses across studies have shown that more intensive treatments produced larger gains than less intensive treatments, but few studies have examined intensity directly as an independent variable and even fewer studies have examined this variable in a service setting. The current study addressed this research need in a government-funded EIBI program.

St.Amant Inc. is an interdisciplinary community agency in Winnipeg that serves individuals and families living with developmental disabilities. It is also the sole provider of a government-funded EIBI program in Manitoba, which, with the increased prevalence of ASD in recent years (Brownell et al., 2008) has resulted in a growing waitlist. In Manitoba, a child is eligible for placement on the St.Amant Autism Program waitlist if he/she has a formal diagnosis of ASD. Children are typically around four years old by the time they enroll in the program. The St.Amant Autism Program employs trained behavior analysts and tutors to deliver EIBI service to preschool age and school age children. The program offers two service options, comprehensive and focused, that differ in hours of service per week (31 vs. 15.5 hours, respectively) and collects client data at intake and then annually using standardized measures in cognitive, adaptive behavior, autism symptoms, and communication domains. In a retrospective study using the service data from the St.Amant EIBI program, the comprehensive model (31 hours per week) of service has been shown to be highly effective in terms of improving results on outcome measures (Wright, 2012). However, no comparison was made between the two levels of service intensity. Although EIBI has been shown to be effective in a number of well-controlled university-based model programs, researchers have called for evaluations conducted in clinical settings to extend the generality of previous findings (e.g., Perry et al., 2008).

Therefore, the purpose of this study was to examine the effects of treatment intensity on outcome measures in cognitive, adaptive behavior, autism symptoms, and communication domains for children with ASD. The study involved a retrospective analysis of archival data for children who have received one year of service from the St.Amant Early Learning Program. I predicted that the higher-intensity group would produce significantly better scores on all outcome measures than the lower-intensity group. Ethics approval for the study was obtained from the University of Manitoba Psychology/Sociology Research Ethics Board before the study began.

Method

Description of Program Evaluated

All children in Manitoba with a diagnosis of ASD are eligible to receive government-funded services from the St.Amant Autism Program. This program delivers early intensive behavioral intervention to children with ASD based on the principles and procedures of applied behavior analysis.

The St.Amant Autism Program employs the following personnel who are responsible for contributing to children's treatment programs. A Director, Clinical Coordinator, and Senior Manager, all of whom are board certified behavior analysts and/or certified psychologists, are responsible for the supervision and training of the child's direct team, which includes consultants, senior tutors, and tutors. Consultants are behavior analysts with a master's or doctorate degree (either completed or in progress) majoring in applied behavior analysis. They are responsible for assessing a child's skills and creating programs to target skill deficits, as well as analyzing outcomes and modifying necessary areas of programming. Senior tutors must have a bachelor's degree with a major in psychology, and are required to complete two courses on the principles and applications of behavior analysis. Senior tutors oversee tutors and help the consultant to train the parents of children with ASD on how to implement behavioral programs. Tutors conduct one-to-one behavioral intervention with each child based on the programs that have been developed by the consultant. Tutors, who must have a high school diploma, are trained upon being hired, and continue to receive ongoing training on the job from senior tutors and consultants.

Clinic meetings are held monthly for each child, and are attended by the child, parents, tutor, senior tutor, and consultant. Clinic meetings give the entire team an opportunity to meet and assess the child's progress, discuss any new goals parents may have for their child, and decide whether or not any of the child's programs need to be modified.

The St.Amant Autism Program offers two EIBI programs: Early Learning Program (ELP) and School Age Learning Programs (SALP). Children generally enter the ELP after the age of two and could stay in the program until the age of seven. However, some children transition into the SALP at age five and could receive up to three years of intervention in the program. If children participate in both programs, they may receive up to a total of six years of service.

Dataset and Participant Characteristics

Outcome data for children in the ELP were examined for the purpose of this study. Prior to receiving the data, a staff member at St.Amant stripped the data of any identifying information (i.e., name, address). Each client was identified by a unique number. The child's age at intake was computed based on their date of birth and date of intake. The available dataset consisted of 260 children with ASD who have participated in the ELP for at least one year between January 2010 and December 31, 2014.

The dataset contained 208 boys (80%) and 51 girls (20%) with missing gender information for one child. The age of each child when treatment began was determined by calculating the difference between his/her date of birth and the treatment start date. If the treatment start date was missing, the earliest intake date for the outcome measures was used. The mean age at the beginning of treatment could not be determined for 62 children due to missing data. The mean age of the remaining 198 children was 47.4 months (*SD* = 8.63).

Group Assignment. To examine the effects of treatment intensity after one year of service, a child was included for analysis if he/she had both Intake and Year 1 data on at least one of the outcome measures (cognitive, adaptive functioning, or autism severity). Seventy children met this criterion. The mean weekly hours of service received for the 70 children was 26, and this was used to divide the sample into two intensity groups. Children were assigned to the lower-intensity group (Group A) if their mean weekly hours were equal to or below 26, and to the higher-intensity group (Group B) if their mean weekly hours were greater than 26.

The characteristics of the children for the sample and for each subgroup are also shown in Table 1. As shown in Table 1, the 38 children in Group A received an average of 22.4 (*SD* = 11.6) hours of service per week, and the children in Group B received a higher average of 30.4 (*SD* = 8.8) hours of service per week. Children in both groups had fairly similar mean ages at intake, with children in Group A having a mean age of 43.5 months (*SD* = 9.8) and children in Group B having a mean age of 44.4 months (*SD* = 7.9). Group A consisted of 32 males and six females, while Group B consisted of 27 males and five females. Both groups had a male to female ratio of approximately 5.4:1.

Dependent Measures

The St.Amant Autism Program administered a number of standardized measures annually for each child including cognitive, communication, adaptive behavior, and autism symptoms domains. These assessments, described below, were usually conducted by graduate students in Psychology, supervised by a certified psychologist, or by clinical psychologists themselves. For all assessments, standard scores were used for analysis.

Weschler Preschool and Primary Scale of Intelligence (WPPSI-IV). The WPPSI is a psychometric measure of intelligence for children ages 3 to 7 years old. The WPPSI includes subscales for verbal and performance factors of intelligence, including subscales such as verbal comprehension and working memory. The WPPSI provides an overall full-scale IQ score, which is standardized with a mean of 100 and a standard deviation of 15 (Liu & Lynn, 2011). The

WPPSI has been shown to have strong psychometric properties, such as high inter-rater reliability, high internal consistency, as well as strong correlation with other standardized measures of intelligence for preschool children (Gordon, 2004).

Scales of Independent Behavior-Revised (SIB-R). The SIB-R is a structured interview that provides a measure of a child's functional independence and adaptive behaviors. A broad independence standard score is calculated based on four main areas of functioning: personal living, community living, social interaction and communication, and motor skills (Bruininks, Woodcock, Weatherman, & Hill, 1996). Standard scores for the SIB-R have a mean of 100 and a standard deviation of 15. The SIB-R has been shown to have high inter-rater reliability, as well as strong test-retest reliability (Sattler, 2002).

Pervasive Developmental Disorder Behavior Inventory (PDDBI). The PDDBI is a measure of autism symptom severity and is standardized with a population diagnosed with PDD. The PDDBI is intended as a tool for assisting in the diagnosis and intervention of persons with PDD. The PDDBI has been shown to have high construct and criterion-related validity, high long-term test-retest reliability, and high internal consistency (Cohen, Schmidt-Lackner, Romanczyk, & Sudhalter, 2003). Standard scores for the PDDBI are expressed as T scores and have a mean of 50 and a standard deviation of 10. For the purposes of the following analyses, the Autism Composite scale was used for analysis. While subscales of the PDDBI are scored such that an increased score indicates improvement, the Autism Composite Standard Score is interpreted differently. A decreased Autism Composite Standard Score indicates improvement, while an increased Autism Composite Standard Score indicates greater challenges. For example, Autism Composite Standard Scores above 60 would indicate greater challenges than scores below 40.

Communication Subscales. The Clinical Evaluation of Language Fundamentals-Fourth Edition (CELF-4) is a screening and diagnostic tool for language disorders in children and young adults ages 6 to 21. It is made up of 18 subtests, which are organized into four levels of testing: (1) general language ability, (2) nature of the language disorder, (3) phonological awareness, and (4) language disorder on classroom performance (Paslawski, 2005). The CELF-4 has been shown to have high concurrent validity, as well as high inter-examiner reliability (Friberg, 2010).

Although CELF-4 was used by the St.Amant Program, it was not used for analysis in this study because most of the children in our sample would have been too young to be assessed on the CELF-4. In order to examine changes in communication skills, standard scores from several communication subscales were used as a proxy. The first subscale came from the PDDBI and measured expressive communication, with increased scores indicating improvement. The other two subscales came from the WPPSI, and were measures of verbal performance and general language skills.

Data Analysis

I conducted a Repeated Measures Analysis of Variance (RM ANOVA) using SPSS 22. This allowed me to examine the relationship between the intensity of intervention and children's results on annual outcome measures. Since the purpose of an ANOVA is to examine the equality of means across two or more groups, I was able to examine the differences between the two groups. However, since the same sample of children and their outcome measures were examined at two time points, I used repeated measures ANOVA. When a dependent variable is measured for independent groups, the set of groups is called a *between-subjects factor*. When a dependent variable is measured repeatedly for all sample members across time points, this is called a *within-subjects factor*. In the current study, I completed a 2 x 2 RM ANOVA with treatment intensity as the between-groups factor (lower versus higher intensity) and time (Intake and Year 1) as the within-groups factor. Group by time interaction was examined. Statistical significance was evaluated with *p* set at .05, 2-tailed.

There are two main assumptions made about the sample in a RM ANOVA: (1) the assumption of multivariate normality, meaning the dependent variables follow a multivariate normal distribution, and (2) multivariate homogeneity of variance, meaning the variance between dependent variables is equal. Prior to conducting the RM ANOVA, I tested for these assumptions in SPSS. The assumption of multivariate normality was tested through normality plots with tests, and each of the samples in the current study met this assumption. In order to assess whether the samples met the assumption of multivariate homogeneity of variance, results from Levene's Test of Equality of Variances were examined. All of the values were found to be not significant, meaning all samples met this assumption.

In addition, since some research has shown that IQ score at intake could be a potential predictor (Perry et al., 2008), I examined whether the IQ scores were significantly different between groups at intake as a potential covariate. A *t*-test between Group A and Group B showed that the IQ scores at intake were not significantly different between the two groups.

Results

Results are presented in two sections. In Part A, I examined the extent to which children improved after one year of EIBI, and specifically compared outcomes between the lower- and higher-intensity groups at Intake and Year 1. In Part B, I examined correlates and predictors of outcomes at Year 1.

Part A: Analysis of Outcomes at Intake and Year 1

For each outcome measure, children's standard scores at Intake (T0) and Year 1 (T1) were compared, with group (lower vs. higher intensity) as the between-groups factor and time (Intake vs. Year 1) as the within-groups factor. Table 2 shows the results of the RM ANOVA between the two groups from Intake to Year 1 for cognitive and adaptive functioning and autism symptom severity, and Table 3 shows the results of the RM ANOVA between the two groups from Intake to Year 1 for the communication domain.

Cognitive functioning (WPPSI Full Scale IQ Standard Score). For the 24 children who had a WPPSI FSIQ SS at both Intake and Year 1, results showed a significant main effect for time, a nonsignificant main effect of intensity, and a nonsignificant group by time interaction (see Table 2). The 13 children in Group A had a mean gain of 5.07 standard points, whereas the 11 children in Group B had a mean gain of 7.54 standard points (see Figure 1). While Group B (higher-intensity group) showed a slightly greater magnitude of improvement from Intake to Year 1, the changed scores from Intake to Year 1 were not statistically significant for either group.

Adaptive functioning (SIB-R Broad Independence Standard Score). For the 54 children who had an SIB-R BI SS at both Intake and Year 1, there was a significant main effect for time, a nonsignificant main effect of intensity, and a nonsignificant group by time interaction (see Table 2). In other words, both intensity groups improved substantially from Intake to Year 1. The 25 children in Group A had a mean gain of 9.52 standard points ($p < .05$) and the 29 children in Group B had a mean gain of 7.93 points ($p < .01$) from intake to year 1. In this case, Group A (lowerer-intensity group) showed a greater magnitude of improvement when compared to Group B (higher-intensity group), while Group B showed a more significant improvement than Group A (see Figure 2).

Autism severity (PDDBI Autism Composite Standard Score). For the 69 children who had a PDDBI ACSS at both Intake and Year 1, results showed a statistically significant main effect for time, a nonsignificant main effect of intensity, and a nonsignificant group x time interaction (see Table 2). Group A had a mean decrease of 4.71 standard points for symptom severity ($p < .01$) and Group B had a mean decrease of 6.16 standard points ($p < .001$), meaning that Group B had a slightly greater magnitude of improvement (see Figure 3).

Expressive Communication (PDDBI Expressive Language Standard Score). Of the 69 children who had a PDDBI EL SS at both Intake and Year 1, results revealed a statistically significant main effect of time, a nonsignificant main effect of intensity, and a nonsignificant group x time interaction (see Table 3). The 37 children in Group A had a mean increase of 2.73 standard points ($p < .05$), compared to a mean increase of 3.13 standard points for Group B ($p < .01$) (see Figure 4).

Verbal Performance (WPPSI Verbal Standard Score). Of the 23 children who had a WPPSI VSS at both Intake and Year 1, results showed a nonsignificant main effect of time, a nonsignificant main effect of intensity, and a nonsignificant interaction (see Table 3). The 13 children in Group A had a mean increase of .54 standard points while the ten children in Group B had a slightly greater mean increase of 3.6 standard points. Neither group showed a statistically significant mean increase from Intake to Year 1 (see Figure 5).

General Language Skills (WPPSI General Language Standard Score). Of the 26 children who had a WPPSI GL SS at both Intake and Year 1, results revealed a significant main effect of time, a nonsignificant main effect of intensity, and a nonsignificant group x time interaction (see Table 3). The 16 children in Group A improved by a mean of 9.07 standard points ($p < .05$), while the ten children in Group B improved by a mean of 14.7 standard points ($p < .05$) (see Figure 6).

Part A: Summary. As predicted, results revealed that children in the sample, on average, improved on all three standardized outcome measures from Intake to Year 1. Children achieved statistically significant improvements on adaptive functioning, autism severity, and cognitive functioning. Overall, group means showed that children in Group B made significantly better improvements from Intake to Year 1 than children in Group A for both adaptive functioning ($p < .05$ and $p < .01$ for Group A and Group B, respectively) and autism severity ($p < .01$ and $p < .001$ for Group A and Group B, respectively). Three children in Group A and three children in Group B made clinically significant improvements from Intake to Year 1 for cognitive functioning, meaning that they improved by one or more standard deviation from Intake to Year 1. For adaptive functioning, nine children in Group A and 11 children in Group B made clinically significant improvements from Intake to Year 1, and for autism severity 11 children in Group A and 11 children in Group B made clinically significant improvements from Intake to Year 1. Results from communication subscales revealed that all children, on average, improved significantly on both expressive communication and general language skills from Intake to Year 1, with children in Group B showing a greater magnitude of improvement in expressive communication than Group A. Both expressive communication and general language skills subscales were found to have statistically significant main effects of time, and nonsignificant interactions. For verbal performance, there were no significant main effects for time or intensity, and no significant interactions.

Part B: Correlates and Predictors of Outcomes at Year 1

In order to examine possible correlates and predictors of outcomes for children, Pearson correlations were computed for all three outcome measures. Since some research has identified age at intake as an important predictor of a child's success in an EIBI program (e.g., Matson, Wilkins & Gonzalez, 2008; Granpeesheh et al., 2009; Perry et al., 2011), this variable was also examined as a possible predictor. Therefore, children's scores at Year 1 were correlated with the following predictors at intake: (1) Age at intake (months), (2) WPPSI FSIQ SS, (3) PDDBI AC SS, and (4) SIB-R AC SS. Results from the correlation analyses revealed that although cognitive functioning at intake was significantly correlated with cognitive functioning and adaptive functioning at Year 1 ($p < .05$ in both cases), it was not a predictor of autism severity at Year 1. Autism severity at intake was found to be significantly associated with adaptive functioning at Year 1 ($p < .05$), as well as with autism severity at Year 1 ($p < .001$). Autism severity at intake was not, however, a significant predictor of cognitive functioning at Year 1. Adaptive functioning at intake was found to be a significant predictor for cognitive functioning at Year 1 ($p < .05$), as well as both adaptive functioning and autism severity at Year 1 ($p < .001$ in both cases). In other words, children who scored better on adaptive functioning at intake tended to have better scores on all three outcome measures at Year 1. Age at intake was not significantly correlated with any of the three outcome measures.

Overall, and not surprisingly, the strongest correlations were found when an intake score on a given outcome measure was correlated with a Year 1 score of that same outcome measure. In other words, cognitive functioning at intake was found to be the most significant predictor of cognitive functioning at Year 1, adaptive functioning at intake was found to be the strongest predictor of adaptive functioning at Year 1, and autism severity at intake was found to be the strongest predictor of autism severity at Year 1.

Discussion

The purpose of the current study was to conduct a retrospective analysis using archival data from children in the Early Learning Program at St.Amant. The first hypothesis was that children would achieve statistically significant improvements across all standardized outcome measures from Intake to Year 1. As predicted, there was a statistically significant main effect of time, meaning that the average score at Year 1 was significantly higher than at intake, regardless of service intensity. Statistically significant improvements were found across all outcome measures, except for the WPPSI Verbal Performance subscale. While the general language subscale yielded significant main effects for time, the nonsignificant main effect for verbal performance may have been due to the WPPSI Verbal Performance subscale being a measure of Verbal IQ as opposed to a broader language assessment such as the general language subscale.

The second hypothesis was that the higher-intensity group (*Group B*) would perform significantly better on all outcome measures at Year 1 when compared to the lower-intensity group (*Group A*). This hypothesis was not supported, although the higher-intensity group (*Group B*) made slightly larger mean gains on all outcome measures (cognitive and adaptive functioning, autism symptoms, and communication subscales) when compared to Group A (see Changed Scores in Table 1). This finding may be due to two possible reasons. First, our sample size may be too small. When examining our main effects of time, which were significant across all outcome measures, the group split resulted in observed power of .984 and .999 for adaptive functioning and autism severity, respectively, indicating high power. However, our observed power for cognitive functioning was only .541, which may have been due to our small sample size. Second, the difference in service intensity between groups was relatively small. Since a treatment is typically considered high-intensity if it includes anywhere from 20 to 40 hours of one-to-one intervention per week (Maurice, Green, & Foxx, 2001) and low-intensity if it involves anything less than that, it might be appropriate to say that the current study compared two high-intensity groups that varied slightly on the number of service hours provided. Similar to Sallows and Graupner (2005), who compared groups receiving 39 and 32 hours of intervention per week, our study also found slight differences in favor of the higher-intensity group, though both groups showed improvements.

Correlation analyses revealed that adaptive functioning at intake was a significant predictor for all three outcome measures at Year 1, showing that children who scored better on adaptive functioning at intake tended to have better scores on all three outcome measures at Year 1. When examining age at intake as a possible predictor variable, results for the present study contradict findings from Perry and colleagues (2011), as the present study did not find age at intake to be associated with better outcomes at exit. This could have been due to a narrower age range in our sample (i.e., range of 43-45 months) compared to the sample of children in Perry and colleagues (2011) study (i.e., range of two to seven years). Other studies have also failed to show age as a predictor variable (e.g., Hayward, Eikeseth, Gale & Morgan, 2009; Smith et al., 2000), Perry et al. (2011) suggested that this may be due to factors such as differences in sample characteristics and different types of analyses. In addition, a systematic review of 11 studies found that age at intake was not related to outcomes in any of the studies analyzed (Howlin, Magiati, & Charman, 2009).

The current study has a number of strengths that should be noted. First, this study adds to the scarce body of research specifically examining treatment intensity of EIBI. While most studies include treatment intensity as one of many variables, the literature focusing on treatment intensity as a main independent variable is limited. Next, the current study used standardized outcome measures for cognitive, adaptive functioning, and autism severity domains. This allowed for a more comprehensive analysis of the treatment gains, as children across groups can be compared based on standardized scores. A final strength of the present study is that the two intensity groups were almost identical on all variables other than treatment hours. Children in both Group A and Group B received one-to-one therapy by a team of trained tutors, senior tutors, and consultants, and parents for children in both groups were given an average of five hours of parent programs per week. This allowed us to directly compare the two groups based on treatment intensity, while reducing the risk of confounding variables that may have affected the results.

Although the current study offers a number of strengths, it is not without limitations. As noted earlier, the sample size in this study was relatively small. While we initially began our analyses with data from 260 children, group sample sizes were quickly decreased to much smaller numbers, depending on how many children had outcome scores at both Intake and Year 1 time points. Initially, the plan was to compare children receiving the Focused vs. Comprehensive models of service (15.5 and 31 weekly service hours, respectively) at the St.Amant Autism Program. However, given that the majority of children entered the comprehensive program at intake and typically only transition to the focused program upon the Autism Consultant's recommendation, this resulted in extremely uneven sample sizes between the two groups. Consequently, I decided to split the groups based on mean hours of service received.

A second limitation to the present study is that difference in service intensities between the two groups is relatively small (22.4 vs. 30.4 mean hours, respectively). Moreover, the mean hours of service received by the lower-intensity group were relatively high. Several studies consider 20 hours of EIBI per week to be high intensity (Flanagan, Perry, & Freeman, 2012; Foran et al., 2015; Freeman & Perry, 2010; Granpeesheh et al., 2009), with some studies even considering 15 hours or more per week as an "intensive intervention" (Fava et al., 2012). Therefore, a comparison of two EIBI groups with a larger difference in service hours may yield larger difference in outcomes.

A third limitation to the present study is that there was no standardized outcome measure for communication. The CELF-IV was the standardized measure that we had planned to use, but this data was unavailable for the majority of children in our sample, as they were too young to be assessed on the CELF-IV. In order to make up for the lack of standardized scores for communication, communication subscales were taken from other standardized tests. These scales included domains for expressive communication (PDDBI EL SS), verbal performance (WPPSI VSS), and general language skills (WPPSI GL SS). Although the subscales offered some information about children's language functioning, a standardized measure for communication would have been better, as a measure focused on communication may be more sensitive.

A final limitation to the current study is that being an archival study, there was no way to check the data entry and reliability. As a result, there was no way to check for potential errors in the dataset. In addition, an archival study does not allow for manipulation of certain methodological characteristics such as random assignment to groups.

Despite the limitations noted, the current study contributes to the scarcity of research on treatment intensity of EIBI. With the paucity of literature specifically examining treatment intensity of behavioral interventions, the present study adds to this research. Results from this study demonstrate that children with ASD showed significant improvement after one year of EIBI service, and that treatment intensity may influence outcomes even at relatively high levels. This finding holds important implications for families of children with autism, service providers, and government funding agencies. Future research should address the topic of treatment intensity with a larger sample size, and a low-intensity EIBI control group.

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Table 1

Hours of service, age, and gender for all children and the two subgroups [a, b, c]

	All Children *n* = 70	Group A *n* = 38	Group B *n* = 32
Weekly Service Hours			
Mean (*SD*)	26.0 (19.1)	22.4 (11.6)	30.4 (8.8)
Age (months) at Intake			
Mean (*SD*)	43.8 (9.1)	43.5 (9.8)	44.4 (7.9)
n	41 [b]	27 [c]	14 [d]
Gender			
Male	59 (84%)	32 (84%)	27 (84%)
Female	11 (16%)	6 (16%)	5 (16%)
Ratio	5.4:1	5.3:1	5.4:1

[a] All children (*n* = 70) included those with Intake and Year 1 scores for at least one of the following outcome measures (cognitive, adaptive behavior, or autism symptoms). Group A (*n* = 38) was the lower-intensity group and included children with mean weekly hours less than or equal to 26. Group B was the higher-intensity group and included children with mean weekly hours greater than 26.

[b] Age at intake could be determined for only 41 of the 70 children due to missing intake dates.

[c] Age at intake could be determined for only 27 of the 38 children in Group A due to missing intake dates.

[d] Age at intake could be determined for only 14 of the 32 children in Group B due to missing intake dates.

Table 2

Outcomes for Children with Different Service Intensity at Intake and Year 1

	Intake *M* (*SD*)	**Year 1** *M* (*SD*)	**Changed Score**
Cognitive Functioning (WPPSI FS SS)[a]			
Group A (*n* = 13)	77.31 (15.91)	82.38 (15.59)	5.07
Group B (*n* = 11)	68.91 (17.35)	76.45 (13.80)	7.54
Adaptive Functioning (SIB-R BI SS)[b]			
Group A (*n* = 25)	59.72 (21.53)	69.24 (25.26)	9.52 *
Group B (*n* = 29)	58.41 (22.13)	66.34 (25.18)	7.93 **
Autism Severity (PDDBI A C SS)[c]			
Group A (*n* = 37)	52.30 (8.90)	47.59 (10.45)	–4.71 **
Group B (*n* = 32)	52.44 (9.11)	46.28 (8.30)	–6.16 ***

* $p < .05$, ** $p < .01$, *** $p < .001$

Abbreviations: WPPSI FS SS = Wechsler Preschool and Primary Scale of Intelligence Full Scale IQ Standard Score; SIB-R BI SS = Scales of Independent Behavior – Revised Behavioral Inventory Standard Score; PDDBI A C SS = Pervasive Developmental Disability Behavior Inventory Autism Composite Standard Score. Group A = lower service intensity; Group B = higher service intensity.

[a] Repeated Measures ANOVA (group x time) – Significant main effect of time: Wilks' $\Lambda = .826$, $F(1, 22) = 4.650$, $p = .042$, partial $\eta^2 = .174$; nonsignificant main effect of intensity: $F(1, 22) = 1.561$, $p = .225$, partial $\eta^2 = .066$; and nonsignificant interaction: Wilks' $\Lambda = .992$, $F(1, 22) = .178$, $p = .677$, partial $\eta^2 = .008$.

[b] Repeated Measures ANOVA (group x time) – Significant main effect of time: Wilks' $\Lambda = .749$, $F(1, 52) = 17.436$, $p < .001$, partial $\eta^2 = .251$; nonsignificant main effect of intensity: $F(1, 52) = .119$, $p = .732$, partial $\eta^2 = .002$; and nonsignificant interaction: Wilks' $\Lambda = .705$, $F(1, 52) = .145$, $p = .705$, partial $\eta^2 = .003$.

[c] Repeated Measures ANOVA (group x time) – Significant main effect of time: Wilks' $\Lambda = .707$, $F(1, 67) = 27.701$, $p < .001$, partial $\eta^2 = .293$; nonsignificant main effect of intensity: $F(1, 67) = .087$, $p = .768$, and partial $\eta^2 = .001$; and nonsignificant interaction: Wilks' $\Lambda = .993$, $F(1, 67) = .496$, $p = .484$, partial $\eta^2 = .007$.

Table 3

Communication Domain: Outcomes of communication subscales for children with Scores at Intake and Year 1

Language Functioning	**Intake** *M* (*SD*)	**Year 1** *M* (*SD*)	**Changed Score**
Expressive Communication (PDDBI E L SS)[a]			
Group A (n = 37)	50.78 (11.78)	53.51 (10.07)	2.73*
Group B (n = 32)	48.62 (9.83)	51.75 (10.42)	3.13**
Verbal Performance (WPPSI V SS)[b]			
Group A (n = 13)	70.07 (14.24)	70.61 (7.95)	0.54
Group B (n = 10)	68.40 (13.20)	72.00 (9.86)	3.6
General Language Skills (WPPSI G L SS)[c]			
Group A (n = 16)	75.43 (21.27)	84.50 (15.22)	9.07*
Group B (n = 10)	66.90 (22.00)	81.60 (15.52)	14.7*

* p < .05, ** p < .01

Abbreviations: PDDBI E L SS = Pervasive Developmental Disability Behavior Inventory Expressive Communication Standard Score; WPPSI V SS = Wechsler Preschool and Primary Scale of Intelligence Verbal Standard Score; WPPSI G L SS = Wechsler Preschool and Primary Scale of Intelligence General Language Standard Score.

[a] Repeated Measures (group x time) – Significant main effect of time: Wilks' Λ = .822, F(1, 67) = 14.53, p < .01, partial η^2 = .178, nonsignificant main effect of intensity: F(1, 67) = .734, p = .395, partial η^2 = .011, and nonsignificant interaction: Wilks' Λ = .999, F(1, 67) = .066, p = .798, partial η^2 = .001.

[b] Repeated Measures (group x time) – Nonsignificant main effect of time: Wilks' Λ = .968, F(1, 21) = .692, p = .415, partial η^2 =.032, nonsignificant main effect of intensity: F(1, 21) = .663, p = .425, partial η^2 = .031, and nonsignificant interaction: Wilks' Λ = .982, F(1, 21) = .379, p = .545, partial η^2 = .018.

[c] Repeated Measures (group x time) – Significant main effect of time: Wilks' Λ = .660, F(1, 24) = 12.37, p < .01, partial η^2 = .340, nonsignificant main effect of intensity: F(1, 24) = .720, p = .405, partial η^2 = .029, and nonsignificant interaction: Wilks' Λ = .972, F(1, 24) = .697, p = .412, partial η^2 = .028.

Table 4

Pearson Correlations between Predictors at Intake and Outcomes at Year 1

	Predictors at Intake			
	Age	Cognitive Functioning WPPSI FSIQ SS	Adaptive Functioning SIB-B BI SS	Autism Severity PDDBI AC SS
Outcomes at Year 1				
Cognitive Functioning WPPSI FSIQ SS	–.140	.611*	.328*	.038
Adaptive Functioning SIB-R BI SS	.033	.523*	.798***	−.307*
Autism Severity PDDBI AC SS	–.097	.089	− .469***	.573***

* $p < .05$, *** $p < .001$

Note: For intake scores: age (n = 35), WPPSI FSIQ SS (n = 28), PDDBI AC SS (n = 69), and SIB-R BI SS (n = 69). For outcome variables at T1, n varies.

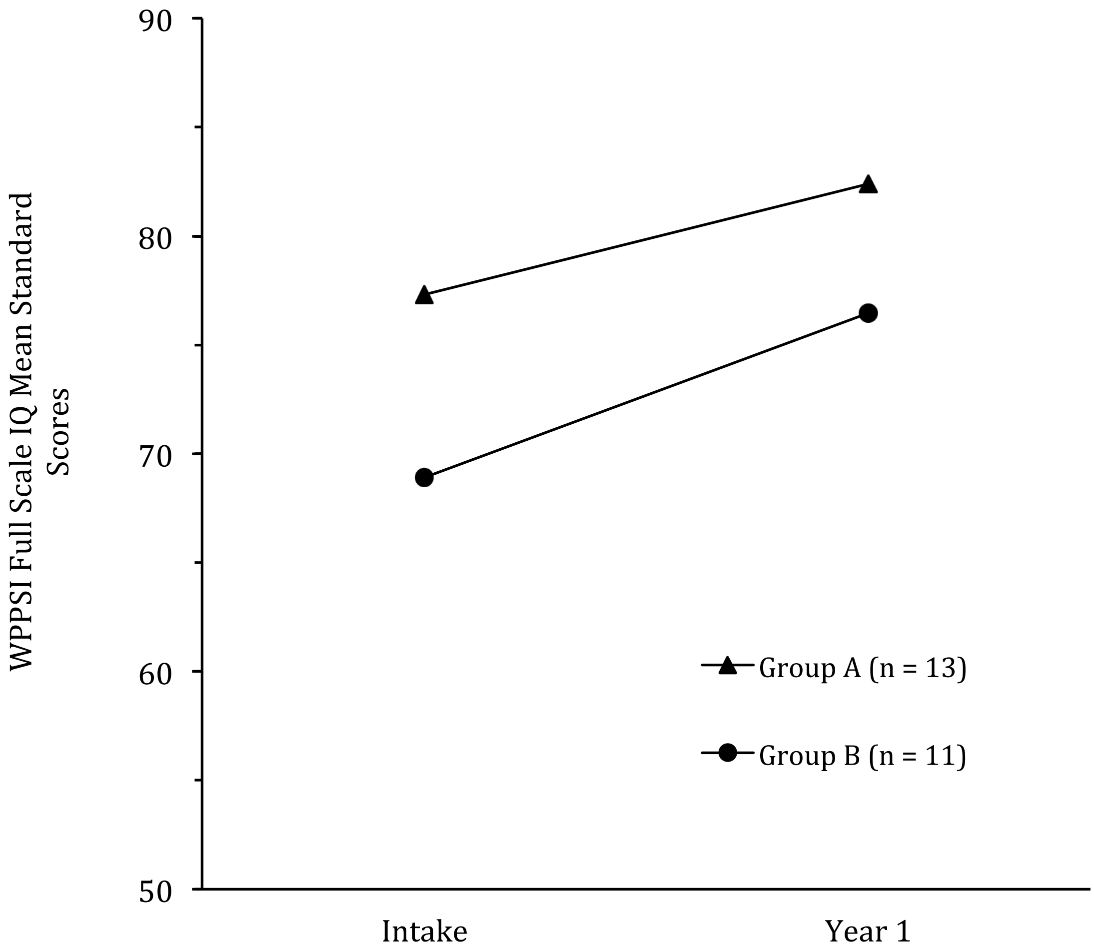

Figure 1. WPPSI Full Scale IQ mean standard scores at Intake and Year 1 for lower-intensity (Group A) and higher-intensity (Group B) groups.

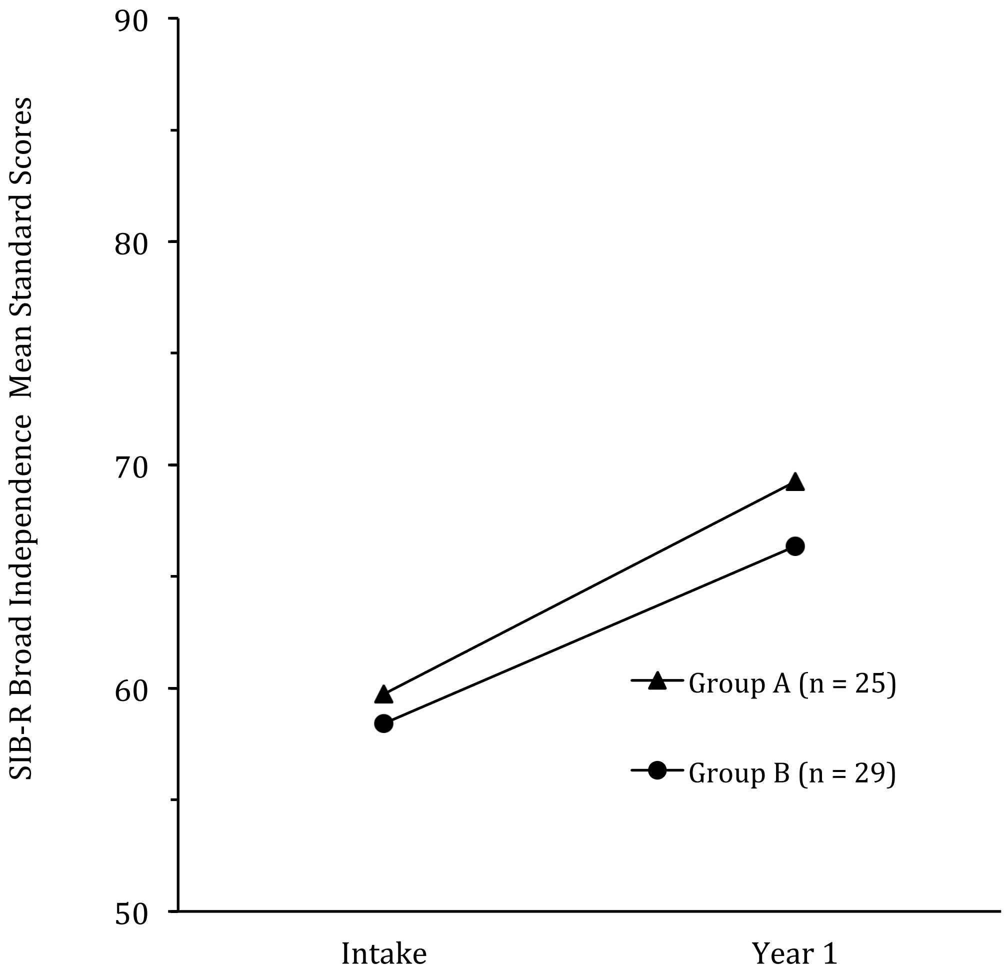

Figure 2. SIB-R Broad Independence mean standard scores at Intake and Year 1 for lower-intensity (Group A) and higher-intensity (Group B) groups.

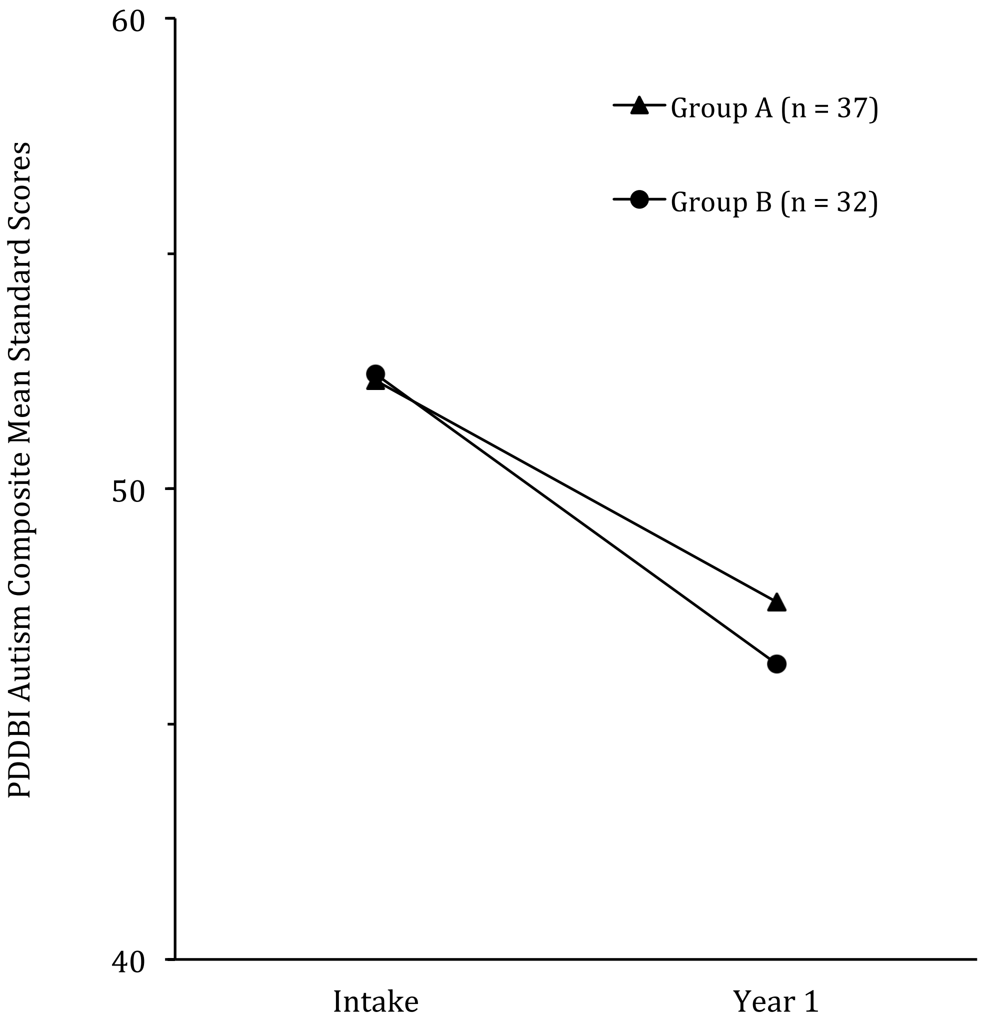

Figure 3. PDDBI Autism Composite mean standard scores at Intake and Year 1 for lower-intensity (Group A) and higher-intensity (Group B) groups.

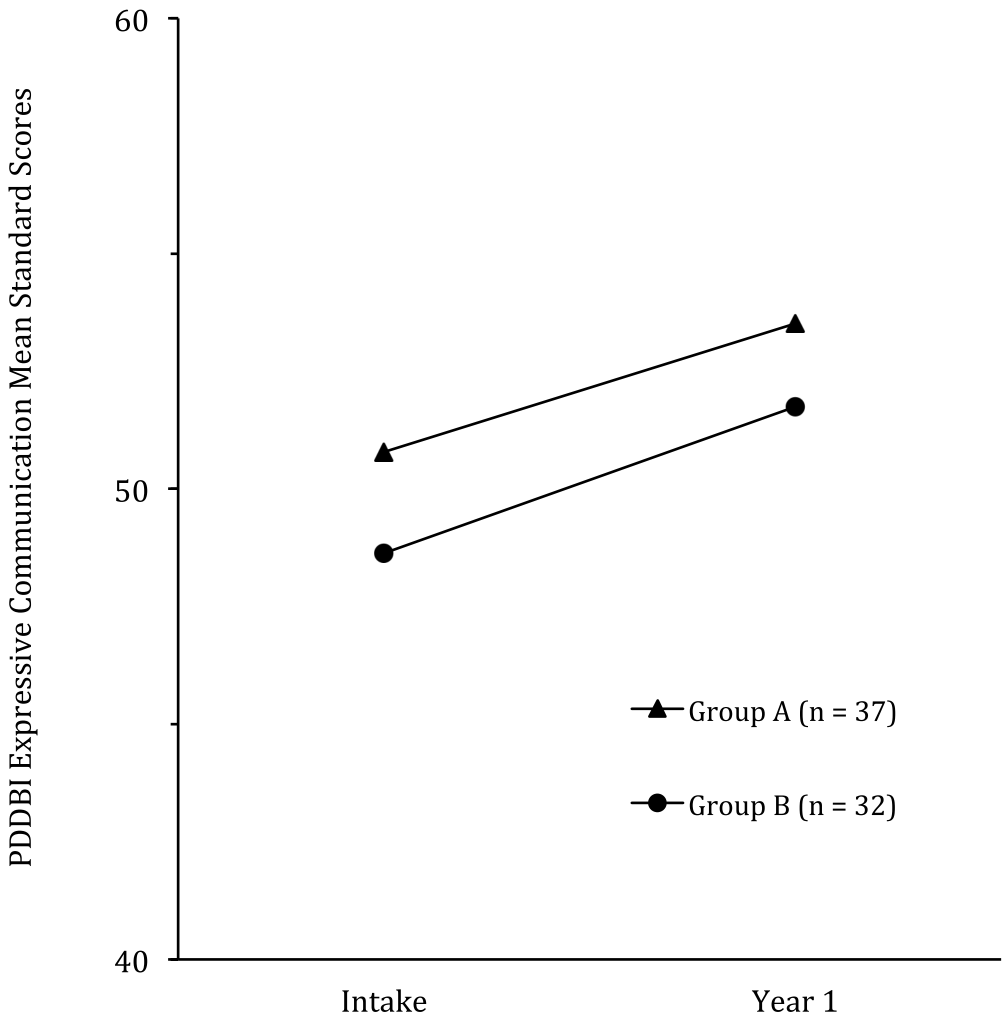

Figure 4. PDDBI Expressive Language mean standard scores at Intake and Year 1 for lower-intensity (Group A) and higher-intensity (Group B) groups.

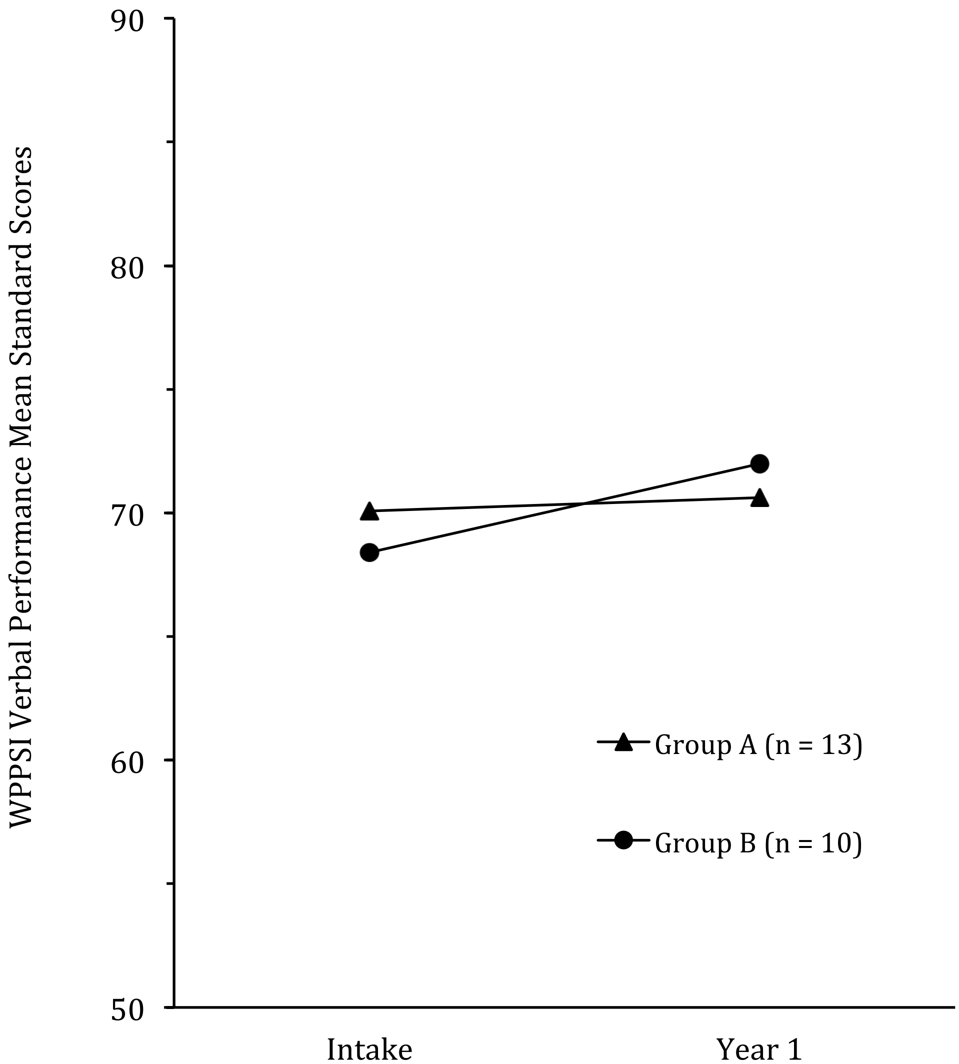

Figure 5. WPPSI Verbal Performance standard scores at Intake and Year 1 for lower-intensity (Group A) and higher-intensity (Group B) groups.

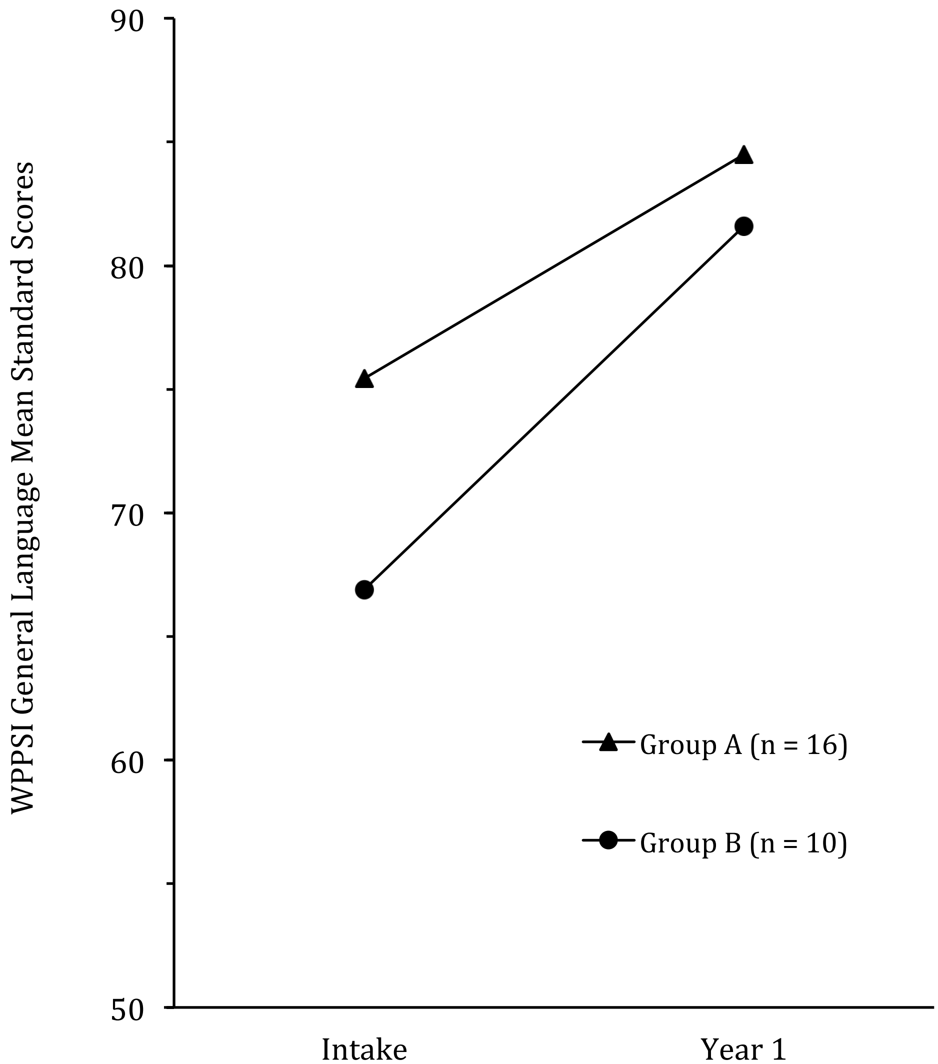

Figure 6. WPPSI General Language mean standard scores at Intake and Year 1 for lower-intensity (Group A) and higher-intensity (Group B) groups.