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The effects of age and treatment intensity on behavioral intervention outcomes for children with autism spectrum disorders

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ABSTRACT

Early intensive behavioral intervention (EIBI) has been shown to effectively remediate some cases of autism. However, few studies have evaluated the importance of various factors, such as the effect of treatment intensity on treatment outcomes, and how these outcomes vary by age.

The objective of this study was to evaluate the relationship of treatment hours and participant age with the rate of learning within an early intensive behavioral intervention program. The present study evaluated treatment progress for 245 children receiving EIBI services. Regression analyses were conducted to predict treatment progress based upon the number of monthly treatment hours received and the participant's age. Each of these variables were significant predictors and accounted for considerable portions of the observed variance. Further, the younger participants showed a greater benefit from increased treatment hours when compared to older participants.

These data indicate that for children between 2 and 7 years of age, there was a significant increase in new skill acquisition with increased treatment hours. Further, there was not a point of diminishing-returns.

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Early intensive behavioral intervention (EIBI) has been shown to effectively remediate some cases of autism (Eikeseth, 2009). Recent reviews by independent groups have agreed that the evidence for the effectiveness of EIBI is substantial. For example, Rogers and Vismara (2008) concluded that EIBI is the only treatment for autism that is "well-established." In another recent review, Myers and Plauché Johnson (2007) concluded that "the effectiveness of ABA-based intervention in ASDs has been well documented through five decades of research by using single-subject methodology and in controlled studies of comprehensive early intensive behavioral intervention programs in university and community settings" (p. 1164). The scientific support for EIBI has led several independent bodies to endorse EIBI as a treatment for autism, including the U.S. Surgeon General (US Department of Health and Human Services, 1999), the New York State Department of Health (New York State Department of Health, Early Intervention Program, 1999), and the National Academy of Sciences (National Academy of Sciences, 2001). Public policy changes have also occurred on the basis of this evidence, such as state-level legislation mandating medical insurance companies to cover ABA treatment (e.g., "Steven's Law," Arizona House Bill 2487).

Although EIBI is supported by a substantial foundation of empirical evidence, several aspects still require further investigation. In a recent review of EIBI studies, Matson and Smith (2008) noted a number of questions that have gone unaddressed in the literature. One of their avenues of inquiry may be summed as inquiries into the relationship between the intensity of treatment and the child's age. To date, an insufficient amount of research has evaluated the effect of treatment intensity (usually defined as hours per week of intervention) on behavioral intervention outcomes. This is surprising considering that the seminal paper by Lovaas (1987) included a controlled comparison of treatment intensity. In that study, a high-intensity group that received approximately 40 h per week of intervention was compared to a low-intensity group that received approximately 10 h per week of intervention. The high-intensity group achieved robust treatment effects and the low-intensity group improved very little.

While no other controlled studies have evaluated the impact of treatment intensity on outcomes, researchers have continued to address this issue and two other studies have implications. First, Eldevik, Eikeseth, Jahr, and Smith (2006) retrospectively compared the effects of low intensity behavioral intervention (12 h per week) to a group which received the same amount of "eclectic" treatment. The eclectic treatment consisted of a mix of multiple intervention procedures, including those taken from applied behavior analysis, sensory motor therapies, Treatment and Education of Autistic and related Communication-handicapped Children (TEACCH), alternative communication, and the personal experience of the teachers. The group that received behavioral intervention outperformed the group that received eclectic intervention. However, the treatment effects were small and the authors questioned whether they were clinically significant.

In another study addressing the topic of intensity, Reed, Osborne, and Corness (2007) descriptively compared outcomes for children who received low intensity (mean 12 h per week) behavioral intervention to those of children who received higher intensity (mean 30 h per week) behavioral intervention. Both groups received treatment for 9–10 months, a significantly shorter period of time than has been evaluated in previous research on EIBI. Despite the short overall duration of treatment, the higher intensity group made significantly greater gains in intellectual and educational functioning. In a recent meta-analysis of EIBI research, Reichow and Wolery (2009) examined effect sizes of studies which compared low- and high-intensity interventions and also concluded that high-intensity interventions produced greater effects than lower intensity interventions, however, only IQ data were available for analysis.

From these studies, it is apparent that the existing evidence suggests that higher intensity behavioral intervention should be favored over low intensity. However, further replication across regions and across clinical service providers seems warranted. In addition, all studies of EIBI save one have evaluated treatment effects across relatively small sample sizes (e.g., 20–30 children). The only exception is a study by Perry et al. (2008), wherein an uncontrolled evaluation of a province-wide program of EIBI was conducted in Ontario, Canada. The effects produced were relatively robust but all children received relatively high-intensity intervention (i.e., 20–40 h per week). Thus, no direct implications for varying levels of intensity can be gleaned from the study. Therefore, it appears that

additional research on the intensity of behavioral intervention for children with autism is warranted, particularly across larger sample sizes.

The age of the individual receiving EIBI is an additional variable that may impact treatment outcome, although surprisingly little research has directly addressed this issue. Generally speaking, most studies of ASD treatment have included children of a relatively young age. For example, in a recent review paper, Ospina et al. (2008) concluded that the median age of participants in treatment studies was 62 months. Furthermore, few studies have attempted to directly address the impact of age on outcome. In an early study on the topic, Fenske, Zalenski, Krantz, and McClannahan (1985) compared outcomes for nine children who entered intensive behavioral intervention before 60 months of age to nine children who entered the same treatment program after 60 months of age. Early entry was found to be positively related to placement in public school classrooms and residence in parents' homes. Similarly, Harris and Handleman (2000) evaluated age at intake as a predictor of outcome in 27 children with ASDs who attended intensive behavioral intervention programs. They too found that younger age at intake was related to placement in regular education at discharge.

The existing evidence would appear to support the notion that individuals with ASDs should enter behavioral intervention as young as possible. However, this will be limited by the degree to which the disorder can be detected at a very young age (Matson, Wilkins, & Gonzaléz, 2008; Matson et al., 2009). Further, the Fenske et al. (1985) and the Harris and Handleman (2000) studies included small sample sizes (i.e., 18 and 27 children, respectively). In addition, they used educational placement as their primary outcome variable. Educational placement is a crucial component of the lives of individuals with ASDs but research is still needed that includes more direct measures of learning in behavioral intervention programs. Therefore, more research on the effects of age on behavioral intervention outcome appears warranted, including larger sample sizes and direct measures of learning.

One challenge to overcome in the design of such studies is the issue of how to measure the effects of treatment intensity and child age. Operationalizing the amount that a child learns may be quite difficult. Measures of learning used in previous research on behavioral intervention tend to be quite molecular, for example, moment-to-moment direct measures of particular behaviors, or quite molar, consisting of standardized global assessments, such as tests of intelligence, language, adaptive functioning, or diagnostic scales (Matson, 2007). Direct measures of behavior assess changes in a child's repertoire in the very short-term and have the advantage of giving a very fine-grained picture of what a child can do at a particular point in time and therefore are highly useful for guiding daily treatment decisions, but they have the disadvantage of not capturing larger changes in overall skill repertoires. On the other hand, psychoeducational assessments detect changes in a child's repertoire in longer term increments (e.g., typically a year or more), and have the advantages of giving a more global picture of a child's abilities and of producing results that are comparable across other children in the population, but often lack the sensitivity required to demonstrate small changes in children's abilities.

Direct measures of behavior and standardized assessments fulfill their purposes well; the former helping to guide moment-to-moment treatment decisions and the latter giving a broad picture of the outcome of treatment after an extended period of time. However, little in the way of measurement exists which can capture changes in a child's repertoire that may occur in between these measurement intervals, that is, over periods longer than a few days and shorter than a year. One viable alternative is to track the number of behavioral objectives mastered per unit of time (e.g., week, month, quarter, etc.). Only one published study of which we are aware has attempted to do this. Green, Brennan, and Fein (2002) described a case study of EIBI for a single girl diagnosed as at-risk for autism. They reported the number of skills mastered during each month for the first 60 months of treatment. Mastered skills were graphed and summarized separately for motor skills, receptive labeling, expressive labeling, and following one-step instructions. As treatment in each of these areas progressed, orderly increases in mastered skills were observed.

The use of mastered skills as a dependent variable may allow for the measurement of treatment outcomes that are too general for specific behavior definitions. Likewise, this dependent variable allows for the measurement of relatively short-term outcomes which diagnostic scales are not

designed to detect. Further, EIBI service providers should readily have these data available as a part of ongoing intervention services.

The purpose of the current study was to evaluate the relationship of treatment hours and participant age with the number of monthly mastered behavioral objectives within an early intensive behavioral intervention program.

1. Methods

1.1. Participants

Participants in the current study were selected from a pool of 379 children receiving behavioral intervention services at a large-scale community-based service provision agency. To be included in the study participants needed to meet the following criteria: age between 16 months and 12 years; received an average of 20 or more hours per month for the duration of the study; and have mastered at least one item per month. Further, any clients who were in their first month of treatment or who had been in treatment for over 4 years were removed from the dataset. These criteria resulted in a sample size of 245 children. The mean age of participants was 6.16 years (SD = 2.33). The average number of hours received per month was 76.65 (SD = 37.9) with a range from 20.25 to 168.88. There were 227 participants with a diagnosis of Autistic Disorder (299.00) and 18 with a diagnosis of Pervasive Developmental Disorder Not Otherwise Specified (PDD NOS). Participants in this study resided and received services in the states of California, Arizona, Illinois, Texas, Virginia, and New York.

1.2. Data collection

Data were collected prospectively for a period of 4 months. These data were collected as a regular part of the participants' clinical services. Each month, a member of the child's therapy team would enter into a spreadsheet the number of behavioral objectives that the child mastered that month. The criterion for mastery of a behavioral objective was that the child achieved 80% correct or higher on that objective for two consecutive therapy sessions. If the child met this criterion, then the objective was scored as ''mastered''. Client files were reviewed to obtain participant age and service start date. Monthly billing records were reviewed to determine the number of face-to-face therapist treatment hours that were delivered for each child.

Several potential limitations of using mastered behavioral objectives as a measure of therapeutic progress are apparent. First, not all behavioral objectives are created equal. That is to say, some are inherently more difficult to master than others, and even for the same degree of difficulty, some require more time than others. For example, learning to ask for one's favorite toy by name would be considered mastery of a skill, whereas learning to follow a three-step direction containing prepositions would also be considered mastery of a single skill, despite the clear difference in difficulty and complexity of these two very different tasks. Therefore, if one is to examine changes in the rate of new skills being mastered as a function of changes in treatment (or any other variable), such analyses may well be confounded by changes to the child's intervention program, such as implementing new objectives that are harder or easier. Despite the inherent potential flaws to considering the number of mastered skills as a measure of treatment progress, it seems likely that, given a large enough sample size, these measurement errors should be evenly distributed across the participants, such that the crude measure will be a relatively valid proxy of overall treatment progress.

1.3. Behavioral intervention services

The participants in this study received individualized behavioral intervention services. Each child's program was customized to address all areas of functioning in which he/she displayed skill deficits (e.g., language, socialization, independent living skills, motor skills, academics, play, social cognition, and executive functions). The exact format of each child's program varied, depending on local and regional regulations and standards, available funding, and other practical considerations. However, the following characteristics were common to all participants' intervention programs: (1) one-to-one

intervention by a trained behavioral therapist, (2) both structured (i.e., discrete trial training) and unstructured (i.e., natural environment training) behavioral teaching strategies are employed, (3) verbal behavior-oriented language intervention, (4) use of both errorless prompting strategies and least-to-most prompting, (5) use of behavioral principles to design and implement teaching (i.e., reinforcement, extinction, stimulus control, generalization training, chaining and shaping), (6) function-based approach to assessing and treating challenging behaviors, (7) inclusion of parents in all treatment decisions and regular parent training, and (8) frequent (at least biweekly) direct supervision by an expert in behavioral intervention for children with autism.

2. Results

The primary research question was addressed through a linear regression analysis. The number of face-to-face treatment hours and participant age were used as predictors of the number of monthly mastered behavioral objectives. The analysis indicated that there was a significant linear relationship between the predictor variables and the number of behavioral objectives mastered ($F(2,242) = 20.85$; $p < 000$). This relationship accounted for approximately 14.7% of the observed variance in monthly mastered behavioral objectives.

To allow for further analysis of age effects on the association between treatment hours and mastered behavioral objectives, the overall sample was divided into three equal groups based upon participant age. This yielded three groups with participants aged 2 through 5.15 years placed into group 1, participants aged 5.15 through 7.14 years placed into group 2, and participants aged 7.14 through 12 years placed into group 3. The number of treatment hours received per group was evaluated through an ANOVA, which found no significant differences among groups ($F(2,242) = 1.24$, p = ns).

An ANOVA among groups was conducted to evaluate differences in the number of mastered behavioral objectives. Results of the analysis found significant differences among groups ($F(2,242) = 7.64$, $p < 0.01$). A post hoc analysis (Tukey HSD) found significant differences only in contrasts between groups 1 and 3 ($p < 0.01$) and groups 2 and 3 ($p < 0.01$).

A regression analysis was conducted for each age group using the number of monthly treatment hours as a predictor of the number of monthly mastered behavioral objectives. For age group 1, there was a quadratic relationship between the number of treatment hours and monthly mastered behavioral objectives ($F(2,79) = 4.715$, $p < 0.05$). This relationship accounted for approximately 11% of the observed variance in monthly mastered behavioral objectives among the participants in age group 1. For age group 2, there was also a quadratic relationship between the number of treatment hours and monthly mastered behavioral objectives ($F(2,78) = 10.487$, $p < 0.001$). This relationship accounted for approximately 21% of the observed variance in monthly mastered behavioral objectives among the participants in age group 2. Age group 3 did not show a significant relationship of any kind between treatment hours and monthly mastered behavioral objectives. Fig. 1 displays the relationship between the number of monthly treatment hours and the predicted monthly mastered behavioral objectives. Each curve shown is the curve of best-fit for the respective age group which describes the relationship between treatment hours and mastered behavioral objectives. No line is drawn for age group 3 because a significant relationship was not found.

3. Discussion

The results of the present study help to address two important factors related to the implementation of EIBI services for children with autism. The primary purpose of the study was to evaluate the relationship between the number of treatment hours and the number of mastered behavioral objectives. This was to evaluate two assumptions pointed out by Matson and Smith (2008) and Matson et al. (2008). First, the tacit assumption that more treatment hours will yield greater gains; or the converse, that there is a point of diminishing-returns where the child does not show an increased improvement from more treatment (Matson & Smith, 2008). Second, to address the assumption that younger children would benefit the greatest from treatment, and that earlier is better (Matson et al., 2008).

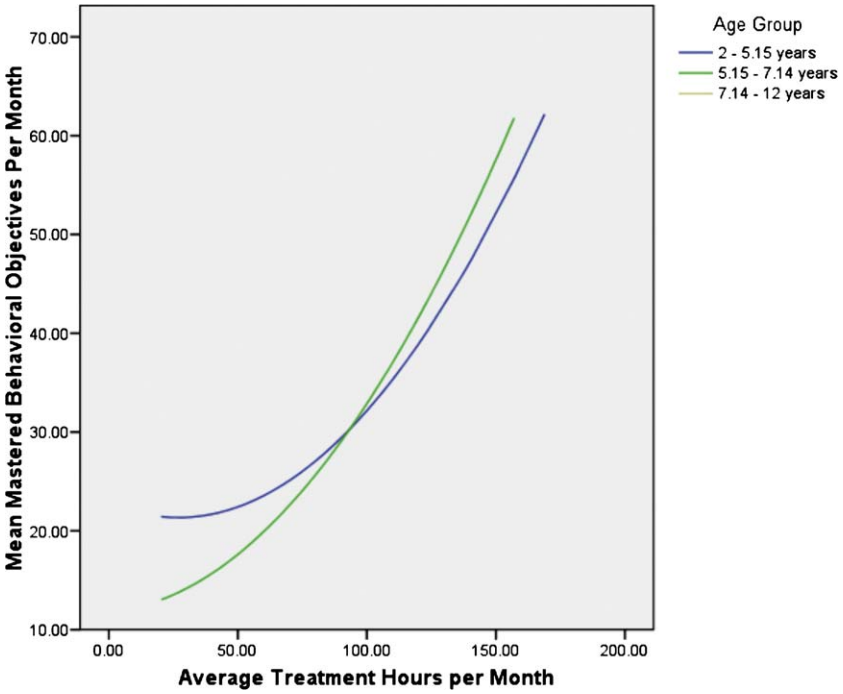

Fig. 1. Relationship between monthly mastered behavioral objectives and monthly treatment hours.

Our data indicated that the number of treatment hours and the child's age showed a linear relationship with the number of mastered behavioral objectives. That is to say, that an increase in treatment hours and a decrease in child age predicted an increase in the number of mastered behavioral objectives. When participants were placed into groups based upon age, three distinct differences in the relationship between treatment hours and treatment outcome were observed. First, the youngest group showed the greatest response to treatment at low levels of intensity and similar level of gains as the middle age group at high levels of intensity. Like the youngest group, the middle age group showed a similar increasing trend such that there was no point of diminishing-returns from increased treatment hours. This trend is naturally limited though to the actual range of treatment hours provided in our sample (up to 42 h per week). Children in the highest age group (7–12 years) did not show a significant relationship between treatment hours and the number of behavioral objectives mastered. That is, participants in this age group showed a relatively flat line in that approximately 17 behavioral objectives were mastered each month regardless of if the child was receiving high or low levels of treatment hours.

These data have a number of implications. First is that these treatment-specific and child-specific variables are not independent but will influence one another such that the number of treatment hours matters greatly to children under 7 but less so to those above 7 years of age. Maximizing the treatment hours during the younger ages could potentially yield much greater efficiency in treatment gains.

Another important implication of these data is that for children under 7, there was not a point at which participants began to burn-out from treatment. Rather, we observed that there was an increasing trend, such that the rate of learning was much higher for those children receiving relatively high levels of treatment (40 h per week). The fact that continued increases in treatment intensity led to continued increases in treatment gain, per unit of time, raises the possibility that children with autism may benefit by receiving more than what is currently considered high-intensity treatment, that is, 40 h per week. It is possible that groups of children in general, or individual children in particular, may have outcomes of a more optimal nature if they received well over 40 h per week of

intervention. However, response to intensity above 40 h per week is purely speculative as it goes beyond our data and is based upon our observed trend. Caution should be used as these speculations require empirical validation. However, a basic assumption underlying behavioral intervention is that treatment progress is the product of learning and there is no obvious reason to believe that learning does not occur during other waking hours, outside of the 40 h per week of interaction with a behavioral therapist. From the beginning, behavioral intervention programs have trained parents in behavioral principles and procedures and have encouraged them to implement them during all waking hours of their child's life (Lovaas, 1987).

In order to explore the possibility that greater intensities of EIBI may produce greater outcomes, future research is needed that pursues one or both of two approaches: (1) increasing the intensity and quality of parent training, such that parents do indeed maximize all waking hours of a child's life for learning, or (2) place professional behavioral therapists in greater proportions of the child's waking hours. Currently, behavioral therapists in EIBI programs are generally present during "business hours" (i.e., approximately 8 a.m. to 6 p.m.), usually on weekdays, but this is simply a matter of convention. There is no research to suggest that behavioral therapists should not be present during very early morning, evening, or weekend hours. Given the continued trends toward learning produced by increases in treatment hours in the current study, it seems at least plausible that either or both of these two avenues could demonstrate enhanced treatment effectiveness, but empirical research is needed to evaluate them directly.

The results of this study demonstrated that the efficiency of intervention decreases as the age of the child increases. This finding reinforces the generally accepted notion that early intervention is crucial for individuals with autism. In the provision of EIBI services, the goal is essentially to "catch a child up" to their typical peers, in other words, to increase their developmental age to the point that it is equal or exceeds their chronological age. Given that a child with autism is, by definition, developmentally delayed, behavioral intervention must increase their rate of development to be greater than that of their typically developing peers. As the gap between their chronological age and developmental age increases, remediation presumably becomes more and more of a challenge (Howard, Sparkman, Cohen, Green, & Stanislaw, 2005). The present data provide further evidence by showing that, per unit time, behavioral intervention produces more efficient skill acquisition for younger children, thereby underscoring the need for early intervention.

An additional contribution of the current study is to be found in the sample size. Only one other study of behavioral intervention has included a similarly large sample (Perry et al., 2008). Not only is the current sample size substantial, the data were collected from clients being served in a diverse set of geographical and socioeconomic regions (i.e., six different states across the United States, including west coast, east coast, and middle regions). The large sample size and the diverse regions from which the data were collected bolster the external validity of the study, given that the likelihood of the sample being highly biased or only representative of a small segment of the overall population is deceased by these factors.

Several limitations of the study warrant discussion. First, are the limitations inherent in the use of mastered behavioral objectives as a dependent measure. This measure has the advantages discussed earlier (most notably it serves as an intermediate measure, between the day-to-day data on particular occurrences of behavior and yearly batteries of standardized assessments), but it suffers from significant limitations. Perhaps the most troublesome is the fact that different objectives are of different difficulty to master, therefore some amount of the difference in mastery between different objectives at different times must surely be due to this extraneous variable. Second, no formal interobserver agreement (IOA) was collected on these data. Summarizing and tabulating these data are a normal part of clinical practice at the organization which collected them, so there is no reason to suspect that data collection was particularly difficult or problematic for the clinicians who completed it, but some level of error must be assumed to have occurred. The limitations of mastered behavioral objectives are significant and the measure should therefore be considered somewhat crude, but it seems likely that it is still a reasonable estimate of the pace of learning in the context of behavioral intervention programs and it provides a picture of such learning on a time scale not addressed by any other available measure. In addition, there is no reason that the limitations inherent in mastered behavioral objectives would selectively affect the data from either lower or

higher intensity interventions, so it seems unlikely that they constitute a potential confounding variable in the current study. Therefore, so long as the limitations of the measure are acknowledged and the data are interpreted with caution, it may still serve as a useful tool for evaluating treatment progress.

Another limitation and caution in the interpretation of these data is that since this was an evaluation of existing clinical services, participants were not able to be randomly assigned to differing levels of treatment hours. The participants in the present study received a mixture of public and private funding for their treatment services. Thus, the level of treatment hours for each participant was outside of our control and determined by factors unknown to us. It may be the case that funding agencies provided greater funding for those children whom they felt would respond best to treatment, or vice versa, that the children showing greater severity of ASD symptoms were provided greater amounts of funding. As we were not privy to these decisions we are left only to speculate and caution that these data are purely exploratory and await a more rigorous evaluation.

In spite of these limitations, it is clear that both the child's age and the number of treatment hours received will have a significant impact on treatment outcome. Matson and Smith (2008) noted the importance of considering the impact of factors such as severity of ASD symptoms, intellectual functioning, and comorbid psychopathology on treatment outcomes. Further, they noted that age would likely play an important role. These data are in agreement with the recommendations made by Matson and Smith and stress the importance of age as a moderating variable in treatment outcome studies.

These data offer an exploratory evaluation of two factors commonly assumed to impact treatment outcome, the child's age and the intensity of treatment. Both of these factors were found to be important variables. While these conclusions are limited by the nature of the data, future research on EIBI outcomes should consider both of these factors as important moderating variables to be evaluated empirically.

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