A Retrospective Analysis of Clinically Meaningful Outcomes in a Comprehensive Early Intervention Outpatient Program

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Introduction

Autism Spectrum Disorder (ASD) is a neurological developmental disorder characterized by impairments in language, social communication, interaction, and play skills and restricted, repetitive patterns of behavior, interests, or activities (DSM-IV; 2013). According to the Centers for Disease Control (CDC), autism affects an estimated 1 in 36 children in the United States today (2020). Although the diagnostic criteria have evolved, the prognosis has consistently been one of children falling farther and farther behind their peers with significant impairments in adaptive behavior that restrict everyday functioning and ultimately have a severe impact on their overall adaptive and quality of life as adults (Lockyer & Rutter, 1970; Ballaban-Gill et al., 1996; Howlin et al., 2000).

Early Intensive Behavioral intervention (EIBI) is a treatment approach based on applied behavior analysis (ABA) principles. EIBI has the most substantial body of empirical support demonstrating efficacy for improving the functioning of children diagnosed with ASD (Leaf et al., 2008; New et al. Department of Health, 1999; Simpson, 2005; Medavarapu et al., 2019). EIBI also positively impacts the core symptoms of ASD, language and communication skills, daily living skills, adaptive behavior, maladaptive behavior, social skills, and overall quality of life. (e.g., Granpeesheh, Tarbox, & Dixon, 2009; Peters-Scheffer et al., 2001; Slocum et al., 2019; Choi et al., 2022).

Among the factors that have been shown to be linked to optimal outcomes in children with ASD is the child's age at the onset of treatment, with younger children showing more favorable progress (Eldevik et al., 2012; Flanagan et al., 2012; Perry et al., 2013). More developmentally mature and better-adapted children, as well as those with milder autism symptomatology, have also shown more positive outcomes of EIBI (Eldevik et al., 2012; Perry et al., 2011, 2013; Rogers & Vismara, 2008; Smith et al., 2015). Additionally, one common environmental factor impacting EIBI treatment outcomes is parent stress and involvement (Osborne et al., 2008; Shine & Perry, 2010). While both child and family environmental factors are crucial to understanding EIBI outcomes, the predictive power of treatment conceptualization and its delivery is paramount for EIBI outcomes and is under the control of the service provider and their clinical team. Several studies have demonstrated a positive relationship between the intensity (quantity) of EIBI (hours of training/week) and outcomes (Klintwall et al., 2015; Virués-Ortega, 2010; Virués-Ortega et al., 2012). However, it is not always straightforward to control for or estimate the “true” intensity of training time spent on the child (Eldevik et al., 2012).

As the understanding of ASD deepens and treatment evolves, the need for reliable and comprehensive outcome measures that accurately demonstrate progress and overall improvements becomes paramount. Unfortunately, in the field of ABA, there is no universally accepted outcome measure for measuring changes in the core symptoms of ASD. Typically, progress is measured through a combination of standardized assessments, skills assessments, behavioral observations, and parental or caregiver reports (Chatham et al., 2018). These measurements help track the child's progress across the various areas targeted for treatment and provide valuable information for making intervention changes based on the child's response to treatment in real-time. However, such measures of progress do not provide an analysis of the child's adaptive behavior and ability to function in everyday life. While they are leading indicators for evaluating the current treatment goals and the fidelity of the programming. Given the diagnostic criteria for ASD includes deficits in adaptive behavior across multiple domains, changes in overall adaptive behavior must be a key element in assessing treatment progress.

One assessment measure that provides such analysis is the Vineland Adaptive Behavior Scale (Vineland-3). The Vineland is a standardized assessment tool used to measure adaptive behavior in individuals from birth through adulthood (Sparrow, 2016). Adaptive behavior refers to the skills and behaviors individuals use to function effectively and independently in their everyday lives. These skills include communication, social skills, daily living skills (e.g., eating, dressing, and personal hygiene), and motor skills. The assessment is conducted through interviews, questionnaires, or observations with caregivers, parents, teachers, or other individuals familiar with the individual being assessed. It provides a comprehensive overview of how individuals with autism develop and function compared to their same-age peers across various domains. Additionally, the Vineland can demonstrate statistical significance and clinical meaningfulness (Jacobson& Truax, 1991; Jaescke et al., 1989; Guyatt et al., 2002), thus solidifying it as a valid measure of treatment efficacy.

The purpose of the current paper is twofold: (1) to conduct a retrospective review of Vineland-3 test scores to determine the efficacy of ABA treatment in a private outpatient EIBI clinic and (2) to identify the specific domains that were impacted by the intervention.

Method

Program Description & Setting

Behavioral Innovations (BI) is a multi-site private healthcare company that provides ABA treatment to children (ages 18 months to 10 years) with ASD in an outpatient clinic setting. At BI, the core elements of our treatment approach could be described as progressive (Leaf et al., 2015). While the curriculum is structured and there is general uniformity in the system across sites, the application of the model is individualized to the learner. The procedures are implemented flexibly and in a child-friendly manner based on each client's ever-changing needs and evolving skills.

The curriculum is individually applied, emphasizing functionality, meaningfulness, generality, and promoting independence in everyday life.

Services are delivered through the efforts of bachelor's level therapists with oversight from master's or doctoral-level clinicians (BCBA- Board Certified Behavior Analyst). The BCBA is responsible for all aspects of case management, including developing programs, analyzing data, making data-based treatment decisions, training staff and families, and overseeing the therapists' performance working directly with each client. Typically, clients receive 25-35 hours of treatment per week for one to three years. Client dose-response relationship, length of stay, and BCBA oversight were not held constant for this analysis.

At Behavioral Innovations, client progress is measured daily, monthly, and at six-month intervals. Data is used to evaluate each client's response to treatment and make necessary changes to their treatment program.

Participants

As part of BI's quality assurance program, an internal audit of child assessments (N= 2202) from 2017-2022 was retrospectively reviewed to evaluate the efficacy of the intervention. There were 1141 participants with an initial assessment and at least one 6-month post-assessment after early intensive behavior intervention (EIBI) treated at BI. Of the 1141 participants, 597 children received a second post-assessment after 12 months of EIBI. Participants ranged in age from 1-16 years, with a mean age of 4.8.

Outcome Measure: Vineland -3

The Vineland -3 measures the child's adaptive behavior relative to age-matched peers. The Vineland-3 is a validated norm-referenced outcome measure of the generalizability of clinical gains outside the center environment at BI. The Vineland is conducted for each client before the start of treatment and every six months thereafter as a measure of improvements in adaptive ability.

Participant's adaptive scoring levels using the Vineland-3 ABC Composite Standard Score ranged from 27-100. The ABC Composite Standard Score identifies the level of adaptive behaviors a child displays. Scores > 86 demonstrate adequate adaptive behaviors, scores of 71-85 demonstrate moderately low adaptive behaviors, and scores 0-70 are considered low adaptive behaviors. Since the lowest category of the Vineland-3 is very broad, 70 points versus 15 points for the moderately low category, the adaptive scoring levels of the low category were further grouped into the following three additional levels: scores < 44, scores 45-59, and scores 60-70.

In the context of the Vineland, statistical significance refers to whether the difference or

changes observed in an individual's scores are likely to occur by chance. The clinically meaningful significance goes beyond statistical significance. It involves interpreting whether the observed changes in the Vineland scores have practical relevance and impact on the individual's daily life and functioning. In clinical practice, a change is considered clinically meaningful if it is substantial enough to lead to a noticeable improvement in the individual's adaptive behavior.

Beyond its statistical merits, Vineland's ability to reflect changes in clinical interventions that are meaningful and clinically significant aids in establishing it as an effective measure of real-world clinical outcomes (Chatham et al., 2018; Ranganathan et al., 2015). Its capacity to provide a comprehensive profile of a child's adaptive skills equips clinicians with a deep understanding of the child's abilities, challenges, and potential areas for growth. This knowledge serves as a foundation for individualized treatment that capitalizes on the child's strengths while addressing their individual needs. Furthermore, Vineland's sensitivity to change allows practitioners to track progress over time, making it an invaluable tool in gauging the effectiveness of treatment (Chatham et al., 2018; Sparrow et al., 2016). By capturing even subtle improvements, the Vineland empowers clinicians to measure progress, individualize treatment, and ultimately improve the lives of children with ASD.

Statistical Data Analysis

Analyses examined differences in score changes from a) the initial assessment using the ABC composite standard score and four individual domain (communication, social, daily living, and motor skills) scores compared to the first 6-month post-assessments and b) the initial Vineland-3 assessment to ABC composite standard score and four individual domain scores compared to 12-month post-assessment. Data are categorized by initial ABC Composite Standard Scores and age ranges. Groups were analyzed only if there were >12 participants in the group for statistical power and to reduce participants' identity.

Due to the ordinal data of the Vineland -3, a Wilcoxon Signed Rank test was used to calculate significance and effect sizes. The statistical significance of $p = .01$ was used to correct for multiple non-parametric analyses. Effect sizes were calculated. Effect size provides a measure of the size or magnitude of the changes from pre- to post-assessments. Measures for the Wilcoxon Signed rank effect sizes are as follows: 0.1= small effect, 0.3 medium effect, 0.5 large effect.

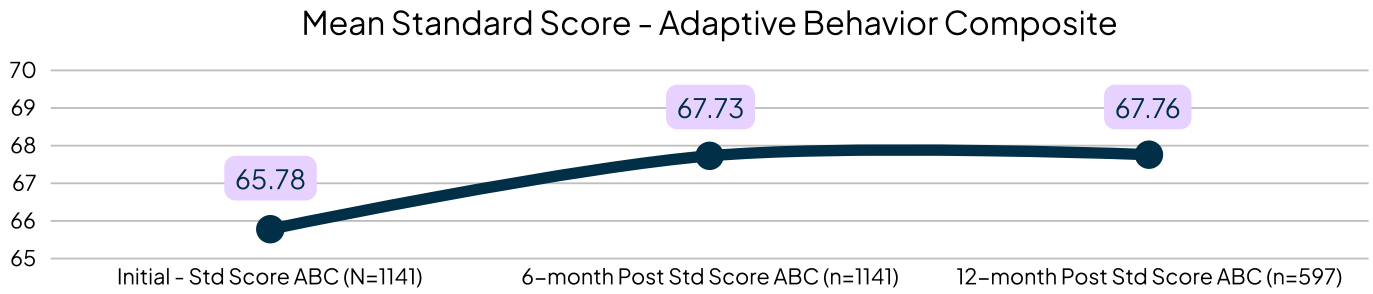
Average changes in pre- and post-scores were calculated to identify the Minimally Clinically Important Differences (MCID). The MCID reflects changes in clinical interventions that are meaningful or practical for the patient and their families. A change of 2 in the ABC Composite Standard Score demonstrated important differences in a child's behavior (Chatham et al., 2018). There are no established MCIDs for individual communication, socialization, daily living, and motor skills domains.

Results

Adaptive Behavior Composite Standard Score Outcomes

The ABC Standard score is comprised of four domains: communication, socialization, daily living, and motor skills. When reviewing all clients' ABC Standard scores, statistically significant improvements were seen at post-assessments 1 and 2 (p = <.001) despite age or severity when all participants were grouped together. See Figure 1.

Figure 1

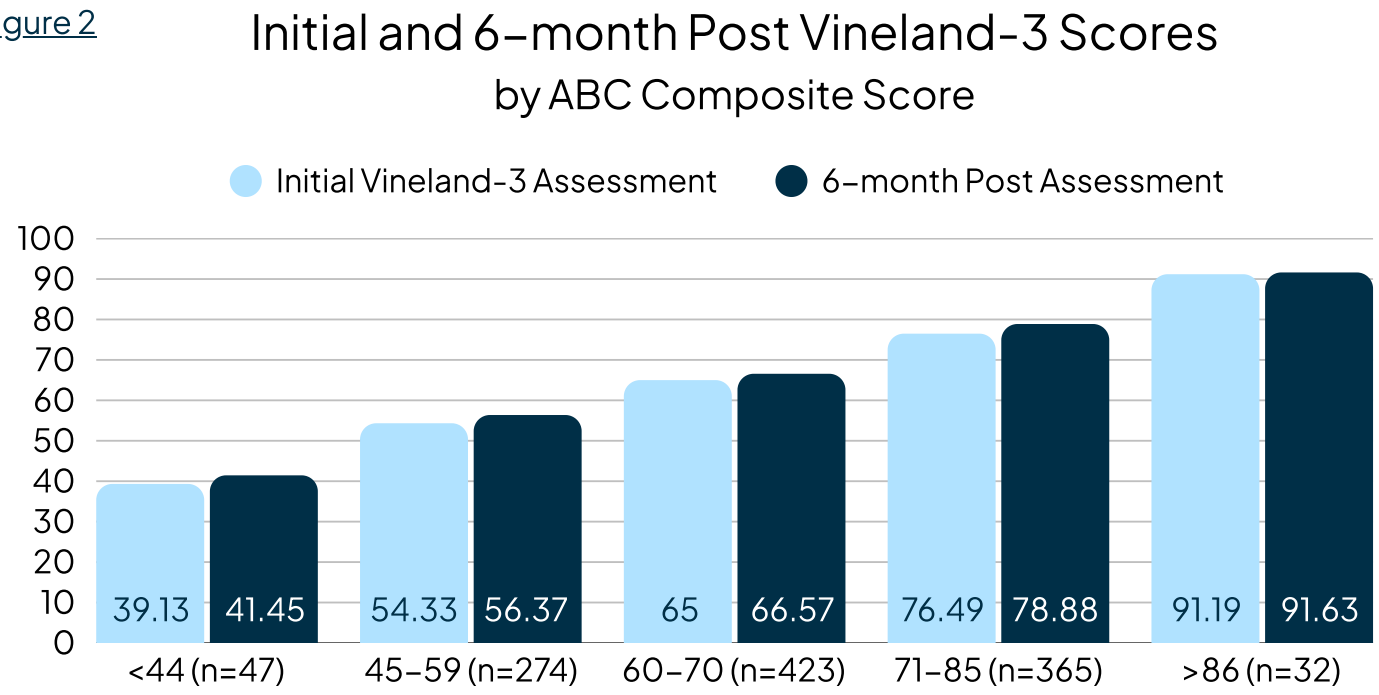


When all severity levels and age groups were combined, effect sizes demonstrated a small to medium effect (.23) for the changes from the initial assessment to the 6-month post-assessment and a small to medium effect (.21) from the initial assessment to the 12-month post-assessment. This is interpreted as there are small to medium statistically significant differences in the Vineland -3 assessments after six months of intervention and after one year of intervention.

Adaptive Scoring Levels using the ABC Composite Standard Score

Data were further analyzed by categories using the initial ABC Standard composite scores. See Figure 2 for initial assessment and post-6-month assessment Vineland-3 scores when grouped by ABC Composite Score.

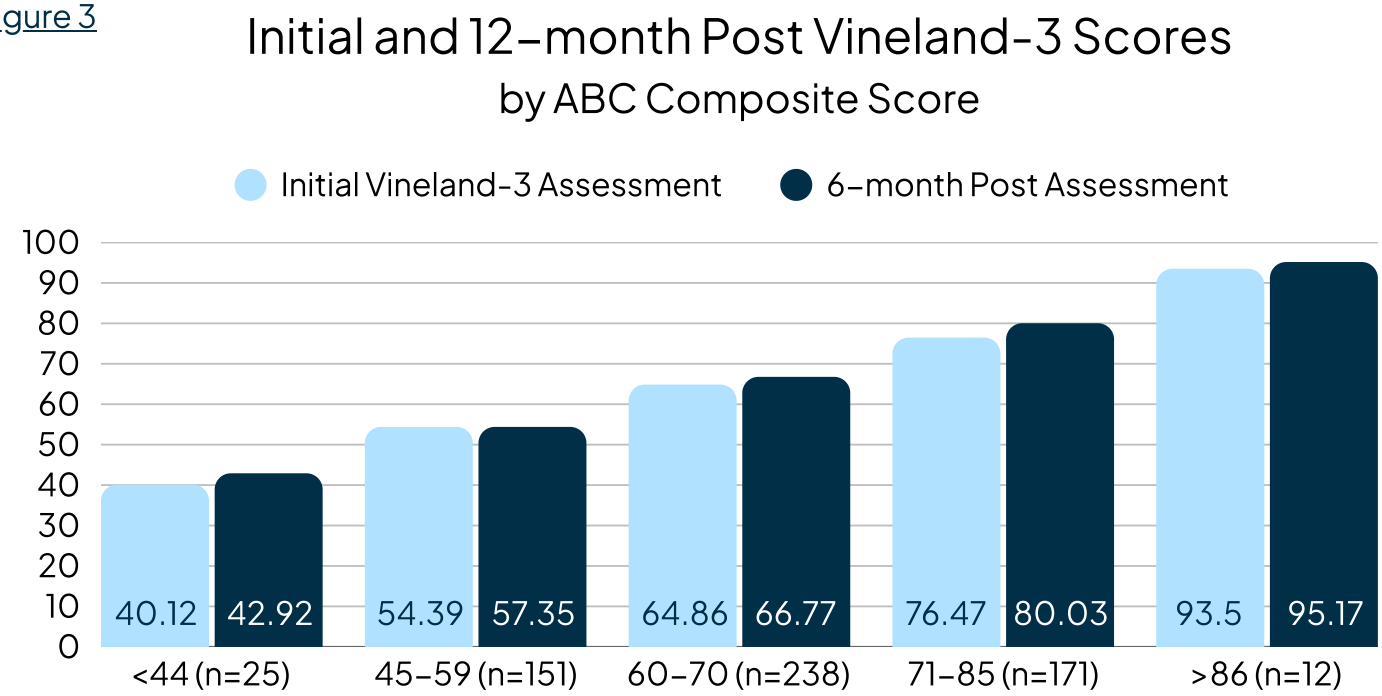
Figure 2



All ABC composite score categories considered low and moderately low demonstrated statistically significant increases from the initial assessment to the first 6-month assessment with small to medium effects. All the low categories increased > 2 points except the 60-70 category. The clients who started with an adequate or higher ABC standard score were able to maintain their scores with intervention.

Figure 3 illustrates the changes from the initial Vineland-3 assessment to the post-12-month assessment group by the initial ABC Standard Composite Score.

Figure 3



The clients with initial assessments in the adaptive behavior categories of 45-59, 60-70, and 71-85 and who were seen for an additional six months and received a second assessment (total of 12 months of intervention) made statistically significant gains from initial assessment to second post assessment with small to medium effects. After one year of intervention, all categories increased by>2 points except for the adequate or higher behavior categories, which increased by 1.67 points, suggesting meaningful changes in the child's behavior were realized.

Age Category Changes in Adaptive Behavior Composite Standards Score

See Figure 4 for initial and post-6-month assessment using Vineland-3 when analyzed by age groups.

Figure 4

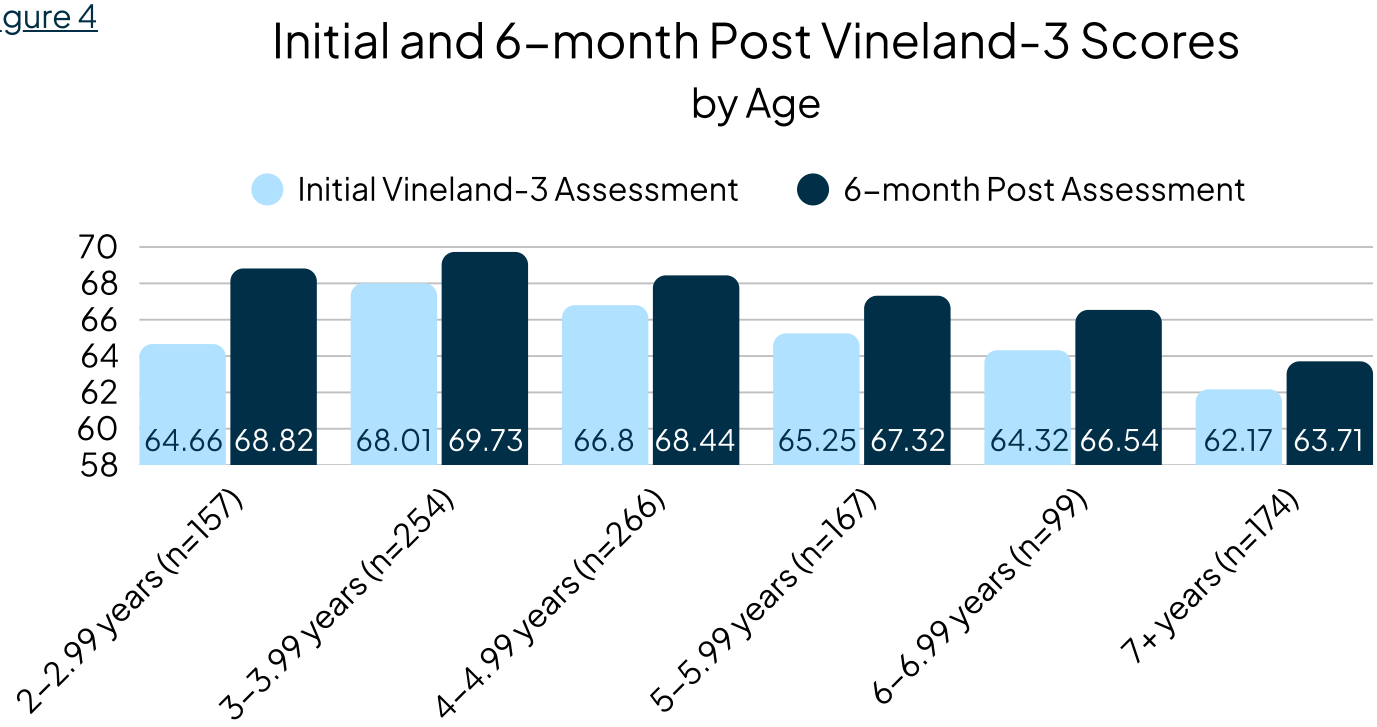
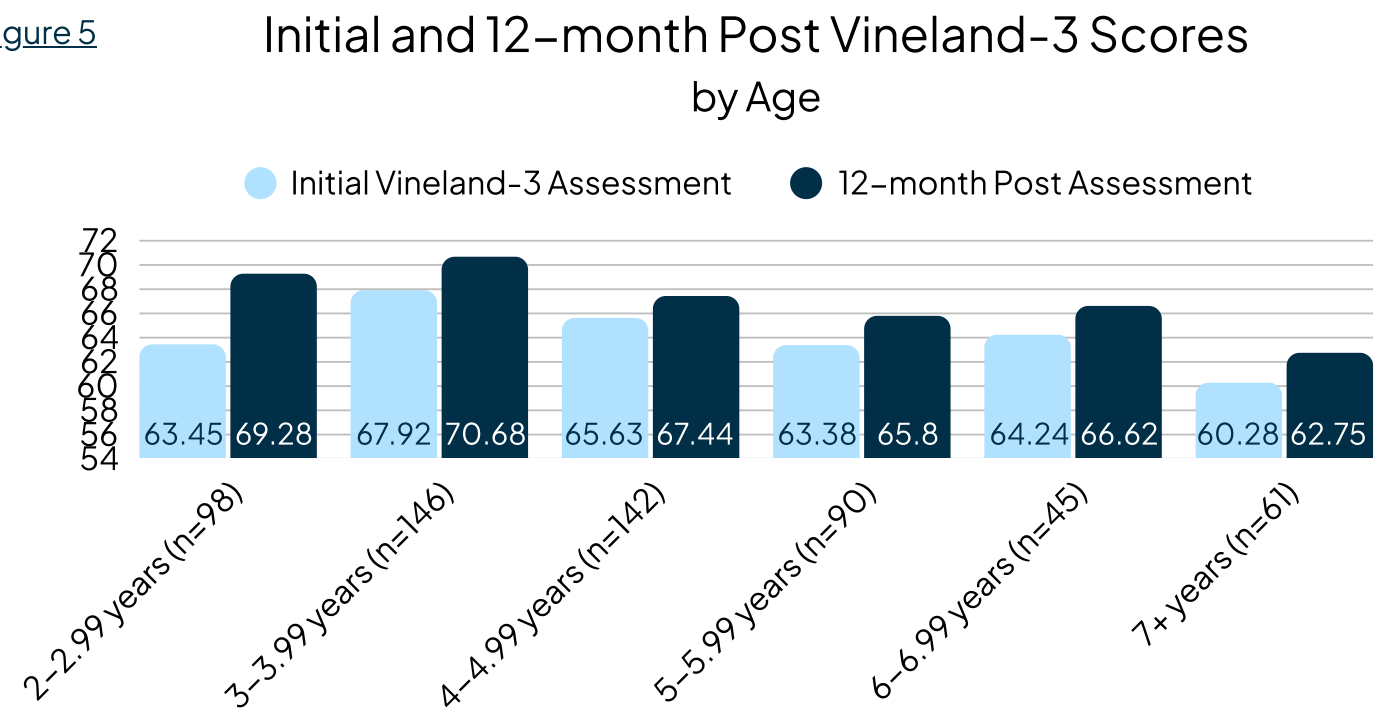


Figure 5. Illustrates the initial and post-12-month assessment of Vineland-3 data by Age group.

Figure 5



After six and 12 months of EIBI, the largest change and strongest effect (.36 and .33 after six and 12 months, respectively) in ABC Standard Scores occurred when intervention was started with clients at the age of two. However, all age groups demonstrated statistically significant changes after six months of intervention with small effects. All age groups demonstrated statistically significant changes after one year of intervention with small effects (effect range .16-.23), except six-year-olds did not make a statistically significant change (p=.067) but resulted in similarly small effects (.19).

Individual Skills Analysis of Adaptive Behavior Composite Standard Score

To identify what skills EIBI had the greatest impact on, the four skill domains of communication, socialization, daily living, and motor skills were reviewed individually within initial score categories and within age groups.

Communication Skills

Table 1 demonstrates changes in the communication domain. The greatest gain in communication skills after six months and one year of intervention occurred in those clients who started with an ABC Standard Score category of 45-59. All abilities of adaptive behavior had significant changes except the highest and lowest categories.

However, when parceling communication skills by age, all age groups after six months of intervention made statistically significant changes ($p < .01$). The 2-year-old group made the greatest gains in communication, with a change score of 8.92 with medium effects (.41). All

changes in each of the age categories from three years to over seven years demonstrate a small effect (range .13-19) after six months of intervention.

After one year of intervention, the 2-year-old, 3-year-old, and 5-year-old age groups made significant changes. The two-year-olds again make the greatest gain of 11.82 and medium effect. However, all groups demonstrate a small change effect (effect range .14-.21).

Table 1 Communication Skill Domain changes

Communication Skill Domain						
ABCStd Score Level*	**Initial Communication**	**6- month Communication**	**Standard Dev**	**p**	**effect size**	**Communication 6-month**
<44 (n=47)	25.23	26.64	6.8	0.257	0.11	1.41
45-59 (n= 274)	39.92	43.68	10.96	<.001	0.21	3.76
60-70 (n=423)	58.97	61.65	10.62	<.001	0.18	2.68
71-85 (n=365)	77.08	79.58	8.66	<.001	0.22	2.5
86+ (n= 32)	91.41	91.97	9.84	0.62	0.06	0.56
ABCStd Score Level*	**Initial Communication**	**1-year Communication**	**Standard Dev**	**p**	**effect size**	**Communication 1 year change**
<44 (n=25)	25.56	27.52	7.01	0.472	0.1	1.96
45-59 (n=151)	39.68	45.2	12.64	<.001	0.26	5.52
60-70 (n= 238)	58.68	62.16	13.33	<.001	0.17	3.48
71-85 (n= 171)	76.48	79.71	11.93	<.001	0.24	3.23
86+ (n=12)	96.33	93.92	8.16	0.35	0.19	-2.41
Age	**Initial Communication Score**	**6- month Communication Score**	**Standard Dev**	**p**	**effect size**	**Communication 6-month change**
2 yo (n= 157)	52.83	61.75	13.11	<.001	0.41	8.92
3 yo (n= 254)	63.58	65.87	8.91	<.001	0.18	2.29
4 yo (n= 266)	61.35	63.18	8.88	<.001	0.14	1.83
5 yo (n =167)	58.41	61.27	9.65	<.001	0.18	2.86
6 yo (n= 99)	60.12	62.38	8.26	0.008	0.19	2.26
7+ yo (n= 174)	57.65	58.87	7.49	0.011	0.13	1.22

Age	Initial Communication	1-year Communication	Standard Dev	p	effect size	Communication 1 year change
2 yo (n=98)	51.27	63.09	15.35	<.001	0.44	11.82
3 yo (n= 146)	63.25	66.51	12.12	0.004	0.17	3.26
4 yo (n=142)	59.36	61.25	11	0.022	0.14	1.89
5 yo (n= 90)	55.9	58.86	8.61	0.004	0.21	2.96
6 yo (n= 45)	60.56	63.56	1.6	0.137	0.17	3
7+ yo (n =61)	54.95	57.21	8.87	0.044	0.18	2.26

***ABCStd Score Level = Vineland -3 initial ABC Composite Standard Score**

Socialization Skills

After six months of EIBI, all adaptive ability levels had significant changes in socialization scores. The greatest gains in socialization occurred in the <44 and 45-59 adaptive score categories with small to medium effects. See Table 2. The highest adaptive ability groups did not have significant changes. After one year of EIBI, the change was greatest in the <44 adaptive score category with small to medium effects.

When categories were distributed by age groups, the over seven-year-olds had the greatest impact and change in socialization scores. The intervention had a limited and non-significant effect on the two-year-olds. Though many of the other age groupings had significant changes, the effects were small.

Table 2 Socialization Skill Domain changes

Socialization Skill Domain						
ABCStd Score Level*	Initial Socialization	6- month Socialization	Standard Dev	p	effect size	Socialization 6-month change
<44 (n=47)	32.91	37.49	8.13	<.001	0.35	4.574
45-59 (n= 274)	51.91	54.18	10.39	<.001	0.35	2.266
60-70 (n=423)	64.34	66.05	11.15	0.002	0.11	1.707
71-85 (n=365)	77.38	79.88	9.02	<.001	0.21	2.501
86+ (n= 32)	91.47	89.88	9.39	0.337	0.12	-1.594

ABCStd Score Level*	Initial Socialization	1-year Socialization	Standard Dev	p	effect size	Socialization 1 year change
<44 (n=25)	33.56	39.04	9.23	0.009	0.37	5.48
45-59 (n=151)	52.28	54.87	13.1	0.025	0.13	2.589
60-70 (n= 238)	64.49	65.47	11.85	0.194	0.06	0.975
71-85 (n= 171)	78.54	81.83	13.65	<.001	0.21	3.286
86+ (n=12)	92.67	95.75	13.28	0.41	0.17	3.083
Age	**Initial Socialization**	**6- month Socialization**	**Standard Dev**	**p**	**effect size**	**Socialization 6-month change**
2 yo (n= 157)	68.97	70.55	9.87	0.075	0.1	1.58
3 yo (n= 254)	66.87	69	10.2	0.001	0.15	2.13
4 yo (n= 266)	65.97	67.98	10.32	<.001	0.15	2.019
5 yo (n =167)	64.29	66.78	10.78	0.002	0.17	2.491
6 yo (n= 99)	61.37	63.78	9.49	0.01	0.18	2.404
7+ yo (n= 174)	58.17	61.26	9.79	<.001	0.22	3.092
Age	**Initial Socialization**	**1-year Socialization**	**Standard Dev**	**p**	**effect size**	**Socialization 1 year change**
2 yo (n=98)	67.98	68.64	14.99	0.99	0.0009	0.663
3 yo (n= 146)	66.57	70.15	12.51	0.001	0.2	3.582
4 yo (n=142)	64.79	67.1	10.78	0.006	0.16	2.31
5 yo (n= 90)	61.44	64.51	10.69	0.01	0.19	3.067
6 yo (n= 45)	61.89	62.51	12.05	0.619	0.05	0.622
7+ yo (n =61)	56.39	59.82	12.17	0.011	0.23	3.426

***ABCStd Score Level = Vineland -3 initial ABC Composite Standard Score**

Daily Living Skills

Daily living skills, see Table 3, similar to communication skills, had a significant effect on all adaptive score levels except for the highest and lowest adaptive levels. Refer to Table 3. Though the 45-59, 60-70, and 71-85 categories had statistically significant changes, the 45-59 groups demonstrated the greatest change in effect after six and twelve months of intervention. When looking at the changing impact of daily living skills in the six different age groups, the two-

year-old's had the most remarkable changes with the most significant effect after six and twelve months of intervention.

Table 3 Daily Living Skill Domain changes

Daily Living Skill Domain						
ABCStd Score Level*	**Initial Daily Living Skills**	**6- month Daily Living Skill Score**	**Standard Dev**	**p**	**effect size**	**Daily Living 6-month change**
<44 (n=47)	44.85	46.02	5.72	0.198	0.13	1.17
45-59 (n= 274)	56.51	59.48	8.18	<.001	0.22	2.974
60-70 (n=423)	67.68	69.24	8.56	<.001	0.13	1.565
71-85 (n=365)	80.89	82.77	10.46	<.001	0.14	1.882
86+ (n= 32)	98.22	98.16	11.98	0.952	0.0075	-0.063
ABCStd Score Level*	**Initial Daily Living Skill Score**	**1-year Daily Living Skill Score**	**Standard Dev**	**p**	**effect size**	**Daily Living 1 year change**
<44 (n=25)	46.52	47.56	8.53	0.881	0.02	1.04
45-59 (n=151)	56.6	60.84	10.19	<.001	0.29	4.238
60-70 (n= 238)	67.23	69.58	10.4	0.002	0.14	2.345
71-85 (n= 171)	80.84	83.91	12.38	0.001	0.17	3.064
86+ (n=12)	97.33	100.25	9.74	0.284	0.22	2.917
Age	**Initial Daily Living Skill Score**	**6- month Daily Living Skill Score**	**Standard Dev**	**p**	**effect size**	**Daily Living 6-month change**
2 yo (n= 157)	67.18	72.16	11.67	<.001	0.29	4.96
3 yo (n= 254)	71.73	73.09	7.15	0.003	0.13	1.358
4 yo (n= 266)	69.65	71.83	7.97	<.001	0.16	1.88
5 yo (n =167)	68.47	70.6	9.04	0.004	0.16	2.132
6 yo (n= 99)	67.1	70.28	8.41	0.001	0.25	3.182
7+ yo (n= 174)	66.05	66.97	9.17	0.296	0.05	0.914

Age	Initial Daily Living Skills	1-year Daily Living Skill Score	Standard Dev	p	effect size	Daily Living 1 year change
2 yo (n=98)	65.08	72.91	15.11	<.001	0.35	7.82
3 yo (n= 146)	71.97	73.97	9.71	0.023	0.13	2
4 yo (n=142)	68.49	71.09	8.81	<.001	0.2	2.606
5 yo (n= 90)	68.82	69.36	9.1	0.02	0.17	2.533
6 yo (n= 45)	65.71	69.49	9.88	0.016	0.25	3.778
7+ yo (n =61)	63.79	65.38	9.28	0.258	0.1	1.59

***ABCStd Score Level = Vineland -3 initial ABC Composite Standard Score**

Motor Skills

Table 4 illustrates changes in the motor skill domain.The early intervention did not have a significant effect on motor skills. Additionally, if there was a considerable effect, the score demonstrated a loss in motor skills. See Table 4. However, over 100 clients' motor scores were not assessed with.

Table 4 Motor Skill Domain changes

Motor Skills Domain						
ABCStd Score Level*	Initial Motor Score	1 year Motor Score	Standard Dev	p	effect size	Motor Skill 6-month change
<44 (n=47)	55.54	55.23	14.1	0.93	0.01	0.314
45-59 (n= 274)	69.88	69.01	8.86	0.119	0.07	-0.869
60-70 (n=423)	78.48	77.87	8.92	0.023	0.08	-0.611
71-85 (n=365)	86.49	85.84	8.76	0.211	0.05	-0.643
86+ (n= 32)	91.87	93.42	9.93	0.487	0.09	1.548

ABCStd Score Level*	Initial Motor Score	1 year Motor Score	Standard Dev	p	effect size	Motor Skill 1 year change
<44 (n=25)	56.87	58.78	16.71	0.935	0.01	1.913
45-59 (n=151)	70.37	69.11	10.02	0.463	0.04	-0.957
60-70 (n= 238)	78.57	77.21	9.56	0.001	0.16	-1.359
71-85 (n= 171)	87.24	85.97	11.33	0.213	0.07	1.25
86+ (n=12)	92.2	96.9	7.03	0.068	0.4	4.7
Age	**Initial Motor Score***	**6- month Motor Score***	**Standard Dev**	**p**	**effect size**	**Motor Skill 6- month change**
2 yo (n= 157)	86.05	82.79	8.56	0.001	0.27	-3.26
3 yo (n= 254)	80.8	79.38	10.92	0.007	0.122	-1.414
4 yo (n= 266)	76.82	77.7	8.18	0.271	0.05	0.879
5 yo (n =167)	76.12	76.65	8.45	0.292	0.06	0.529
6 yo (n= 99)	75.3	76.57	5.11	0.02	0.17	1.273
7+ yo (n= 174)	72.67	72.44	8.99	0.906	0.006	-0.225
Age	**Initial Motor Score**	**1 year Motor Score**	**Standard Dev**	**p**	**effect size**	**Motor Skill 1 year change**
2 yo (n=98)	84.55	79.57	10.09	0.001	0.34	-4.989
3 yo (n= 146)	81.57	80.21	11.37	0.128	0.18	-1.363
4 yo (n=142)	75.68	77.05	9.05	0.158	0.09	1.368
5 yo (n= 90)	75.02	75.65	8.94	0.541	0.05	0.628
6 yo (n= 45)	75.02	75.59	9.37	0.484	0.07	0.568
7+ yo (n =61)	69.88	70.24	12.01	0.482	0.08	0.366

***ABCStd Score Level = Vineland -3 initial ABC Composite Standard Score**

Overall Effect

The ABC Standard Score is comprised of four skills: communication, socialization, daily living, and motor. Given that the intervention did not impact this population's motor skills and contributed to meaningful effects, a sum score using communication, socialization, and daily living skill scores was used to ascertain what impact EIBI has on overall behaviors except motor. All groupings had positive changes (range 5.73-20.303) except the initial adaptive groups that

had an initial ABC Standard score greater than 86. See Figures 6 and 7 illustrating the three domain changes grouped by initial ABC composite score. Figures 8 and 9 illustrate the three domain changes grouped by age.

When combining the three domain scores (COMM, SOC, and DAILY skills), the two-year-old made the most meaningful gains, in most cases double the improvement of any other age group. *See Table 5.*

Figure 6 Severity Changes in Vineland-3 Skill Domains after Six months of EIBI

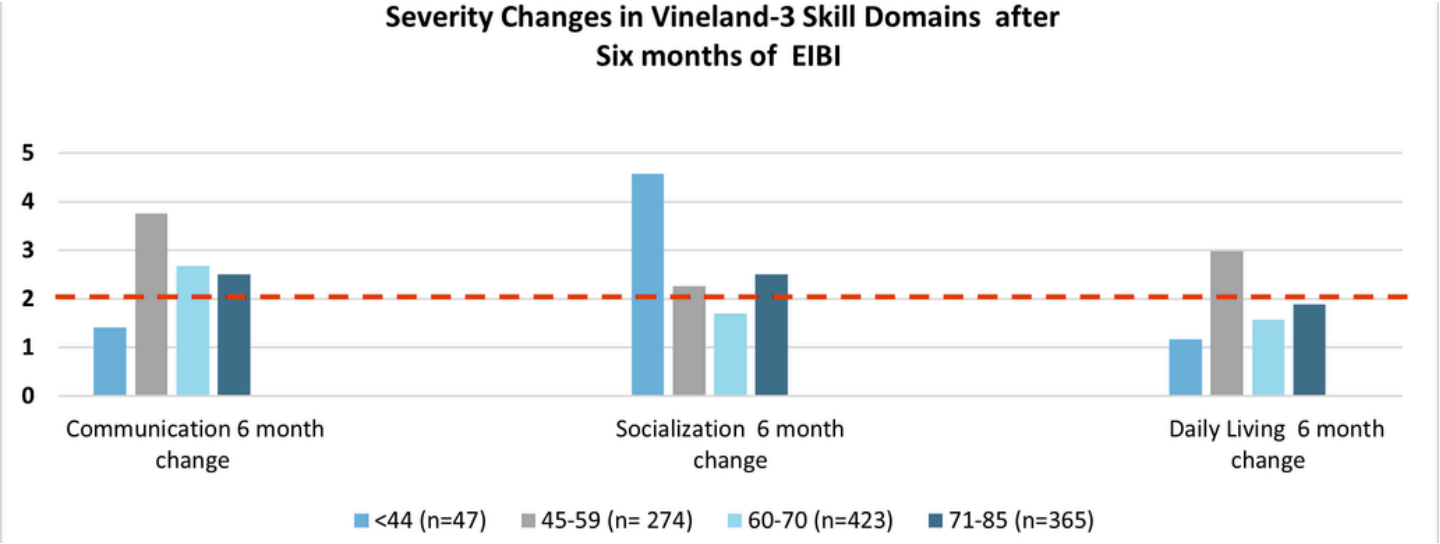


Figure 6. Statistically significant and clinically meaningful improvements across three domains when seen for six months of EIBI by severity level. (MCID Threshold = 2).From 1st to 2nd administration, data indicates the findings have real-world significance.Adaptive scores improved related to same-age peers.

Figure 7 Severity Changes in Vineland-3 Skill Domains after One-year of EIBI

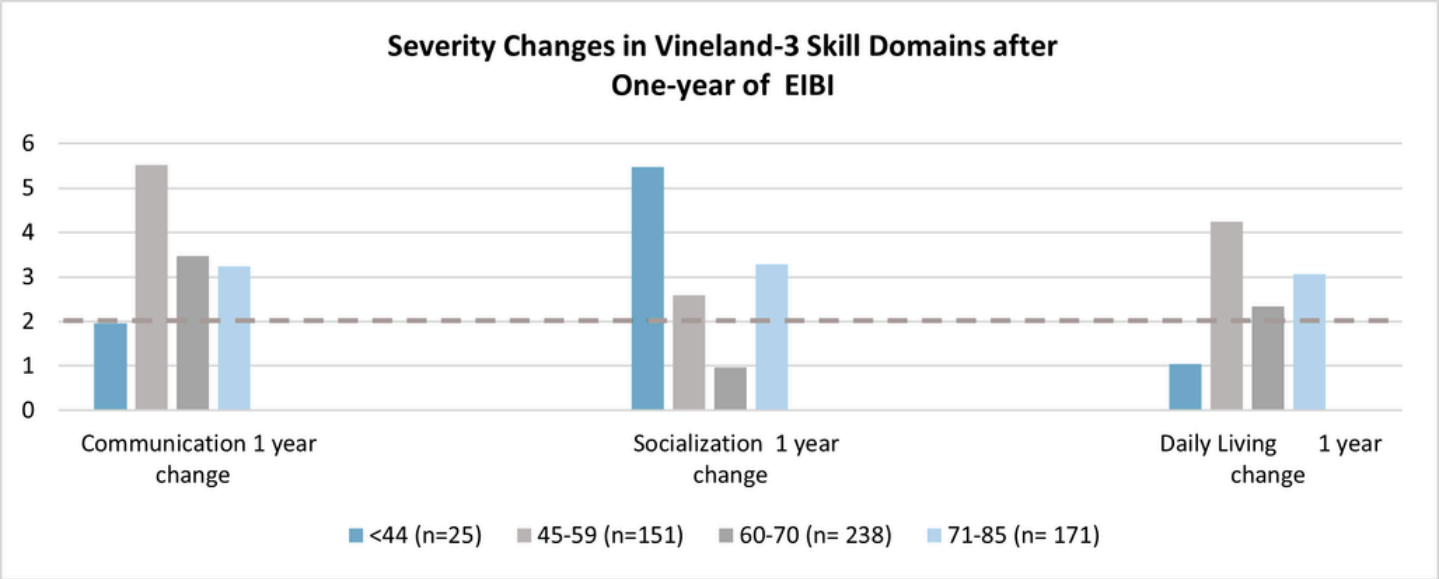


Figure 7. Statistically significant and clinically meaningful improvements across three domains when seen for one year of EIBI by severity level. (MCID Threshold = 2).From 2nd to 3rd administration, data indicates the findings have real-world significance. Adaptive scores improved related to same-age peers.

Figure 8 Age Group Changes in Vineland-3 Skill Domains after Six months of EIBI

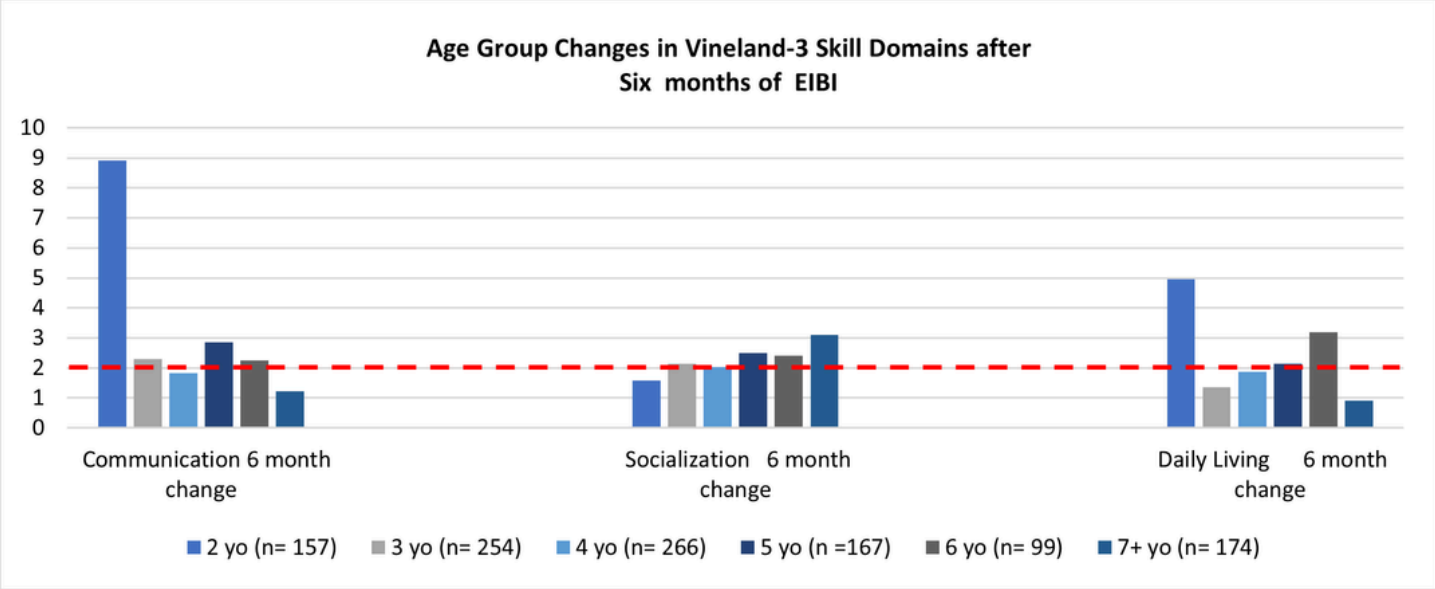


Figure 8. Statistically significant and clinically meaningful improvements across three domains when seen for six months of EIBI by age group. (MCID Threshold = 2). From 1st to 2nd administration, data indicates the findings have real-world significance. Adaptive scores improved related to same-age peers.

Figure 9 Age Group Changes in Vineland-3 Skill Domains after One-year of EIBI

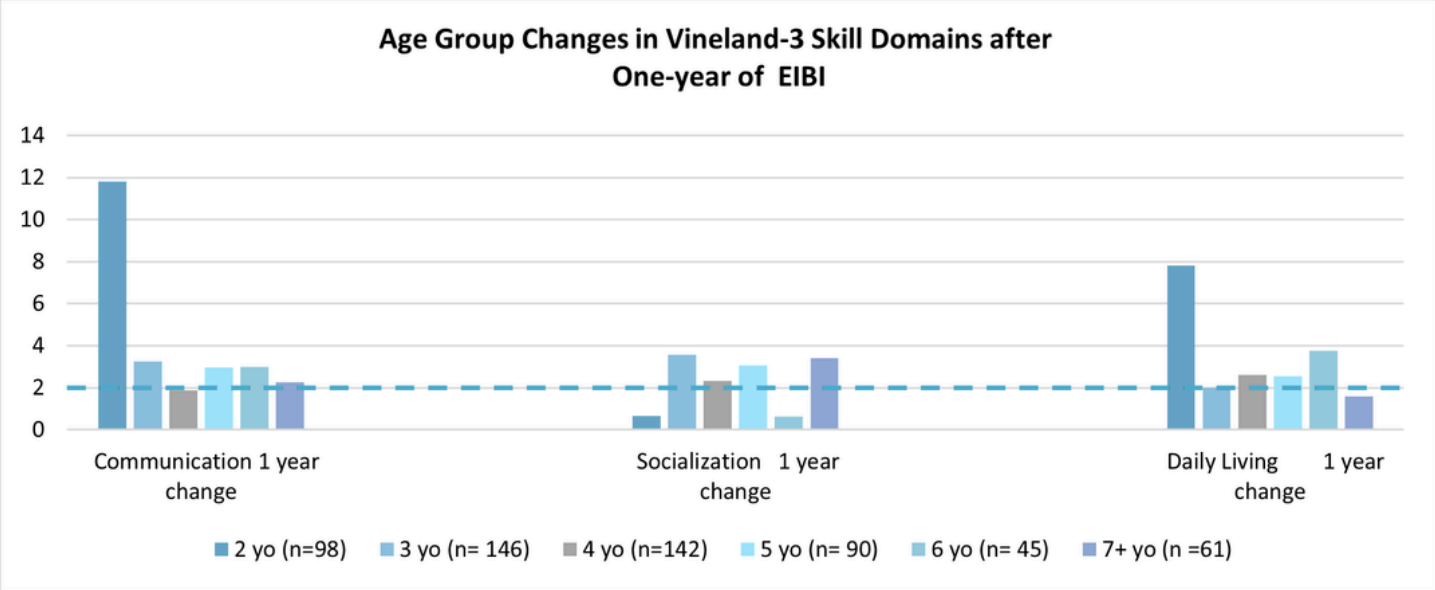


Figure 9. Statistically significant and clinically meaningful improvements across three domains when seen for six months of EIBI by age group. (MCID Threshold = 2). From 2nd to 3rd administration, data indicates the findings have real-world significance. Adaptive scores improved related to same-age peers.

Table 5 Change Scores by Initial ABC Composite Score and Age

ABCStd Score Level*	Communication 6-month	Socialization 6-month change	Daily Living 6-month change	SUM change = (COM+SOC+DA	Motor Skill 6-month change	SUM change= (COM+SOC+DA
<44 (n=47)	1.41	4.574	1.17	7.154	0.314	7.468
45-59 (n= 274)	3.76	2.266	2.974	9	-0.869	8.131
60-70 (n=423)	2.68	1.707	1.565	5.952	-0.611	5.341
71-85 (n=365)	2.5	2.501	1.882	6.883	-0.643	6.24
ABCStd Score Level*	**Communication 1 year change**	**Socialization 1 year change**	**Daily Living 1 year change**	**SUM change = (COM+SOC+DA**	**Motor Skill 1 year change**	**SUM change= (COM+SOC+DA**
<44 (n=25)	1.96	5.48	1.04	8.48	1.913	10.393
45-59 (n=151)	5.52	2.589	4.238	12.347	-0.957	11.39
60-70 (n= 238)	3.48	0.975	2.345	6.8	-1.359	5.441
71-85 (n= 171)	3.23	3.286	3.064	9.58	1.25	10.83
Age	**Communication 6-month**	**Socialization 6-month change**	**Daily Living 6-month change**	**SUM change = (COM+SOC+DA**	**Motor Skill 6-month change**	**SUM change= (COM+SOC+DA**
2 yo (n= 157)	8.92	1.58	4.96	15.46	-3.26	12.2
3 yo (n= 254)	2.29	2.13	1.358	5.778	-1.414	4.364
4 yo (n= 266)	1.83	2.019	1.88	5.729	0.879	6.608
5 yo (n =167)	2.86	2.491	2.132	7.483	0.529	8.012
6 yo (n= 99)	2.26	2.404	3.182	7.846	1.273	9.119
7+ yo (n= 174)	1.22	3.092	0.914	5.226	-0.225	5.001

Age	Communication 1 year change	Socialization 1 year change	Daily Living 1 year change	SUM change = (COM+SOC+DA	Motor Skill 1 year change	SUM change= (COM+SOC+DA
2 yo (n=98)	11.82	0.663	7.82	20.303	-4.989	15.314
3 yo (n= 146)	3.26	3.582	2	8.842	-1.363	7.479
4 yo (n=142)	1.89	2.31	2.606	6.806	1.368	8.174
5 yo (n= 90)	2.96	3.067	2.533	8.56	0.628	9.188
6 yo (n= 45)	3	0.622	3.778	7.4	0.568	7.968
7+ yo (n =61)	2.26	3.426	1.59	7.276	0.366	7.642

Discussion

This study aimed to conduct a retrospective analysis of Vineland-3 test scores to determine the efficacy of EIBI treatment for clients in an outpatient clinic and identify specific domains that were impacted by the intervention. Results for the 1141 clients from 2017-2022 indicate statistically significant and clinically meaningful changes across all age categories and severity levels. When broken down by age categories, clinically meaningful increases were seen after six and 12 months of intervention, with the most significant gains in the 2-year-old age group.

The findings suggest that EIBI has the most meaningful change on communication, socialization, and daily living skills for all age groups and the least impact on motor skills. There was 50% more improvement in the Vineland-3 combined score of communication, socialization, and daily living skills when starting treatment at two years of age than at any other age group. This is consistent with the early intervention research (Eldevik et al., 2012; Flanagan et al., 2012; Perry et al., 2013) demonstrating the need to start intervention as early as possible to maximize clinically meaningful outcomes. A particularly promising aspect of this study is that significant clinically meaningful improvements were achieved independent of the dose-response relationship and the duration and intensity of intervention.

Additionally, clients with an initial ABC composite score rating of 45-59 have the most significant benefit from EIBI, and those with an initial score greater than 86 have the least adaptive behavior changes. This is contrary to previous reports that suggested developmentally mature and better-adapted children, perhaps those with a Vineland-3 initial ABC Standard score above 86, considered adequate adaptive behaviors, have shown more positive outcomes of EIBI (Eldevik et al., 2012; Perry et al., 2011, 2013; Rogers & Vismara, 2008; Smith et al., 2015).

These findings have meaningful implications as individuals with ASD increasingly fall behind their same-age peers in adaptive behavior. Impairments in adaptive behavior often predict real-world outcomes for children with ASD (Charman et al., 2011; Klin et al., 2007), including but not

limited to educational placement, ability to live independently, and the type and amount of support needed in the future settings (Farley et al., 2009; Sytemat et al.; 2005; Taylor et al., 2015; Veenstra-VanderWeele et al., 2017).

In our initial data review, we wanted to see if treatment had a clinically and meaningful significant impact on our client's overall well-being and adaptive behavior. Our next steps are to break down the data across age and severity based on the number of therapy hours, duration of treatment, BCBA supervision hours, and parent training hours.

Conclusion

The findings from this review suggest that EIBI treatment is efficacious in improving adaptive behaviors in children with ASD after outpatient treatment. Communication, socialization, and daily living skills were the behavioral domains that demonstrated significant changes from the intervention. Our current review shows that EIBI did not substantially affect motor skills. Treatment at two years of age demonstrated the greatest effect on adaptive behaviors.

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