European Journal of Behavior Analysis

ISSN: 1502-1149 (Print) 2377-729X (Online) Journal homepage: https://www.tandfonline.com/loi/rejo20

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To cite this article: Sigmund Eldevik, Kristine Berg Titlestad, Hege Aarlie & Roy Tønnesen (2019): Community Implementation of Early Behavioral Intervention: Higher Intensity Gives Better Outcome, European Journal of Behavior Analysis, DOI: 10.1080/15021149.2019.1629781

To link to this article: https://doi.org/10.1080/15021149.2019.1629781

Published online: 21 Jun 2019.

EUROPEAN JOURNAL OF BEHAVIOR ANALYSIS
https://doi.org/10.1080/15021149.2019.1629781

ARTICLE

Community Implementation of Early Behavioral Intervention: Higher Intensity Gives Better Outcome

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ABSTRACT

We evaluated the outcome of early behavioral intervention for children with Autism Spectrum Disorders (ASD) as it was provided through public service providers in Norway. A group of 21 children received low-intensity intervention (11.1 weekly hours), a second group of 26 children higher intensity intervention (18.1 weekly hours), and a third group of 17 children received eclectic special education. Group assignment was based on independent referrals. We compared outcomes on adaptive behavior, ASD severity, and intellectual functioning after one year. The lower and higher intensity behavioral intervention groups received fewer hours than what is recommendedbut did significantly better than the eclectic group. Moreover, the higher intensity behavioral group did better than the lower intensity behavioral group. Nevertheless, gains in both groups were more modest than what is reported for intervention that is more intensive. We describe the model of service delivery, discuss challenges with it, and propose improvements.

ARTICLE HISTORY
Received 30 October 2018
Accepted 4 June 2019

KEYWORDS
Autism spectrum disorder; early intensive behavioral intervention; outcome; community based; dose-response relationship

Early Intensive Behavioral Intervention (EIBI) for children with Autism Spectrum Disorders (ASD) is provided through public service providers in Norway. ASD is in ICD-11 characterized by "persistent deficits in the ability to initiate and to sustain reciprocal social interaction and social communication, and by a range of restricted, repetitive, and inflexible patterns of behavior and interests." (World Health Organization, 2018b). Symptoms of ASD may not become fully manifest until social skills are required, but "the deficits are sufficiently severe to cause impairment in personal, family, social, educational, occupational or other important areas of functioning and are usually a pervasive feature of the individual's functioning observable in all settings, although they may vary according to social, educational, or other context. Individuals along the spectrum exhibit a full range of intellectual functioning and language abilities" (World Health Organization, 2018b).

In Norway, EIBI is considered a best practice for helping children with ASD (Vea et al., 2017). EIBI is based on the principles of applied behavior analysis (ABA), and is by most

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standards considered a well-established intervention for children with ASD (Eikeseth, 2009; Makrygianni, Gena, Katoudi, & Galanis, 2018; Reichow, Hume, Barton, & Boyd, 2018). The origin of EIBI is the Los Angeles Young Autism Project, also called the UCLA-model (Lovaas, 1987; Reichow, Barton, Boyd, & Hume, 2014). EIBI is a highly structured teaching approach for pre-school children (Eikeseth, Klintwall, Jahr, & Karlsson, 2012; Weissman, Bridgemohan, Augustyn, Patterson, & Torchia, 2018). Although EIBI is provided in several different ways it involves some common core elements: a) it blends research from ABA, ASD and child development, b) it addresses all the important skill domains, c) skill are broken down into teachable units and built up step by step, d) it is based on positive reinforcement to build new skills and reduce problem behaviors, e) procedures to reduce problem behaviors are based on functional analysis, f) direct observation and data collection are used for selecting new targets and evaluations, g) many well-documented behavior analytic procedures are used, both child-initiated and adult-directed methods (such as discrete trial teaching), h) intervention is individualized to the needs of the child and the family, i) it is conducted in many settings, j) parental involvement, k) explicit generalization training, and, l) it is designed and overseen by professionals with appropriate training (Green, 2011). In addition, the general recommendations when implementing EIBI is to seek input from the family and to draw upon prior clinical experience (Reichow et al., 2018; Waters, Amerine Dickens, Thurston, Lu, & Smith, 2018).

In Norway, where the present study was conducted, all children are principally enrolled in their local pre-school. Children who require EIBI are referred to either a regional specialist health service or the local department of education who may provide the necessary training and supervision for implementation. It is important to point out that EIBI is not offered in all Norwegian municipalities or specialist health services. Pre-schools staffing density is regulated by the department of education. The extra resources (i.e., weekly hours of extra support) provided for a child with special needs is based on a statement from the local pedagogical-psychological services (PPT) and funded by the local municipality. To organize and implement EIBI programs in a pre-school, two-three members of the pre-school staff form an intervention team. This team is responsible for the day-to-day implementation of EIBI. The weekly intervention hours are scheduled based on the extra weekly hours in the child's statement and divided between the members of the team. The supervisor's responsibility is to provide training and ongoing supervision to the pre-school team and the parents. Furthermore, the supervisor is responsible for selecting the weekly goals.

Favorable outcome of EIBI have been reported mostly from university-based studies like the pioneer study by Lovaas (1987) conducted at UCLA. The evidence supports the use of EIBI for children with ASD. However, the status of the EIBI evidence is described as limited because of the reliance on the outcome from non-randomized studies. A recent systematic review showed evidence for gains in adaptive behavior (communication, socialization, and daily living skills) and intellectual functioning (Reichow et al., 2018).

Effectiveness studies suggest that the outcome from real-world community-based EIBI services is more moderate than the outcome from university-based efficacy studies (Dingfelder & Mandell, 2011; Eldevik, Hastings, Jahr, & Hughes, 2012; Perry et al., 2008; Smith, Klorman, & Mruzek, 2015). The reported effect sizes for changes in IQ following community-based behavioral intervention has ranged from 0.5 to 0.7 (Makrygianni et al., 2018). Thus, there seems to be a research-to-practice gap. However, more favorable results

for the community-based interventions have been reported when EIBI is more closely supervised by on-site experts, and when provided in a center-based setting, ES 1.58 (Makrygianni et al., 2018; Howard, Stanislaw, Green, Sparkman, & Cohen, 2014).

Currently, there is no consensus on what should be considered high-intensity behavioral intervention. The Behavior Analyst Certification Board (BACB) practice guidelines suggests 30–40 hours a week for a comprehensive ABA treatment program, whereas programs that provide 10–25 hours a week are considered focused ABA treatment (The Behavior Analyst Certification Board, 2014). Others have recommend a minimum of 25 hours per week for practice (Weissman et al., 2018), whereas an intensity of 20–40 hours per week is a well-established a treatment for ASD (Reichow et al., 2018). Several studies have evaluated clinical outcomes for low-intensity interventions (below 15 weekly hours). Even though these studies report clinically meaningful gains, the gains are more moderate than studies reporting outcomes of more intensive behavioral intervention (Eldevik et al., 2012; Lotfizadeh, Kazemi, Pompa-Craven, & Eldevik, 2018)

Another uncertain factor is the age range for which EIBI is effective. A Norwegian guideline recommends EIBI at an early age (Vea et al., 2017), but research suggests that EIBI can be effective also for children who start the intervention between 4 and 7 years of age (Eikeseth, Smith, Jahr, & Eldevik, 2002, 2007; Waters et al., 2018).

Characteristics of the Nordic welfare states are a high degree of equality, a high level of taxes and a high level of public spending on welfare (Greve, 2007). The core elements of EIBI are the same regardless of setting. But the organizing and funding of the intervention differs greatly from country to country. In many countries, like the United States of America, EIBI is usually funded through health insurance. In Norway, EIBI is usually publicly funded. Children with ASD are typically enrolled in their local mainstream pre-school and the intervention is delivered by public tax-payer-funded agencies.

Universalism has been argued as a central aspect of the Nordic welfare model (Greve, 2007). Treatment intensity (Eldevik et al., 2010), duration (Makrygianni & Reed, 2010) and overall intervention time (Virues-Ortega, Rodríguez, & Yu, 2013) have been suggested as important factors for an effect on EIBI treatment outcomes. Due to the Nordic welfare models emphasis on equality, the implementation of an expensive and very resource demanding program such as EIBI is difficult. For instance, the statemented weekly hours may be determined by the economy/priorities of the local municipality. With the increasing prevalence of ASD (The Norwegian Institute of Public Health, 2015) and the increased demand for evidence-based services, the welfare model is put under pressure.

In our clinical practice, we sometimes experience that parents demand 30–40 hours per week for their child. This is logical, as many parents know that hours per week is an important success factor. Data from our community intervention centers suggest that over the last decade weekly statement hours has gradually decreased from about 35 to about 20. This has left many parents and ABA professionals frustrated. At the same time, it is important to know more about what can be achieved with 20 hours (or less) per week. Although there is some research on this, there are no definite answers.

Further, complicating the picture is another factor that influence EIBI outcomes. Supervisors' credentials have been found to have an impact. Children who received supervision from a Board Certified Behavior Analyst (BCBA) mastered significantly more learning objectives (Dixon et al., 2016). Teachers with special expertise in working with children with ASD are one core features of successful EIBI (Weissman et al., 2018).

Also, it is reported that the intensity of supervision is associated with outcome (Eikeseth, Hayward, Gale, Gitlesen, & Eldevik, 2009).

In Norway, very few supervisors are BACB-certified. The majority of EIBI supervisors are social educators. A social educator is a licensed professional that has a bachelor's degree in the habilitation of individuals with various disabilities. The purpose of the degree is to educate specialists who are able to deliver safe and secure health and welfare services to people with complex needs (Grung, 2016). At some Norwegian colleges, the degree includes extensive ABA coursework. Although EIBI supervisors are often recruited from these colleges, the candidates will have no special competency on EIBI. Hence, they will have to undergo additional training. Such training will start with a six-nine-month full-time practicum as a therapist before they are allowed to supervise and train others. This model of training is similar to what has been advocated as the apprenticeship training model by experts in the field (e.g., Lovaas, 2003).

The aim of this study was to evaluate the outcome for children receiving community-based behavioral intervention of varying intensity from two centers in Norway. We also compared the outcome from these centers to a group of children receiving the intervention more typically provided in the community – eclectic special education (TAU; Treatment As Usual). We describe the community-based behavioral intervention service model currently in use, and we discuss the pros and cons of this publicly funded intervention model.

Methods

Participants

All children who met the following criteria were included in the present study: (a) an independent diagnosis of autism spectrum disorder – either childhood autism F84.0 or atypical autism F84.1 based on the ICD-10 criteria (World Health Organization, 2018a) and based on the ADI-R (Lord, Rutter, & Le Couteur, 1994) and/or the ADOS (Lord et al., 2000); (b) between 2 and 7 years of age at intake; (c) a full-scale intelligence test or a measure of adaptive behavior administered at intake and after about 1 year of intervention, and (d) at least 5 hours per week of intervention. For the purposes of this study, only the time spent implementing teaching methods towards specified weekly targets were counted as intervention hours. Time spent on general practical assistance was not counted as intervention hours.

In total, 74 children met the inclusion criteria. The children were divided into three groups based on the type and intensity of intervention they received. A total of 36 children that received intervention through a center in Bergen made up a higher intensity behavioral intervention group. A total of 21 children that received intervention through a center in Oslo made up a lower intensity behavioral intervention group. Finally, a group of 17 children, that received treatment as usual (TAU), made up a comparison group. See Table 1.

Note that the behavioral intervention groups in this study are called higher and lower intensity relative to each other only. The higher intensity group in this study would not be considered (high intensity) EIBI by any of the commonly applied standards. We will in the following therefore refer to the behavioral intervention groups as either lower or higher intensity Early Behavioral Intervention (EBI) and the supervision centers as EBI centers. See Table 2.

Service setting

Oslo and Bergen are the largest and second largest cities in Norway, and including Akershus County where the comparison group was recruited, the catchment area of this study has a population of about 1.6 million. The referral process usually starts with parents or pre-school staffs reporting a concern about a child's development to the PPT. Following observation and consultation with the parents the PPT, together with the child's family physician, may refer the child for a formal diagnostic assessment at the regional specialist health service. A team of professionals assesses the child to see of if the child's problems fulfill the criteria for a diagnosis on the autism spectrum. The diagnostic centers usually employ state of the art assessment instruments such as the ADI-R (Lord et al., 1994) and the ADOS (Lord et al., 2000) along with an assessment of intellectual functioning and level of adaptive behaviors. A diagnostic report including intervention recommendations is sent back to the PPT. Based on the report and other information, the consultant from PPT writes a statement of needs for that particular child. The child will then be granted resources and referred to a local intervention unit.

Several options are available when referring to an intervention unit. Some children will be referred to their local PPT consultant. Some children will be referred to the regional specialist health-care centers and some children will be referred to a local EIB center. The choice of intervention is made in collaboration with the parents. Regardless of where the child is referred the services involve no extra costs for the family, the pre-school, or the community.

Pre-school units for children under the age of three years have a 1:3 staff to child ratio and typically enroll 9 children. For children between three and six years of age, the child to staff ratio is 1:6, and the unit enrolls 18 children. In the present study, this ranged from 12 to 40 hours per week. These hours are put towards intervention and to ensure that the child with ASD can be helped without taking resources away from the other children in the unit.

The EBI service model

In Norway, the supervision for EBI programs is funded in two different ways. Either through the regional specialist health services or through the local department of education. During the last decades, some of the larger municipalities have funded EBI supervision centers through the local department of education. The municipality of Oslo established an EBI supervision center in 2000 and the municipality of Bergen did the same in 2005. These EBI centers offer supervision and training to the personnel in the local pre-schools. In other regions of the country, supervision of EBI programs is most often provided through the specialist health services. Apart from who it is that provides the supervision (either local EBI centers or the specialist health service), the EBI service model is the same.

In the present study, we evaluate outcome from the EBI centers in Oslo and Bergen. The center in Oslo employed a psychologist that was also a doctoral level board-certified behavior analyst – with approximately 25 years of experience implementing EBI programs and four social educators as case supervisors. The center in Bergen consisted of four social educators serving as supervisors that received a consultation by the same psychologist

employed in Oslo. The supervisors employed in Oslo and Bergen, had between four and fifteen years of practical experience implementing EBI programs.

To organize and implement EBI programs in a pre-school, 2–3 members of the pre-school staff formed an intervention team. The team was responsible for the day-to-day implementation of the intervention. The weekly intervention hours were scheduled based on the extra hours of the provision in the child's statement and divided between the members of the team. One of the team members had the responsibility for scheduling and monitoring intervention hours, preparations for the weekly team meetings, updating the program records, and making sure the material needed for the various programs was available. All team meetings were in the local pre-school.

The supervisor's responsibility was to provide training and ongoing supervision to the staff and parents. Furthermore, the supervisor was responsible for selecting the weekly goals – based on assessments, intervention manuals and input from the staff and parents. Supervision and training started with a three-day workshop in the pre-school. Following this supervision was provided at a weekly team meeting and consultation. The team meetings and consultations lasted 2–4 hours. The pre-school staff attended the workshop and the team meetings. Parents were offered the same type of training as the pre-school staff and were also encouraged to attend the weekly team meetings.

Based on the child's progress, the child's goals and/or teaching procedures were reviewed and adjusted at the team meetings. At any given time, a child would normally be working towards goals on all important areas of functioning. The aim was to provide a balanced, fun and varied week for the child. Some goals would be for improved language and communication, some goals would be related to increased independency such as toileting, eating or dressing, and some goal would be related to improving social skills, such as toy play, games or outside ball play. At the workshop and the weekly consultations, the supervisor explained and demonstrated how to do a particular program. Then the staff took turns, while the supervisor gave hands-on instruction and feedback.

Parents were encouraged to work on generalization and maintenance of skills at home and to different community settings. Treatment fidelity was monitored with a proprietary 25 point checklist that evaluated the implementation of discrete trial teaching and yielded scores on teaching preparation, presenting instructions and materials, prompting, shaping, providing consequences and session structure. Parent participation varied within the EBI groups. Ranging from no/very little to attending every team meeting and working on programmed goals 4–5 hours a week. Unfortunately, we don't have reliable or valid data on parental involvement.

The teaching programs were based on widely used and well-documented behavior analytic procedures such as differential reinforcement, shaping, chaining, task analysis, and various procedures for prompting and prompt fading. The weekly treatment goals were individually tailored and based on assessments and input from parents and staff and widely used manuals (e.g., Leaf & McEachin, 1999; Lovaas, 2003; Maurice, Green, & Foxx, 2001; Maurice, Green, & Luce, 1996; Sundberg & Partington, 1998).

Treatment as usual (TAU)

Treatment, as Usual, was an eclectic combination of different methods and approaches. The choice of methods and treatment approaches was tailored to fit the needs of each

child. Further, the teachers incorporated personal experience and knowledge. Therefore, it is difficult to give a precise description of the intervention. Typically, TAU included elements of alternative communication, applied behavior analysis (ABA), programs based on TEACCH, total communication, and sensory motor therapies. We were not able to extract data on how many hours a week that was spent on the weekly goals or data on the outcome for the targeted areas of intervention. This was due to a lack of formal registration and data collection. By Norwegian law, all children who receive a statement and a formal/legislative decision documenting the need for special educational support are entitled to an individualized special education plan. The purpose of this plan is to make sure the child's needs are met by planning the content of the intervention and evaluating the results. The only data we could find in these plans are the number of hours weekly carried out by a special educator. Targets described in these plans tended to be general goals in areas such communication, social skills, and daily living skills (e.g., "Teacher will work towards facilitating communication skills for NN in all situations throughout the day".)

The supervision and staff training in the TAU comparison group was done by a special education teacher from the local educational department (PPT). There were typically one or two consultations a week, that included training and supervision of the staff in the pre-school – totaling two to 5 hours a week. As in the behavioral intervention groups, between one and three staff members in the pre-school were recruited to do the daily work with the child.

Outcome measures

All the outcome measures were administered at intake (±3 months) and after one year of intervention.

Adaptive behavior

The Vineland Adaptive Behavior Scales-II (VABS-II; Sparrow, Cicchetti, & Balla, 2005) was used to measure daily life functioning. For the participants in the comparison and lower intensity EBI group the survey version was used, and for the participants in the higher intensity EBI group, the parent/caregiver form was used. According to the manual, both versions should yield the similar scores. The VABS yields standard scores on four domains: communication, daily living, socialization, and for children under the age of six years, motor skills. Based on the child's scores in these domains, an adaptive behavior composite score is computed (ABC score).

Intellectual functioning

The Bayley Scales of Infant Development-Third Edition (BSID-3; Bayley, 2006) was used for the youngest children and children that scored below the basal on intelligence tests standardized for their chronological age. The BSID-3 is a measure of mental development for children up to 42 months. It will yield a mental developmental index (MDI), which is considered equivalent to an IQ score. If the child scored below the norms on this test or was too old for the norms, we computed a ratio IQ score by dividing the obtained mental age with chronological age and multiplying by 100. For the older children, we used the

Stanford–Binet Intelligence Scale: Fifth Edition (Roid, 2003), or the Norwegian version of the Wechsler Preschool and Primary Scale Intelligence-III (Wechsler, 2002).

ASD severity

To determine the severity of ASD the Childhood Autism Rating Scale 2 edition (CARS2; Schopler, Van Bourgondien, Wellman, & Love, 2010) was used. CARS2 rates children's behavior on fifteen items (relationship to people, imitation, emotional response, fear and nervousness verbal- and non-verbal communication, activity level, level and consistency of intellectual response and general) on a scale from one to four ranging from normal to severe. The total raw score is used to categorize autism severity as either non-autistic/mildly autistic, moderately autistic, or severely autistic. The ratings were completed by the case supervisor with the help of parents and the pre-school staff. In the higher intensity group in Bergen, two supervisors did the CARS2 independently of each other based on direct observation of the child and through interviews with the pre-school staff. Any disagreements in scores were solved by discussion. CARS2 was taken before the intervention started, and then after one year of intervention in the lower and higher intensity EBI groups. Unfortunately, the CARS2 was not a part of the standard assessment battery for the TAU group, so we only have CARS2 data for the behavioral intervention groups.

Data analysis

Outcome

Since significant differences were found between the groups at intake, we used ANCOVA models to compare group differences in change scores. We entered diagnosis and VABS scores at intake as covariates. We analyzed changes in adaptive behavior composite scores and domain scores after one year of intervention in all three groups. Changes in intellectual functioning were analyzed for the two groups where we had available data; the TAU comparison group and the low-intensity behavioral intervention group. Furthermore, changes in ASD severity were compared for the lower and higher intensity behavioral intervention groups, since these were the only two groups where we had available scores. Based on the mean differences in outcome between the groups, standardized effect size measures were calculated for changes in IQ, ABC, and ASD severity scores. In an attempt to correct for the small sample sizes, the Hedges' g effect size was employed.

Analysis of reliable change

At this level of analysis, we compared the proportion of children that achieved reliable change in IQ and ABC scores in each group. This was done following the same procedure as Remington et al. (2007) and Eldevik et al. (2012) who employed an analysis of reliable change that was suggested by Jacobson and Truax (1991). This analysis establishes with 95% certainty whether observed changes at an individual level are meaningful and significant in the sense that they cannot be accounted for by measurement error and/or sample variance. The amount of change required for IQ and ABC scores to be considered as reliable has been established from a benchmark analysis of almost 300 individual children with ASD who received EIBI across 16 separate evaluation studies (Eldevik et al., 2010). These authors established, using the

formulae from Jacobson and Truax (1991), that change in IQ would need to be 27+ points to be considered reliable and 21+ points for adaptive behavior composite standard scores. For the ASD severity scores, we applied another measure of clinically meaningful change, also proposed by Jacobson and Truax (1991). For change to be clinically meaningful the child would have to move from the "clinical" group to the "non-clinical" group. Therefore, we compared the proportion of children in the lower and higher intensity EBI groups that moved from the "moderate" or "severe" category to the "minimal/no" category on the CARS2. Outcome between the groups was compared using chi-square statistics.

Results

The ANCOVA models showed that the higher intensity EBI group made significantly larger gains on the adaptive behavior composite scores than the TAU comparison after controlling for diagnosis and VABS adaptive composite scores at intake, F (2, 66) = 4.58, p = .014. The same pattern in favor of the higher intensity EBI was seen on all domains on the VABS: communication, F (2, 65) = 3.92, p = .025, daily living skills, F (2, 66) = 3.37, p = .040, socialization, F (2, 66) = 9.72, p = .000, and motor skills, F (2, 64) = 3.13, p = .05. There were no statistically significant differences in change between the TAU comparison and the low-intensity EBI group or between the lower intensity EBI group and the higher intensity EBI group. We are missing VABS data on one participant in the comparison group and two in the lower intensity EIBI group. The results of all comparisons, mean scores, standard deviations, and ranges, for each group at intake and after one year of intervention are displayed in Table 3.

Changes in ABC scores for the individual child after one year of intervention in each group are displayed in Figure 1. Each bar on the graph represents the individual child's change in test score. These have been sorted left to right from highest negative to highest positive change. The solid line on the y-axis shows the criterion for reliable change (from Eldevik et al., 2010) and the dotted line shows the mean gain for the group. No children in the TAU comparison or the low-intensity EBI group met the criterion for reliable change in ABC scores (21+ points). However, seven of the 36 children (19.4%) met criteria for reliable change in the higher intensity EBI group. A chi-square test showed a significant association between higher intensity EBI and whether or not criterion for reliable change was met, χ^2 (2) = 7.75,

Table 1. Age at intake, adaptive behavior, intellectual functioning, ASD severity scores, intervention hours per week and duration, for each group.

	TAU Comparison (n = 17)		Lower Intensity EBI (n = 21)		Higher Intensity EBI (n = 36)	
Characteristics	*M*	*SD* (range)	*M*	*SD* (range)	*M*	*SD* (range)
Age at intake	45.4a	11.9 (24–63)	46.8a	10.0 (32–69)	44.1a	11.2 (21–77)
Adaptive Behavior Composite (ABC)	71.9a	9.6 (47–92)	68.6a	9.5 (52–91)	59.6b	10.0 (39–98)
Intellectual functioning (IQ)	68.8a	18.3 (35–107)	67.4a	18.8 (33–102)	not available	
ASD severity (CARS2 raw scores)*	not available		30.9a	9.2 (17–44)	40.6b	6.5 (27.5–54)
Hours spent on weekly goals	5+ (estimate)a		11.1b	3.0 (5–15)	18.2c	3.0 (10–20)
Duration of intervention (months)	22.5a	7.1 (7–31)	12.5b	2.7 (7–17)	12.1b	0.3 (12–14)

Each subscript letter denotes a subset of categories whose column proportions do not differ significantly from each other at the .05 level.

*We only have data on 7 participants in the Lower Intensity EBI Group.

Table 2. Diagnosis, gender and level of intellectual disability in each group.

	Comparison (n = 17)		Lower intensity EBI (n = 21)		Higher Intensity EBI (n = 36)	
Characteristic	n	%	n	%	n	%
Diagnosis						
Childhood Autism	5a	39.4	8a	38.1	30b	83.3
Atypical Autism	12a	70.6	13a	61.9	6b	16.7
Gender						
Male	13a	76.5	19a	90.5	29a	80.6
Female	4a	23.5	2a	9.5	7a	19.4
Level of intellectual disability (ID)						
No ID	11a	64.7	10a	47.6	3b	8.3
Mild ID	5a	29.4	11b	52.4	29b	80.6
Moderate ID	2a	5.9	0a	0.0	4a	11.1
Severe ID	0	0	0	0	0	0
Profound	0	0	0	0	0	0

Each subscript letter denotes a subset of categories whose column proportions do not differ significantly from each other at the .05 level.

$p < .021$. We calculated the Hedges' g standardized mean difference effect size for changes in ABC scores between each of the three groups. Between the TAU comparison and the higher intensity EBI group, the effect size was 0.98 (95% confidence interval [CI] = 0.36–1.59). Between the TAU comparison and the low-intensity EBI group, the effect size was 0.58 (95% confidence interval [CI] = −0.01–1.26). Finally, the effect size between the lower and higher intensity EBI groups were 0.51 (95% confidence interval [CI] = −0.05–1.08).

Changes in intellectual functioning were analyzed for the two groups where we had available data; the TAU group and the low-intensity EBI group. In addition to missing data on intellectual functioning for the higher intensity EBI group, we are missing data on two of the participants in the lower intensity EBI group. The ANCOVA models showed that the low-intensity EBI group made significantly larger gains in intellectual functioning (IQ-scores) than the TAU comparison when we entered the same covariates as above (diagnosis and VABS scores at intake), $F(1, 32) = 6.09$, $p = .019$. No children in the TAU group met the criterion for reliable change in IQ (27+ points), and only one out of 19 children (5.3%) in the low-intensity EBI group did so. This group difference was not significant. Changes in IQ scores for the individual children after one year of intervention are displayed in Figure 2. Again, each bar on the graph represents an individual child's change in test score. As in Figure 1, the dotted line represents the criterion for reliable change (from Eldevik et al., 2010) and the solid the mean gain for the group.

We also calculated the Hedges' g effect size for changes in IQ scores for the two groups where we had available data, the TAU comparison, and the low-intensity EBI group. The Hedges' g effect size was 0.89 (95% confidence interval [CI] = 0.20–1.58).

Next, changes in ASD severity were compared for the lower and higher intensity EBI groups. Note that in addition to missing data for the TAU comparison group we are missing data on 14 of the 21 participants in the lower intensity EBI group. The higher intensity EBI group reduced their severity scores by 9.1 points whereas the lower intensity groups only reduced their scores with 4.9 points. The ANCOVA models revealed no significant differences in change scores between the groups when age, VABS, diagnosis and CARS2 scores at intake where entered as covariates. See Table 3. In the lower intensity EBI group, 28.6% of the children received an improved CARS2 classification, whereas 71.4% in the higher intensity EBI group did so. A Chi-square test showed

Table 3. Unadjusted means, SDs, and range of scores at intake and after one year of intervention by the group.

	TAU Comparison (n = 17)							Lower Intensity EBI (n = 21)							Higher Intensity EBI (n = 36)						
	Intake		After 1 year		Change			Intake		After 1 year		Change			Intake		After 1 year		Change		
Measures	*M*	*SD* (range)	*M*	*SD* (range)	*M*	*SD*	*n*	*M*	*SD* (range)	*M*	*SD* (range)	*M*	*SD*	*n*	*M*	*SD* (range)	*M*	*SD* (range)	*M*	*SD*	*n*
Intellectual functioning (IQ)	68.8a	18.3 (35–107)	68.4a	23.1 (27–111)	−0.4a	12.2	17	67.4a	18.8 (33–102)	76.6a	22.8 (38–118)	9.3b	9.6	19	not available						
Vineland Adaptive Behavior Scales																					
Composite	71.9a	9.6 (47–92)	69.8a	12.5 (64–97)	−2.1a	10.7	16	68.6a	9.5 (52–91)	71.7a	11.6 (50–88)	3.2ab	7.6	19	59.6b	10.0 (39–98)	67.6a	13.5 (44–103)	8.0b	10.2	36
Communication	74.9a	14.0 (42–97)	74.9a	17.1 (49–106)	−2.2a	8.3	15	65.0a	15.9 (25–84)	70.5a	16.9 (40–100)	5.6ab	11.2	19	53.2b	15.5 (20–85)	66.1a	16.6 (38–111)	12.9b	13.4	36
Daily Living	77.4a	14.0 (43–101)	73.1a	15.3 (42–103)	−4.7a	12.0	16	76.7a	11.1 (60–103)	76.8a	11.2 (55–93)	.1ab	11.1	19	64.4b	10.4 (46–109)	71.3a	15.9 (40–109)	6.9b	12.4	36
Socialization	72.4a	8.4 (55–88)	69.6a	10.8 (48–87)	−2.8a	10.2	16	70.2a	9.2 (55–88)	74.8a	12.3 (53–94)	4.6ab	8.9	19	60.6b	8.8 (47–94)	69.5a	13.2 (49–106)	8.9b	11.0	36
Motor	75.0a	10.4 (56–94)	68.6a	11.2 (47–88)	−5.6a	9.1	14	75.1a	12.6 (59–100)	76.8a	14.3 (59–111)	1.7ab	10.7	19	70.7a	13.0 (50–107)	74.9 a	13.6 (53–104)	4.3b	12.00	36
Childhood Autism Rating Scale Autism Severity raw score	not available							30.9a	9.2 (17–44)	26.0a	6.8 (16.5–34)	−4.9a	7.4	7	40.6b	6.5 (27.5–54)	31.8a	7.3 (15.5–46)	−9.1a	4.6	35

Each subscript letter denotes a subset of categories whose column proportions do not differ significantly from each other at the .05 level.

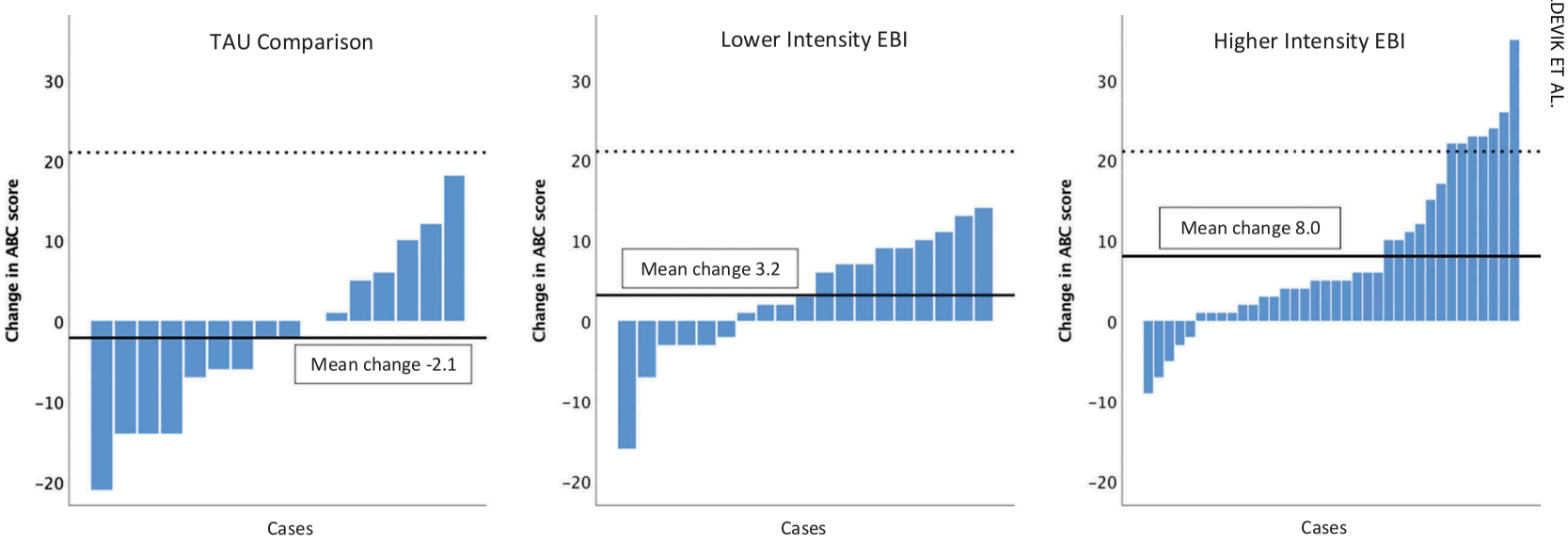

Figure 1. Change in adaptive behavior composite scores for the individual children in each group. Each bar represents one child's change in score. These have been sorted left to right, from highest negative to highest positive change. The dotted line shows the criterion for reliable change (+21 ABC points) and the solid line shows the mean change for the group. No children met the criterion for reliable change in ABC scores (21+ points) in the TAU comparison or the lower intensity EBI group. In the higher intensity EBI group, seven of the 36 children (19.4%) met criteria for reliable change. There was a significant association between intensity and whether or not criterion for reliable change was met χ^2 (2) = 7.75, $p < .021$.

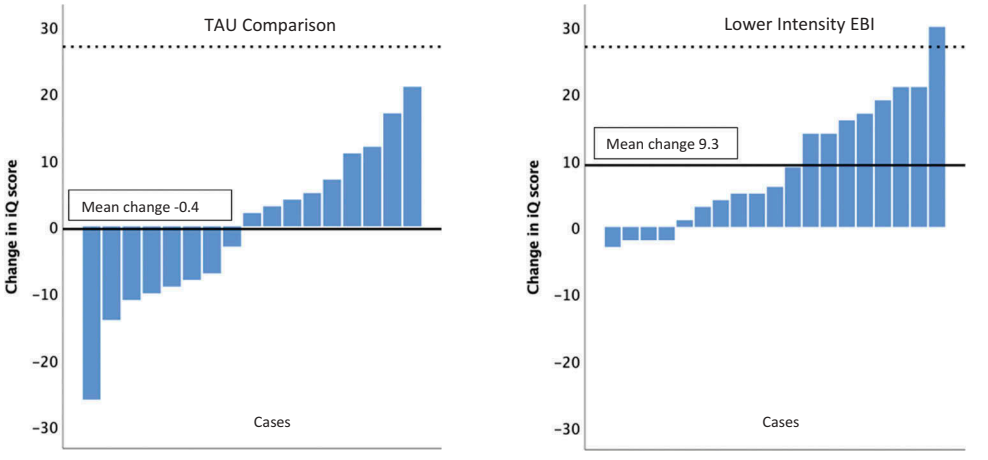

Figure 2. Changes in IQ scores for the individual children in each group. Each bar represents one child's change in score. These have been sorted left to right from highest negative to highest positive change. The dotted line shows the criterion for reliable change (+27 IQ) and the solid line shows the mean change for the group. No children in the TAU comparison group met the criterion for reliable change in IQ scores. In the lower intensity EBI group, one of the 19 children (5.4%) met criteria for reliable change.

a significant association between higher intensity EBI and whether or not an improved classification was observed, χ^2 (1) = 4.67, $p < .031$.

Discussion

We compared outcome in three groups of children with ASD following one year of intervention. One group received higher intensity EBI (*M* 18.2 hours per week), the second group received lower intensity EBI (*M* 11.1 hours per week), and the third group received treatment as usual – an eclectic mix of interventions tailored to meet the needs of the individual child.

The higher intensity EBI group made significantly larger gains in composite and domain standard scores on the VABS than the TAU comparison group. In the higher intensity group, 19.4% met the criteria for reliable change in composite standard scores on the VABS (21+ points) following the intervention. This was significantly better than the lower intensity and the TAU comparison group. The percentage of children in the higher intensity group that met the criterion for reliable change was at a suggested benchmark for EBI outcome (Eldevik et al., 2010).

We did not have data on intellectual functioning for the higher intensity behavioral intervention group. However, we found that the lower intensity EBI group had significantly larger gains in IQ-scores than the TAU comparison group. However, the proportion of children that met the criterion for reliable change in the low-intensity behavioral intervention group was only 5.3%. This is considerably lower than the proposed 30% benchmark (Eldevik et al., 2010). The 9–point average IQ gain in the low-intensity group was as expected, and confirms a dose–response relationship between weekly hours (dose) and gain in IQ (response).

The higher intensity behavioral intervention group reduced the ASD severity scores more than the lower intensity behavioral intervention group, but the difference between the groups was not significant. This analysis only included 7 participants in the low-intensity group, so the non-significant result may be due to low statistical power. Unfortunately, we did not have data on autism severity for the TAU comparison group, so comparisons to the TAU groups could not be done.

Regarding the outcome measures. We want to highlight that there is a difference between relative effect and absolute effect. The CARS2 categorical data is one way to measure the clinical significance and as such, it is a measure of absolute effects. It tells us whether or not the child is scoring in the clinical range before and after the intervention. Whereas IQ and VABS data can also be used to measure relative effects, as improvements in scores. Both measures are important as they yield different perspectives on clinically significant change.

For the participants from the center in Bergen, the parent/caregiver form from the VABS was administered rather than the survey forms. According to the VABS manual, we should except both versions to give the same standard scores. However, we cannot rule out that there is a difference in how changes after one year of intervention are scored and reported. This remains a threat to the validity of our findings, and future studies should use the same forms across groups.

We think it is reasonable to conclude that our outcome data support prior reviews that have found a dose-response-relationship between weekly hours and outcome (e.g., Virues-Ortega, 2010). We found this even in the limited range of hours per week we compared (11.1 hours the lower intensity group and 18.1 hours in the higher intensity group). It should be noted again, that our higher intensity group is not *intensive* early intervention according to any of the proposed standards.

This brings us to an evaluation of the service model as such. The weaknesses of this model are notable. First, a tax-payer funded universal approach means that the statemented intervention hours, in reality, are determined by the economy of the municipality and not by the child's individual needs and published research. Over the last decade, there has been an increase in the prevalence of ASD. Municipal budgets for intervention in pre-schools have not kept up with this. Previously, a pre-school unit enrolling a child with ASD would get one extra staff (40 hours a week). Now, this is often one-half extra staff (20 hours a week). In addition, many of the pre-schools struggle to deliver the statemented number of weekly intervention hours. This can be due to staff being off ill, the staff having to do other work in the pre-school, the child not attending, the child being dropped of late in the day or being picked up early, and a host of logistical problems with organizing 4–5 hours a day of intervention in this setting. The increased prevalence of ASD has also resulted in long waiting lists at the EBI centers. Employing more supervisors at the centers has not been prioritized by the authorities.

Second, in this model, the children with ASD will normally attend their local pre-school. Since ASD is still relatively rare, it means that in most cases the pre-school staff and treatment team are inexperienced both with ASD and EBI. This in turn means that the supervisors from the EBI centers must train the pre-school team from scratch. Because of this, it will normally be a period of 3–6 months before the intervention program is up and running properly. A possible improvement to the model is to have the EBI trained pre-school staff employed through the EBI intervention center, instead of through the local authority. The EBI center could supply both a properly trained treatment team and the supervision of the team from day one.

Third, the procedures for referring children to the EBI centers sometimes create challenges. Some parents are very well informed on ASD and various interventions and have actively sought out EBI for their child. Other parents may know little about ASD and EBI. Over the last 10–15 years the proportion of referred families from non-western cultures with poor Norwegian/English language skills has grown. This creates challenges in communicating with the parents and involving them in the intervention program and team meetings. It is also difficult to communicate the seriousness of an ASD diagnosis and the importance of early intervention. The EBI centers do not have a legal basis for requiring that the parents attend workshops and the weekly team meetings or that they work at home with their child. As a result of the above, there is a large variation in how much the parents are involved in the intervention. An improvement of the model would be to change the law so that parental involvement could be required.

Although there are challenges with the model, the model also has some positive sides. EBI is offered to families that have not researched it well and fought hard to get it. EBI does not cost the family anything extra. EBI is based on the existing resources in the community and does not cost the municipality more than treatment as usual.

This study has limitations that need to be addressed as they might compromise the validity of the findings. First, we are missing important outcome data. We do not have ASD severity data from the TAU comparison group, and only on a very limited number of participants on the low-intensity behavioral intervention group. Also, we are missing data on intellectual functioning in the higher intensity behavioral intervention group.

Furthermore, there were some significant differences between the groups at intake. The higher intensity behavioral intervention group had significantly lower VABS scores at intake and significantly higher CARS2 scores. There was also a significantly higher proportion of childhood autism diagnosis in this group. This suggests that the higher intensity group was lower functioning than the two other groups. Meta-analytic reviews have not found that lower functioning children will have larger gains following early intervention (Eldevik et al., 2010). Hence, there is no reason to believe that the lower scores at intake are the reason they show larger gains. Rather, it is more plausible that the larger gains seen in this group are due to the fact that they received more weekly intervention hours (Virues-Ortega, 2010).

There are also limitations in the research design of the present study. Children were not randomly assigned to groups. In addition to the possible bias relating to group assignment, there is a potential for further bias in the actual referral process to the intervention centers as a number of considerations could affect whether or not a particular child was referred. Unfortunately, we do not have data on the factors affecting referral decisions, but an informal check clearly shows that some parts of the municipalities are overrepresented. This could be because other service providers were better established in parts of the municipalities or the pattern of referral may reflect the professional preferences of the local authorities.

The quality of the behavioral intervention programs in both the lower and higher intensity groups were reviewed every month on a 30-point proprietary checklist. This checklist included scores for parental involvement and treatment fidelity. We did not find any systematic differences between the groups on these quality scores, except on the hours of weekly intervention. Although we don't have data on socioeconomic

status, we could infer from an inspection of the referral records that the groups were similar on at least some variables (e.g., a similar proportion of immigrant families).

To better control for these limitations we recommend that future studies should have a larger sample and that participants are randomly assigned to either an EIBI group that receive services in line with the Norwegian clinical procedures proposed by Vea et al. (2017), or to a comparison group that is provided with state of the art eclectic intervention of similar intensity and amount of supervision.

Acknowledgments

We would like to thank the following supervisors for their help: Kristine Gjerde, Mariann Lauritsen, Christine Lie, Kim Liland, Marianne Mjøs, Silje Nikolaisen, Elisabeth Rustebakke, Hanne Skau, Hege Tryggetstad, and Astri Valmo.

Ethics Statement

This investigation was approved by a research ethics committee and have been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Disclosure statement

No potential conflict of interest was reported by the authors.

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