

# Treatment Gains from Early and Intensive Behavioral Intervention (EIBI) are Maintained 10 Years Later

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## Abstract

This study reports outcome in adolescents with autism who in their childhood received Early and Intensive Behavioral Intervention (EIBI). Nineteen children (16 boys) who had received two years of EIBI starting at a mean age of 2-years-and-11-months were followed up, on average, 12 years later. Results showed the participants significantly increased their cognitive and adaptive standard scores during the two years of EIBI, and that these gains were maintained at follow-up, 10 years after the EIBI had ended. Participants also showed a significant reduction in autism symptoms between intake and follow-up. At follow-up, none of the participants had received any additional psychiatric diagnoses, and none were taking any psychotropic medication. Results indicate that treatment gains achieved in EIBI are maintained into adolescence.

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**Keywords**

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Early intensive behavioral intervention (EIBI) based on applied behavior analysis (ABA) is a well-researched comprehensive psycho-educational intervention for pre-school aged children with autism spectrum disorder (ASD) (Eikeseth & Klintwall, 2014). Meta analyses have shown that EIBI, as compared to eclectic treatment or treatment-as-usual, results in more children making reliable improvements with medium-to-large effect sizes in intellectual and adaptive functioning (Eldevik et al., 2009; Eldevik, Jahr, Eikeseth, Hastings, & Hughes, 2010; Makrygianni, Gena, Katoudi, & Galanis, 2018; Makrygianni & Reed, 2010; Peters-Scheffer, Didden, Korzilius, & Sturmey, 2010; Reichow, Barton, Boyd, & Hume, 2012; Reichow & Wolery, 2009; Virues-Ortega, 2010).

While it has been shown that EIBI may be effective (Eikeseth, 2009; Eldevik et al., 2010; Howlin, Magiati, & Charman, 2009; Rogers & Vismara, 2008, Smith & Idarola, 2015), little is known as to whether gains are maintained after the treatment has been terminated. Indeed, an evaluation of the effectiveness of EIBI involves the assessment of long-term outcome in adolescence and adulthood. To date, only a few studies have reported outcome after discontinuation of EIBI, two studies with primary school children and one with children who had reached adolescence.

One of the studies on primary school children found maintenance of treatment gains four-to-five years after the treatment ended (McEachin, Smith, & Lovaas, 1993) while the other study reported that gains were not maintained two years after the end of EIBI (Kovshoff, Hastings, & Remington, 2011). The study reporting outcome in adolescence for children with ASD who had received three years of EIBI found that age equivalent scores on adaptive and cognitive functioning increased and autism symptoms decreased (Perry, Koudys, Prichard, & Ho, 2017). However, when examining standard scores (i.e., comparing children with peers at the same chronological age) there was a decrease in cognitive and adaptive scores between the end of the EIBI and the follow-up at age 16. This suggests that although the children continued to make progress after EIBI had ended, some of the gains in IQ and adaptive behaviors made during EIBI were not sustained into adolescent years. Clearly, more research is needed to evaluate long-term outcome for children who have received EIBI.

The current study reports on a group of children who received, on average, two years of EIBI. The participants in the current study were a

subsample of children who participated in a previously published study. Hayward, Eikeseth, Gale, and Morgan (2009a) examined progress after one year for children with autism who received a mean of 36 hours per week of EIBI. Between intake and follow-up, children improved significantly on IQ, visual-spatial IQ, language comprehension, expressive language, social skills, motor skills and adaptive behavior. The current study reports data from intake, at the end of EIBI, and finally, 10 years after EIBI was terminated when the children were, on average, 15 years of age. Data are presented on participants' current provision, placement, and attainments, as well as adaptive behavior, cognitive functioning, and severity of autism symptoms. We hypothesized: (a) that children's cognitive and adaptive scores increased significantly between intake and two years of EIBI, (b) this increase was maintained at the follow-up 10 years after completion of the EIBI, and (c) that children had a significant reduction of autism symptoms between intake and the final follow-up.

## Method

### *Participants*

All participants in the current study also participated in the Hayward et al. (2009a) study. Inclusion criteria for Hayward et al. (2009a) were: (a) a diagnosis of autism according to ICD-10 (World Health Organisation, 1993) and confirmed by the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994); (b) a chronological age between 24 and 42 months at onset of treatment; and (c) an absence of medical conditions that may interfere with the behavioral treatment (e.g., uncontrolled epilepsy). Following the Hayward et al. (2009a) study, one of the 44 families did not wish to be contacted, and one was not available. Therefore, forty-two of 44 children from the Hayward et al. (2009a) study were invited to participate in the current study. Invitation was done by writing to families at the last known address and by advertising in the publication of a national support group for parents interested in ABA. Twenty families responded and 19 (16 boys), agreed to participate. The mean age of participants at follow-up was 15 years 4 months (range; 11 years, 1 month – 20 years, 1 month). As shown in Table 1, the current sample was similar to the children from the original sample who did not agree to participate in this follow-up on chronological age, IQ, and adaptive functioning at intake. All differences were non-significant, measured as student's *t*-test ( $p > .05$ ). Additional participant information is available in Hayward et al. (2009a).

**Table 1.** Differences at Intake between Children from the Original Study who Agreed to Participate in the Current Sample and Those Who did not.

	Included in follow-up Mean, SD, N	Not included in follow-up Mean, SD, N	Cohen's <i>d</i>
Age (years) at intake	2.9 (0.5) <i>n</i> = 19	2.9 (0.5) <i>n</i> = 25	0.017
IQ at intake	54.8 (17.4) <i>n</i> = 19	53.8 (12.6) <i>n</i> = 25	0.046
Vineland at intake	63.7 (11.0) <i>n</i> = 19	63.6 (6.3) <i>n</i> = 25	0.014

## Measures

**Education history and placement.** A questionnaire was developed for the purposes of the current study with the aim of collecting information about the educational history and current placement status of each participant. It was administered by post to all participants' parents or guardians. Parents provided information on the following areas: education placement, teaching support received, and funding received for each year of the child's life from pre-school to post-secondary education (if applicable); child's educational achievements during that time; leisure/social activities/clubs that the child currently participated in; current favorite leisure activities of the child; what (if any) respite services were received by the family; any re-evaluation of the child's diagnosis; and any medication currently being taken by the child.

The length of the EIBI, ABA, and other educational services was assessed by the questionnaire as follows: Parents entered information on educational services for each year of the child's life from pre-school to post-secondary education to the present. Parents reported the educational services as full-time or part-time, with full-time meaning school hours or more, and part-time as less than school hours.

**Intellectual functioning.** Participants in the Hayward et al. (2009a) study were originally assessed at intake and later after two years of treatment using either the Bayley Scales of Infant Development-Revised (Bayley, 1993) or the Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R; Wechsler, 1989) depending on the age and ability of the participants. Since, in the current study, the participants were older than the age cut-off for the Bayley and the WPPSI, intellectual functioning was assessed using the Wechsler Intelligence Scale for Children (WISC; Wechsler, 2003, 4<sup>th</sup> edition). However, if the participant did not achieve a basal on the WISC, then the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) was administered. If a basal was not achieved on the WASI, then the Peabody Picture Vocabulary Test-IV (PPVT; Dunn & Dunn, 2007) and the Expressive

Vocabulary Test-II (EVT; Williams, 2007) were administered and an average of the two standard scores was utilized to give a verbal standard score to substitute the IQ score. These measures were used since vocabulary is related to cognitive ability and measures of intelligence typically include a vocabulary subtest (Dunn & Dunn, 2007; Williams & Wang, 1997). Eleven of the nineteen participants achieved a basal on the WISC, four participants were assessed with the WASI, and four using the PPVT and the EVT. Out of the 19 participants, 11 had available IQ-measures for all three time-points (8 were not tested at end of EIBI).

*Adaptive behavior.* The Vineland Adaptive Behavior Scales-II Survey Form (VABS-II; Sparrow, Cicchetti, & Balla, 2005) was used to measure adaptive functioning. It was administered at intake, as reported by Hayward et al. (2009a), and following two years of EIBI treatment, and was administered for the current study. The VABS-II yields a composite standard score across the three areas of communication, daily living skills, and socialization, and a standard score for each of these areas, as well as a composite raw score for maladaptive behavior. Out of the 19 participants, 12 had measures of Adaptive behavior for all three time-points (7 were not assessed at end of EIBI).

*Autism symptoms.* Participants in the Hayward et al. (2009a) study were assessed at intake using the Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994). Autism symptoms in the current study were assessed using the ADI-R and the Childhood Autism Rating Scale, Second Edition (CARS-2; Schopler, Van Bourgondien, Wellman, & Love, 2010). The ADI-R has questions about symptoms across different content areas and most questions probe whether they have “ever” occurred or are “current.” The interview was administered with one or both parents present during which the informant’s responses were recorded and coded. To identify the symptoms shown by the participants in the present study, only the “current” category was used. Not all items and content areas were relevant for all age groups and skill levels, therefore only the items that yielded data at both intake and follow-up were included. The content areas included were: social interaction, communication, and repetitive/stereotyped behavior.

The CARS-2 consists of a list of 15 behavioral categories rated on a four-point scale. The total score varies between 15 and 60 and, based on the total score, children fall within the following three severity groups: minimal-to-no symptoms of ASD, mild-to-moderate symptoms of ASD, and severe symptoms of ASD. All 19 children were assessed using the CARS. Data for the ADI-R and the CARS-2 were available for 18 of the 19 participants.

## *Treatment*

Originally, all children received treatment based on the UCLA model for EIBI (Hayward et al., 2009a; Hayward, Gale & Eikeseth, 2009; Lovaas, 2003) for an average of two years. Following this, they were in a variety of educational settings while they continued to receive interventions based on ABA. The model of EIBI is described in detail in Hayward, Gale, and Eikeseth (2009b). Participants in the Hayward et al. (2009a) study received on average 36 hours per week of treatment and this continued throughout the two-year EIBI period. Treatment was initially home-based, included parental training and involvement, and included fundamental principles of systematic reinforcement, stimulus control, motivating operations, and generalization. Teaching procedures included discrete trial, natural environment, and incidental teaching (Hayward et al., 2009b).

School integration began once a range of skills had been acquired that enabled the children to access materials, curriculum and peers in the pre-school or school environment. The children were located in different parts of the United Kingdom and therefore each participant attended a different school. An ABA-trained tutor shadowed each child at their school, in social and play situations, as well as for the academic curriculum. Tutors received a minimum of one half-day of theory training, 60 hours of hands on practical training with a trained staff member, and ongoing weekly supervision and training from a senior member of the organization (for full details of staff training see Hayward et al., 2009b). For children who progressively learned more from their school environment, the tutor systematically reduced interventions such as prompting and reinforcement, until the child attended all or part of the school day independently. For children who did not learn sufficiently from the classroom environment, the tutor continued to shadow and concentrated on integrating the child for activities in which they were successful. If necessary, time was also allocated to ongoing one-to-one tutoring, both at home and school, during which individual learning goals, including independent living skills, were addressed more efficiently than in the classroom.

## *Procedure*

Parents of the participants of the Hayward et al. (2009a) study were contacted by letter inviting them to participate in the follow-up study. The letter contained information about the study, an informed consent form, and the education history and placement questionnaire. To enter the study, parents had to sign the informed consent form and return it together with the questionnaire

by mail. If they did not wish to participate parents were able to choose not to return the questionnaire and the consent form, or to return a signed form explicitly stating that they did not wish to participate, of the 20 parents that responded, one indicated they did not wish to participate.

Interviews and assessments took place in the families' homes or the participants' schools. The cognitive assessments were conducted by a trained doctoral student from Swansea University, who was independent of, and blind to, the purposes of this study. All cognitive and adaptive assessments performed at intake and after two years of EIBI were conducted by licensed psychologist, who were independent of and blind to the purposes of this study. The VABS interviews at follow-up were conducted by consultants from the service provider who were unaware of the purposes of the study. The ADI-R interviews were conducted by the second author of the present study (D.H.) who was trained and certified to use the instrument for research purposes. The same author conducted the CARS and was trained and supervised by the fourth author (S.E.), who is a licensed clinical psychologist with an expertise in ASD.

## Results

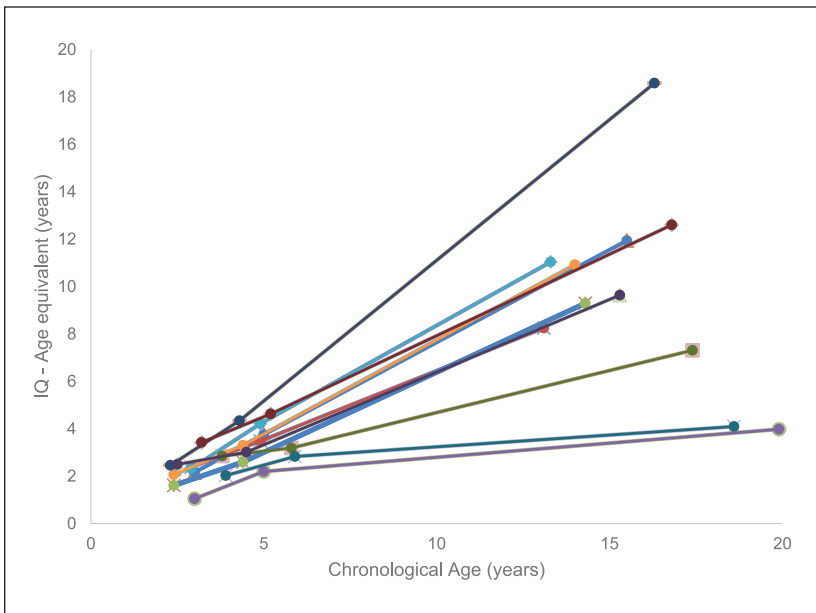
Mean scores are presented for cognitive and adaptive functioning at the three time points (intake, end of EIBI and 10-year follow-up). Changes in cognitive and adaptive functioning were investigated using paired *t*-tests, using the JASP software. Data showing individual developmental trajectories for cognitive and adaptive functioning are also presented. Autism symptoms mean scores are presented for intake and follow-up. Information on changes to diagnosis, medication, leisure activities, current educational placement and respite at follow-up are presented with reported length of EIBI and ABA services. Finally, individual scores are presented for those children who scored above 70 on both IQ and adaptive functioning to provide more detailed information for those children that fared best within the group.

### *Cognitive and Adaptive Functioning*

Results from the cognitive and adaptive assessment can be seen in Table 2, including the paired *t*-test comparisons across the three time-points. Similar to Hayward et al. (2009a), the participants from our subsample increased their cognitive and adaptive standard scores significantly between intake and the end of the two-years of EIBI. Between the end of the EIBI and the current follow-up (at age 15), children's cognitive and adaptive scores did not change significantly in either direction, suggesting that the children had maintained

**Table 2.** Intake, Two-years, and Follow-up Data for the Current Sample.

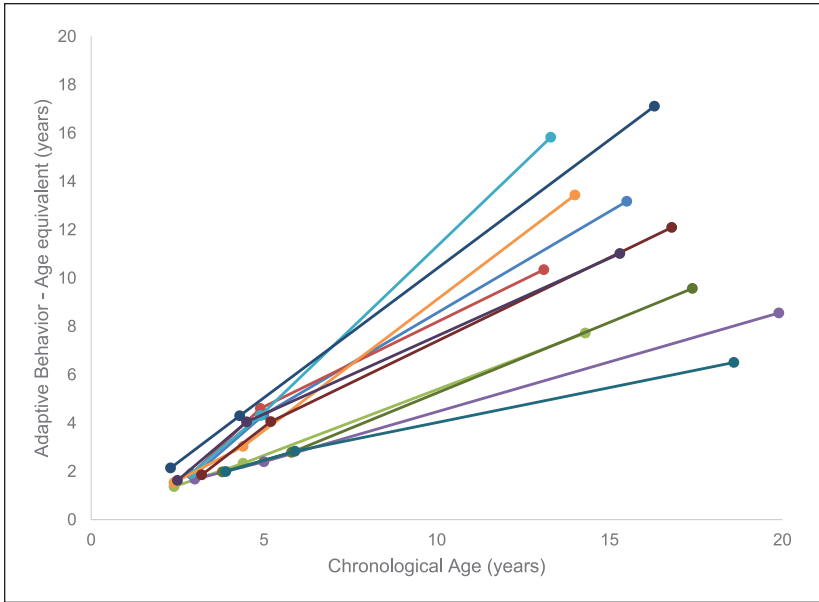
	Mean standard scores (SD)			Paired t-test: t-value (p-value)	
	Intake (age 2:11)	End of EIBI (age 5:2)	Follow-up (age 15:4)	Intake to end of EIBI	End of EIBI to follow-up
Cognitive Score (IQ)	54.5 (17.9)	70.0 (17.7)	67.5 (27.8)	3.281 (.008)	-1.627 (.125)
Adaptive Score (Vineland)	63.7 (11.3)	71.0 (20.1)	69.6 (22.9)	2.265 (.045)	0.132 (.897)



**Figure 1.** Individual developmental trajectories using IQ.

the gains in cognitive and adaptive behavior made during EIBI into adolescence. Individual developmental trajectories using age equivalent scores are presented in Figure 1 for IQ, and Figure 2 for adaptive behavior. The figures demonstrate variability among the participants and that individuals made progress at different rates, while also demonstrating the group made progress and maintained gains at follow-up.





**Figure 2.** Individual developmental trajectories using Vineland Adaptive Behavior Scales.

### *Autism Symptoms and Maladaptive Behavior*

As can be seen in Table 3, there was a significant reduction in autism symptoms between intake and follow-up, as measured by the ADI-R. The reduction was across the total ADI-R score, and all three domains (language and communication, reciprocal social interactions, and restricted, repetitive and stereotyped behaviors and interests), indicating a decrease in autism symptomatology. The effect size of all of these scores was large.

Data from CARS-2 and on maladaptive behavior were only available at follow-up. On CARS-2, the 19 participants scored on average 26.8 (SD = 7.0), and for maladaptive behavior the average score was 13.6 (SD = 8.4). Nine participants scored as having minimal-to-no symptoms of ASD, as measured by the CARS-2, 7 scored as having mild-to-moderate symptoms of ASD, and 2 scored as having severe symptoms of ASD. Seven of the participants scored average on the maladaptive behavior index of the VABS. Ten scored elevated and two scored within the clinically significant range.

**Table 3.** Autism symptoms assessed by the Autism Diagnostic Interview-Revised at Intake and follow-up.

	Intake mean (SD)	Follow-up mean (SD)	Paired t-test t- value (p-value)	Cohen's d
ADI-R total	31.5 (4.0)	14.9 (10.8)	6.659 (.000)	2.04
Social	15.3 (2.2)	6.9 (5.0)	6.857 (.000)	2.18
Communication	10.3 (1.6)	4.6 (3.9)	6.440 (.000)	1.91
Repetitive	5.9 (1.6)	3.4 (2.7)	3.404 (.003)	1.13

Note: ADI-R: Social = Reciprocal Social Interactions, Communication = Language and Communication, Repetitive = Restricted, repetitive, and stereotyped patterns of behavior.

### *Changes to Diagnosis and Medication*

According to the parent questionnaire, none of the participants had received any additional psychiatric diagnoses, and none of the participants were given any psychotropic medication. One of the participants had his diagnosis of childhood autism removed (and was not given any other diagnosis), and one participant had his diagnosis changed from childhood autism to Asperger Syndrome. Two participants were diagnosed with epilepsy.

### *Current Leisure Activities*

According to the parent questionnaire, participants were taking part in a mean of 4.3 leisure activities (range: 0-9). These activities included sport, art, music and dance, and community clubs (e.g., cubs, church groups). Seventy-nine percent of participants were taking part in three or more leisure activities (see Table 4 for more information regarding leisure activities).

### *Education and Placement*

Data on education and placement are shown in Table 4.

*Current educational placement.* Forty-two percent of the participants were attending a mainstream school, 21% an ABA school, 32% a school for children with special educational needs, and 5% were receiving home schooling. Of the 42% of children attending a mainstream school, 25% were unsupported, 12.5% were supported full-time by an ABA shadow, 12.5% were supported full-time by a teaching assistant/learning support assistant (TA/LSA), and 50% were supported part-time by a TA/LSA.

**Table 4.** Comorbid Psychiatric Diagnosis, Medication, Leisure Activities, Education Placement, Length of EIBI (ABA) Program, and Respite and Residential Care.

Other psychiatric diagnosis:	0%
Psychotropic medication:	0%
Leisure activities	
Mean number of leisure activities:	4.3 (Range: 0-9)
Three or more leisure activities:	79%
Educational Placement	
Mainstream school:	42% (Unsupported 25%; Part time TA/LSA 50%; 12.5% ABA shadow; Full time TA/LSA 12.5%)
ABA school:	21%
Special education:	32%
Home schooling:	5%
Length of EIBI and ABA services	
Mean length of home-based EIBI	2.3 years (Range 1-7 years)
Mean length full time ABA services	6.4 years (Range: 0-13 years)
Mean length full time and part time ABA services	9.4 years (Range: 3-15 years)
Respite and residential care	
Full time residential care:	0%
No respite care of any kind:	74%
Part time non-residential respite care:	21%
Part-time combined residential care and non-residential respite care:	5%

Note: TA = Teaching Assistant; LSA = Learning Support Assistant.

*Length of EIBI and ABA services.* The mean length of the full-time, home-based EIBI programs was 2.3 years (Range 1-7 years). Subsequently, children entered a variety of different educational settings during which they received, on average, 9.4 years of ABA services (Range 3-15 years). These ABA services included part-time home programs plus part-time mainstream school placements with an ABA-trained tutor providing support; full-time mainstream school placements with an ABA-trained tutor providing support; and full-time placements in ABA schools.

*Respite and residential care.* None of the participants were in full time residential care and 14 (74%) received no respite care of any kind. One participant received combined part-time (56 nights per year) residential care and

non-residential respite care. Four additional participants received non-residential respite care, one of whom received an average of 22.5 hours per week, and three of whom received an average of four hours or fewer per week.

Nine participants fared particularly well at follow-up, they were identified as scoring above 70 on both IQ and adaptive functioning ( $M$  IQ = 89 and  $M$  Adaptive Score = 88). Individual data for these best-outcome participants is shown in Table 5 to provide more detailed information on those participants.

## Discussion

This study reports outcome in adolescence for individuals with ASD who in their childhood received two years of EIBI. Results showed the participants significantly increased their cognitive and adaptive standard scores between intake and two years of EIBI, and that these standard scores were maintained at follow-up, 10 years after the EIBI had ended.

Results of the present study are consistent with the results of McEachin et al. (1993), in that both studies demonstrated maintenance of treatment gains several years after the EIBI had ended. Participants of these two studies fared better as compared to the participants of Perry et al. (2017) study and Kovshoff et al. (2011). One reason for this may be that the participants of the present study received additional ABA provisions after the EIBI had ended as part of the children's integration into school. This is consistent with Kovshoff et al. (2011), who in a post-hoc analysis found that for a subgroup of children who had received EIBI, gains were maintained at follow-up, two years after EIBI had ended. This subgroup had received a parent-managed EIBI provision, as compared to the other EIBI subgroup, who had received a university-commissioned EIBI provision. Kovshoff et al. (2011) argued that parental involvement was greater in the parent managed EIBI group, and that the children may have maintained their gains because some forms of ABA provision continued for those children after the EIBI had formally ended.

Autism symptoms decreased significantly between intake and follow-up in the adolescents, and the effect size was large, a finding also reported by Perry et al. (2017). Also, at follow-up, 47% of participants scored within the minimal-to-no symptoms category of ASD (as measured by the CARS-2), only 11% scored within the clinically significant range on maladaptive behavior, and none of the participants received any subsequent comorbid psychiatric diagnosis or were taking any psychotropic medication. Previous studies have shown that adolescents with autism often experience increased

**Table 5. Individual Data for the Participants (N = 9) who Achieved a follow-up Standard Score of 70 or above on IQ and Adaptive Functioning.**

Partici- pant	IQ		VL ABC		VL Comm		VL DLS		VL Soc		VL Mal		ADI Soc		ADIComm		ADI Rep		CARS		Length of full-time ABA (years)		Educational Placement		Specialist Support		Respite (hours per week)		Leisure activities		
	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	Intake	F-up	
1	76	121	78	77	73	86	75	68	75	68	76	85	Avr	13	2	12	1	3	0	Minimal-to-no symptoms	5	Mainstream	None	F-up	0	Sport, music					
2	83	88	87	80	108	86	78	83	94	76	94	76	El	17	7	10	3	6	3	Mild-to-moderate symptoms	6	Mainstream	Part time TA	F-up	0	Sport, music					
3	42	78	63	82	60	81	63	89	62	82	62	82	Avr	12	3	12	1	5	0	Minimal-to-no symptoms	3	Mainstream	Part time TA	F-up	0	Sport, music, clubs, youth club					
4	56	87	62	75	60	86	62	71	60	75	60	75	Avr	14	6	10	0	7	2	Minimal-to-no symptoms	9	Special education	Full time TA	F-up	0	Swimming, dancing,					
5	65	78	64	96	68	90	66	110	65	91	65	91	El	15	5	11	3	6	4	Minimal-to-no symptoms	11	Mainstream	Full time ABA shadow	F-up	0	Swimming, community trips					
6	54	83	66	119	71	116	66	119	73	112	73	112	Avr	15	0	7	0	4	5	Minimal-to-no symptoms	9	Mainstream	Part time TA	F-up	4	Sport, music, theatre					
7	72	114	93	105	76	103	84	105	101	106	106	Avr	18	0	10	0	6	0	0	Minimal-to-no symptoms	5	Mainstream	None	F-up	0	Sport					
8	54	75	58	72	61	68	69	87	56	67	67	El	19	12	11	8	8	2	2	Mild-to-moderate symptoms	14	EIBI program	Full time ABA shadow	F-up	0	Music, art, gardening					
9	61	77	62	85	62	89	74	89	66	89	66	89	Avr	12	0	7	0	4	0	Minimal-to-no symptoms	8	Mainstream	Part time TA	F-up	0	Sport, choir, ballet					
Mean	62.5	89	70.3	87.9	71	89.4	70.8	91.2	72.6	87	72.6	87	na	15	3.9	10	1.8	5.4	1.8	na	7.8	na	na	na	0.4	na	na	na	na	na	na

psychiatric symptoms as they grow older and may receive comorbid diagnoses and take psychotropic medication. Kaat, Gadow, and Lecavalier (2013) found that 86% of a group of participants with ASD between 6 and 12 years of age had at least one comorbid psychiatric diagnosis. The most common was ADHD (67-71%), oppositional defiant disorder (35-33%), and anxiety disorder (47-34%). Simonoff et al. (2008) found that 70% of participants with a mean age of 11.5 years had at least one comorbid diagnosis, and 41% had two or more. The most common diagnoses were social anxiety disorder (29% of participants), ADHD (28%), and oppositional defiant disorder (28%). Similarly, van Steensel, Bögels, and de Bruin (2013) found that 58% of participants with ASD between 7 and 18 years-of-age had at least one comorbid diagnosis. The prevalence of comorbid diagnoses in adults with autism is similar, with studies showing that up to 69% of participants meet the criteria for an additional psychiatric disorder (Buck et al., 2014) and individuals may have an average of three psychiatric disorders (Joshi et al., 2013). Comorbid disorders may also be found in adults with high-functioning autism and Asperger Syndrome (Mazzone, Ruta, & Reale, 2012). Also the use of psychotropic medication is quite common in adolescents and adults with autism. Frazier et al., 2011 found that 34% of 920 teenagers, with a mean age of 15 years, with ASD (and no comorbid diagnoses) were taking psychotropic medication, such as antipsychotics or antidepressants. Buck et al. (2014) found that 59% of the 129 adults with autism they studied were taking psychotropic medication, and research has shown that the likelihood of taking such medications increases with age (Seltzer, Shattuck, Abbeduto, & Greenberg, 2004).

The data on comorbid psychiatric diagnosis and psychotropic medication in the current study should be interpreted with caution, as these data were obtained from a questionnaire rather than determined directly from medical records. It is possible that the parents underreported these data, due to, for example, demand characteristics. However, examining the maladaptive scores on the VABS, only two participants scored within the clinically significant range on maladaptive behavior. This suggests that the participants, in general, had few maladaptive behaviors, which corresponds with the parent reports of absence of comorbid psychiatric diagnosis and use of psychotropic drugs.

Slightly above 40% of the participants were attending a mainstream school, whereas approximately 20% attended ABA schools and approximately 30% attended schools for children with special educational needs (SEN), and various types of educational support was provided in these settings. In the UK, where this study was conducted, ABA schools and schools for children with SEN are two distinct types of provision. ABA schools

provide an educational program based solely on behavioral principles, designed by behavior analysts and delivered by individuals trained primarily in ABA. Schools for children with SEN in the UK provide what is known as “eclectic” treatment which may include some instructional methods based on ABA. While no definitive definition of eclectic treatment exists, this is generally described as being a combination of treatments that address specific areas of need (Dillenburger, 2011) and is delivered by SEN teachers and teaching assistants. School placement and educational support, however, may not be a valid measure for evaluating outcome because type of school placement and support seem to depend largely on extraneous factors such as educational policies, funding issues, and parental input (Keen, Webster, & Ridley, 2015; Kurth, 2015).

McEachin et al. (1993) found that 47% of children with ASD who had received a minimum of two years of EIBI could be classified as functioning in the normal range at a mean age of 11.5 years. In the current study, 47% of the participants scored above 70 on both IQ and adaptive functioning, but the majority of these children had either elevated autism symptoms, elevated maladaptive scores or had some form of specialist support in mainstream schools, suggesting that most of these children, though faring well, likely were not functioning in the normal range. This difference in outcome at follow-up could be due to differences in participant characteristics at intake. For example, the mean intake IQ for participants in the McEachin et al. (1993) study (originally reported in Lovaas [1987]) was 62.9 at a mean age of 34.6 months (Eldevik et al., 2009). In comparison, the intake IQ for the current study, which was 54.8 at a mean age of 2 years 11 months (35 months), suggesting participants may have been functioning at a lower level at intake than those in the McEachin et al. (1993) study. Another reason for the difference in outcome between the McEachin et al. (1993) study and the current study may be the differences in duration since EIBI treatment ended, and also age at follow-up. The participants in the McEachin et al. (1993) study were assessed for follow-up at a mean of 13 years old and a mean of 5 years after treatment ended. In comparison, participants in the current study were followed up around age 5 years (after two years of EIBI) and 15 years (a mean of 10 years after EIBI ended), making a direct comparison difficult.

As with Perry et al. (2017) a limitation of the current study was that it lacked a control group. Hence, it cannot be determined if the participants of the current study did better than children receiving special education or other types of specialist autism provision. We have not been able to identify any recent long-term follow-up studies in adolescence of participants who have received comprehensive interventions other than EIBI. This type

of outcome research is clearly needed, and hence, should be a priority for future research.

In the current study, all participants of the Hayward et al (2009a) study were invited to participate. Though attrition is virtually inevitable in a study of this kind, particularly since many years have elapsed since the previous follow-up, the loss of more than half of the original cohort is a substantial limitation. The similarity at intake between participants who did and did not complete the current follow-up is somewhat reassuring, but it is unknown whether these two groups of participants subsequently had differing developmental trajectories. Other limitations pertain to the relatively small sample size and thus also the power. Moreover, the assessment of the autism symptoms was conducted by one of the investigators, and that we relied on parent report measuring several of the outcome variables. A strength of the current study was that IQ was measured by independent and blind assessors throughout the study.

Future research could aim to replicate and extend the current study, by including control groups of participants receiving other types of interventions. Research could examine which children benefit from only early intervention, and which children could benefit from longer term behavioral or other types of intervention. Such research could inform us about the potential financial benefits of continuing intervention. If specific programs increase independence and placement in least-restrictive environments, as well as reduce the need for respite care and supported living environments and residential care, then costs of supporting adults with autism could be significantly reduced. The costs of the period of ongoing ABA services during primary school age and adolescence is not more expensive as compared to specialist day schools for people with autism, which likely would have been the alternative provision for these individuals. Therefore, the investment in ABA services during this period does not pose a significant financial impact, but rather, the possibility of a long-term saving.

The economic impact of each individual with high-functioning autism is estimated to be £3.1 million (\$3.8 million), and for each individual with low-functioning autism to be £4.6 million (\$5.7 million). Residential/foster care costs for individuals with autism can be as high as £62,536 per annum (\$77,289) and residential/hospital care costs for adults can be as high as £97,863 per annum (\$121,004) (Knapp, Romeo, & Beecham, 2007). The cost of residential schools for individuals with autism may be even higher than this, for example in the UK as much £156,360 per year (\$193,422) ("Taxpayer foots £156,000 bill", 2011).

Future research could also examine more closely factors that may be associated with positive outcomes. For example, it may be that parental



involvement in the child's program is an important factor that is related to outcome. Parental involvement is vital for the generalization and maintenance of skills learned. Also, parents who have been trained to carry out behavioral intervention can ensure that the child continues to learn new skills and maintain previously learned skills even when a formal program has been phased out (Kovshoff et al., 2011).

In the current study, outcome for nineteen adolescents who received two years of EIBI is reported at a time point of ten years after EIBI ended, at an average age of fifteen years. Cognitive and adaptive standard scores increased significantly between intake and the end of the two-year EIBI period, furthermore these gains were maintained ten years after EIBI ended. The adolescents showed a significant reduction in autism symptoms between intake and follow-up at age 15 years. At follow-up, none of the participants had received any additional psychiatric diagnoses, and none were taking any psychotropic medication. These findings indicate that treatment gains achieved in EIBI are maintained into adolescence.

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