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ORIGINAL PAPER

Overview of Meta-Analyses on Early Intensive Behavioral Intervention for Young Children with Autism Spectrum Disorders

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Abstract This paper presents an overview of 5 meta-analyses of early intensive behavioral intervention (EIBI) for young children with autism spectrum disorders (ASDs) published in 2009 and 2010. There were many differences between meta-analyses, leading to different estimates of effect and overall conclusions. The weighted mean effect sizes across meta-analyses for IQ and adaptive behavior ranged from $g = .38–1.19$ and $g = .30–1.09$, respectively. Four of five meta-analyses concluded EIBI was an effective intervention strategy for many children with ASDs. A discussion highlighting potential confounds and limitations of the meta-analyses leading to these discrepancies and conclusions about the efficacy of EIBI as an intervention for young children with ASDs are provided.

Keywords Early intensive behavioral intervention · EIBI · Early intervention · Autism spectrum disorders · Meta-analysis

Early intensive behavioral intervention (EIBI; sometimes referred to as intensive behavioral intervention, early behavioral treatment, Lovaas therapy, etc.) was one of the first comprehensive treatment programs for young children with autism spectrum disorders (ASDs; Lovaas 1981). EIBI is based on the principles and technologies of applied behavior analysis and is typically an intensive home-based program (e.g., intervention lasting 2+ years involving comprehensive programming for upwards of 40 h per week with an initial emphasis on discrete trial training using 1-to-1 adult-to-child ratios). According to surveys of parents and service providers (Green et al. 2006; Stahmer et al. 2005), EIBI is one of the most common, popular, and requested treatment approaches for young children with ASDs.

The first empirical results of the effects of EIBI were published in 1987 (Lovaas 1987), and were very encouraging; 47% of the children with autism receiving EIBI achieved best outcome (i.e., post-treatment IQ > 85 and unassisted placement in a general education classroom or successful completion of first grade in a general education classroom). A follow-up report (McEachin et al. 1993) suggested much of the gains the children with best outcome achieved during intervention were maintained for 6 years. However, the report also revealed some individuals receiving greater than 7 years of EIBI did not make good progress. The initial report and subsequent follow-up report stirred much debate (e.g., Foxx 1993; Gresham and MacMillan 1998; Mesibov 1993; Mundy 1993; Schopler et al. 1989), and many replications ensued (e.g., Birnbrauer and Leach 1993; Anderson et al. 1987; Cohen et al. 2006; Sallows and Graupner 2005; Smith et al. 2000). Due much in part to the strong effects shown in the initial study and the surrounding debate on the effectiveness of the intervention, EIBI has become the most studied comprehensive treatment model for young children with ASDs.

Given the large amount of resources invested in EIBI, precise estimates of the effects of EIBI should be a priority. Since 2009, five meta-analyses of EIBI for young children with ASDs have been published in peer-reviewed journals (Eldevik et al. 2009; Makrygianni and Reed 2010; Reichow and Wolery 2009; Spreckley and Boyd 2009; Virués-Ortega 2010). The results and key methodological characteristics of these five meta-analyses are shown in Table 1. The basic findings of these meta-analyses varied from strong

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Table 1 Inclusion criteria and meta-analytic methods of reviews included in overview

	Population (age range)	Interventions	Research designs	Other criteria	Included studies	Number of participants	Effect size used	Weighted mean effect size (95% CI)	Tests of heterogeneity	Evidence of publication bias
Eldevik et al. (2009)	Autism or PDD-NOS (2–7 years)	EIBI based on Green et al. (2002)	Comparison and/or control group; not case study or series	12–36 Months of treatment duration	9	Treatment: 153 Control: 144	SMD	IQ—1.10 (.87–1.33) AB—.66 (.41-.90)	IQ—$Q(9) = 10.07$, $p = .35$ $I^2 = 10.66$ AB—$Q(7) = 8.5$, $p = .29$ $I^2 = 17.65$	No
Reichow and Wolery (2009)	Autism, ASD, PDD, PDD-NOS (<7 years)	EIBI based on Lovaas UCLA YAP model	RCTs, 2-group comparison, one group pre/post	>12 months of treatment duration	11	Treatment: 251	SMC	IQ—.69 (.39–1.00)	IQ—$Q(10) = 22.6$, $p = .02$ $I^2 = 51.2$	Yes
Spreckley and Boyd (2009)	Autism or PDD (1.5–6 years)	Applied behavior intervention	Systematic reviews, RCTs, quasi-RCTs, controlled trials	Rigor—PEDro score ≥ 6	4	Treatment: 41 Control: 35	SMD	IQ—.38 (−.09–.84) AB—.30 (−.16–.77)	IQ—$Q(2) = 2.99$, $p = .22$ $I^2 = 33.1$ AB—$Q(2) = 5.87$, $p = .05$ $I^2 = 33.1$	Not reported
Virués-Ortega 2010	Autism (not specified)	Comprehensive ABA intervention (e.g., Maurice et al. 2001)	Group design with > 5 participants	>10 h of treatment per week and >45 weeks of treatment duration	22	Treatment: 323 Control: 180	SMC and SMD: together	IQ—1.19 (.91–1.47) AB—1.09 (.70–1.47)	IQ—$I^2 = 75$ AB—$I^2 = 68$	Yes
Makrygianni and Reed (2010)	Autism, ASD, PDD, PDD-NOS (<4.5 years)	Comprehensive treatment based on ABA	Pre and post-treatment measures; excluded reviews or single subject designs	High (H) or moderate (M) methodological rigor based on modified criteria of Reichow et al. (2008)	14	Treatment: 303 Control: 162	SMC and SMD: separate	SMC: IQ—H: .95 M: .91 AB—H: .42 M: .47 SMD: IQ—H: .57 M: .73 AB—H: .97 M: .66	SMC: IQ—H: $Q(4) = .54$ M: $Q(10) = 17.73$ AB—H: $Q(3) = 7.99$ M: $Q(6) = 8.03$ SMD: IQ—H: $Q(2) = 5.08$ M: $Q(7) = 19.43$ AB—H: $Q(1) = 4.31$ M: $Q(4) = 11.52$	No

Key: *CI* confidence interval, *PDD-NOS* pervasive developmental disorder-not otherwise specified, *EIBI* early intensive behavioral intervention, *SMD* standardized mean difference effect size, *IQ* intelligence quotient, *AB* adaptive behavior, *Q* Q-statistic, I^2 I-squared, *ASD* autism spectrum disorder, *PDD* pervasive developmental disorder, *UCLA YAP* University of California at Los Angeles Young Autism Program, *RCTs* randomized control trials, *SMC* standardized mean change effect size, *PEDro* physiotherapy evidence database scale of quality assessment, *ABA* applied behavior analysis, *H* high methodological rigor, *M* moderate methodological rigor support of EIBI to a conclusion that EIBI was not superior to standard care. Four of five meta-analyses (Eldevik et al. 2009; Makrygianni and Reed 2010; Reichow and Wolery 2009; Virués-Ortega 2010) concluded EIBI was an effective intervention strategy for many children with ASDs. For these four meta-analyses, the weighted mean effect sizes for IQ had a range of $g = .57–1.19$ and the range of weighted mean effect sizes for adaptive behavior was $g = .42–1.09$, respectively. The one meta-analysis (Spreckley and Boyd 2009) concluding EIBI was not superior to standard care reported weighted mean effect sizes of $g = .38$ and $g = .30$ for IQ and adaptive behavior, respectively.

Although it is evident that much effort was employed by the research teams conducting the meta-analyses included in this overview, all meta-analyses had at least one methodological limitation including calculation of effect sizes based on small samples (sometimes without reference to a control group), inclusion of non-randomized studies, over inclusion of participant data, and lack of standardized comparison or control groups. This paper provides an overview of the five meta-analyses on EIBI for young children with ASDs and an examination of key differences and potential confounds that might have led to the discrepant findings.

Overview of Meta-Analyses

Inclusion Criteria of Meta-Analyses

One striking difference across meta-analyses is the variation in inclusion criteria. Although all meta-analyses synthesized comprehensive treatment programs for young children with ASDs based on applied behavior analysis, the specific definitions of the intervention varied from restriction to EIBI based on the manuals of Lovaas (e.g., Lovaas 1981, 2003; inclusion criterion of Reichow and Wolery 2009) to broader definitions of EIBI leading to the inclusion of programs such as Pivotal Response Treatment and Group Intensive Family Training (studies by Baker-Ericzen et al. 2007 and Anan et al. 2008, respectively; inclusion criterion of Virués-Ortega 2010), which have significant differences from the treatment described in the Lovaas manuals and many conceptualizations of EIBI. Care must be taken when conducting meta-analyses not to combine studies evaluating different independent variables (frequently referred to in meta-analysis as the apples and oranges problem; Borenstein et al. 2009), which appears to be a possible confound that cannot be ruled out of all meta-analyses included in this overview. An additional limitation of each meta-analysis is that all of the studies on EIBI had at least one methodological shortcoming including use of quasi-experimental designs, small sample sizes, non-random assignment to groups, inadequate participant characterization, narrow and inadequate outcome measures, lack of fidelity data, and lack of standardized treatment methods for control and/or comparison groups.

The different definitions of EIBI was largely responsible for the differences in which studies were included in each meta-analysis, which resulted in large differences in the total number of studies within each meta-analysis (from 4 studies with a total of 41participants in the Spreckley and Boyd (2009) meta-analysis to 22 studies with a total of 323 participants in the Virués-Ortega (2010) meta-analysis). Table 2 provides characteristics of each study included across meta-analyses. As shown in Table 2, most studies were included in two, three, or four meta-analyses, except for one study that was included in all five meta-analyses (Smith et al. 2000) and eight studies that were included in only one meta-analysis apiece (Anan et al. 2008; Baker-Ericzen et al. 2007; Ben-Itzchak et al. 2008; Harris et al. 1991; Harris and Handleman 2000; Boyd and Corley 2001, Matos and Mustaca 2005, and Reed et al. 2007b).

The other inclusion criterion likely to have had a significant effect on the conclusions of each meta-analysis is the research design. In the evaluation of EIBI, studies using multiple research designs (e.g., randomized clinical trials, retrospective pre/post comparisons, multiple-arm trials) with many different types of comparison groups (e.g., standardized nursery school, treatment as usual, eclectic models) have been conducted. No meta-analysis restricted inclusion to randomized control trials, which is a common recommendation in meta-analysis (Reeves et al. 2008). All meta-analyses restricted inclusion to group research design studies. Eldevik et al. (2009) and Spreckley and Boyd (2009) further restricted the criteria to comparative group research designs, which limited the number of studies meeting eligibility criteria. Given the lack of a standardized comparison group, both strategies seem justifiable, however, the inclusion of non-randomized studies is a potential confound and should be considered a limitation of all meta-analyses included in this overview. The lack of standardized conditions for comparison groups creates a situation in which drawing strong conclusions about the effectiveness of EIBI is difficult and should be considered a limitation that needs to be carefully addressed in future meta-analyses. Furthermore, the lack of a standardized comparison group across studies evaluating EIBI also created a situation in which the research teams conducting meta-analysis had to make decisions on how to interpret different comparison groups, which had significant consequences on the outcome of each meta-analysis.

Differences in the Interpretation of Comparison Groups

Misinterpretation of Sallows and Graupner Parent-Directed EIBI Group

The interpretation of a comparison group had a significant impact on the outcome of the Spreckley and Boyd (2009) meta-analysis, which interpreted the parent-directed EIBI group of the Sallows and Graupner (2005) study as a control group. In the Sallows and Graupner study, participants in the parent-directed EIBI group received greater than 30 h of EIBI per week using the same curriculum (Lovaas 1981; Maurice et al. 1996) delivered from therapists hired from the same agency as the clinic-directed EIBI group, which also received greater than 30 h of EIBI per week. The treatment received by the participants in the parent-directed EIBI group was not equivalent to standard care or a traditional no-treatment control group and should not be considered as such (see Smith et al. 2009 for further explanation). In fact, the results showed that, on average, both the parent-directed EIBI group and the clinic-directed EIBI group made significant gains on the standardized assessments between pre-treatment and post-treatment but there were not statistically significant differences between the two EIBI groups. The interpretation of the Sallows and Graupner parent-directed EIBI group as a control group likely led to the smaller effect sizes found in the Spreckley and Boyd meta-analysis and their subsequent conclusion that EIBI was not superior to standard care.

It is noteworthy that the Spreckley and Boyd (2009) meta-analysis was the only meta-analysis included in this overview to calculate an effect size for the Sallows and Graupner (2005) study with the parent-directed EIBI group treated as a control group. Eldevik et al. (2009) excluded the Sallows and Graupner study because they concluded the study did not have a control or comparison group. The other three meta-analyses included in this overview (Makrygianni and Reed 2010; Reichow and Wolery 2009; Virués-Ortega 2010) calculated the standardized mean change effect size for the Sallows and Graupner study, which is calculated with respect to change scores and not post-treatment differences between groups. Although the Sallows and Graupner parent-directed EIBI group was treated as a control group in only one of five meta-analyses included in this overview, it has occurred elsewhere with similar consequences. Multiple health insurance agencies (e.g., Aetna 2010; Blue Cross and Blue Shield 2009; Cigna 2009) have either made a similar misinterpretation or used the Spreckely and Boyd results to conclude the effectiveness of EIBI has not been well established, leading to policy decisions denying coverage of the treatment. The misinterpretation of the parent-directed EIBI group of the Sallows and Graupner study as a control group (and limitation to randomized clinical trials) also likely led to erroneous conclusions in the recent What Works Clearinghouse Intervention Report: *Lovaas Method of Applied Behavior Analysis* (What Works Clearinghouse 2010). The significance of the misinterpretation of the Sallows and Graupner parent-directed EIBI group cannot be understated and future reviews should take great care to ensure this mistake is not made.

Multiple-arm Studies

Multiple-arm studies compare one group of participants receiving a treatment (e.g., EIBI) to at least two other groups not receiving that treatment (e.g., TAU and no treatment control). Three studies included in one or more meta-analyses were conducted using multiple-arm methodology (Howard et al. 2005; Lovaas 1987; Reed et al. 2007b). When a multi-arm trial is included in a meta-analysis, recommended practice suggests using only one comparison either by selecting the comparison that is the closest to other comparisons in the meta-analysis or by creating a comparison that averages the results of all pairwise comparisons between the treatment and comparison groups (Borenstein et al. 2009; Higgins et al. 2008). It appears that most meta-analyses including multiple-arm trials (Makrygianni and Reed 2010; Reichow and Wolery 2009; Virués-Ortega 2010) followed these conventions. However, the Eldevik et al. (2009) meta-analysis has multiple effect size estimates for the treatment group of the Howard et al. (2005) study, creating a situation in which the results of the participants of the treatment group counted twice. Given the large effect size estimates of both comparisons from the Howard et al. study, it is possible that the inclusion of multiple comparisons inflated the weighted mean effect sizes and should therefore be considered a limitation.

Effect Size Calculations

Because studies with and without comparison groups were included across meta-analyses, two different types of effect size estimates were used. The standardized mean difference effect size with Hedges and Olkin's (1985) small sample correction, which compares post-treatment scores for the treatment and comparison groups, could be calculated for studies comparing one group receiving EIBI with another group not receiving EIBI. For studies without a comparison group, the standardized mean change effect size with Hedges and Olkin's small sample correction, which compares pre-treatment and post-treatment scores of one group, had to be used. Across meta-analyses calculations based on

Table 2 Characteristics of studies included in reviews

Study	Year	Included in	Pretreatment participant characteristics by group								Treatment characteristics		
			Group	*n*	Age	M,F	IQ	VABS	EL	RL	Model	hr/wk	Mo of Tx
Lovaas	1987	E, R, V, M	TX	19	34.6	–	62.7	–	–	–	UCLA	40	24+
			C	19	40.9	–	57.0	–	–	–	UCLA	10	24+
			C	21	<42	–	60.0	–	–	–	TAU	–	24+
Anderson et al.	1987	R, V, M	TX	14	42.8	–	57.3	50.7			UCLA	15–25	12–24
Harris et al.	1991	V	TX	9	50.1	8,1	67.6	–	–	–	EIBI	35–45	11.4
Birnbrauer and Leach	1993	E, R, V	TX	9	38.1	5,4	51.3	46.1	–	–	UCLA	18.7	21.6
			C	5	33.2	5,0	54.5	51.5	–	–	–	–	24
Smith et al.	1997	E, R, V, M	TX	11	36	11,0	28	50.3	–	–	UCLA	30	35
			C	10	38	8,2	27	–	–	–	UCLA	10	26
Sheinkopf and Siegel	1998	R, V	TX	11	33.8	–	62.8	–	–	–	UCLA	27.0	15.7
			C	11	35.3	–	61.7	–	–	–	TAU	11.1	18
Weiss	1999	V, M	TX	20	41.5	19,1	–	49.9	–	–	EIBI	40	24
Harris and Handleman	2000	V	TX	27	49.0	–	59.3	–	–	–	EIBI	35–40	93
Smith et al.	2000	E, R, S, V, M	TX	15	36.1	12,3	50.5	63.4	41.9	37.3	UCLA	24.5	33.4
			C	13	35.8	11,2	50.7	65.2	45.6	38.3	UCLA	15–20	24
Bibby et al.	2002	R, V	TX	66	45.0	55,11	50.8	54.5	–	–	UCLA	30.3	32.8
Boyd and Corley	2001	R	TX	22	41.3	16,6	–	–	–	–	UCLA	20–30	23
Eikeseth et al.	2002	E, S, V	TX	13	66.3	8,5	61.9	55.8	45.1	49.0	UCLA	28.0	12.2
			C	12	65.0	11,1	65.2	60.0	51.2	50.4	Eclectic	29.1	13.6
Howard et al.	2005	E, V, M	TX	29	30.9	25,4	58.5	70.5	51.9	52.2	EIBI	25–40	14.2
			C	16	37.4	13,3	53.7	69.8	43.9	45.4	Eclectic	25–30	13.3
			C	16	34.6	16,0	59.9	71.6	48.8	49.0	Eclectic	15	14.8
Matos and Mustaca	2005	V	TX	9	48	8,1	31	21	–	32	UCLA	30	9–12
Sallows and Graupner	2005	R, S, V, M	TX	13	35.0	11,2	50.9	59.5	47.9	38.9	UCLA	37.6	48
			TX	10	37.1	8,2	52.1	60.9	48.4	38.8	UCLA	31.3	48
Cohen et al.	2006	E, R, V, M	TX	21	30.2	18,3	61.6	69.8	52.9	51.7	UCLA	35–40	36
			C	21	33.2	17,4	59.4	70.6	52.8	52.7	Eclectic	–	–
Eldevik et al.	2006	E, R, V, M	TX	13	53.0	10,3	41.0	52.5	33.8	37.3	UCLA	12.5	20.3
			C	15	49.0	14,1	47.2	52.5	41.6	33.2	Eclectic	12.0	21.4
Baker-Ericzen et al.	2007	V	TX	158	49.4	128,28	–	–	–	–	PRT	–	12
Ben-Itzchak and Zachor	2007	V, M	TX	25	26.6	23,2	70.7	–	–	–	EIBI	35	12
Eikeseth et al.	2007	R, S	TX	13	66.3	8,5	61.9	55.8	45.1	49.0	UCLA	28.0	31.4
			C	12	65.0	11,1	65.2	60.0	51.2	50.4	Eclectic	29.1	33.3
Magiati et al.	2007	R, V, M	TX	28	38.0	27,1	83.0	59.6	2.2^{r}	4.9^{r}	UCLA	32.4	25.5
			C	16	42.5	12,4	65.2	55.4	1.7^{r}	2.9^{r}	Eclectic	25.6	26.0
Reed et al.	2007a	V, M	TX	12	40	11,1	56.8	58.2	–	–	EIBI	30.4	9
			C	20	43	18,2	57.8	53.0	–	–	Eclectic	12.7	9
			C	16	38	–	53.4	58.6	–	–	Portage	8.5	9
Reed et al.	2007b	M	TX	14	42.9	14,0	60.1	59.3	–	–	EIBI	30.4	9–10
			C	13	40.8	13,0	56.6	56.5	–	–	EIBI	12.6	9–10
Remington et al.	2007	E, V, M	TX	23	38.4	–	61.4	114.8^{r}	–	–	EIBI	25.6	24
			C	21	35.7	–	62.3	113.6^{r}	–	–	TAU	15.3	24
Anan et al.	2008	V	TX	72	44	61,11	51.7	53.11	–	–	EIBI	15	2.8
Ben-Itzchak et al.	2008	V	TX	44	27.3	43,1	74.8	–	–	–	EIBI	45	12
			C	37	24.2	23,14	71.0	–	–	–	TAU	–	12

Key: *Age* average age by group in months, *M* male, *F* female, *IQ* intelligence quotient, *VABS* vineland adaptive behavior scales (Sparrow et al. 1984) composite standardized score, *EL* expressive language, *RL* receptive language, *hr/wk* average number of hours per week of treatment, *mo of tx* average number of months of treatment, *E* Eldevik et al., 2009, *R* Reichow and Wolery 2009, *V* Virués-Ortega 2010, *M* Makrygianni and Reed 2010, *S* Spreckley and Boyd 2009, *TX* treatment group, *C* control/comparison group,—not reported *UCLA* University of California at Los Angeles, *TAU* treatment as usual, *EIBI* early intensive behavioral intervention, *PRT* pivotal response treatment, ^{r} raw score the different effect sizes led to very large differences (e.g., $>g = 1.50$) in effect size estimates for individual studies A sensitivity analysis from one meta-analysis (Virués-Ortega 2010) including both effect sizes suggested that studies with control groups had a larger weighted mean effect size for IQ but a smaller weighted mean effect size for adaptive behavior than studies that did not contain control groups. Because the standardized mean change effect size does not account for maturation, the use of this effect size in meta-analysis should be considered a potential confound and limitation of the meta-analyses using this estimate.

Moderator Analyses

Three reviews (Makrygianni and Reed 2010; Reichow and Wolery 2009; Virués-Ortega 2010) concluded their meta-analysis showed enough between group differences to conduct moderator analyses. Makrygianni and Reed used partial correlations controlling for methodological quality to examine seven treatment and pre-intervention child characteristics (treatment intensity, treatment duration, parental training, chronological age, IQ, language, and adaptive behavior). They found large relations suggesting (a) higher treatment intensity was related to larger changes and greater between group differences in IQ and adaptive behavior, (b) greater treatment duration was related to greater between group differences in adaptive behavior, (c) inclusion of parent training was related to greater between group differences in adaptive behavior, and (d) better pre-treatment adaptive behavior was related to larger changes in language and greater between group differences in adaptive behavior. No statistically significant relations were found for pre-intervention chronological age, IQ, or language ability.

Reichow and Wolery (2009) used analysis of variance methods to examine methodological rigor and method of group assignment, both of which did not have a statistically significant relation to changes in IQ. Weighted multiple regression was used to examine six additional variables (model of supervisor training, treatment density [intensity], treatment duration, total hours of treatment, pre-intervention chronological age, and pre-intervention IQ). Only one variable had a significant relation; studies in which supervisors were trained using the UCLA procedures had greater increases in IQ scores.

Finally, Virués-Ortega (2010) used random-effects meta-regression models and dose–response meta-analysis to examine relations between effect sizes for IQ, language composite, and adaptive behavior and intervention (duration and intensity) and child (pre-intervention age and pre-intervention IQ) characteristics. The meta-regression showed longer treatment duration was related to larger differences in language composite scores. The dose–response meta-analysis suggested longer treatment duration was related to higher expressive and receptive language scores and greater treatment intensity was related to higher adaptive behavior scores.

Publication and Selection Bias

Publication bias should be considered a potential confound in all of the meta-analyses. All meta-analyses included in this overview only included studies published in peer-reviewed journals, which increases the threat of publication bias. Publication bias was assessed in four meta-analyses; two analyses found evidence of publication bias (Reichow and Wolery 2009; Virués-Ortega 2010) and two did not (Eldevik et al. 2009; Makrygianni and Reed 2010). Therefore, it is unclear what, if any, effect publication bias might have had on the results of these meta-analyses; future meta-analyses should consider more inclusive inclusion criteria. A related risk is selection bias. Three of five meta-analyses (i.e., Eldevik et al. 2009; Makrygianni and Reed 2010; Spreckley and Boyd 2009) included in this review were conducted by a research team that included at least one individual previously involved in studying EIBI. Furthermore, the author of this overview was involved in one of the meta-analyses included in this review (Reichow and Wolery 2009). Although peer-review might help limit the threat of selection bias, it cannot be ruled out.

Conclusions and Future Recommendations

This paper presents an overview of five meta-analyses on EIBI for young children with ASDs. By synthesizing the results across multiple studies, meta-analysis can be a powerful tool for estimating the average effects of an intervention; thus, the collective and accumulating evidence supporting EIBI from meta-analytic studies cannot be dismissed. On average, EIBI can be a powerful intervention capable of producing large gains in IQ and/or adaptive behavior for many young children with ASDs. Despite their differences, most (4 of 5) meta-analyses (Eldevik et al. 2009; Makrygianni and Reed 2010; Reichow and Wolery 2009; Virués-Ortega 2010) reached the conclusion that EIBI is an effective intervention. It should be noted that the four meta-analyses reaching this conclusion are also the four meta-analyses that properly interpreted the Sallows and Graupner (2005) parent-directed EIBI group. Stated differently, all meta-analyses correctly interpreting the Sallows and Graupner parent-directed EIBI group concluded EIBI is an effective intervention. The conclusion that EIBI can be an effective intervention for many children with autism is also supported by multiple descriptive reviews (e.g., Granpeesheh et al. 2009; Eikeseth 2009; Matson and Smith 2008; Rogers and Vismara 2008) and in a recent "mega-analysis" of 309 individual participant data (Eldevik et al. 2010). Furthermore, the current evidence on the effectiveness of EIBI meets the threshold and criteria for the highest levels of evidence-based treatments across definitions (e.g., Kratochwill and Stoiber 2002; National Autism Center 2009; Odom et al. 2005; Reichow 2011; Silverman and Hinshaw 2008). Collectively, EIBI is the comprehensive treatment model for individuals with ASDs with the greatest amount of empirical support and should be given strong consideration when deciding treatment options for young children with ASDs.

Although the average effects of EIBI appear to be strong and robust, no treatment, including EIBI, has been effective for all children with ASDs. Therefore, data providing information on the child characteristics that are most likely to be associated with best outcomes are needed. Because of the discrepant findings across moderator analyses, the meta-analyses included in this review shed little light on this issue. To continue to move the field forward and increase the knowledge on effective treatments for children with ASDs, it is imperative that thorough pre-treatment participant characterization and collection of outcome data across a broad range of measures be collected.

Discrepancies across moderator analyses were also seen with respect to treatment characteristics, suggesting the specific treatment components with the greatest effects remain unclear. Recent survey data suggest that while EIBI programs often use a similar conceptual foundation (e.g., intensive intervention based on applied behavior analysis). specific program characteristics vary across and within programs (Love et al. 2009). To fully realize the potential benefits of EIBI, additional knowledge on the characteristics of EIBI programs outside of treatment studies (i.e., how EIBI is used in real world settings) is needed. Guidelines focusing on the intensity, duration, level of treatment fidelity, and therapist experience and/or training necessary to achieve optimal outcomes should also be more closely measured and reported in future research.

Finally, in addition to the greater specificity needed for treatment components, better knowledge about treatment outcomes are needed. Based on the meta-analyses reviewed for this overview, most young children with ASDs receiving EIBI can expect, on average, large increases in IQ and lesser (but still significant) increases in adaptive behavior. Although some studies have shown large gains on standardized measures of language (e.g., Cohen et al. 2006; Smith et al. 2000), it has been less frequently reported in studies of EIBI and was not synthesized in all of the meta-analyses. A better understanding of the effects of EIBI on language abilities is needed. Moreover, although measuring social competence is difficult, it is a defining feature of ASDs (Kanner 1943) and determining the effects of this intervention, if any, on this core feature of the disorder should be given careful consideration in future studies. Finally, the differences in measurement instruments across studies for psychopathology have likely led to no synthesis of these measures. Better measurement and reporting of psychopathology and in turn, a better understanding of the effects of EIBI on the core symptomotology of children receiving the treatment should be a priority. Data reflecting typical changes on standard outcomes such as IQ, adaptive behavior, language abilities, and psychopathology due to treatment in real life settings should also be collected. Once data on optimal child characteristics, necessary treatment components, and likely outcomes are collected, parents and clinicians will be able to make more informed choices when selecting EIBI as a treatment for young children with ASDs.

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Studies included in the reviews are indicated with an asterisk (*). Reviews included in the overview are indicated with a cross (+)

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