



The Efficacy of Early Interventions for Children with Autism Spectrum Disorders: A Systematic Review and Meta-Analysis

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Abstract: The superiority of early interventions for children with autism spectrum disorders (ASDs) compared to treatment as usual (TAU) has recently been questioned. This study was aimed to investigate the efficacy of early interventions in improving the cognitive ability, language, and adaptive behavior of pre-school children with ASDs through a systematic review of randomized controlled trials (RCTs). In total, 33 RCTs were included in the meta-analysis using the random effects model. The total sample consisted of 2581 children (age range: 12–132 months). Early interventions led to positive outcomes for cognitive ability (g = 0.32; 95% CI: 0.05, 0.58; p = 0.02), daily living skills (g = 0.35; 95% CI: 0.08, 0.63; p = 0.01), and motor skills (g = 0.39; 95% CI: 0.16, 0.62; p = 0.001), while no positive outcomes were found for the remaining variables. However, when studies without the blinding of outcome assessment were excluded, positive outcomes of early interventions only remained for daily living skills (g = 0.28; 95% CI: 0.04, 0.52; p = 0.02) and motor skills (g = 0.40; 95% CI: 0.11, 0.69; p = 0.007). Although early intervention might not have positive impacts on children with ASDs for several outcomes compared to controls, these results should be interpreted with caution considering the great variability in participant and intervention characteristics.

Keywords: autism spectrum disorders; early interventions; cognitive ability; language; meta-analysis

1. Introduction

The increasing prevalence rates in autism diagnoses during recent years (1 in every 150 children in 2000, 1 in every 68 children in 2012, and now 1 in every 44 children) [1] has enhanced the establishment of a variety of interventions for young children with ASDs [2–6]. Such approaches are classified according to their manual and targeted outcomes as behavioral interventions, developmental interventions, naturalistic developmental behavioral interventions (NCBI), TEACCH, sensory-based interventions, animal-assisted interventions and technology-based interventions [2]. Sensory-based interventions are motivated by the theory that children with ASDs may fail to respond to sensory inputs such as sound, touch, body movement, sight, taste, and smell. Within this concept, sensory integration therapy aims to help children with ASDs use their senses together to enhance their engagement and participation in a range of daily living activities. For example, sensory stimuli, such as a hug machine with ASDs during travelling [7].

Despite the existence of various treatment programs, there is insufficient evidence for the superiority of a treatment model in improving core areas of deficits of children with ASDs, such as cognitive ability, language, communication, socialization and adaptive behavior. Recently, the American Psychological Association (APA) published a meta-analysis about the efficacy of early interventions. The authors concluded that, when no study quality criteria were considered, positive outcomes were found for behavioral, developmental and NCB interventions. However, when the analysis was limited to RCTs at a low risk of detection bias, there was no evidence of positive outcomes for young children with ASDs [2].



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Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). Partially consistent with the results published by APA is the meta-analysis conducted by Yi et al. (2019) [8]. The authors compared the effectiveness of applied behavior analysis (ABA), early start Denver model (ESDM), Picture Exchange Communication Systems (PECS), and discrete trial training (DTT) investigated via randomized controlled trials (RCTs). They found positive outcomes of ABA-based interventions in socialization, communication, and expressive language, but not in receptive language, adaptive behavior and cognitive ability. Rogers et al. (2021) [9], conducted a meta-analysis of non-randomized studies about the efficacy of ABA. They did not find any significant outcomes for cognitive ability or adaptive behavior, but children in the experimental group outperformed children in the control group in the adaptive behavior scale over a 2-year follow-up. Positive outcomes for children in cognitive competence, language-communication, social competence, and adaptive behavior were also reported in a substantial number of meta-analyses [10–18]. However, the aforementioned findings were not ubiquitous [19–21].

The majority of previous meta-analyses pointed out that the considered studies had considerable methodological limitations [1,18,22,23]. Moreover, if we carefully examine the studies testing the effectiveness of early interventions, we notice that regardless of their theoretical frameworks or "brand-name", they presented extensive differences in terms of treatment intensity and duration. Some studies included more comprehensive interventions, focusing on core functional areas such as cognitive ability, language, or adaptive behavior, while others included targeted interventions addressing more restricted areas, such as joint attention and imitation. However, children with autism who present higher scores of joint attention, imitation, and object play in infancy are more likely to have stronger communication and intellectual skills in the subsequent years [24].

The aim of the current meta-analysis was to draw a valid conclusion about the efficacy of early intervention programs for pre-school children with ASDs compared to children that did not receive any of the abovementioned early intervention treatments in improving their cognitive ability, language skills, communication, socialization and adaptive behavior. Furthermore, this is the first meta-analysis to synthesize all available information from the included studies through mathematical formulas that enabled the combined testing of multiple measurements of the dependent variables across studies (e.g., single variables measured by different scales). Considering the impact that the improvement in proximal variables can have on distal variables [24], we included studies focusing on both comprehensive and targeted areas of functionality. We also aimed to extend the findings of Sandback et al., 2020 [2] and examine whether intervention duration and intensity can predict the performance of participants post treatment. To fulfil this purpose, we decided to only include RCTs, because this design can provide more reliable results regarding the causal effect of an intervention [25].

2. Materials and Methods

2.1. Search Strategy

We searched PsycInfo, ERIC and MEDLINE PubMed, and Google Scholar on 11 May 2022 without applying any time limit for peer-reviewed studies published in English language by entering the following keywords: (autism) OR (autistic) OR (developmental disorder) OR (autism spectrum disorder) OR (Asperger)) AND ((preschool age children) OR (young children) OR (toddlers) OR (pupils)) AND ((intervention) OR (comprehensive intervention) OR (parent training) OR (parent implemented) OR (comprehensive approach) OR (developmental approach) OR (behavioral approach) OR (therapy) OR (EIBI) OR (ABA)) AND ((cognition) OR (cognitive ability) OR (language) OR (adaptive behavio*)). A pilot search was first conducted in October 2021. The literature search was performed by two independent authors. Disagreements were solved after discussion and the re-evaluation of the relevance of each study until a consensus was reached.

Query logic was adapted to each search database to optimize retrieval. Following the recommendations by [26], the study selection process was conducted and presented using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (http://prisma-

statement.org/, accessed on 26 May 2022) as a guide (see Figure 1). The PRISMA study selection process entails four phases: identification, screening, eligibility and final synthesis.

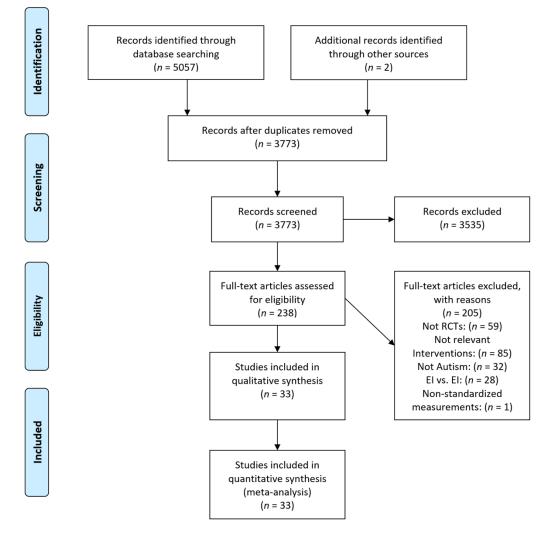


Figure 1. Flow diagram of study selection.

2.2. Study Selection

We included studies that: (i) were randomized controlled trials (RCTs); (ii) focused on participants who were infants at risk of autism and preschool-aged children with a diagnosis of autistic spectrum disorders (ASDs), autistic disorder (AD), pervasive developmental disorders-not-otherwise-specified (PDD-NOS), and/or pervasive developmental disorders (PDDs) (studies including exclusively infants who were all under 18 months of age were not included, since we aimed at measuring a clear manifestation of the autistic or developmental symptoms); (iii) considered interventions that included psychosocial parent- or/and professional-implemented specialized interventions aiming at reducing ASD-related impairments (studies examining pharmacological treatments and alternative interventions such as music therapy or equine therapy were not included, and since we tested the overall effectiveness of early interventions, we did not include studies examining the effectiveness of different versions of the same approach, varying in intervention providers, setting, or dosage, for example, or studies comparing different kinds of early interventions); (iv) measured outcomes that included at least one of the following domains—cognitive ability, expressive language, receptive language, communication, socialization, adaptive behavior composite, daily living skills and motor skills-measured by standardized scales (outcomes had to be presented by means and standard deviations for both groups); and (v) were published in the English language and were peer-reviewed articles.

2.3. Data Extraction and Coding

We created three different spreadsheets in Excel (version 2206, Microsoft Excel, Microsoft Corporation, Redmont, WA, USA). The first spreadsheet contained descriptive information of each study including study name, date, study sample size, participant's age, gender, and intervention-related information such as intervention type, duration, intensity, intervention providers, and intervention setting (Table 1). Experimental group interventions included any intervention. The intervention duration and intensity were coded as moderators of the result and were thus analyzed as independent variables. The second spreadsheet contained the means and standard deviations, as well as the scales of measurement of the examined variables for each outcome, and the third spreadsheet was identical to second for the combined outcomes (Tables A1 and A2).

Study	Participants n (% Males), Mean Age (Age Range)	Experiment Group Intervention	Duration and Intensity of Intervention	Comparison Condition	Duration	Intervention Providers	Setting
Aldred et al. (2004) [27]	<i>n</i> = 28 (89.29%, males); mean age: 49.5 (24–71)	Social Communication Intervention	6 months with monthly sessions followed by another 6 months of 2-monthly consolidation sessions plus 30 min daily parent-child interaction	TAU	12 months	Professionals and parents	Individual
Brian et al. (2017) [28]	n = 62 (75.8%, males); mean age: 25.26 (16–30)	Social ABCs	12 weeks of 1.5 h home visits with tapering intensity (week 1: 3 visits; week 2: 2 visits; weeks 3-8: 1 visit/week; weeks 10 and 12: 1 "booster" visit/week; weeks 9 and 11: check-in phone call)	TAU: 3 months: up to 1 h/week of "other" direct therapy	3 months	Parents	Individual
Carter et al. (2011) [29]	n = 62 (82.26% males); mean age: 20.25 (15–25)	Hanen's More Than Words (HMTW)	8 group parent sessions of 2.5 h and three in-home individualized parent-child sessions of 1 h	No treatment	3.5 months	Parents	Individual and group
Dawson et al. (2010) [30]	n = 48 (77.1% males); mean age: 23.5 (18–30)	The Early Start Denver Model (ESDM)	15.2 h therapist-delivered and 16.3 h/week parent-delivered therapy, 5 days/week	TAU: 9.1 h of individual therapy and an average of 9.3 h/week of group interventions for 2 years	2 years	Parents	Individual
Divan et al. (2019) [31]	n = 40 (87.5% males); mean age: 64 (27–105)	Parent mediated intervention for Autism Spectrum Disorder Plus (PASS Plus)	12 fortnightly home-based session between the parent and the lay health worker after a 10 min period of play between the parent and the child	TAU	6 months	Parents	Individual
Drew et al. (2002) [32]	<i>n</i> = 24 (79.17% males); mean age: 22.5 (-)	Parent training intervention with a focus on the development of joint attention skills and joint action routines	3 h parent sessions every 6 weeks	TAU: 3 months: 32.9 h/week	12 months	Parents	Individual
Estes et al. (2015), follow-up of Dawson et al. (2010) [33]	<i>n</i> = 39 (77% males); mean age: 2.9	The Early Start Denver Model (ESDM)	15.2 h therapist-delivered and 16.3 h/week parent-delivered therapy, 5 days/week	TAU: 9.1 h of individual therapy and an average of 9.3 h/week of group interventions for 2 years	2 years	Parents	Individual
Gengoux et al. (2019) [34]	<i>n</i> = 43 (88.4% males); mean age: 48.4 (24–60)	PRT-P	Weeks 1 to 12: weekly 60 min parent training sessions and 10 h per week of clinician delivered in-home treatment for children. Weeks 12 to 24: monthly 60 min parent training sessions and 5 h per week of in-home treatment for children	Waitlist and stable community treatments	24 weeks	Professionals and parents	Individual

Table 1. Characteristics of the included studies.

Study	Participants n (% Males), Mean Age (Age Range)	Experiment Group Intervention	Duration and Intensity of Intervention	Comparison Condition	Duration	Intervention Providers	Setting
Green et al. (2010) [35]	<i>n</i> = 152 (90.79% males); mean age: 45 (24–60)	Parent-mediated communication- focused treatment in children with autism (PACT) Paediatric	2 h clinic sessions every 2 weeks for 6 months followed by monthly booster sessions for 6 months, plus 30 min of daily home practice	TAU	13 months	Parents	Individual
Green et al. (2022) [36]	<i>n</i> = 248 (79.4% males); mean age: 63 (24–132)	Autism Communication Therapy- Generalised (PACT-G)	12 intervention sessions over 6 months at home plus 12 sessions over 6 months, again with 50% remote delivery	TAU	6 months	Professionals and parents	Individual
Hampton et al. (2020) [37]	n = 73 (79% males); mean age: 43 (36–60)	Caregiver training, Discrete Trial Teaching, and JASP + EMT + SGD	36 sessions in the clinic and at home, 45–60 min per session	TAU	4 months	Professionals and parents	Individual
Hardan et al. (2015) [38]	n = 47 (75% males); mean age: 49.2 (24–84)	Pivotal Response Treatment (PRT)	1 session of 90 min/week	Psychoeducation: 12 weeks: 1 session of 60 min/week	12 weeks	Parents	Individual
Kaale et al. (2014) [39]	n = 61 (78.7% males); mean age: 48.8 (24–60)	Social communication treatment	2 daily 20 min sessions, including 5 min of table-top training and 15 min of floor play	TAU	8 weeks	Teachers	Group
Kasari et al. (2015) [40]	n = 86 (81.4% males); mean age: 31.5	Joint Attention, Symbolic Play, Engagement and Regulation (JASPER)	2 sessions of 30 min per week	Psychoeducation: 1 h per week	10 weeks	Professionals and parents	Individual
Landa et al. (2011) [41]	n = 48 (88.3% males); mean age: 28.7 (21–33)	Interpersonal Synchrony	10 h per week in classroom, student-to-teacher ratio, schedule, home-based parent training (1.5 h per month), parent education (38 h), plus supplementary curriculum targeting socially engaged imitation, joint attention, and affect sharing	Non- Interpersonal Synchrony: 10 h per week in classroom, student-to- teacher ratio, schedule, home-based parent training (1.5 h per month), parent education (38 h)	6 months	Teachers, Parents	Group, Individual
Oosterling et al. (2010) [42]	n = 65 (77.61% males); mean age: 34.32 (<12-42)	Joint attention and language skills stimulation TOBY app	2 h sessions with parents, 3 h home visits every 6 weeks during the first year. In the second year, 3-month intervals between home visits	TAU	2 years	Parents	Individua
Parsons et al. (2019) [43]	<i>n</i> = 59 (81.4% males); mean age: 62.6 (24–72)	targeting visual motor, imitation, language and social parameters	At least 20 min on the TOBY app daily for 3 months using an iPad	TAU	3 months	-	Individua
Rahman et al. (2016) [44]	n = 65 (81.5% males); mean age: 64.5 24–108)	PASS (plus TAU)	1 h sessions every 2 weeks for 6 months	TAU	6 months	Professionals and parents	Individua
Reitzel et al. (2013) [45]	<i>n</i> = 11 (-); mean age: 58.5 (38–82)	Functional Behaviour Skills Training program (FBST)	30 min parents-only training sessions, a simultaneous children's activity session, and a 90 min combined children's and parents' training session	TAU	4 months	Professionals and parents	Individua
Rickards et al. (2007) [46]	n = 59 (79.7% males); mean age: 43.87 (36–60)	Home-based Program (in addition to a center-based program)	1 and $1\frac{1}{2}$ h during school terms over a 12-month period plus 5 h spread over two weekly sessions during school terms	Center-based program: 5 h spread over two sessions weekly during school terms	12 months	Professionals	Individua
Roberts et al. (2011) [47]	n = 56 (90.5% males); mean age: 42.6 (26.3–60.3)	Building Blocks home-based	Visit for 2 h once a fortnight over a 40-week period (20 sessions maximum)	Waitlist	1 year	Parents	Individual

Study	Participants n (% Males), Mean Age (Age Range)	Experiment Group Intervention	Duration and Intensity of Intervention	Comparison Condition	Duration	Intervention Providers	Setting
Rogers et al. (2012) [48]	n = 98 (77.55% males); mean age: 20.98 (12-24)	Brief Early Start Denver Model (P-ESDM) Parent-based Intervention	1 session of 1 h/week	TAU	12 weeks	Parents	Individual
Rogers et al. (2019) [49]	n = 118 (78% males); mean age: 21.02 (14-24)	Early Start Denver Model (ESDM)	3 months of weekly parent coaching followed by 24 months of 15 h per week (on average) 1:1 treatment weekly on average in homes or daycare settings from supervised therapy assistants while parents received 4 h of coaching monthly from a certified ESDM therapist	TAU	27 months	Professionals and parents	Individual
Scahill et al. (2016) [50]	n = 180 (87.7% males); mean age: 4.75 (36–83)	Parent training (PT)	Eleven 60-to-90-minute core sessions, up to 2 optional sessions, and a home visit over 16 weeks, as well as a home visit and 2 telephone booster sessions between weeks 16 and 24	Structured parent education program (PEP): twelve 60-to-90- minute individually administered sessions and 1 home visit over 24 weeks	24 weeks	Parents	Individual
Schertz et al. (2013) [51]	<i>n</i> = 23 (-); mean age: 26.11 (<30)	Joint Attention Mediated Learning (JAML)	15 home visits included 10 min parent-child interaction plus 30 min daily parent-child interaction	TAU	7 months	Parents	Individual
Siller et al. (2013) [52]	<i>n</i> = 70 (91% males); mean age: 57.1 (32–82)	Focused Playtime Intervention	1 session per week for 12 weeks, 90 min per session	PAC	12 weeks	Parents	Individual
Solomon et al. (2014) [53]	n = 128 (78.91%) males); mean age: 50.19 (32–71)	(FPI) PLAY Project Home Consultation program (PLAY)	3 h home visits/month	TAU: 2 h/week	1 year	Parents	Individual
Strain and Bovey (2011) [54]	(32-71) n = 294; mean age: 50.33	LEAP intervention (Learning Experiences and Alternative Program for Preschoolers and Their Parents)	2.75–3 h per day, 5 days per week	Intervention manuals and related written materials to preschool staff: 2.75–3 h per day, 5 days per week	2 years	Professionals and parents	Group
Tonge et al. (2014) [55]	n = 70 (82.86% males); mean age: 46.56 (23–70)	Education and behavior management skills for Pre-schoolers with Autism	Ten 90-minute small group (4–5 families) sessions alternated with ten 60-minute individual family sessions over a 20-week period.	TAU	20 weeks	Parents	Individual and group
Turner- Brown et al. (2019) [56]	<i>n</i> = 49 (85.7% males); mean age: 29.6 (17–35)	(PEBM) Family Implemented TEACCH for Toddlers (FITT) Cooperative	Twenty 90-minute in-home sessions where the FITT coach works directly with the family and toddler and 4 parent group sessions.	TAU	6 months	Parents and profes- sionals	Individual and group
Valeri et al. (2020) [57]	n = 34 (79% males); mean age: 48.3 (24–132)	parent-mediated therapy (CPMT) plus low-intensity psychosocial intervention	15 sessions of 60 min. 12 core sessions, 1 per week, were delivered in the first 3 months, followed by 3 monthly booster sessions plus 4 h LIP per week	Low-intensity psychosocial intervention (LPI)	6 months	Parents and profes- sionals	Individual
Vernon et al. (2019) [58]	n = 23 (87% males); mean age: 35.13 (18–56)	(LPI) Pivotal Response Intervention for Social Motivation (PRISM)	10 h a week of intervention: 8 h of one-on-one clinician-implemented treatment and 2 h of parent education in the intervention strategies with the child present	TAU	6 months	Parents and profes- sionals	Individual
Welterlin et al. (2012) [59]	<i>n</i> = 20 (90% males); mean age: 30.5 (24–39)	Home TEACCHing Program for Toddlers with Autism	1.5 h per week for 12 sessions plus 30 min of parents' psychoeducation	Waitlist	12 weeks	Parents	Individual

Table 1. Cont.

2.4. Risk of Bias

The quality of each study was assessed with the Cochrane risk of bias tool RoB 2 [60] by two independent examiners. This tool includes six items that cover the following bias domains: (i) bias arising from the randomization process, (ii) bias due to deviation from intended interventions, (iii) bias due to missing outcome data, (iv) bias in the measurement of the outcome, (v) bias in the selection of the reported results, and (vi) overall bias. This tool has three grading levels: (i) low, (ii) unclear, and (iii) high risk of bias. The worst grading in individual items define the overall risk of bias for each single study.

2.5. Data Analysis

Meta-analysis was performed using the Review Manager (RevMan, version 5.4.1, The Nordic Cochrane Centre, Copenhagen, Denmark). RevMan is the Cochrane Collaboration's software for preparing and maintaining Cochrane reviews. Because there was meaningful variability across studies regarding participant and intervention characteristics, we analyzed the results using the random effects model of meta-analysis. In our study, we used variable instruments for assessing the same variable (e.g., expressive language was measured with Mullen Scales of Early Learning (MSEL), MacArthur Communicative Development Inventories (MCDI), or other standardized scales). We converted all the measurements to standardized mean differences and variances so that they could be comparable to each other. The standardized mean difference is the difference in mean outcome between groups divided by the standard deviation of outcome across participants [25]. Subsequently, based on the standardized mean differences and variances, we calculated Hedges' g with RevMan software. Hedges' g and Cohen's d were interpreted in the same way according to the rule of thumb that Cohen suggested, where an effect size of 0.20 is small, an effect size of 0.50 is moderate, and an effect size of 0.80 is large [61].

After computing the effect sizes and their statistical significance, we conducted a heterogeneity test in order to establish whether our data were consistent. The heterogeneity was assessed using tau², a metric that we used to define the variance of the true effects sizes and to determine the weight assigned to each included study analyzed with the random effects model [62]. Additionally, we calculated the I^2 statistic, which describes the magnitude of heterogeneity across studies that is attributable to the true differences of the results rather than chance or sampling error [63]. Heterogeneity can be interpreted as low when $I^2 = 0-40\%$, as moderate when $I^2 = 30-60\%$, as substantial when $I^2 = 50-90\%$ and as considerable when $I^2 = 75-100\%$ [62].

In the current review, many of the included studies contained outcomes that were measured by more than one scale (MSEL and MCDI for expressive language). We could not analyze the different outcomes as they were independent because this could lead to incorrect estimates of the variance for the summary effect [62]. Since we analyzed the standardized mean differences for each outcome, we calculated an effect size for all the multiple outcomes per variable for each study. In this case, we calculated the mean effect sizes and the variances for all the multiple outcomes and then the corresponding standard errors (SEs). To compute the combined variance, we applied the formulas suggested by Borenstein et al., (2021) [62]. In this way, we could include all the relevant and available information across studies and at the same time address the problem of non-independence, since all the measurements per study came from the same sample. The formulas were as follows.

(1) Computed variance in case we had two outcomes per study.

$$V_{\overline{Y}} = 1/4 \left(V_{Y1} + V_{Y2} + 2r\sqrt{V_{Y1}} \sqrt{V_{Y2}} \right)$$

(2) Computed variance in case we had more than two outcomes per study.

$$V_{\overline{Y}} = \left(\frac{1}{m}\right)^2 var\left(\sum_{j=1}^m Y_i\right) = \left(\frac{1}{m}\right)^2 \left(\sum_{j=1}^m V_i + \sum_{j \neq k} \left(r_{jk}\sqrt{V_j}\sqrt{V_k}\right)\right)$$

3. Results

3.1. Search Results

A PRISMA flowchart summarizing the article selection process is presented in Figure 1. After the initial database search, 5057 studies, plus two studies identified in Google Scholar, were retrieved. After excluding duplicates and studies that did not meet our inclusion criteria, 33 studies were included in the analysis.

3.2. Study Characteristics

A full description of the included studies [27–59] is depicted in Table 1. The total number of children was 2581. All children had a diagnosis of either ASDs or PDD. The participant age at the beginning of the study ranged from 12 to 132 months.

Out of the 33 studies included, 12 studies were categorized as long-term interventions, 9 were categorized as medium-term interventions, and 12 were categorized as short-term interventions. Additionally, 10 studies implemented high-intensity interventions and 23 studies implemented low-intensity interventions. Twenty-two studies compared the interventions of our interest with TAU, three studies compared early interventions with no treatment or a WL, and eight studies included an altered or low intensity intervention compared to the intervention of the experimental group. The duration of the provided interventions ranged from 12 weeks to 2 years, and their intensity ranged from 3 h of parent sessions every 6 weeks to 15.2 h of therapist-delivered and 16.3 h per week of parent-delivered therapy 5 days per week for 2 years. Intervention providers were both professionals and parents in 13 studies, parents only in 17 studies, and professionals only in three studies. In 27 studies, the intervention setting was individual therapy; in two studies, the setting was both group and individual therapy; and in four studies, the setting was group therapy. All the studies included in meta-analysis reported results obtained from standardized tests.

3.3. Risk of Bias Assessment

All studies were assessed for risk of bias by two independent authors (Figure 2). Disagreements were solved through the re-evaluation of the original papers and discussion until a consensus was reached. In general, 11 studies were assessed as having some concerns due to a lack of specific information and three studies were assessed as having a high risk of bias in randomization process criterium. All studies were assessed as having a high risk of bias in deviation from intended intervention criterium because the participants and personnel were not blinded to intervention status. Four studies were assessed as having some concerns, and seven studies were assessed as having a high risk of bias due to missing outcome data criterium. Two studies were assessed as having some concerns, and five studies were assessed as having a high risk of bias in the measurement of the outcome criterium. Finally, two studies were assessed as having some concerns regarding bias in the selection of the reported results.

				Risk of bia			
		D1	D2	D3	D4	D5	Overall
	Aldred et al. (2004)	+	×	+	+	+	
	Brian et al. (2017)	+	×	+	+	+	×
	Carter et al. (2011)	-	×	+	+	+	
	Dawson et al. (2010)	-		-	+	+	
	Divan et al. (2019)	+	×	+	+	+	
	Drew et al. (2002)	×	×	+	×	+	
	Estes et al. (2015)	-	×	-	+	+	
	Gengoux et al. (2019)	+	×	+	+	+	×
	Green et al. (2010)	+	×	+	+	+	
	Green et al. (2022)	+	×	+	+	+	X
	Hampton et al. (2020)	+	×	×	+	+	
	Hardan et al. (2015)	+	×	+	+	+	×
	Kaale et al. (2014)	+	×	+	+	+	
	Kasari et al. (2015)	+	×	+	+	+	×
	Landa et al. (2011)	×	×	+	+	+	
	Oosterling et al. (2010)		×	+	×	+	
Study	Parsons et al. (2019)	+	×	×	×	+	
	Rahman et al. (2016)	+	×	+	+	+	
	Reitzel et al. (2013)	+	×	×	+	+	8
	Rickards et al. (2007)	×	×	×	+	+	
	Roberts et al. (2011)	+	×	+	-	-	
	Rogers et al. (2012)	-	×	×	-	+	
	Rogers et al. (2019)	+	×	+	+	+	
	Scahill et al. (2016)	+	×	×	+	+	
	Schertz et al. (2013)	-	×	-	×	+	8
	Siller et al. (2013)	-	×	×	+	+	8
	Solomon et al. (2014)	-	×	+	+	+	8
	Strain & Bovey (2011)	+	×	+	+	+	8
	Tonge et al. (2014)	-	X	-	+	+	X
	Turner-Brown et al. (2019)	-	X	+	+	+	×
	Valeri et al. (2020)	+	×	+	+	+	×
	Vernon et al. (2019)	-	×	+	×	+	×
	Welterlin et al. (2012)	-	×	+	+	-	×
	Domains: D1: Bias arising fror D2: Bias due to devi D3: Bias due to miss D4: Bias in measure D5: Bias in selectior		Judgement High Some Low	concerns			

Risk of bias domains

Figure 2. Risk of bias assessment [27–59].

After the completion of the risk of bias assessment, studies that were assessed as having a high risk of bias in the measurement of the outcome criterium were excluded from the analysis.

3.4. Meta-Analysis

Appendix A (Table A1) contains the pre- and post-measurements for every variable across studies, and (Table A2) contains tables with the effect sizes of the combined outcomes after the statistical formulas were applied.

3.4.1. Sensitivity Analysis

In order to calculate the variance for the combined outcomes, we had to provide their correlation coefficients. Since we did not know the correlation between our combined outcomes, we assumed it was r = 0.5. Subsequently, we performed a sensitivity analysis for

r = 0.25 and r = 0.75, and the results confirmed our assumption, since we did not observe any differences in the results.

3.4.2. Cognitive Ability Results

The overall effect size of cognitive ability was based on data from 12 studies (Figure 3). The overall result of the meta-analysis indicated that early intervention programs are efficacious in improving the cognitive ability of pre-school children with ASDs (g = 0.32; 95% CI: 0.05, 0.58; p = 0.02) based on the pre-treatment and post-treatment assessments.

				Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Brian 2017	-0.2404	0.255	9.2%	-0.24 [-0.74, 0.26]	-+-
Carter 2011	-0.061	0.2542	9.2%	-0.06 [-0.56, 0.44]	-+-
Dawson 2010	0.5987	0.3054	8.0%	0.60 [0.00, 1.20]	⊢ •−−
Drew 2002	0.7379	0.4219	5.8%	0.74 [-0.09, 1.56]	
Landa 2011	0.3152	0.2905	8.4%	0.32 [-0.25, 0.88]	+ -
Rickards 2007	0.4378	0.325	7.6%	0.44 [-0.20, 1.07]	+
Rogers 2019	0.1432	0.1973	10.6%	0.14 [-0.24, 0.53]	-+
Strain 2011	0.8734	0.1245	12.4%	0.87 [0.63, 1.12]	+
Tonge 2014	0.1682	0.2395	9.6%	0.17 [-0.30, 0.64]	
Turner-Brown 2019	-0.1386	0.3004	8.1%	-0.14 [-0.73, 0.45]	
Vernon 2019	0.9015	0.4381	5.6%	0.90 [0.04, 1.76]	
Welterlin 2012	0.26	0.4491	5.4%	0.26 [-0.62, 1.14]	
Total (95% CI)			100.0%	0.32 [0.05, 0.58]	◆
Heterogeneity: Tau ² =	= 0.13; Chi ² = 32.45, df = 1	11 (P = 0	.0006): ²:	= 66%	

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				Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Brian 2017	-0.2404	0.255	10.4%	-0.24 [-0.74, 0.26]	-+-
Carter 2011	-0.061	0.2542	10.4%	-0.06 [-0.56, 0.44]	
Dawson 2010	0.5987	0.3054	9.1%	0.60 [0.00, 1.20]	
Drew 2002	0.7379	0.4219	0.0%	0.74 [-0.09, 1.56]	
Landa 2011	0.3152	0.2905	9.5%	0.32 [-0.25, 0.88]	- +-
Rickards 2007	0.4378	0.325	8.7%	0.44 [-0.20, 1.07]	+
Rogers 2019	0.1432	0.1973	11.9%	0.14 [-0.24, 0.53]	
Strain 2011	0.8734	0.1245	13.7%	0.87 [0.63, 1.12]	-
Tonge 2014	0.1682	0.2395	10.8%	0.17 [-0.30, 0.64]	
Turner-Brown 2019	-0.1386	0.3004	9.3%	-0.14 [-0.73, 0.45]	- _
Vernon 2019	0.9015	0.4381	0.0%	0.90 [0.04, 1.76]	
Welterlin 2012	0.26	0.4491	6.2%	0.26 [-0.62, 1.14]	
Total (95% CI)			100.0%	0.25 [-0.04, 0.54]	•
Heterogeneity: Tau ² =	: 0.14; Chi ² = 30.49, df =	9 (P = 0.0	0004); I ² =	70%	
Test for overall effect:	Z = 1.71 (P = 0.09)				-4 -2 U 2 4 Favours control Favours experimental
					avours control Favours experimental

Figure 3. Forest plots for cognitive ability results. (a) Overall effect [28–30,32,41,46,49,54–56,58,59]. (b) Results after exclusion of studies with no blinding of outcome assessment [28–30,41,46,49,54–56,58,59].

A subgroup analysis was performed to test whether intervention intensity and intervention duration modified the effect of early intervention in comparison to control conditions (analysis not presented). However, the number of trials and participants contributing data to the intervention duration subgroups (5 trials and 543 participants for long-term interventions, 3 trials and 120 participants for medium-term interventions, and 4 trials and 214 participants for short-term interventions) and the intervention intensity subgroups (7 trials and 614 participants for high-intensity interventions and 5 trials and 263 participants for low-intensity interventions) was unequal, meaning that the analysis was unlikely to produce useful findings [64].

After the exclusion of studies with bias in measuring of the outcomes, there were no positive outcomes of early intervention for cognitive ability (g = 0.25; 95% CI: -0.04, 0.54; p = 0.09).

3.4.3. Language Results

The analysis was based on 26 studies for expressive language and on 23 studies for receptive language (Figures 4 and 5). After combining the results of studies with multiple outcomes, analysis showed that early interventions were marginally insignificant

for expressive language (g = 0.10; 95% CI: -0.00, 0.20; p = 0.06) and not efficacious in improving the receptive language skills of pre-school children with ASDs (g = 0.12; 95% CI: -0.06, 0.31; p = 0.19). The I²-statistic showed that the heterogeneity among studies was insignificant for expressive language ($Tau^2 = 0.01$; $I^2 = 20\%$, p = 0.18) and substantial and significant for receptive language ($Tau^2 = 0.14$; $I^2 = 74\%$, $p \le 0.0001$).

l)				d. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	0.378	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Aldred 2004 Brian 2017	0.0092	0.378	1.7% 4.2%	0.01 [-0.73, 0.75] -0.18 [-0.62, 0.25]	
Carter 2011	-0.0646		3.4%	-0.06 [-0.56, 0.43]	-
Dawson 2010		0.3046	2.5%	0.56 [-0.04, 1.16]	
Drew 2002	0.5904		1.8%	0.59 [-0.12, 1.30]	
Gengoux 2019 Green 2010	0.521	0.2222	4.2% 8.0%	0.52 [0.09, 0.96] 0.02 [-0.26, 0.29]	
Green 2022	-0.0383		7.5%	-0.04 [-0.33, 0.25]	-
Hampton 2020	0	0.2425	3.6%	0.00 [-0.48, 0.48]	
Hardan 2015		0.1865	5.5%	0.11 [-0.26, 0.47]	
Kaale 2014	-0.2013		3.3%	-0.20 [-0.71, 0.31]	
Kasari 2015	-0.1777 0.1527	0.216 0.289	4.4% 2.7%	-0.18 [-0.60, 0.25]	
Landa 2011 Oosterling 2010	0.1527		4.4%	0.15 (-0.41, 0.72) 0.05 (-0.38, 0.47)	
Parsons 2019	0.1352		2.7%	0.14 [-0.44, 0.71]	
Rahman 2016	-0.1209	0.2607	3.2%	-0.12 [-0.63, 0.39]	
Roberts 2011	-0.2443		3.1%	-0.24 [-0.77, 0.28]	
Rogers 2012 Schertz 2013	0.0499	0.2021	4.9% 1.4%	0.05 [-0.35, 0.45] 0.45 [-0.38, 1.28]	—
Siller 2013	0.087	0.2393	3.7%	0.09 [-0.38, 0.56]	
Solomon 2014	0.0035	0.17	6.3%	0.00 [-0.33, 0.34]	+
Strain 2011	0.4921	0.1209	9.6%	0.49 [0.26, 0.73]	+
Tonge 2014 Valeri 2020	-0.0565 0.187	0.2391 0.4574	3.7% 1.2%	-0.06 [-0.53, 0.41] 0.19 [-0.71, 1.08]	
Vernon 2019		0.4574	1.7%	0.67 [-0.06, 1.40]	
Welterlin 2012		0.3886	1.6%	0.06 [-0.70, 0.82]	
					l
Total (95% CI)			100.0%	0.10 [-0.00, 0.20]	†
Test for overall effect	= 0.01; Chi ² = 31.12, df = t 7 = 1.90 (P = 0.06)	25 (P = 0.	18); I*= 20	%	-4 -2 0 2 4
restror storal ence					Favours control Favours experimental
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·			S	td. Mean Difference	Std. Mean Difference
Study or Subgroup		SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
8.2.1 High-intensity Dawson 2010		0.3046	2.5%	0.56 [-0.04, 1.16]	<u> </u>
Drew 2002	0.5904	0.3612	1.8%	0.59 [-0.12, 1.30]	+
Gengoux 2019	0.521		4.2%	0.52 [0.09, 0.96]	⊢ •−
Kaale 2014	-0.2013		3.3%	-0.20 [-0.71, 0.31]	<u> </u>
Landa 2011 Parsons 2019	0.1527	0.289	2.7%	0.15 [-0.41, 0.72] 0.14 [-0.44, 0.71]	
Strain 2011	0.4921		9.6%	0.49 [0.26, 0.73]	+
Vernon 2019		0.3718	1.7%	0.67 [-0.06, 1.40]	
Subtotal (95% CI)			28.4%	0.37 [0.18, 0.57]	•
Heterogeneity: Tau ²	= 0.02; Chi ² = 8.93, df = 1 t: Z = 3.72 (P = 0.0002)	7 (P = 0.28	5); I* = 22%		
8.2.2 Low-intensity					
Aldred 2004 Brian 2017	0.0092		1.7% 4.2%	0.01 [-0.73, 0.75] -0.18 [-0.62, 0.25]	
Carter 2011	-0.0646		3.4%	-0.06 [-0.56, 0.43]	-
Green 2010	0.0182		8.0%	0.02 [-0.26, 0.29]	+
Green 2022	-0.0383		7.5%	-0.04 [-0.33, 0.25]	+
Hampton 2020	0		3.6%	0.00 [-0.48, 0.48]	-
Hardan 2015 Kasari 2015	0.1094	0.1865	5.5% 4.4%	0.11 [-0.26, 0.47] -0.18 [-0.60, 0.25]	
Oosterling 2010	0.0466		4.4%	0.05 [-0.38, 0.47]	+
Rahman 2016	-0.1209		3.2%	-0.12 [-0.63, 0.39]	
Roberts 2011	-0.2443		3.1% 4.9%	-0.24 [-0.77, 0.28]	
Rogers 2012 Schertz 2013	0.0499		4.9%	0.05 [-0.35, 0.45] 0.45 [-0.38, 1.28]	
Siller 2013	0.087		3.7%	0.09 [-0.38, 0.56]	+
Solomon 2014	0.0035	0.17	6.3%	0.00 [+0.33, 0.34]	+
Tonge 2014	-0.0565		3.7%	-0.06 [-0.53, 0.41]	-
Valeri 2020	0.187		1.2% 1.6%	0.19 [-0.71, 1.08]	
Welterlin 2012 Subtotal (95% CI)	0.059	0.3886	71.6%	0.06 [-0.70, 0.82] -0.01 [-0.12, 0.09]	
	= 0.00; Chi ² = 4.47, df = 1	7 (P = 1.0			1
Test for overall effect	t: Z = 0.25 (P = 0.81)				
Total (95% CI)			100.0%	0.10 [-0.00, 0.20]	•
Heterogeneity: Tau ²	= 0.01; Chi ² = 31.12, df =	25 (P = 0			-4 -2 0 2 4
Test for overall effect	t: Z = 1.90 (P = 0.06) ifferences: Chi ² = 11.64,				-4 -2 U 2 4 Favours control Favours experimental
restion subdroup d	merences. onr = 11.64, i	ai = 1 (P =	0.0000), P	- 01.470	
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)					
Study or Subaroup S	td. Mean Difference	E Weight	Std. Mean	Difference Iom, 95% Cl	Std. Mean Difference IV, Random, 95% CI
	0.0092 0.37			-0.73, 0.75]	
Idred 2004	-0.185 0.220			0.62, 0.25	<u> </u>
Udred 2004 Brian 2017	0.0010 0.000		-0.06 0.56	0.56, 0.43]	—
Idred 2004	-0.0646 0.254 0.5612 0.304		0.59	0.12, 1.30]	
Ndred 2004 Brian 2017 Carter 2011 Dawson 2010 Drew 2002	0.5612 0.304 0.5904 0.361				
Ndred 2004 Brian 2017 Carter 2011 Dawson 2010 Drew 2002 Bengoux 2019	0.5612 0.304 0.5904 0.361 0.521 0.222	2 4.8%	0.52	[0.09, 0.96]	-
Ndred 2004 Brian 2017 Sarter 2011 Sawson 2010 Drew 2002 Sengoux 2019 Sreen 2010	0.5612 0.304 0.5904 0.361 0.521 0.222 0.0182 0.140	2 4.8% 15 9.0%	0.02	0.26, 0.29]	+
Ndred 2004 Srian 2017 Sarter 2011 Dawson 2010 Drew 2002 Sengoux 2019 Sreen 2010 Sreen 2022 Hampton 2020	0.5612 0.304 0.5904 0.361 0.521 0.222 0.0132 0.140 -0.0383 0.146 0 0.242	12 4.8% 15 9.0% 11 8.4% 15 4.2%	0.02 -0.04 0.00	-0.26, 0.29] -0.33, 0.25] -0.48, 0.48]	+
Udred 2004 Srian 2017 Sarter 2011 Sawson 2010 Drew 2002 Seengoux 2019 Sreen 2010 Sreen 2010 Sreen 2022 Hampton 2020 Hardan 2015	0.5612 0.304 0.5904 0.361 0.521 0.222 0.0182 0.140 -0.0383 0.146 0 0.242 0.1094 0.186	2 4.8% 5 9.0% 1 8.4% 5 4.2% 5 6.2%	0.02 -0.04 0.00 0.11	0.26, 0.29] 0.33, 0.25] 0.48, 0.48] 0.26, 0.47]	
Udred 2004 strian 2017 Carter 2011 Sawson 2010 Drew 2002 Shengoux 2019 Sheen 2010 Sheen 2010 Hardan 2015 Gaale 2014	0.5612 0.304 0.5904 0.361 0.521 0.222 0.0182 0.146 -0.0383 0.146 0 0.244 0.1094 0.188 -0.2013 0.256	2 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 14 3.8%	0.02 +0.04 0.00 0.11 +0.20	0.26, 0.29] 0.33, 0.25] 0.48, 0.48] 0.26, 0.47] 0.71, 0.31]	
Udred 2004 strian 2017 sarter 2011 Sarter 2011 Somo 2010 Soreen 2022 Hampton 2020 Hampton 2020 Hampton 2020 Hardnan 2015 (sale 2014 (sale 2015 sanda 2011	0.5612 0.304 0.5904 0.361 0.521 0.222 0.0182 0.140 -0.0383 0.145 0.1094 0.186 -0.2013 0.256 -0.1777 0.21 0.1527 0.25	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 14 3.8% 16 5.0% 19 3.1%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15	0.26, 0.29] 0.33, 0.25] 0.48, 0.48] 0.26, 0.47] 0.71, 0.31] 0.60, 0.25] 0.41, 0.72]	
Udred 2004 strian 2017 sarter 2011 Jawson 2010 Drew 2002 Bregnoux 2019 Sreen 2022 Hampton 2020 Hardan 2015 Saale 2014 Casent 2015 Josterling 2010	0.5612 0.304 0.5904 0.361 0.521 0.222 0.0182 0.144 0.0383 0.144 0.0244 0.1094 0.186 -0.2013 0.255 -0.1777 0.21 0.1527 0.25 0.0466 0.215	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 14 3.8% 16 5.0% 19 3.1% 18 0.0%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.05	+0.26, 0.29] +0.33, 0.25] +0.48, 0.48] +0.26, 0.47] +0.71, 0.31] +0.71, 0.31] +0.41, 0.72] +0.38, 0.47]	
Udred 2004 strian 2017 sarter 2011 Sarter 2011 Somo 2010 Soreen 2022 Hampton 2020 Hampton 2020 Hampton 2020 Hardnan 2015 (sale 2014 (sale 2015 sanda 2011	0.5612 0.304 0.5904 0.361 0.521 0.222 0.0182 0.140 -0.0383 0.145 0.1094 0.186 -0.2013 0.256 -0.1777 0.21 0.1527 0.25	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 14 3.8% 16 5.0% 19 3.1% 18 0.0% 13 0.0%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.05 0.14	+0.26, 0.29] +0.33, 0.26] +0.48, 0.48] +0.48, 0.48] +0.26, 0.47] +0.71, 0.31] +0.71, 0.31] +0.41, 0.72] +0.41, 0.72] +0.44, 0.71]	
Judied 2004 Judied 2004 Joakson 2011 Joakson 2010 Jorew 2002 Jorew 2012 Jorew 2012 Jorew 2020 Jorew 2020 Jorew 2020 Jampion 2020 Jampion 2020 Jampion 2020 Jampion 2014 Casal 2015 Jamis 2019 Varisons 2019 Valman 2016 Coberts 2011	0.5612 0.204 0.5904 0.361 0.521 0.222 0.0182 0.144 -0.033 0.144 0.1034 0.184 -0.2013 0.254 -0.177 0.21 0.1527 0.25 0.1527 0.29 0.1529 0.264 -0.243 0.285 -0.243 0.285	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 14 3.8% 15 5.0% 19 3.1% 18 0.0% 13 0.0% 13 3.5%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.05 0.05 0.14 -0.12 -0.24	0.26, 0.29] 0.33, 0.25] 0.48, 0.48] 0.26, 0.47] 0.26, 0.47] 0.60, 0.25] 0.41, 0.72] 0.38, 0.47] 0.44, 0.71] 0.63, 0.39] 0.77, 0.28]	
Jidred 2004 Vilan 2017 Zarler 2011 Jilan 2010 Vilan 2010 Vilan 2010 View 2002 View 2002 View 2002 View 2010 View 2002 View 2010 View 2010 Vie	0.5612 0.304 0.5904 0.361 0.521 0.22 0.0120 0.144 -0.0383 0.144 -0.0383 0.142 0.1094 0.186 -0.2173 0.252 0.0466 0.215 0.1527 0.22 0.0466 0.215 0.1352 0.299 -0.1290 0.266 0.0443 0.265 0.0494 0.203	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 14 3.8% 16 5.0% 19 3.1% 18 0.0% 13 0.0% 13 3.5% 11 5.5%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.05 0.14 -0.12 -0.24 0.05	0.26, 0.29] 0.33, 0.25] 0.48, 0.48] 0.26, 0.47] 0.71, 0.31] 0.60, 0.25] 0.41, 0.72] 0.38, 0.47] 0.44, 0.71] 0.63, 0.39] 0.77, 0.28] 0.35, 0.45]	
Judred 2004 Hinn 2017 Sarder 2011 Sarder 2010 Sarder 2010 Sareen 2010 Sareen 2010 Sareen 2010 Sareen 2010 Sareen 2010 Sareen 2010 Sareen 2010 Sareen 2019 Sareen	0.5612 0.304 0.5904 0.361 0.521 0.322 0.0182 0.144 -0.0333 0.144 -0.0333 0.144 -0.0333 0.024 -0.01777 0.27 0.1527 0.28 0.0466 0.211 0.1529 0.28 -0.2434 0.286 -0.2443 0.286 -0.2443 0.286 0.0449 0.422 0.449 0.422	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 16 5.0% 18 0.0% 19 3.1% 18 0.0% 3 0.0% 17 3.7% 13 3.5% 16 0.0% 16 0.0%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.05 0.14 -0.12 -0.24 0.05 0.45	0 26, 0 29] 0 33, 0 25] 0 48, 0 48] 0 26, 0 47] 0 26, 0 47] 0 40, 0 25] 0 41, 0 72] 0 44, 0 72] 0 38, 0 47] 0 44, 0 71] 0 45, 0 39] 0 77, 0 28] 0 77, 0 28] 0 38, 0 45] 0 38, 0 45]	
Jidred 2004 Jidred 2004 Jidre 2011 Jarker 2010 Jarker 2010 Jreew 2002 Jeren 2022 Jeren 2022 Jeren 2022 Jeren 2022 Jeren 2022 Jeren 2023 Jeren 2016 Jeren 2016 Jeren 2019 Jeren 2020 Jeren 2019 Jeren 2020 Jeren 2020 Je	0.5612 0.304 0.5904 0.361 0.521 0.322 0.0182 0.144 -0.0333 0.144 -0.0333 0.144 -0.0333 0.024 -0.024 -0.024 0.1527 0.22 0.0466 0.211 0.1529 0.284 -0.2443 0.286 -0.2443 0.286 -0.2443 0.286 0.0499 0.202 0.449 0.422 0.067 0.23 0.067 0.23 0.067 0.23	12 4.8% 15 9.0% 16 8.4% 15 4.2% 15 6.2% 14 3.8% 6 5.0% 19 3.1% 18 0.0% 13 3.5% 14 5.5% 15 5.5% 16 0.0% 13 3.5% 13 4.3% 13 4.3% 13 4.3% 16 0.0% 13 4.3%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.15 0.14 -0.12 -0.24 0.05 0.45 0.05 0.45 0.00	0 26, 0 29] 0 33, 0 25] 0 48, 0 48] 0 27, 0 48] 0 27, 0 48] 0 47, 0 31] 0 48, 0 31] 0 48, 0 47] 0 38, 0 47] 0 48, 0 39] 0 44, 0 71] 0 48, 0 39] 0 38, 0 45] 0 38, 0 45] 0 38, 0 56] 0 33, 0 34]	
vided 2004 vinn 2017 anter 2011 yewson 2010 yrew 2002 yreen 2005 yreen 2005 y	0.5612 0.304 0.5904 0.361 0.521 0.222 0.0182 0.144 -0.0333 0.144 0.0343 0.044 0.0344 0.0445 -0.2177 0.25 0.0465 0.217 0.129 0.256 0.0469 0.202 0.0449 0.222 0.067 0.235 0.0355 0.1 0.429 0.122 0.0635 0.1 0.429 0.122 0.055 0.1 0.429 0.122 0.055 0.1 0.429 0.122 0.055 0.1 0.429 0.1 0.4	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 15 6.2% 16 6.5.0% 19 3.1% 13 3.5% 14 3.8% 15 5.0% 16 0.0% 17 3.7% 13 3.5% 14 5.5% 15 0.0% 13 4.3% 14 5.5% 15 0.0% 16 0.0% 17 7.1% 19 10.6%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.15 0.14 -0.24 -0.24 0.05 0.45 0.09 0.00 0.49	0 26, 0 29] 0 33, 0 25] 0 48, 0 46] 0 26, 0 47] 0 26, 0 47] 0 47] 0 47] 0 48, 0 48] 0 47] 0 48, 0 47] 0 44, 0 71] 0 45, 0 45, 0 45] 0 40, 0 45, 0 45] 0 40, 0 45, 0 45, 0 45] 0 40, 0 45, 0 45, 0 45] 0 40, 0 45, 0 45, 0 45, 0 45, 0 45, 0 45, 0 45, 0 45, 0 45, 0 45, 0 4	
Jidred 2004 Jidred 2004 Jidre 2011 Jarker 2010 Jarker 2010 Jreew 2002 Jereen 2012 Jereen 2012 Jereen 2012 Jereen 2019 Jereen	0.5612 0.304 0.5904 0.361 0.521 0.22 0.0182 0.144 -0.0383 0.144 -0.0313 0.144 -0.013 0.254 -0.013 0.254 -0.013 0.255 -0.177 0.21 -0.129 0.266 -0.443 0.262 0.0469 0.233 0.0057 0.33 0.0057 0.33 0.0057 0.33 0.04921 0.122 -0.055 0.238	12 4.8% 15 9.0% 11 8.4% 15 6.2% 15 6.2% 16 5.0% 19 3.1% 18 0.0% 11 5.5% 12 3.7% 13 3.5% 11 5.5% 16 0.0% 11 5.5% 12 5.7% 13 3.5% 14 4.3% 15 1.4%	0.02 -0.04 0.00 -0.18 0.15 0.05 0.05 0.04 0.14 -0.12 -0.24 0.05 0.05 0.045 0.09 0.00 0.00 0.049 -0.06	0.26, 0.29] 0.03, 0.25] 0.48, 0.48] 0.27, 0.471 0.27, 0.311 0.05, 0.471 0.05, 0.471 0.05, 0.471 0.05, 0.471 0.05, 0.39] 0.05, 0.45] 0.05, 0.45] 0.03, 0.45] 0.03, 0.56] 0.05, 0.41]	
Jidred 2004 Inten 2017 Jarter 2011 Jarter 2010 Jarwey 2020 Jarwey 2020 Jarong 2020 Jarong 2019 Jarong 2014 Jarong 2019 Jarong 2014 Jarong 2019 Jarong 2014 Jarong 2019 Jarong 2014 Jarong 2019 Jarong	0.5912 0.203 0.5920 0.236 0.592 0.222 0.0182 0.144 0 0.234 0 0.244 0 0.244 0.0152 0.222 0.0152 0.224 0.0152 0.224 0.0440 0.224 0.0440 0.224 0.0440 0.244 0.0440 0.244 0.0460 0.2440 0.2460 0.2440 0.2460 0.2440 0.24	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 15 6.2% 16 5.0% 19 3.1% 18 0.0% 13 0.0% 14 3.8% 15 5.5% 10.0% 3.1% 11 5.5% 10 0.0% 11 4.3% 14 1.4% 14 1.4%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.05 0.14 -0.12 -0.24 0.24 0.24 0.24 0.09 0.000 0.49 0.000 0.49 0.000	0-26,0,29] -0-28,0,49] -0-28,0,449] -0-28,0,471 -0-28,0,471 -0-28,0,471 -0-28,0,471 -0-28,0,471 -0-41,0,72] -0-41,0,72] -0-41,0,72] -0-41,0,72] -0-38,0,2471 -0-38,0,249 -0-3	
Udred 2004 shan 2017 shan 2017 sharter 2011 Jawsson 2010 Drew 2002 Jergen 2010 Jergen 2010 Jergen 2010 Jergen 2010 Jergen 2012 Hardan 2015 saale 2014 (saasir 2015 .anda 2011 Dosterling 2010 Jarsons 2019	0.5612 0.304 0.5904 0.361 0.521 0.22 0.0152 0.144 0.10380 0.44 0.10380 0.44 0.1038 0.044 0.1031 0.1527 0.22 0.0462 0.216 0.0459 0.232 0.0499 0.22 0.0499 0.22 0.0497 0.23 0.0497 0.457	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 15 6.2% 16 5.0% 19 3.1% 18 0.0% 13 0.0% 14 3.8% 15 5.5% 10.0% 3.1% 11 5.5% 10 0.0% 11 4.3% 14 1.4% 14 1.4%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.05 0.14 -0.12 -0.24 0.24 0.24 0.24 0.09 0.000 0.49 0.000 0.49 0.000	0 - 26, 0 - 29 - 0 - 26, 0 - 29 - 0 - 48, 0 - 48 - 0 - 28, 0 - 47 - 0 - 28, 0 - 47 - 0 - 27, 0 - 31 - 0 - 41, 0 - 72 - 0 - 41, 0 - 72 - 0 - 43, 0 - 71 - 0 - 43, 0 - 71 - 0 - 43, 0 - 71 - 0 - 53, 0 - 45 - 0 - 38, 0 - 56 - 0 - 58, 0 - 58 - 0 - 58, 0 -	
Jidred 2004 Inten 2017 Jarter 2011 Jarter 2010 Jarwey 2020 Jarwey 2020 Jarter 2010 Jarter 2010 Jarter 2010 Jarter 2010 Jarter 2014 Jarter 2015 Jarter	0.5912 0.203 0.5920 0.236 0.592 0.222 0.0182 0.144 0 0.234 0 0.244 0 0.244 0.0152 0.222 0.0152 0.224 0.0152 0.224 0.0440 0.224 0.0440 0.224 0.0440 0.244 0.0440 0.244 0.0460 0.2440 0.2460 0.2440 0.2460 0.2440 0.24	12 4.8% 15 9.0% 11 8.4% 15 4.2% 15 6.2% 15 6.2% 16 5.0% 19 3.1% 18 0.0% 13 0.0% 14 3.8% 15 5.5% 10.0% 3.1% 11 5.5% 10 0.0% 11 4.3% 14 1.4% 14 1.4%	0.02 -0.04 0.00 0.11 -0.20 -0.18 0.15 0.05 0.14 -0.12 -0.24 0.05 0.45 0.09 0.00 0.49 0.000 0.49 0.006 0.19 0.067	0-26,0,29] -0-28,0,49] -0-28,0,449] -0-28,0,471 -0-28,0,471 -0-28,0,471 -0-28,0,471 -0-28,0,471 -0-41,0,72] -0-41,0,72] -0-41,0,72] -0-41,0,72] -0-38,0,2471 -0-38,0,249 -0-3	

Figure 4. Forest plots for expressive language results. (a) Overall effect [27–30,32,34–44,47,48,51–55,57–59]. (b) Subgroup analysis: intensity of intervention. (c) Results after exclusion of studies with no blinding of outcome assessment [27–30,34–41,44,47,48,52–55,57,59].

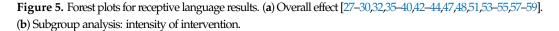
The test for subgroup differences indicated that there was no statistically significant subgroup effect (p = 0.16 for expressive language and p = 0.09 for receptive language; analysis not presented), suggesting that intervention duration does not modify the effect of early intervention in comparison to control conditions. However, the number of trials and participants that contributed data to the subgroups was unequal, meaning that the analysis may not have been able to detect subgroup differences. Additionally, although the subgroup analysis performed to test whether intervention intensity modifies the effect of early intervention in comparison to control conditions (analysis not presented) indicated that there was a statistically significant subgroup effect, the number of trials and participants that contributed data to the intervention intensity subgroups (8 trials and 613 participants for high-intensity interventions and 18 trials and 1278 participants for high-intensity interventions for expressive language; 6 trials and 522 participants for high-intensity interventions for low-intensity interventions for receptive language) was unequal, meaning that the analysis was also unlikely to produce useful findings [64].



a)					
				Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% Cl
Aldred 2004	0.0025	0.378	3.2%	0.00 [-0.74, 0.74]	
Brian 2017	-0.0261	0.2202	4.9%	-0.03 [-0.46, 0.41]	+
Carter 2011	-0.2566	0.2551	4.5%	-0.26 [-0.76, 0.24]	-++
Dawson 2010	0.6097	0.3056	3.9%	0.61 [0.01, 1.21]	
Drew 2002	0.7346	0.4218	2.9%	0.73 [-0.09, 1.56]	<u> </u>
Green 2010	0.1405	0.1407	5.7%	0.14 [-0.14, 0.42]	+-
Green 2022	-0.0303	0.1598	5.5%	-0.03 [-0.34, 0.28]	+
Hampton 2020	0.1533	0.2428	4.6%	0.15 [-0.32, 0.63]	
Hardan 2015	0.2238	0.2932	4.0%	0.22 [-0.35, 0.80]	
Kaale 2014	-0.1118	0.187	5.2%	-0.11 [-0.48, 0.25]	-+
Kasari 2015	-0.1848	0.2161	4.9%	-0.18 [-0.61, 0.24]	
Oosterling 2010	0.1203	0.2486	4.5%	0.12 [-0.37, 0.61]	- - -
Parsons 2019	0.0169	0.291	4.1%	0.02 [-0.55, 0.59]	
Rahman 2016	-0.0886	0.2605	4.4%	-0.09 [-0.60, 0.42]	
Roberts 2011	-0.337	0.2692	4.3%	-0.34 [-0.86, 0.19]	
Rogers 2012	-0.2108	0.1755	5.4%	-0.21 [-0.55, 0.13]	-+
Schertz 2013	0.2949	0.4197	2.9%	0.29 [-0.53, 1.12]	
Solomon 2014	0.119	0.1311	5.8%	0.12 [-0.14, 0.38]	+
Strain 2011	1.0996	0.1275	5.9%	1.10 [0.85, 1.35]	-
Tonge 2014	-0.2443	0.2399	4.6%	-0.24 [-0.71, 0.23]	
Valeri 2020	0.2769	0.4777	2.5%	0.28 [-0.66, 1.21]	
Vernon 2019	0.8563	0.3783	3.2%	0.86 [0.11, 1.60]	_
Welterlin 2012	0.1579	0.388	3.1%	0.16 [-0.60, 0.92]	
Total (95% CI)			100.0%	0.12 [-0.06, 0.31]	+
Heterogeneity: Tau ² =	= 0.14; Chi ² = 83.54, df = 2	22 (P < 0	.00001); F	²= 74%	
Test for overall effect	Z = 1.30 (P = 0.19)				-4 -2 0 2 4 Favours control Favours experimental
					Favours control Favours experimental

(b)

0)						
,				Std. Mean Difference		Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI		IV, Random, 95% CI
8.3.1 High-intensity i	interventions					
Dawson 2010	0.6097	0.3056	3.9%	0.61 [0.01, 1.21]		
Drew 2002	0.7346	0.4218	2.9%	0.73 [-0.09, 1.56]		<u> </u>
Kaale 2014	-0.1118	0.187	5.2%	-0.11 [-0.48, 0.25]		-
Parsons 2019	0.0169	0.291	4.1%	0.02 [-0.55, 0.59]		
Strain 2011	1.0996	0.1275	5.9%	1.10 [0.85, 1.35]		-
Vernon 2019	0.8563	0.3783	3.2%	0.86 [0.11, 1.60]		
Subtotal (95% CI)			25.2%	0.53 [0.00, 1.05]		◆
	= 0.34; Chi ² = 34.12, df =	5 (P < 0.0	00001); I² :	= 85%		
Test for overall effect	: Z = 1.98 (P = 0.05)					
8.3.2 Low-intensity i	nterventions					
Aldred 2004	0.0025	0.378	3.2%	0.00 [-0.74, 0.74]		
Brian 2017	-0.0261	0.2202	4.9%	-0.03 [-0.46, 0.41]		-
Carter 2011	-0.2566	0.2551	4.5%	-0.26 [-0.76, 0.24]		
Green 2010	0.1405	0.1407	5.7%	0.14 [-0.14, 0.42]		+-
Green 2022	-0.0303	0.1598	5.5%	-0.03 [-0.34, 0.28]		+
Hampton 2020	0.1533	0.2428	4.6%	0.15 [-0.32, 0.63]		- -
Hardan 2015	0.2238	0.2932	4.0%	0.22 [-0.35, 0.80]		
Kasari 2015	-0.1848	0.2161	4.9%	-0.18 [-0.61, 0.24]		
Oosterling 2010	0.1203	0.2486	4.5%	0.12 [-0.37, 0.61]		
Rahman 2016	-0.0886	0.2605	4.4%	-0.09 [-0.60, 0.42]		
Roberts 2011	-0.337	0.2692	4.3%	-0.34 [-0.86, 0.19]		
Rogers 2012	-0.2108	0.1755	5.4%	-0.21 [-0.55, 0.13]		
Schertz 2013	0.2949	0.4197	2.9%	0.29 [-0.53, 1.12]		
Solomon 2014	0.119	0.1311	5.8%	0.12 [-0.14, 0.38]		+-
Tonge 2014	-0.2443	0.2399	4.6%	-0.24 [-0.71, 0.23]		+
Valeri 2020	0.2769	0.4777	2.5%	0.28 [-0.66, 1.21]		_
Welterlin 2012	0.1579	0.388	3.1%	0.16 [-0.60, 0.92]		_ _ _
Subtotal (95% CI)			74.8%	-0.00 [-0.11, 0.10]		•
Heterogeneity: Tau ² = Test for overall effect	= 0.00; Chi ² = 9.98, df = 1 7 = 0.08 (P = 0.93)	6 (P = 0.8	87); I² = 09	6		
	2 0.00 (0.00)					L
Total (95% CI)			100.0%	0.12 [-0.06, 0.31]		. 7
	= 0.14; Chi ² = 83.54, df =	22 (P < 0	.00001); P	² = 74%	-4	-2 0 2 4
Test for overall effect						Favours control Favours experimental
Test for subgroup dif	fferences: Chi ² = 3.82, df	= 1 (P = ().05), I ² = 7	73.8%		



However, when studies with bias in the measurement of the outcome were excluded from the analysis, the results remained insignificant for expressive language (g = 0.07; 95% CI: -0.04, 0.18; p = 0.20).

3.4.4. Adaptive Behavior Composite, Communication, Socialization, Daily Living Skills and Motor Skills Results

The final effect size for the adaptive behavior composite result was based on the results from seven studies (Figure 6) and showed that early intervention was not effective for the adaptive behavior composite (g = 0.20; 95% CI: -0.16, 0.55; p = 0.27). Analysis also indicated that early interventions were not statistically significant, either for improving communication (17 studies, g = 0.06; 95% CI: -0.07, 0.12; p = 0.36, Figure 7) and socialization (16 studies, g = 0.10; 95% CI: -0.06, 0.27; p = 0.21, Figure 8); on the other hand, early interventions were statistically significant for daily living (seven studies, g = 0.35; 95% CI: 0.08, 0.63; p = 0.01, Figure 9) and motor skills (sight studies, g = 0.39; 95% CI: 0.16, 0.62; p = 0.001, Figure 10).

			5	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Dawson 2010	0.7336	0.3087	14.3%	0.73 [0.13, 1.34]	-
Divan 2019	0.348	0.319	13.9%	0.35 [-0.28, 0.97]	- +
Green 2010	-0.1667	0.1525	21.1%	-0.17 [-0.47, 0.13]	
Rahman 2016	-0.1654	0.2608	16.3%	-0.17 [-0.68, 0.35]	
Reitzel 2013	-0.093	0.6271	6.2%	-0.09 [-1.32, 1.14]	
Rogers 2019	-0.0819	0.2066	18.7%	-0.08 [-0.49, 0.32]	
Vernon 2019	1.3333	0.4614	9.4%	1.33 [0.43, 2.24]	
Total (95% CI)			100.0%	0.20 [-0.16, 0.55]	•
Heterogeneity: Tau ² =	= 0.13; Chi ² = 16.67, df = 1	6 (P = 0.0	01); I² = 64	% -	
Test for overall effect	Z = 1.09 (P = 0.27)				-4 -2 0 2 4 Favours control Favours experimental

Figure 6. Forest plot for adaptive behavior composite. Overall effect [30,31,35,44,45,49,58].

			:	Std. Mean Difference		Std. Mean Difference	
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI		IV, Random, 95% CI	
Aldred 2004	0.431	0.3823	3.1%	0.43 [-0.32, 1.18]			
Brian 2017	-0.2037	0.2548	6.2%	-0.20 [-0.70, 0.30]			
Carter 2011	-0.021	0.2541	6.2%	-0.02 [-0.52, 0.48]		-	
Dawson 2010	0.6484	0.3068	4.5%	0.65 [0.05, 1.25]		⊢ •−−	
Divan 2019	0.3139	0.3186	4.2%	0.31 [-0.31, 0.94]		- +•	
Gengoux 2019	0.0969	0.3059	4.6%	0.10 [-0.50, 0.70]		_ - _	
Green 2010	-0.0308	0.1622	12.0%	-0.03 [-0.35, 0.29]		-+-	
Hardan 2015	0.3423	0.2945	4.9%	0.34 [-0.23, 0.92]		+•	
Kaale 2014	0.054	0.2237	7.6%	0.05 [-0.38, 0.49]		<u> </u>	
Rahman 2016	-0.0325	0.2604	6.0%	-0.03 [-0.54, 0.48]			
Reitzel 2013	-0.0924	0.657	1.1%	-0.09 [-1.38, 1.20]			
Roberts 2011	-0.373	0.2696	5.6%	-0.37 [-0.90, 0.16]			
Rogers 2012	-0.1302	0.2022	8.9%	-0.13 [-0.53, 0.27]			
Scahill 2016	-0.0682	0.1491	13.4%	-0.07 [-0.36, 0.22]			
Schertz 2013	0.4579	0.4228	2.6%	0.46 [-0.37, 1.29]		—	
Tonge 2014	0.0989	0.2392	6.9%	0.10 [-0.37, 0.57]		- -	
Vernon 2019	1.2343	0.4553	2.2%	1.23 [0.34, 2.13]			
Total (95% CI)			100.0%	0.06 [-0.07, 0.20]		•	
Heterogeneity: Tau ² =	= 0.01; Chi ² = 19.58, df =	16 (P = 0	.24); I ² = 1	8%		<u> t </u>	÷
Test for overall effect					-4	-2 U 2 Foueuro control. Foueuro experiment	4
						Favours control Favours experiment	B

Figure 7. Forest plot for communication results. Overall effect [27-31,34,35,38,39,44,45,47,48,50,51,55,58].

(a) Std. Mean Difference Std. Mean Difference Std. Mean Difference IV, Random, 95% CI Study or Subgroup SE Weight IV, Random, 95% CI Brian 2017 -0.0722 0.2542 6.7% -0.07 [-0.57, 0.43] Carter 2011 0.2543 0.10 [-0.40, 0.60] 0.1031 6.7% Dawson 2010 0.5658 0.3049 5.3% 0.57 [-0.03, 1.16] 0.48 [-0.15, 1.11] -0.20 [-0.52, 0.12] Divan 2019 0.4788 0.3211 4.9% Green 2010 -0.2033 0.1627 10.6% -0.49 [-1.07, 0.09] 0.23 [-0.21, 0.66] Hardan 2015 -0.4898 0.2967 5.5% Kaale 2014 0.2258 0.224 7.8% Parsons 2019 0.6624 0.2987 5.4% 0.66 [0.08, 1.25] Rahman 2016 -0.0337 0.2604 6.5% 0.03 [-0.54, 0.48] Reitzel 2013 -0.1901 0.628 1.6% -0.19 [-1.42, 1.04] -0.0714 0.2757 -0.1348 0.2023 Roberts 2011 6.0% -0.07 [-0.61, 0.47] Rogers 2012 0.2023 8.7% -0.13 [-0.53, 0.26] -0.01 [-0.31, 0.28] 0.36 [-0.11, 0.83] Scahill 2016 -0.0131 0.1491 11 4% 0.3581 Tonge 2014 0.241 7.2% Vernon 2019 1.0496 0.4452 2.9% 1.05 (0.18, 1.92) Welterlin 2012 0.4513 0.38 [-0.50, 1.27] 0.3836 2.9% Total (95% CI) 100.0% 0.10 [-0.06, 0.27] Heterogeneity: Tau² = 0.04; Chi² = 24.07, df = 15 (P = 0.06); l² = 38% Test for overall effect: Z = 1.26 (P = 0.21) Favours control Favours experimental

(b)

			5	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
23.1.1 High-intensit	ty interventions				
Dawson 2010	0.5658	0.3049	5.3%	0.57 [-0.03, 1.16]	
Kaale 2014	0.2258	0.224	7.8%	0.23 [-0.21, 0.66]	
Parsons 2019	0.6624	0.2987	5.4%	0.66 [0.08, 1.25]	
Vernon 2019	1.0496	0.4452	2.9%	1.05 [0.18, 1.92]	
Subtotal (95% CI)			21.4%	0.51 [0.20, 0.82]	◆
Heterogeneity: Tau ²	² = 0.01; Chi ² = 3.36, df = 3	(P = 0.34	4); I ² = 11%		
Test for overall effec	et: Z = 3.25 (P = 0.001)				
23.1.2 Low-intensit	y interventions				
Brian 2017	-0.0722	0.2542	6.7%	-0.07 [-0.57, 0.43]	- _
Carter 2011	0.1031	0.2543	6.7%	0.10 [-0.40, 0.60]	_ _
Divan 2019	0.4788	0.3211	4.9%	0.48 [-0.15, 1.11]	+
Green 2010	-0.2033	0.1627	10.6%	-0.20 [-0.52, 0.12]	-+
Hardan 2015	-0.4898	0.2967	5.5%	-0.49 [-1.07, 0.09]	
Rahman 2016	-0.0337	0.2604	6.5%	-0.03 [-0.54, 0.48]	
Reitzel 2013	-0.1901	0.628	1.6%	-0.19 [-1.42, 1.04]	
Roberts 2011	-0.0714	0.2757	6.0%	-0.07 [-0.61, 0.47]	
Rogers 2012	-0.1348	0.2023	8.7%	-0.13 [-0.53, 0.26]	
Scahill 2016	-0.0131	0.1491	11.4%	-0.01 [-0.31, 0.28]	-
Tonge 2014	0.3581	0.241	7.2%	0.36 [-0.11, 0.83]	+
Welterlin 2012	0.3836	0.4513	2.9%	0.38 [-0.50, 1.27]	
Subtotal (95% CI)			78.6%	-0.03 [-0.16, 0.11]	•
	^z = 0.00; Chi ^z = 10.15, df =	11 (P = 0	.52); I ² = 0	%	
Test for overall effec	ct: Z = 0.40 (P = 0.69)				
Total (95% CI)			100.0%	0.10 [-0.06, 0.27]	+
Heterogeneity: Tau ²	= 0.04; Chi ² = 24.07, df =	15 (P = 0	.06); I ² = 3	B%	
Test for overall effect	t: Z = 1.26 (P = 0.21)				-4 -2 U 2 4 Favours control Favours experimental
Test for subaroup d	lifferences: Chi ² = 9.86, df	= 1 (P = (0.002), I ² =	89.9%	Favours control Favours experimental

Figure 8. Forest plots for socialization results. (a) Overall effect [28–31,35,38,39,43–45,47,48,50,55,58,59].
(b) Subgroup analysis: intensity of intervention.

The I^2 -statistics showed that the heterogeneity among studies was moderate for socialization ($Tau^2 = 0.07$; $I^2 = 55\%$, p = 0.004) and statistically insignificant for all the other variables. Non-significant heterogeneity tests for the remaining outcomes possibly occurred due to a low power, since the number of studies included in these analyses was small [25].

The test for subgroup differences indicated that there was no statistically significant subgroup effect for the adaptive behavior composite (p = 0.70), communication (p = 0.54), socialization (p = 0.51), daily living skills (p = 0.56), and motor skills (p = 0.27), suggesting that intervention duration does not modify the effect of early interventions in comparison to control conditions. However, the number of trials and participants that contributed data to the subgroups was unequal, meaning that the analysis may not have been able to detect subgroup differences. Similarly, although the subgroup analysis performed to test whether intervention intensity modified the effect of early intervention in comparison to control conditions (analysis not presented) indicated that there was a statistically significant subgroup effect for socialization, the number of trials and participants that contributed data to the intervention intensity subgroups (4 trials and 191 participants for high-intensity interventions and 12 trials and 754 participants for low-intensity interventions) was unequal, meaning that the analysis was also unlikely to produce useful findings [64].

After the exclusion of studies with a high risk of bias, results remained positive for daily living skills (g = 0.28; 95% CI: 0.04, 0.52; p = 0.02) and motor skills (g = 0.49; 95% CI: 0.28, 0.79; $p \le 0.00001$).

				Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Carter 2011	0.5638	0.2591	15.5%	0.56 [0.06, 1.07]	
Dawson 2010	0.6199	0.3061	12.8%	0.62 [0.02, 1.22]	
Reitzel 2013	0.1244	0.6273	4.3%	0.12 [-1.11, 1.35]	
Rogers 2012	-0.131	0.2022	19.5%	-0.13 [-0.53, 0.27]	
Scahill 2016	0.1859	0.1494	24.0%	0.19 [-0.11, 0.48]	
Tonge 2014	0.4653	0.2422	16.6%	0.47 [-0.01, 0.94]	
Vernon 2019	1.1604	0.4511	7.4%	1.16 [0.28, 2.04]	
Total (95% CI)			100.0%	0.35 [0.08, 0.63]	◆
Heterogeneity: Tau ² =	= 0.06; Chi ² = 11.41, df =	6 (P = 0.0	08); I ² = 47	%	
Test for overall effect:	7 = 2.54 (P = 0.01)				-4 -2 0 2 4 Favours control Favours experimental
0					
)				Std Moon Difforence	Std Mean Difference
	Std. Mean Difference	SE		Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference		Weight	IV, Random, 95% CI	Std. Mean Difference IV, Random, 95% Cl
Study or Subgroup Carter 2011	0.5638	0.2591	Weight 15.7%	IV, Random, 95% Cl 0.56 [0.06, 1.07]	
Study or Subgroup Carter 2011 Dawson 2010	0.5638 0.6199	0.2591 0.3061	Weight 15.7% 12.3%	IV, Random, 95% Cl 0.56 [0.06, 1.07] 0.62 [0.02, 1.22]	
Study or Subgroup Carter 2011 Dawson 2010 Reitzel 2013	0.5638 0.6199 0.1244	0.2591 0.3061 0.6273	Weight 15.7% 12.3% 3.6%	IV, Random, 95% Cl 0.56 [0.06, 1.07] 0.62 [0.02, 1.22] 0.12 [-1.11, 1.35]	
Study or Subgroup Carter 2011 Dawson 2010 Reitzel 2013 Rogers 2012	0.5638 0.6199 0.1244 -0.131	0.2591 0.3061 0.6273 0.2022	Weight 15.7% 12.3% 3.6% 21.6%	IV, Random, 95% Cl 0.56 [0.06, 1.07] 0.62 [0.02, 1.22] 0.12 [-1.11, 1.35] -0.13 [-0.53, 0.27]	
Study or Subgroup Carter 2011 Dawson 2010 Reitzel 2013 Rogers 2012 Scahill 2016	0.5638 0.6199 0.1244 -0.131 0.1859	0.2591 0.3061 0.6273 0.2022 0.1494	Weight 15.7% 12.3% 3.6% 21.6% 29.5%	IV, Random, 95% Cl 0.56 [0.06, 1.07] 0.62 [0.02, 1.22] 0.12 [-1.11, 1.35] -0.13 [-0.53, 0.27] 0.19 [-0.11, 0.48]	
Study or Subgroup Carter 2011 Dawson 2010 Reitzel 2013 Rogers 2012 Scahill 2016 Tonge 2014	0.5638 0.6199 0.1244 -0.131 0.1859 0.4653	0.2591 0.3061 0.6273 0.2022 0.1494 0.2422	Weight 15.7% 12.3% 3.6% 21.6% 29.5% 17.2%	IV, Random, 95% Cl 0.56 [0.06, 1.07] 0.62 [0.02, 1.22] 0.12 [-1.11, 1.35] -0.13 [-0.53, 0.27] 0.19 [-0.11, 0.48] 0.47 [-0.01, 0.94]	
Study or Subgroup Carter 2011 Dawson 2010 Reitzel 2013 Rogers 2012 Scahill 2016	0.5638 0.6199 0.1244 -0.131 0.1859	0.2591 0.3061 0.6273 0.2022 0.1494 0.2422	Weight 15.7% 12.3% 3.6% 21.6% 29.5%	IV, Random, 95% Cl 0.56 [0.06, 1.07] 0.62 [0.02, 1.22] 0.12 [-1.11, 1.35] -0.13 [-0.53, 0.27] 0.19 [-0.11, 0.48]	
Study or Subgroup Carter 2011 Dawson 2010 Reitzel 2013 Rogers 2012 Scahill 2016 Tonge 2014	0.5638 0.6199 0.1244 -0.131 0.1859 0.4653	0.2591 0.3061 0.6273 0.2022 0.1494 0.2422	Weight 15.7% 12.3% 3.6% 21.6% 29.5% 17.2%	IV, Random, 95% Cl 0.56 [0.06, 1.07] 0.62 [0.02, 1.22] 0.12 [-1.11, 1.35] -0.13 [-0.53, 0.27] 0.19 [-0.11, 0.48] 0.47 [-0.01, 0.94]	
Study or Subgroup Carter 2011 Dawson 2010 Reitzel 2013 Rogers 2012 Scahill 2016 Tonge 2014 Vernon 2019 Total (95% CI)	0.5638 0.6199 0.1244 -0.131 0.1859 0.4653	0.2591 0.3061 0.6273 0.2022 0.1494 0.2422 0.4511	Weight 15.7% 12.3% 3.6% 21.6% 29.5% 17.2% 0.0% 100.0%	IV, Random, 95% Cl 0.56 [0.06, 1.07] 0.62 [0.02, 1.22] 0.12 [-1.11, 1.35] -0.13 [-0.53, 0.27] 0.19 [-0.11, 0.48] 0.47 [-0.01, 0.94] 1.16 [0.28, 2.04] 0.28 [0.04, 0.52]	

Figure 9. Forest plots for daily living skills. (**a**) Overall effect [29,30,45,48,50,55,58]. (**b**) Results after exclusion of studies with no blinding of outcome assessment [29,30,45,48,50,55].

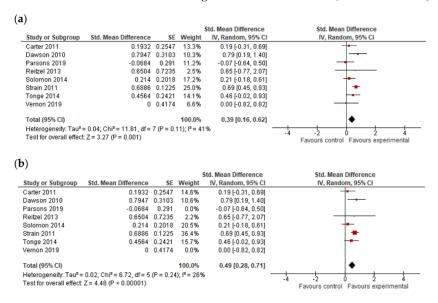


Figure 10. Forest plots for motor skills. (**a**) Overall effect [29,30,43,45,53–55,58]. (**b**) Results after exclusion of studies with no blinding of outcome assessment [29,30,45,53–55].

3.4.5. Follow-Up Data

Since early intervention may initiate a cascade of developmental events that is not yet apparent at post-treatment [65], follow-up data recorded sometime after the intervention period is over could provide evidence of the efficacy of early interventions [2]. For this reason, we conducted a separate analysis of follow-up data despite the limited number of studies that reported follow-up data. These results must be interpreted with caution. A detailed depiction of follow-up data is shown in Figure 11. Overall, the analysis of follow-up data did not provide evidence of the sustainability of positive outcomes. A positive result was found for daily living skills (g = 0.46, p = 0.03), and a marginally insignificant result was found for the adaptive behavior composite (g = 0.34, p = -0.04). However, due to the instability of the estimated pooled effects, we recommend a descriptive use of Figure 11 regarding the results of the included studies.

(a) Cognitive ability

`	, 0	2				
					Std. Mean Difference	Std. Mean Difference
	Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
	Carter 2011	-0.061	0.2542	28.3%	-0.06 [-0.56, 0.44]	
	Estes 2015	0.5951	0.3556	14.4%	0.60 [-0.10, 1.29]	
	Landa 2011	0.2499	0.2898	21.8%	0.25 [-0.32, 0.82]	
	Rogers 2019	0.1526	0.2268	35.5%	0.15 [-0.29, 0.60]	+
	Total (95% CI)			100.0%	0.18 [-0.09, 0.44]	•
	Heterogeneity: Tau ² =	0.00; Chi ² = 2.33, df = 3	(P = 0.51)	$); ^2 = 0\%$		
	Test for overall effect.	Z = 1.31 (P = 0.19)				-4 -2 U 2 4
						Favours control Favours experimental

(b) Expressive language

				Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Brian 2017	-0.2659	0.2553	18.5%	-0.27 [-0.77, 0.23]	
Hampton 2020	-0.181	0.243	20.4%	-0.18 [-0.66, 0.30]	
Kasari 2015	-0.0363	0.2157	25.9%	-0.04 [-0.46, 0.39]	-+-
Landa 2011	0.2585	0.2899	14.3%	0.26 [-0.31, 0.83]	
Siller 2013	0.1479	0.2395	21.0%	0.15 [-0.32, 0.62]	
Total (95% CI)			100.0%	-0.03 [-0.24, 0.19]	•
Heterogeneity: Tau ² =	0.00; Chi ² = 2.78, df = 4	(P = 0.59	3); I ² = 0%		
Test for overall effect:	Z = 0.25 (P = 0.80)				Favours control Favours experimental

(c) Receptive language

				Std. Mean Difference	Std. Mean Difference	
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI	
Brian 2017	-0.1297	0.2544	28.6%	-0.13 [-0.63, 0.37]		
Hampton 2020	0	0.2425	31.5%	0.00 [-0.48, 0.48]	-+-	
Kasari 2015	-0.0409	0.2157	39.8%	-0.04 [-0.46, 0.38]	-	
Total (95% CI)			100.0%	-0.05 [-0.32, 0.21]	+	
Heterogeneity: Tau ² = Test for overall effect:	0.00; Chi ² = 0.14, df = 2 Z = 0.39 (P = 0.69)	(P = 0.93	3); I² = 0%		-4 -2 0 2	4
					Favours control Favours expe	rimental

(d) Adaptive behavior composite

				Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Estes 2015	0.5951	0.3556	28.7%	0.60 [-0.10, 1.29]	+ - -
Rogers 2019	0.2339	0.2255	71.3%	0.23 [-0.21, 0.68]	
Total (95% CI)			100.0%	0.34 [-0.04, 0.71]	◆
	0.00; Chi ² = 0.74, df = 1	(P = 0.39	3); I² = 0%		-4 -2 0 2 4
Test for overall effect	Z = 1.77 (P = 0.08)				Favours control Favours experimental

(e) Communication

			5	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Brian 2017	-0.2037	0.2548	38.8%	-0.20 [-0.70, 0.30]	
Carter 2011	-0.0208	0.2542	39.0%	-0.02 [-0.52, 0.48]	-+-
Estes 2015	0.4404	0.3473	22.3%	0.44 [-0.24, 1.12]	+
Total (95% CI)			100.0%	0.01 [-0.32, 0.35]	★
Heterogeneity: Tau ² =	= 0.01; Chi ² = 2.25, df = 2	(P = 0.32	2); I ² = 11%	-	
Test for overall effect	Z = 0.06 (P = 0.95)				-4 -2 0 2 4 Favours control Favours experimental

(f) Socialization

			1	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Brian 2017	-0.0722	0.2542	38.6%	-0.07 [-0.57, 0.43]	
Carter 2011	0.1031	0.2543	38.6%	0.10 [-0.40, 0.60]	-
Estes 2015	0.638	0.3575	22.8%	0.64 [-0.06, 1.34]	
Total (95% CI)			100.0%	0.16 [-0.21, 0.53]	•
Heterogeneity: Tau ² =	0.03; Chi ² = 2.66, df = 2	(P = 0.26)	5); I ² = 25%	6 -	
Test for overall effect:	Z = 0.84 (P = 0.40)				-4 -2 U 2 4 Favours control Favours experimental

(g) Daily living skills

				Std. Mean Difference		Std. Mean Differe	nce	
Study or Subgroup	or Subgroup Std. Mean Difference		Weight	IV, Random, 95% CI		IV, Random, 959	CI	
Carter 2011	0.5638	0.2591	64.0%	0.56 [0.06, 1.07]				
Estes 2015	0.2725	0.3457	36.0%	0.27 [-0.41, 0.95]		-		
Total (95% CI)			100.0%	0.46 [0.05, 0.87]		•		
Heterogeneity: Tau ² =	= 0.00; Chi ² = 0.45, df = 1	(P = 0.50	0); I ² = 0%		.		1	-
Test for overall effect	Z = 2.21 (P = 0.03)				-4 Favou	irs control Favou	rs experin	4 nental

(h) Motor skills

				Std. Mean Difference		Std. N	Aean Differ	ence	
Study or Subgroup	Std. Mean Difference	SE	Weight	IV, Random, 95% CI		IV, Random, 95% CI			
Carter 2011	0.1932	0.2547	100.0%	0.19 [-0.31, 0.69]					
Total (95% CI)			100.0%	0.19 [-0.31, 0.69]			+		
Heterogeneity: Not ap					-4	-2	-	1	
Test for overall effect	Z = 0.76 (P = 0.45)				-	Favours co	ntrol Favo	urs exper	imental

Figure 11. Forest plots for follow-up data. (a) Cognitive ability [29,33,41,49]. (b) Expressive language [28,37,40,41,52]. (c) Receptive language [28,37,40]. (d) Adaptive behavior composite [33,49]. (e) Communication [28,29,33]. (f) Socialization [28,29,33]. (g) Daily living skills [29,33]. (h) Motor skills [29].

3.5. Publication Bias

A possible way to assess publication bias is via a funnel plot [66]. Regarding publication bias, the results of smaller studies were spread widely, due to lower precision, and asymmetrically around the average estimate compared to the results of larger studies. This asymmetry is suggestive of missing studies. In the absence of publication bias, individual study results are more evenly distributed around a pooled estimate. However, caution should be exercised when interpreting funnel plots, especially when the number of included studies is smaller than 10 (ref. Cochrane handbook) [29,67]. In our case, the funnel plot (Figure 12) indicates no publication bias.

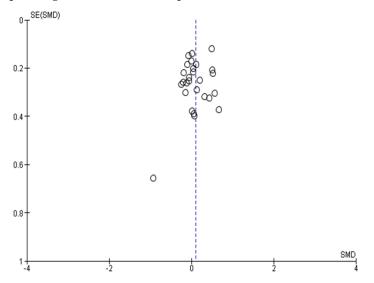


Figure 12. Funnel plot for publication bias.

4. Discussion

The purpose of this meta-analysis was to assess the efficacy of early interventions in pre-school children with ASDs and investigate how the intervention intensity and duration could mediate the final outcome. Considering the overall effect, when all the included studies were analyzed, early interventions showed significant effects on the cognitive ability, daily living skills, and motor skills of children with autism, while there were no additional benefits for expressive language, receptive language, communication, socialization, and adaptive behavior compared to whatever other interventions were provided. It should be noted here that the results for expressive language were marginally insignificant and worth further investigation. Moreover, when studies with detection bias were excluded from the analyses, positive early intervention effects were detected solely for daily living skills and motor skills. The subgroup analyses on the intervention intensity and duration did not reveal any significant effects. This could be attributed to the fact that the number of studies and participants included in the subgroups were unequal, limiting the power to identify any actual effects of these moderators on the tested outcomes.

Apart from daily living skills and motor skills, our main results are consistent with the meta-analysis of Sandback et al., (2020) [2], where no positive effect of early intervention was detected when the analysis was based only on RCTs with no detection bias. Similarly, Rogers et al., (2021) [8], in their meta-analysis of non-randomized studies about the efficacy of ABA, did not find any significant effects on cognitive ability or adaptive behavior. Additionally, the results of our study are in partial agreement with those of Tachibana et al., (2017) [21], who also only included RCTs and excluded studies with a high risk of bias or studies that did not meet other decisive quality criteria from the final analysis. That study indicated that early intervention did not appear to be efficacious for expressive language, receptive language, and adaptive behavior. Howlin et al., (2009) [68] also failed to find a significant effect of EIBI for expressive language. Nevil et al., (2016) [20] also based their analysis on RCTs and reported that a parent-mediated intervention only resulted

in minor improvements in socialization and cognition of children with ASDs. They also reported insignificant improvements in communication language, which incorporated the expressive and receptive language variables. In addition, a recent meta-analysis conducted by Reichow et al., (2018) [18] that examined the efficacy of EIBI concluded that there is low-quality evidence that EIBI can improve IQ, language and adaptive behavior. The authors also underlined the fact that most of the data were derived from studies with many methodological limitations that could have affected the outcomes. Additionally, Speckley et al., (2009) [19] examined the efficacy of applied behavioral intervention and concluded that it did not lead to significant improvements in cognitive ability, language and adaptive behavior compared to TAU. Furthermore, the results of our study are in partial agreement with those of the meta-analysis conducted by Peters-Scheffer et al., (2011) [69], who indicated that EIBI only showed statistically significant effects for IQ, not for expressive and receptive language or for communication, socialization and daily living skills. The described inconsistencies with previous studies could be attributed to the different inclusion criteria applied in each case, which resulted in considerably different study samples. They could also be partly or entirely attributed to biases within the included studies or to the quality of the collected data. In our study, only five of the included studies were assessed as having a low risk of bias in all criteria.

Various studies on the efficacy of early interventions have also demonstrated positive effects in specific areas. A series of meta-analyses that tested high-intensity interventions showed positive outcomes. Yu et al. (2020) [8] concluded that ABA-based interventions can have a positive effect on socialization, communication, and expressive language but not on receptive language, adaptive behavior, daily living skills, IQ, verbal IQ, nonverbal IQ, and cognition. Fuller et al., (2020) [70] conducted a meta-analysis regarding the efficacy of ESDM for children with ASDs and found positive outcomes for cognition and language but not for adaptive behavior. Finally, Warren et al., (2011) [71], Makrygianni et al., (2018) [12], and Reichow et al., (2011) [13] concluded that early intervention is efficient in improving the IQ, language, and adaptive behavior of children with ASDs.

Based on the current evidence, it is not yet clear whether early intervention is effective. There seems to be a trend where older meta-analyses more often reported positive outcomes while more recent ones that included studies of higher quality did not show such strong overall effects, only improvements on isolated variables if on any variable at all. Especially when only RCTs were included, the claimed positive effects could not be established. Considering the extended heterogeneity presented by children with ASDs and the different types of interventions tested, we cannot conclude at present that early intervention is not an effective intervention. There could be many explanations for the absence of effects. We suggest that the main priority in relevant research should be to identify which treatment works best and for whom [72,73]. It is not yet clear which characteristics of a child and family may affect the success of an intervention. Early interventions target children even at infancy and until more than ten years of age. In our review, the age range of the participants was found to be 24–132 months. Although there have been a limited number studies examining the influence of age of therapy initiation on outcomes, research has shown that the sooner an intervention takes place, the higher the impact on the altered brain circuity of children with ASDs, resulting in positive outcomes [72,73]. In addition, the predictive value of cognitive ability at pre-treatment on participants' performance is not yet clear [21,72]. Of course, different researchers have used different inclusion criteria to attempt to account for the limitations and controversies that the previous ASD research presents. On the other hand, these controversies may highlight the need for more targeted interventions in response to age of treatment onset and cognitive ability at baseline [74,75]. Improvements in daily living skills have been previously associated with increased age, higher developmental quotient and lower symptom severity, while children with lower IQs and more severe symptoms have shown slower daily living skills gains. Caregivers and treatment providers may need to adjust their interventions according each child's developmental and autism level [76–78]. On the other hand, motor skills are an essential

component for social communication and social engagement, since they influence how someone responds to social stimuli. Gestures and facial expressions rely on motor function and are crucial for the communication and social engagement of children with ASDs. Motor skill deficits are common for people with ASDs and influence how people with ASDs interact and perceive communication with other people and their environment. For this reason, in recent years, research has been focused on investigating the mechanisms of motor skills and the impact that motor skills interventions can have on ASD-related symptoms [79–81].

Lately, more and more studies have highlighted the need for parent involvement and parent training. When parents are actively involved, either as main intervention providers or as co-therapists, intervention is associated with more positive outcomes for children with ASDs. Current evidence suggests that effective skills need to be intensively practiced in everyday life so that an intervention can be effective. Therefore, interventions in which families are trained to work daily on the skills that children with ASDs need to acquire may be the most promising. In order to be applicable and to maximize the effects, such interventions should be individualized, considering the needs of the child, family life, and their interactions [82,83].

Although our subgroup analysis failed to demonstrate any mediating effect of the duration and intensity of interventions on outcomes, it is strongly recommended to compare the early interventions based on their intensity and duration and not just on their manuals. Given the fact that the majority of the control groups in the current meta-analysis were assigned to TAU, it should be noted that, particularly in the case of very low and of highintensity experimental interventions, the TAU group should be receiving at least as much intervention as the experimental groups so that the comparisons are meaningful. This was not always the case. Additionally, some studies, such as those involving very shortterm interventions (e.g., 12 weeks), were not designed to examine whether major changes occur in cognition and language as a result of treatment but rather whether intervention can differentially alter or accelerate development in specific skills in ASDs. However, by including these studies, we wanted to see whether this acceleration could indirectly influence more comprehensive skills such as cognition, language and adaptive behavior as distal variables [2]. Additionally, early intervention may initiate a cascade of developmental events that lead to an altered brain circuity, resulting in better developmental outcomes [65]. For this reason, we performed a meta-analysis of follow-up data. According to our analysis, there is no evidence that experimental groups perform better than control groups after the course of the intervention. However, follow-up data were not reported consistently, so this analysis can be considered unstable due to the limited number of available studies. Another possible explanation for the absence of effects is that standardized measures are not always sensitive to the kinds of change activated by treatment for children with ASDs since they measure molar aspects of behavior and fail to detect the acquisition of specific skills [2].

The current study has certain limitations. One of the main limitations was the high variability of the included studies in the participants' age and the targeted outcomes, as reported above. The provided interventions also varied regarding their duration, intensity, and structural elements. The combination of outcomes in statistical analysis could have diluted or masked the isolated gains that might have occurred due to the intervention. In children with a complex, multi-system disorder such as an ASDs, even those isolated gains are noteworthy. Furthermore, the current meta-analysis included data from pilot studies, such as those of Divan et al., (2019) [36], Drew et al., (2002) [37], Vernon et al., (2019) [63], and Reitzel et al., (2013) [50], that did not have a large number of participants. Additionally, many participants across all studies received other kind of therapies apart from the examined interventions during the study periods, and this could have exerted some influence on the results.

On the other hand, apart from its limitations, the current meta-analysis has many strengths. The first and most important is that this meta-analysis reports outcomes based

only on RCTs, so many study quality parameters, such as the adequate randomization procedure, the existence of a control condition, the comparability of the groups at baseline, and the use of standardized measurements were fulfilled across all studies. Additionally, following the quality assessment of the included studies, those assessed as having a high risk of bias in the measurement of the outcome were excluded from the analysis, so it can be assumed that the outcomes ere accurate and valid. Moreover, using the formula suggested by Borenstein et al., (2021) [29], it was possible to combine all outcomes for the same variable across studies using a valid method to calculate the variances of the multiple outcomes so that each study was appropriately weighted in the final analysis. In this way, we included all the available information derived from different tests and scales for each single variable.

5. Conclusions

In conclusion, the current meta-analysis has demonstrated that although early intervention generally might not lead to positive outcomes for cognitive ability, language, communication and socialization for children with ASDs, these results should be interpreted with caution considering the great variability in participant and intervention characteristics. Perhaps it is not that the intervention itself is ineffective but that researchers should consider (a) the need for participants to attain sufficient intervention dosage, since previous literature has yielded positive outcomes for high-intensity interventions; (b) the need to design or use more sensitive measures than standardized measures; and (c) the need to examine longer-term effects through follow-up studies, since early intervention programs initiate a circuit of developmental events and children who received early intervention may continue to progress well years after the initial intervention. On the other hand, we identified significant positive effects of early intervention on daily living and motor skills, which have implications for everyday life and social communication. We recommend that future research should focus on creating more specific intervention groups using participants with comparable cognitive ability at baseline and a smaller age range in order to explore whether specific subgroups of children with ASDs respond better to early interventions than others. Additionally, we underline the need for future studies that meet the quality research standards in order to draw more valid and accurate conclusions.

Author Contributions: Conceptualization, S.D. and H.Z.; methodology, S.D. and H.Z.; software, S.D.; data collection and analysis, S.D. and N.P.; data curation, S.D.; writing—original draft preparation, S.D.; writing—review and editing, N.P. and H.Z., visualization, S.D.; supervision, H.Z. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: All data are available in the main text or the extended data. The search protocols and datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

HereHordMCDMCDNoNNNAldred et al. (2001) [2]ReceptiveMCD/ words port(22740.451.41.46.61.14.21.4CommunicationVARS post35.92.1241.41.46.61.14.21.4CommunicationVARS post35.92.133.03.21.233.03.23.231.233.23.231.233.23.233.	Study	Outcome	Measure	Exp	erimental Gro	oup	C	Control Grou	р
Aldred et al. (200) [27]ReceptiveMCDI words post222740.43114146.811,42614CommunicationVABS post36.921.214.128.716.614EgpressiveMSEL follow up29.0312.1.33030.8714.5132.Bian et al. (2017) [25]CommunicationVABS follow up75.8318.183078.4448.232.CommunicationVABS follow up75.8318.273076.4748.232.Cognitive AhlityMSEL65.216.233066.9119.2132.ReceptivePL5.47.7413.783076.9715.232.BacchaitentonVABS follow up77.417.373066.9119.2132.SciulizationVABS follow up77.847.77327.276.0130.SciulizationVABS follow up7.847.76327.4833.030.Cognitive AhlityMSEL61.607.363217.488.3030.ReceptiveMSEL16.27.333216.4833.030.FypressiveMSEL16.27.333216.4833.030.0ReceptiveMSEL16.27.333216.4833.030.0ReceptiveMSEL16.27.333216.4833.030.0ReceptiveMSEL16.27.323216.4833.0				Mean	SD	Ν	Mean	SD	Ν
CommunicationVABS post36.921.21428.716.614ExpressiveMSEL follow up28.5312.13303213.8632Brian et al. (2017) [25]CommunicationVABS follow up75.6313.183078.3413.4232SocializationVABS follow up75.838.273067.8413.6232SocializationVABS follow up75.838.273067.9712.232ExpressivePLS-475.4313.783067.9712.232ReceptivePLS-470.3317.73068.9114.0550SocializationVABS follow up71.427.07327.076.8930Dall physics skillsVABS follow up71.427.07327.076.8930Carter et al. (2011)[26]Motor skillsVABS follow up7.1847.263216.1830Motor skillsVABS follow up63.167.263216.488.3030ExpressiveMSEL16.27.233216.687.8830ExpressiveMSEL16.27.233216.687.8832Daves et al. (2017)[16]Cognitive AbilityMSEL16.27.233216.83217.1Ability ebaivaur compositeVABS68.715.92.446.415.92.112.112.112.112.112.11		Expressive	MCDI words post	199.4	25.606	14	33.1	683	14
ExpressiveMSEL follow up28.3312.13303213.8632Brian et al. (2017) [28]ReceptiveMSEL follow up75.6313.163075.4413.2SocializationVABS follow up75.838.273076.448.6232Cognitive AbilityMSEL65.216.23306.89.112.15732ExpressivePL5.475.413.853276.4314.0530SocializationVABS follow up77.4413.853276.4314.0530CarmunicationVABS follow up77.447.073272.9510.1130Daily living skillsVABS follow up77.847.073272.9510.1130Carter et al. (2011) [29]Motor skillsVABS follow up77.847.07328.8513.030Daily living skillsVABS follow up77.847.07327.848.303030ExpressiveMSEL15.526.933217.883030323130BeceptiveMSEL15.526.933217.883032323130Biolow upVABS6.8715.624309.2213236313231Daily living killsVABS6.6715.624309.231323232323232323232	Aldred et al. (2004) [27]	Receptive	MCDI words post	222.7	40.431	14	146.8	11,426	14
ReceptiveMSEL follow up29.0713.173030.8714.5132CommunicationVABS follow up75.6313.183078.4413.2432SocializationVABS follow up75.838.273076.4416.2632Cognitive AbilityMSEL65.216.238066.8121.5732ExpressiveP15-475.4013.783066.9112.2132ReceptiveP15-475.4113.853276.4314.0530SocializationVABS follow up77.147.073270.756.8930Dally living skillsVABS follow up77.847.073270.756.9130Motor skillsVABS follow up63.8813.413264.8813.4930ReceptiveMSEL follow up63.8813.413264.8813.4930ReceptiveMSEL follow up63.8813.413264.8813.4930ReceptiveMSEL15.26.932217.483321ReceptiveMSEL78.624.22466.315.321ReceptiveMSEL78.664.715.92493.18.2121Divan et al. (2011)Gattive AbilityMSEL66.715.92495.915.924Divan et al. (2011)Gattive AbilityVABS64.712.42464.112.3<		Communication	VABS post	36.9	21.2	14	28.7	16.6	14
Brian et al. (2017) [23]CommunicationVABS follow up75.6313.183078.3413.4232SocializationVABS follow up75.838.273067.448.6232Cognitive AbiliyMSEL67.5413.783067.9715.0232ExpressiveP1.5475.413.783067.89715.0232ReceptiveP1.5470.317.73068.9119.2130CommunicationVABS follow up71.427.07327.076.8930Daily living skillsVABS follow up77.847.07327.076.8930Motor skillsVABS follow up77.847.07327.046.8930Cognitive AbilityMSEL follow up7.847.07327.048.3030ReceptiveMSEL15.26.933217.488.3330ReceptiveMSEL7.8624.22466.315.321PoressiveMSEL7.8615.624309.221ReceptiveMSEL36.615.62430.59.221Daily living skillsVABS68.715.92463.19.321Daily living skillsVABS68.715.92459.18.321Daily living skillsVABS68.715.92463.19.321Daily living skills <td< td=""><td></td><td>Expressive</td><td>MSEL follow up</td><td>28.53</td><td>12.13</td><td>30</td><td>32</td><td>13.86</td><td>32</td></td<>		Expressive	MSEL follow up	28.53	12.13	30	32	13.86	32
Brian et al. (2017) [28)SocializzationVABS follow up75.838.273076.448.6232Cognitive AbilityMSEL65.216.230369.8121.5732ExpressivePLS-475.413.783066.8110.2132ReceptivePLS-475.413.773066.9110.2132SocializationVABS follow up77.1413.853276.4314.0530SocializationVABS follow up77.847.073270.76.8930Daily living skillsVABS follow up78.347.073270.76.8930Cognitive AbilityMSEL15.26.933281.559.2630Cognitive AbilityMSEL15.26.933211.687.8830ExpressiveMSEL16.27.233216.687.8830ExpressiveMSEL7.6624.2246.315.221ReceptiveMSEL36.615.6249.18.821CommunicationVABS64.715.2249.18.821Divan et al. (2010) [31CommunicationVABS64.712.49.18.12Divan et al. (2010) [31CommunicationVABS64.712.464.112.421Divan et al. (2010) [31]CommunicationVABS64.712.416.611.524 </td <td></td> <td>Receptive</td> <td>MSEL follow up</td> <td>29.07</td> <td>13.17</td> <td>30</td> <td>30.87</td> <td>14.51</td> <td>32</td>		Receptive	MSEL follow up	29.07	13.17	30	30.87	14.51	32
IndextantionIndextantionIndextantionIndextantionIndextantionIndextantionIndextantionIndextantionMSEL65262360608121252ExpressivePLS-475.413.78630668119.2152ReceptivePLS-470.317.76368.9192.152CommunicationVABS follow up71.427.07327.076.8930Dally living skillsVABS follow up71.427.07327.076.8930Ocognitive AbilityVABS follow up83.167.766.226.481.3430Ocognitive AbilityMSEL15.26.93321.748.3330ReceptiveMSEL15.26.93321.68322130Ocognitive AbilityMSEL15.26.93321.683221Cognitive AbilityMSEL16.27.232.46.431.6321Cognitive AbilityMSEL16.67.641.633.0222.1Ability behaviour compositeVABS6.871.592.46.431.632.1Davaon et al. (2010)16.3VABS6.871.592.46.411.582.1Davaon et al. (2010)16.3VABS6.671.621.61.61.61.61.6Davaon et al. (2010)16.3VABS6.871.61.6<		Communication	VABS follow up	75.63	13.18	30	78.34	13.42	32
ExpressivePLS-475.413.783076.9715.0232ReceptivePLS-470.3317.7306.89119.2132CommunicationVABS follow up76.1413.853276.3314.0530SocializationVABS follow up77.427.07327.2510.1130Daily living skillsVABS follow up77.847.07327.2510.1130Motor skillsVABS follow up63.818.143264.8513.4930ReceptiveMSEL15.226.933217.488.3330ReceptiveMSEL15.26.933217.488.3330Cognitive AbilityMSEL7.8624.22466.315.321ReceptiveMSEL36.613.624309.221Adaptive behaviour compositeVABS68.715.92450.18.821Daily living skillsVABS64.712.82466.315.821Daily living skillsVABS65.0012.691966.312.911.6Daily living skillsVABS65.0012.691966.312.911.6Daily living skillsVABS65.0012.691966.117.112Daily living skillsVABS65.0012.691966.117.112Daily living skillsVABS	Brian et al. (2017) [28]	Socialization	VABS follow up	75.83	8.27	30	76.44	8.62	32
ReceptivePLS-470.3317.78068.9119.2132CommunicationVABS follow up76.1413.853276.4314.0530SocializationVABS follow up77.427.073270.706.8030Daily living skillsVABS follow up77.847.073270.706.8030CommunicationVABS follow up63.8618.413264.8813.9430ReceptiveMSEL15.26.933217.488.3330ReceptiveMSEL16.27.233216.687.8830ExpressiveMSEL16.27.233216.687.8830ReceptiveMSEL78.624.22466.315.321ExpressiveMSEL36.613.624309.221ReceptiveMSEL36.615.92431.510.621ReceptiveMSEL4016.32430.99.221Daily living skillsVABS68.715.92468.121Dialy living skillsVABS68.715.92468.12321Dialy living skillsVABS67.719.82464.112.321Dialy living skillsVABS67.719.82464.112.321Dialy living skillsVABS67.719.82464.112.3		Cognitive Ability	MSEL	65.2	16.23	30	69.81	21.57	32
Carter et al. (2011) [29]CommunicationVABS follow up76.1413.853276.4314.0530SocializationVABS follow up71.427.073270.76.8930Daily living skillsVABS follow up77.847.073270.76.8930Motor skillsVABS follow up63.8818.413264.8813.9430Cognitive AbilityMSEL follow up63.8818.413264.883030ReceptiveMSEL15.226.933217.488.3330Cognitive AbilityMSEL7.647.2321.61.687.8830Cognitive AbilityMSEL7.6416.27.2321.61.687.8830Cognitive AbilityMSEL7.6613.62.430.52.1221.12Cognitive AbilityMSEL36.613.62.430.52.1221.12Cognitive AbilityMSEL4016.32.430.52.1221.12Cognitive AbilityVABS69.211.62.46.6112.1221.12Davison et al. (2010) [31CommunicationVABS69.211.62.46.4112.221.12Divan et al. (2011) [31CommunicationVABS61.9317.8196.5012.412.12.1Divan et al. (2012) [32Cognitive AbilityVABS61.9317.8196.6117.112.112.1<		Expressive	PLS-4	75.4	13.78	30	76.97	15.02	32
SocializationVABS follow up71.427.073.27.076.89.00Dally living skillsVABS follow up77.447.073.272.9510.10.01Motor skillsVABS follow up83.167.073.272.95.01.01Cognitive AbilityMSEL follow up63.167.42.02.81.55.02.03ReceptiveMSEL15.2.693.02.16.8.03.03.02ExpressiveMSEL.06.16.2.72.3.02.16.8.03.02.02Cognitive AbilityMSEL.06.6.16.6.04.03.02.02.03.02.02ExpressiveMSEL.06.16.3.24.03.1.01.02 <td></td> <td>Receptive</td> <td>PLS-4</td> <td>70.33</td> <td>17.7</td> <td>30</td> <td>68.91</td> <td>19.21</td> <td>32</td>		Receptive	PLS-4	70.33	17.7	30	68.91	19.21	32
Carter et al. (2011) [29]Daily living skillsVABS follow up7.847.07327.2910.1130Motor skillsVABS follow up63.167.363261.559.2630Cognitive AbilityMSEL follow up63.8816.413264.8813.9430ReceptiveMSEL15.26.933216.687.8830ExpressiveMSEL7.8624.22466.315.321ExpressiveMSEL7.8624.22463.315.921ReceptiveMSEL4016.32430.12430.121ReceptiveMSEL4016.32431.510.62121Adaptive behaviour compositeVABS68.715.92469.415.821Davaon et al. (2010) [31CommunicationVABS68.712.42463.12321Motor skillsVABS64.712.82463.12321212321Davan et al. (2019) [31CommunicationVABS64.712.82464.112.8212463.1232124Davan et al. (2019) [31Cognitive AbilityVABS64.712.42463.123 <td></td> <td>Communication</td> <td>VABS follow up</td> <td>76.14</td> <td>13.85</td> <td>32</td> <td>76.43</td> <td>14.05</td> <td>30</td>		Communication	VABS follow up	76.14	13.85	32	76.43	14.05	30
Carter et al. (2011) [29]Motor skillsVABS follow up83.167.363281.559.2630Cognitive AbilityMSEL follow up63.8818.413264.8813.430ReceptiveMSEL15.526.933217.488.3330ExpressiveMSEL15.27.332216.687.8830Leceptive AbilityMSEL7.8624.22466.315.321Receptive AbilityMSEL36.613.62430.99.221Adaptive behaviour compositeVABS66.715.92455.08.821Adaptive behaviour compositeVABS69.211.62463.19.321Divan et al. (2019) [31]CommunicationVABS69.211.62458.02121Adaptive behaviour compositeVABS69.211.62458.0212121Divan et al. (2019) [31]CommunicationVABS69.211.62458.0212121CommunicationVABS65.0012.691960.5117.1122121Divan et al. (2019) [31]CommunicationVABS68.4710.261963.211.62450.011.62450.011.62450.011.62450.011.62450.012.611.62450.011.62450.011.6 <td></td> <td>Socialization</td> <td>VABS follow up</td> <td>71.42</td> <td>7.07</td> <td>32</td> <td>70.7</td> <td>6.89</td> <td>30</td>		Socialization	VABS follow up	71.42	7.07	32	70.7	6.89	30
Index and Cognitive AbilityMBEL1.001		Daily living skills	VABS follow up	77.84	7.07	32	72.95	10.11	30
ReceptiveMSEL15.526.933217.488.3330ExpressiveMSEL16.27.233216.687.8830ExpressiveMSEL7.6624.22466.315.321ExpressiveMSEL36.613.624.2309.221ReceptiveMSEL36.613.62431.510.621Adaptive behaviour compositeVABS68.715.92469.415.821CommunicationVABS68.711.62469.415.821SocializationVABS69.211.62469.415.821Divan et al. (2019)[31CommunicationVABS69.211.62468.121Divan et al. (2019)[31CommunicationVABS66.012.691960.312.9821Divan et al. (2019)[31CommunicationVABS66.9317.881955.9014.1521Drew et al. (2019)[31Cognitive AbilityNVIQ77.914.81264.117.112Drew et al. (2019)[31Cognitive AbilityNVIQ77.914.81264.117.112Drew et al. (2015)[32ExpressiveMCDI words16.111.21.912100.380.211.6Cognitive AbilityMSEL follow up83.611.2512.823.613.816Cognitive AbilityMSEL follow up8	Carter et al. (2011) [29]	Motor skills	VABS follow up	83.16	7.36	32	81.55	9.26	30
ExpressiveMSEL1627.233216.687.8830ACognitive AbilityMSEL78.624.22466.315.321ExpressiveMSEL36.613.62430.09.221ReceptiveMSEL36.613.62430.19.221Adaptive behaviour compositeVABS68.715.82459.18.821CommunicationVABS68.711.62469.415.821SocializationVABS69.211.62469.415.821Motor skillsVABS64.712.42468.72121Divan et al. (2019)[31CommunicationVABS66.011.8212121Drew et al. (2019)[31Cognitive AbilityNVIQ77.914.81266.111.421Drew et al. (2019)[31Cognitive AbilityNVIQ77.914.81211.4121211.412Drew et al. (2019)[31Cognitive AbilityNVIQ77.914.81261.111.1121211.4121211.41212.511.41212.511.41212.511.41212.511.41212.511.412.511.412.511.512.511.512.511.512.511.512.511.512.511.512.511.512.511.5<		Cognitive Ability	MSEL follow up	63.88	18.41	32	64.88	13.94	30
Conditive AbilityMSEL78.624.22466.315.321ExpressiveMSEL36.613.624309221Adeptive behaviour compositeMSEL4016.32431.510.621Adaptive behaviour compositeVABS68.715.92469.18.821CommunicationVABS68.711.62463.19.321SocializationVABS64.711.42463.19.321Dily living skillsVABS64.712.42468.821Motor skillsVABS65.0012.691960.3312.9821Divan et al. (2019)[31Adaptive behaviour compositeVABS66.9711.81955.9014.1521Drew et al. (2002)[32CommunicationVABS68.4710.261960.3312.9821Drew et al. (2002)[32ExpressiveMCDI words68.4710.261963.211.521Drew et al. (2002)[32ExpressiveMCDI words96.611.88124450.212Drew et al. (2002)[32ExpressiveMCDI words17.61121.91220.118.412Drew et al. (2002)[33ExpressiveMCDI words17.61121.91221.018.412Drew et al. (2002)[34CommunicationVABS follow up83.612.51221.118.412<		Receptive	MSEL	15.52	6.93	32	17.48	8.33	30
Barbon et al. (2010) [30]ExpressiveMSEL36.613.624309.221Adaptive behaviour compositeVABS68.715.92459.18.821Adaptive behaviour compositeVABS68.715.92469.415.821CommunicationVABS69.211.62469.415.821Daily living skillsVABS69.211.62463.19.321Daily living skillsVABS64.712.42468.88.121Motor skillsVABS67.419.82464.112.321Motor skillsVABS66.012.691960.5312.921Divan et al. (2019) [31]CommunicationVABS60.9317.881955.0014.1521Drew et al. (2002) [32]Cognitive AbilityNVIQ77.914.81266.117.112ExpressiveMCDI words96.6118.8124450.211.621Prew et al. (2002) [32]ExpressiveMCDI words96.6118.81224.23.62423.6Cognitive AbilityNVIQ77.914.81229.118.41224.124.124.124.1ExpressiveMCDI words96.6118.81224.113.112.112.112.112.112.112.112.112.112.113.112.1<		Expressive	MSEL	16.2	7.23	32	16.68	7.88	30
Dawson et al. (2010) [30]ExpressiveMSEL36.613.624309.221Adaptive behaviour compositeVABS68.715.92459.18.821CommunicationVABS68.711.82469.415.821SocializationVABS69.211.62463.19.321Diving skillsVABS64.712.42468.88.121Motor skillsVABS64.712.42464.112.321Motor skillsVABS65.0012.691960.5312.9821Divan et al. (2019) [31]CommunicationVABS66.9317.881965.9014.1521Cognitive AbilityNVIQ77.914.81266.117.11212Prew et al. (2002) [32]ExpressiveMCDI words96.6118.8124450.212Estes et al. (2015) [33]Cognitive AbilityMSEL follow up91.512.913.513.611Cognitive AbilityMSEL follow up83.612.51229.118.412Estes et al. (2015) [34]CommunicationVABS follow up91.517.277.016.417.0Cognitive AbilityMSEL follow up83.612.51777.116.417.0Adaptive behaviour compositeVABS follow up83.617.61777.116.417.0Cogni		Cognitive Ability	MSEL	78.6	24.2	24	66.3	15.3	21
Dawson et al. (2010) [30]Adaptive behaviour compositeVABS68.715.92459.18.821CommunicationVABS82.121.82469.415.821SocializationVABS69.211.62463.19.321Daily living skillsVABS64.712.424588.121Motor skillsVABS67.419.82464.112.321Divan et al. (2019) [31]CommunicationVABS60.0317.881965.014.1521SocializationVABS68.4710.261963.2511.4521SocializationVABS68.4710.261963.2511.4521Drew et al. (2002) [32]ExpressiveMCDI words66.6118.81264.112.2ExpressiveMCDI gestures38.612.51229.118.412Adaptive behaviour compositeVABS follow up90.5226.362479.8323.6421ExpressiveMCDI gestures38.612.51229.118.41216Adaptive behaviour compositeVABS follow up88.3519.761777.116.417ExpressiveMCDI sectures38.612.51777.116.417Adaptive behaviour compositeVABS follow up88.3519.761777.116.417ExpressiveCDI 680 <td></td> <td></td> <td>MSEL</td> <td>36.6</td> <td>13.6</td> <td>24</td> <td>30</td> <td>9.2</td> <td>21</td>			MSEL	36.6	13.6	24	30	9.2	21
Dawson et al. (2010) [30] Communication VABS 82.1 21.8 24 69.4 15.8 21 Socialization VABS 69.2 11.6 24 63.1 9.3 21 Daily living skills VABS 64.7 12.4 24 58 8.1 21 Motor skills VABS 64.7 12.4 24 58 8.1 21 Motor skills VABS 64.7 19.8 24 64.1 12.3 21 Motor skills VABS 65.00 12.69 19 60.53 12.98 21 Divan et al. (2019) [31 Communication VABS 60.93 17.88 19 55.90 14.15 21 Drew et al. (202) [32 Cognitive Ability NVIQ 77.9 14.8 12 66.1 17.1 12 Drew et al. (202) [32 Expressive MCDI words 96.6 118.8 12 29.1 18.4 12 Drew et al. (202) [32 Expressive		Receptive	MSEL	40	16.3	24	31.5	10.6	21
CommunicationVABS82.121.82469.415.821SocializationVABS69.211.62463.19.321Daily living skillsVABS64.712.424588.121Motor skillsVABS77.419.82464.312.321Motor skillsVABS65.0012.699.059.14.1521Divan et al. (2019) [31CommunicationVABS68.4710.261963.214.1521SocializationVABS68.4710.261266.117.1121212Prew et al. (2002) [32]Cognitive AbilityNVIQ77.914.81266.117.112Prew et al. (2002) [34]ExpressiveMCDI words38.612.51214.51212ReceptiveMCDI words96.511.881240.112.112121212.1121212.11		Adaptive behaviour composite	VABS	68.7	15.9	24	59.1	8.8	21
Daily living skillsVABS64.712.424588.121Motor skillsVABS77.419.82464.112.321Maptive behaviour compositeVABS65.0012.691960.5312.9821Divan et al. (2019) [31]CommunicationVABS60.9317.881955.9014.1521SocializationVABS68.4710.261963.2511.4521SocializationVABS68.4710.261963.2511.4521Prew et al. (2020) [32]ExpressiveMCDI words96.6118.8124450.212BexpressiveMCDI words96.6118.8124450.21212ReceptiveMCDI words96.612.61210.380.212Adaptive behaviour compositeVABS follow up83.612.61290.383.612Adaptive behaviour compositeVABS follow up83.617.61770.613.616Adaptive behaviour compositeVABS follow up83.616.31796.413.616Adaptive behaviour compositeVABS follow up83.616.31796.413.616CommunicationVABS follow up83.616.31797.118.317Adaptive behaviour compositeVABS follow up83.616.31797.118.317Adaptive b	Dawson et al. (2010) [30]		VABS	82.1	21.8	24	69.4	15.8	21
Motor skilsVABS77.419.82464.112.321Adaptive behaviour compositeVABS65.0012.691960.5312.9821Divan et al. (2019 [31]CommunicationVABS60.9317.881955.9014.1521SocializationVABS66.4710.261963.2511.4521Prew et al. (2020 [32]ExpressiveMCDI words96.6118.81266.117.112Prew et al. (2020 [33]ExpressiveMCDI words96.6118.8124450.212Prew et al. (2015 [33]Cognitive AbilityMCDI words176.1121.912100.380.212Prew et al. (2015 [34]Cognitive AbilityMSEL follow up90.5226.362479.8323.6421Adaptive behaviour compositeVABS follow up81.4117.271772.0613.8616Adaptive behaviour compositeVABS follow up88.3519.761777.7116.417Adaptive behaviour compositeVABS follow up83.0621.561777.7116.417Adaptive behaviour compositeVABS follow up83.0621.561777.7116.417Adaptive behaviour compositeVABS follow up83.0621.561777.7116.417Adaptive behaviour compositeVABS follow up83.0621.561777.7116.417 <td></td> <td>Socialization</td> <td>VABS</td> <td>69.2</td> <td>11.6</td> <td>24</td> <td>63.1</td> <td>9.3</td> <td>21</td>		Socialization	VABS	69.2	11.6	24	63.1	9.3	21
Motor skillsVABS77.419.82464.112.321Adaptive behaviour compositeVABS65.0012.691960.5312.9821Divan et al. (2019)[31]CommunicationVABS60.9317.881955.9014.1521SocializationVABS68.4710.261963.2511.4521Drew et al. (2020)[32]Cognitive AbilityNVIQ77.914.81266.117.112Drew et al. (2020)[33]ExpressiveMCDI words96.6118.81229.118.412ReceptiveMCDI words38.612.51229.118.412ReceptiveMCDI words176.1121.912100.380.212Adaptive behaviour compositeVABS follow up90.5226.362479.8323.6421Adaptive behaviour compositeVABS follow up81.4117.271772.0613.8616Cognitive AbilityVABS follow up83.6519.761777.7116.417Adaptive behaviour compositeVABS follow up83.6621.561777.7116.417Draily living skillsVABS follow up83.6621.561777.7116.417Gengoux et al. (2015)[34]ExpressiveCDI 680256.6200.12384.493.520Gengoux et al. (2016][44]ExpressiveCDI 680256.72		Daily living skills	VABS	64.7	12.4	24	58	8.1	21
Divan et al. (2019) [31] Communication VABS 60.93 17.88 19 55.90 14.15 21 Socialization VABS 68.47 10.26 19 63.25 11.45 21 Drew et al. (2002) [32] Cognitive Ability NVIQ 77.9 14.8 12 66.1 17.1 12 Expressive MCDI words 96.6 118.8 12 44 50.2 12 Expressive MCDI words 38.6 12.5 12 29.1 18.4 12 Receptive MCDI words 176.1 121.9 12 100.3 80.2 12 Receptive MCDI words 176.1 121.9 12 100.3 80.2 12 Adaptive behaviour composite VABS follow up 90.52 26.36 24 79.83 23.64 21 Socialization VABS follow up 88.35 19.76 17 77.01 18.53 17 Socialization VABS follow up 83.06 </td <td></td> <td>Motor skills</td> <td>VABS</td> <td>77.4</td> <td>19.8</td> <td>24</td> <td>64.1</td> <td>12.3</td> <td>21</td>		Motor skills	VABS	77.4	19.8	24	64.1	12.3	21
SocializationVABS68.4710.261963.2511.4521Cognitive AbilityNVIQ77.914.81266.117.112ExpressiveMCDI words96.6118.8124450.212ExpressiveMCDI gestures38.612.51229.118.412ReceptiveMCDI words176.1121.912100.380.212Adaptive AbilityMSEL follow up90.5226.362479.8323.6421Adaptive behaviour compositeVABS follow up81.4117.271772.0613.8516SocializationVABS follow up88.3519.761779.7118.5317SocializationVABS follow up83.0621.561777.7116.417Gengoux et al. (2015) [33]ExpressiveCDI 396194.9133.72384.493.520Gengoux et al. (2019) [44ExpressiveCDI 68025.6200.12316.21620Gengoux et al. (2019) [45ExpressiveFLS-558.710.22356.910.520		Adaptive behaviour composite	VABS	65.00	12.69	19	60.53	12.98	21
Cognitive Ability NVIQ 77.9 14.8 12 66.1 17.1 12 Drew et al. (2002) [32] Expressive MCDI words 96.6 118.8 12 44 50.2 12 Expressive MCDI gestures 38.6 12.5 12 29.1 18.4 12 Receptive MCDI words 176.1 121.9 12 100.3 80.2 12 Adaptive behaviour composite VABS follow up 90.52 26.36 24 79.83 23.64 21 Adaptive behaviour composite VABS follow up 81.41 17.27 17 72.06 13.86 16 Socialization VABS follow up 88.35 19.76 17 79.71 18.53 17 Socialization VABS follow up 89.06 21.56 17 77.71 16.4 17 Daily living skills VABS follow up 83.06 21.56 17 77.71 16.4 20 Expressive CDI 396 194.9 <td>Divan et al. (2019) [31]</td> <td>Communication</td> <td>VABS</td> <td>60.93</td> <td>17.88</td> <td>19</td> <td>55.90</td> <td>14.15</td> <td>21</td>	Divan et al. (2019) [31]	Communication	VABS	60.93	17.88	19	55.90	14.15	21
Drew et al. (2002) [32] Expressive MCDI words 96.6 118.8 12 44 50.2 12 Expressive MCDI gestures 38.6 12.5 12 29.1 18.4 12 Receptive MCDI words 176.1 121.9 12 100.3 80.2 12 Adaptive Ability MSEL follow up 90.52 26.36 24 79.83 23.64 21 Adaptive behaviour composite VABS follow up 81.41 17.27 17 72.06 13.86 16 Communication VABS follow up 88.35 19.76 17 79.71 18.53 17 Socialization VABS follow up 79.24 16.03 17 69.44 13.81 16 Daily living skills VABS follow up 83.06 21.56 17 77.71 16.4 17 Gengoux et al. (2019) [34 Expressive CDI 396 194.9 133.7 23 84.4 93.5 20 Gengoux et al. (2019) [34		Socialization	VABS	68.47	10.26	19	63.25	11.45	21
Drew et al. (2002) [32] Expressive MCDI words 96.6 118.8 12 44 50.2 12 Expressive MCDI gestures 38.6 12.5 12 29.1 18.4 12 Receptive MCDI words 176.1 121.9 12 100.3 80.2 12 Adaptive Ability MSEL follow up 90.52 26.36 24 79.83 23.64 21 Adaptive behaviour composite VABS follow up 81.41 17.27 17 72.06 13.86 16 Communication VABS follow up 88.35 19.76 17 79.71 18.53 17 Socialization VABS follow up 79.24 16.03 17 69.44 13.81 16 Daily living skills VABS follow up 83.06 21.56 17 77.71 16.4 17 Gengoux et al. (2019) [34 Expressive CDI 396 194.9 133.7 23 84.4 93.5 20 Gengoux et al. (2019) [34		Cognitive Ability	NVIQ	77.9	14.8	12	66.1	17.1	12
Expressive MCDI gestures 38.6 12.5 12 29.1 18.4 12 Receptive MCDI words 176.1 121.9 12 100.3 80.2 12 Adaptive Ability MSEL follow up 90.52 26.36 24 79.83 23.64 21 Adaptive behaviour composite VABS follow up 81.41 17.27 17 72.06 13.86 16 Communication VABS follow up 88.35 19.76 17 79.71 18.53 17 Socialization VABS follow up 88.35 19.76 17 69.44 13.81 16 Daily living skills VABS follow up 83.06 21.56 17 77.71 16.4 17 Gengoux et al. (2019) [34] Expressive CDI 396 194.9 133.7 23 84.4 93.5 20 Gengoux et al. (2019) [34] Expressive VABS 7.6 2.4 23 6.2 1.6 20 Gengoux et al. (2019) [34]	D (2000) [00]	Expressive	MCDI words	96.6	118.8	12	44	50.2	12
Receptive MCDI words 176.1 121.9 12 100.3 80.2 12 Cognitive Ability MSEL follow up 90.52 26.36 24 79.83 23.64 21 Adaptive behaviour composite VABS follow up 81.41 17.27 17 72.06 13.86 16 Communication VABS follow up 88.35 19.76 17 79.71 18.53 17 Socialization VABS follow up 79.24 16.03 17 69.44 13.81 16 Daily living skills VABS follow up 83.06 21.56 17 77.71 16.4 17 Expressive CD1 396 194.9 133.7 23 84.4 93.5 20 Expressive CD1 680 256.6 200.1 23 16.2 16 20 Gengoux et al. (2019) [34] Expressive VABS 58.7 10.2 23 6.2 1.6 20 Expressive MSEL 58.7 10.2	Drew et al. (2002) [32]	Expressive	MCDI gestures	38.6	12.5	12	29.1	18.4	12
Estes et al. (2015) [33] Cognitive Ability MSEL follow up 90.52 26.36 24 79.83 23.64 21 Adaptive behaviour composite VABS follow up 81.41 17.27 17 72.06 13.86 16 Communication VABS follow up 88.35 19.76 17 79.71 18.53 17 Socialization VABS follow up 88.35 19.76 17 69.44 13.81 16 Daily living skills VABS follow up 83.06 21.56 17 77.71 16.4 17 Expressive CDI 396 194.9 133.7 23 84.4 93.5 20 Expressive CDI 680 256.6 200.1 23 16.4 20 Expressive VABS 7.6 2.4 23 6.2 1.6 20 Gengoux et al. (2019) [34] Expressive PLS-5 58.7 10.2 23 56.9 10.5 20 Expressive MSEL 21		Receptive		176.1	121.9	12	100.3	80.2	12
Adaptive behaviour composite VABS follow up 81.41 17.27 17 72.06 13.86 16 Estes et al. (2015) [33] Communication VABS follow up 88.35 19.76 17 72.06 13.86 16 Socialization VABS follow up 88.35 19.76 17 79.71 18.53 17 Socialization VABS follow up 79.24 16.03 17 69.44 13.81 16 Daily living skills VABS follow up 83.06 21.56 17 77.71 16.4 17 Expressive CDI 396 194.9 133.7 23 84.4 93.5 20 Expressive CDI 680 256.6 200.1 23 148.1 20 Expressive VABS 7.6 2.4 23 6.2 1.6 20 Gengoux et al. (2019) [34] Expressive PLS-5 58.7 10.2 23 56.9 10.5 20 Expressive MSEL 21 8.7		-	MSEL follow up	90.52	26.36	24	79.83	23.64	21
Exerct at. (2013) [63] Socialization VABS follow up 79.24 16.03 17 69.44 13.81 16 Daily living skills VABS follow up 83.06 21.56 17 77.71 16.4 17 Expressive CDI 396 194.9 133.7 23 84.4 93.5 20 Expressive CDI 680 256.6 200.1 23 112.9 148.1 20 Expressive VABS 7.6 2.4 23 6.2 1.6 20 Gengoux et al. (2019) [34] Expressive PLS-5 58.7 10.2 23 56.9 10.5 20 Expressive MSEL 21 8.7 23 17.3 6.9 20						17			16
Socialization VABS follow up 79.24 16.03 17 69.44 13.81 16 Daily living skills VABS follow up 83.06 21.56 17 77.71 16.4 17 Expressive CDI 396 194.9 133.7 23 84.4 93.5 20 Expressive CDI 680 256.6 200.1 23 112.9 148.1 20 Expressive VABS 7.6 2.4 23 6.2 1.6 20 Expressive PLS-5 58.7 10.2 23 56.9 10.5 20 Expressive MSEL 21 8.7 23 17.3 6.9 20	Estes et al. (2015) [33]	Communication	VABS follow up	88.35	19.76	17	79.71	18.53	17
Expressive CDI 396 194.9 133.7 23 84.4 93.5 20 Expressive CDI 680 256.6 200.1 23 112.9 148.1 20 Expressive VABS 7.6 2.4 23 6.2 1.6 20 Gengoux et al. (2019) [34] Expressive PLS-5 58.7 10.2 23 56.9 10.5 20 Expressive MSEL 21 8.7 23 17.3 6.9 20	Lotes et al. (2010) [00]	Socialization	VABS follow up	79.24	16.03	17	69.44	13.81	16
Gengoux et al. (2019) [34] Expressive CDI 680 256.6 200.1 23 112.9 148.1 20 Gengoux et al. (2019) [34] Expressive VABS 7.6 2.4 23 6.2 1.6 20 Expressive PLS-5 58.7 10.2 23 56.9 10.5 20 Expressive MSEL 21 8.7 23 17.3 6.9 20		Daily living skills	VABS follow up	83.06	21.56	17	77.71	16.4	17
Gengoux et al. (2019) [34] Expressive CDI 680 256.6 200.1 23 112.9 148.1 20 Gengoux et al. (2019) [34] Expressive VABS 7.6 2.4 23 6.2 1.6 20 Expressive PLS-5 58.7 10.2 23 56.9 10.5 20 Expressive MSEL 21 8.7 23 17.3 6.9 20		, 0	CDI 396				84.4		20
Expressive VABS 7.6 2.4 23 6.2 1.6 20 Gengoux et al. (2019) [34] Expressive PLS-5 58.7 10.2 23 56.9 10.5 20 Expressive MSEL 21 8.7 23 17.3 6.9 20		*							
Gengoux et al. (2019) [34] Expressive PLS-5 58.7 10.2 23 56.9 10.5 20 Expressive MSEL 21 8.7 23 17.3 6.9 20		Expressive		7.6		23	6.2		20
Expressive MSEL 21 8.7 23 17.3 6.9 20	Gengoux et al. (2019) [34]								
		*							
			VABS	63.8	14.8	23	62.5	11.6	20

Table A1. Follow up data used in the meta-analysis.

Table A1. Cont.

Study	Outcome	Measure	Expe	rimental Gro	up	Control Group			
			Mean	SD	Ν	Mean	SD	Ν	
	Expressive	PLS	20	11.2	77	20	11.3	75	
	Expressive	MCDI	171.9	150.7	77	163.8	144.3	75	
	Receptive	PLS	21.5	13	77	20.3	12.8	75	
Green et al. (2010) [35]	Receptive	MCDI	233.7	129.6	77	209	131.3	75	
	Adaptive behaviour composite	VABS	60.3	15.2	77	62.8	14.8	75	
	Communication	VABS	6.6	3.3	77	6.7	3.2	75	
	Socialization	VABS	9.2	3	77	9.8	2.9	75	
	Expressive	PLS	57.5	14.9	92	59.3	20	102	
	Expressive	MCDI	42.5	18.5	49	42	21.7	52	
Green et al. (2020) [36]	Receptive	PLS	57.7	13.7	92	59.5	18.9	102	
	Receptive	MCDI	43.2	20	39	42.2	21.9	42	
	Expressive	PLS post	25	5	34	25	5	34	
Linearten et el (2020) [27]	Expressive	PLS follow-up	26	6	34	27	5	34	
Hampton et al. (2020) [37]	Receptive	PLS post	26	7	34	25	6	34	
	Receptive	PLS follow-up	28	8	34	28	7	34	
	Expressive	CDI	172.2	123.6	25	215	118.3	22	
	Expressive	CDI	289.1	181.9	25	239.9	187.1	22	
	Expressive	PLS	63.9	11.6	25	63	13.4	22	
Hardan et al. (2015) [38]	Expressive	VABS	41.7	14.7	25	34	18.9	22	
	Receptive	VABS	21.5	14.7	25	18.9	6.5	22	
	Communication	VABS	78.9	18.9	25	72.8	16.5	22	
	Socialization	SRS	74.9	12.4	25	80.6	10.7	22	
	Expressive	RDSL	27.9	29.48	34	34.1	32.41	27	
	Receptive	RDSL	32.8	29.1	34	39.4	28.5	27	
	Communication	SCQ parents	4.1	3.28	34	4.52	3.42	27	
Kaale et al. (2014) [39]	Communication	SCQ teachers	4.88	3.28	34	4.12	3.22	27	
	Socialization	SCQ parents	5.28	6.23	34	4.13	5.7	27	
	Socialization	SCQ teachers	6.3	4.94	34	5.19	3.22	27	
	Expressive	RDLS post	18.42	8.03	43	19.83	7.84	43	
	Expressive	RDLS follow up	24.26	9.34	43	24.59	8.82	43	
Kasari et al. (2015) [40]	Receptive	RDLS post	20.87	11.85	43	23.17	13.02	43	
	Receptive	RDLS follow up	32.74	15.24	43	33.38	16	43	
	Non-verbal IQ	MSEL post	36.75	14.54	24	32.24	14.07	24	
	Non-verbal IQ	MSEL follow up	34.44	16.67	24	30.28	16.62	24	
Landa et al. (2011) [41]	Expressive	MSEL post	34.08	14.59	24	31.92	13.67	24	
	Expressive	MSEL follow up	34.52	12.33	24	31.36	12.12	24	
	Expressive	MCDI words	182.3	201	34	157.8	206.96	31	
Oosterling et al. (2010) [42]	Expressive	MCDI gestures	35.8	23.9	34	36.4	22.16	29	
0	Receptive	MCDI words	239.9	197.5	34	216.7	187.5	31	
	Expressive	MSEL	70.9	27.97	21	67.5	22.75	27	
	Receptive	MSEL	70.9	32.84	21	71.6	26.98	27	
Parsons et al. (2019) [43]	Fine motor	CSBS	68.8	21.74	21	70.2	19.42	27	
	Socialization	MSEL	36.2	7.07	21	31	8.4	27	

Table A1. Cont.

Study	Outcome	Measure	Exp	erimental Gro	Control Group			
			Mean	SD	Ν	Mean	SD	Ν
	Expressive	MCDI	6.69	2.51	29	6.97	2.11	30
Rahman et al. (2016) [44]	Receptive	MCDI	9.24	2.65	29	9.47	2.54	30
	Adaptive behaviour composite	VABS	61.76	12.51	29	63.67	10.54	30
	Communication	VABS	60.28	13.84	29	60.73	13.84	30
	Socialization	VABS	61.41	9.02	29	61.73	8.07	30
	Motor skills	VABS	72.3	7.1	6	67.7	7	3
	Communication	VABS	58	9.4	7	67	10.4	4
Reitzel et al. (2013) [45]	Socialization	VABS	63.9	5.1	7	64.8	3.9	4
	Daily living skills	VABS	66.9	13.7	7	65.3	11	4
	Adaptive behaviour composite	VABS	62.7	6.8	7	63.3	5.7	4
Rickards et al. (2007) [46]	Cognitive Ability	Bayley/WPPSI-R	57.2	21.9	18	48.6	17.5	21
	Expressive	RDLS	8.8	8.9	28	11.1	9.9	28
	Receptive	RDLS	17.5	6.3	28	22	17.8	28
Roberts et al. (2011) [47]	Communication	VABS	68.4	15.6	28	74.2	15.5	28
	Socialization	VABS	66.4	7.7	28	73.1	10.8	28
	Expressive	MCDI	42.27	61.99	49	38.87	73.71	49
	Receptive	MCDI	106.51	96.81	49	125.72	106.39	49
	Receptive	MCDI phrases	12.73	9.11	49	14.77	8.14	49
Rogers et al. (2012) [48]	Communication	VABS	72.55	12.06	49	74.29	14.55	49
	Socialization	VABS	77.32	9.19	49	78.67	10.78	49
	Daily living skills	VABS	82.25	13.82	49	84.04	13.5	49
	Cognitive Ability	MSEL post	72	18.55	51	69.4	17.77	52
	Cognitive Ability	MSEL follow up	83.09	26.12	44	79.14	25.58	35
Rogers et al. (2019) [49]	Adaptive behaviour composite	VABS post	15.39	5.22	49	15.86	6.25	45
	Adaptive behaviour composite	VABS follow up	39.76	12.07	44	36.69	14.32	36
Scahill et al. (2016) [50]	Communication	VABS	84.75	15.68	89	85.78	14.5	91
	Socialization	VABS	76.46	13.51	89	76.63	12.28	91
	Daily living skills	VABS	82.39	14.61	89	79.6	15.39	91
	Expressive	MSEL	33.27	15.79	11	27.17	11.21	12
Schertz et al. (2013) [51]	Receptive	MSEL	28.27	11.35	11	25.33	8.52	12
	Communication	VABS	75.9	13.51	11	68.08	19.77	12
	Expressive	MSEL post	4.02	1.34	36	3.9	1.42	34
Siller et al. (2013) [52]	Expressive	MSEL follow up	4.38	1.42	36	4.17	1.42	34
Solomon et al. (2014) [53]	Expressive	MSEL	52.82	28.1	52	48.33	29.08	47
	Expressive	MCDI gestures	66.41	58.91	64	81.59	85.58	64
	Expressive	MCDI sentences	598.25	129.12	16	590.55	123.7	22
	Receptive	MSEL	59.1	31.76	52	53.84	29.97	47
	Receptive	MCDI words	285.2	123.98	64	276.2	128.51	64
	Receptive	MCDI	23.09	6.54	64	22.27	7.32	64
	Motor skills	MSEL	59.94	26.36	52	54.33	26.03	47
	Cognitive Ability	MSEL	68.5	7.5	177	61.4	9	
	Expressive	MSEL	38.7	6.4	177	35.9	4.4	117
Strain & Bovey (2011) [54]		MSEL	49.3	7.9		40.7	7.7	117
	Receptive				177			

Study	Outcome	Measure	Exp	erimental Gr	oup	Control Group		
			Mean	SD	Ν	Mean	SD	Ν
	Communication	VABS	71.71	19.83	35	69.53	24.05	35
	Socialization	VABS	73.31	16.59	35	67.35	16.7	35
	Daily living skills	VABS	68.26	16.46	35	60.09	18.59	35
Tonge et al. (2014) [55]	Motor skills	VABS	76.82	20.29	35	68.25	17.13	35
	Cognitive Ability	PEP-R	72.18	24.77	35	67.72	28.14	35
	Expressive	RDLS	17.17	17.07	35	18.24	20.65	35
	Receptive	RDLS	14.06	19.67	35	19.18	22.17	35
Furner-Brown et al. (2019) [56]	Cognitive Ability	MSEL	67.10	23.39	32	70.33	23.16	12
Valeri et al. (2020) [57]	Expressive	MCDI	59.7	104.2	12	43.3	52.1	8
valeri et al. (2020) [57]	Receptive	MCDI	103.3	104.2	12	79.7	25.9	7
	Cognitive Ability	MSEL	90.67	27.28	12	68.36	21.62	1
	Expressive	MSEL	37.83	12.31	12	31.27	11.88	1
	Receptive	MSEL	47.17	14.79	12	31.91	14.83	1
	Expressive	PLS	87.50	15.75	12	74.27	17.39	1
Vernon et al. (2019) [58]	Receptive	PLS	90.17	27.78	12	73.27	20.99	1
vernon et al. (2019) [50]	Adaptive behaviour composite	VABS	87.91	12.99	12	73.27	8.22	1
	Communication	VABS	88.45	16.23	12	70.91	11.59	1
	Socialization	VABS	85.18	10.56	12	74.27	10.21	1
	Daily living skills	VABS	92.45	10.08	12	80.45	10.62	1
	Motor skills	VABS	92.91	18.32	12	92.91	18.33	1
	Cognitive Ability	MSEL	63.7	17.4	10	58.1	25	10
	Expressive	MSEL	58	21.9	10	62.4	32.6	1(
	Expressive	SIB	16.2	7.1	10	14.2	7.1	1(
Welterlin et al. (2012) [59]	Receptive	MSEL	60.9	26.1	10	58.1	30.8	1(
	Receptive	SIB	12	4.7	10	10.9	4.8	1(
	Socialization	SIB	18.4	7.3	10	16	5	10

Table A1. Cont.

VABS indicates Vineland Adaptive Behaviour Scale. MSEL indicates Mullen Scales of Early Learning. PLS-4 indicates Preschool Language scale. SCQ indicates Social Communication Questionnaire. RDLS indicates Reynell Developmental Language Scales. SRS indicates Social Responsiveness scale. WPPSI-R indicates Wechsler Preschool and Primary Scale of Intelligence-Revised. PEP-R indicates psycho-Educational Profile-Revised. SIB indicates Scales of Independent Behaviour scale.

Table A2. List of combined variables for which there were multiple measurements per study.

Study	Outcome	Scale	Hedges' g	SE	Hedges' g Combined	Variance Combined	Correlation	SE Combined
	Expressive	MSEL	-0.2625	0.2553	0.1850	0.0487	0.5	0.2207
Brian et al. (2017) [28]	Expressive	PLS-4	-0.1074	0.2543	0.1850			0.2207
Dilan et al. (2017) [20]	Receptive	MSEL	-0.1281	0.2544	0.02/1	0.0485	0.5	0.0000
	Receptive	PLS-4	0.0758	0.2542	0.0261			0.2202
Duran et al. (2002) [22]	Expressive	MCDI words	0.5768	0.1736	0.5004	0.13046	0.5	0.0(10
Drew et al. (2002) [32]	Expressive	MCDI gestures	0.604	0.1743	- 0.5904			0.3612
	Expressive	CDI 396	0.9460	0.3223	0.5209	0.0493	0.5	
	Expressive	CDI 680	0.8077	0.3179				
Gengoux et al. (2019) [34]	Expressive	VABS	0.6769	0.3143				0.2222
	Expressive	PLS-5	0.1741	0.3063				
	Expressive	MSEL	0.4673	0.3099				
	Expressive	PLS	0.0000	0.1622	0.0100	0.0197	0.5	0.1.405
Green et al. (2010) [35]	Expressive	MCDI	0.0546	0.1623	- 0.0182			0.1405
Green et al. (2010) [55]	Receptive	PLS	0.0925	0.1623	0.0202	0.0255	0.5	0.1500
	Receptive	MCDI	0.1884	0.1626	0.0303			0.1598

Study	Outcome	Scale	Hedges' g	SE	Hedges' g Combined	Variance Combined	Correlation	SE Combined
Green et al. (2022) [36]	Expressive	PLS	0.0247	0.1991	0.0292	0.0222	0.5	0.1491
	Expressive	MCDI	0.0476	0.2224	0.0383			
	Receptive	PLS	-0.1013	0.1438	0.0202	0.0255	0.5	
	Receptive	MCDI	-0.1082	0.1439	0.0303			0.1598
	Expressive	CDI	-0.3480	0.2946		0.0348		
	Expressive	CDI	0.2629	0.2936	-			
Hardan et al. (2015) [38]	Expressive	PLS	0.0711	0.2924	- 0.1094		0.5	0.1865
	Expressive	VABS	0.4518	0.2961	-			
	Communication	SCQ parents	-0.1257	0.2580	0.0540	0.0501	0.5	0.0007
	Communication	SCQ teachers	0.2336	0.2586	- 0.0540			0.2237
Kaale et al. (2014) [39]	Socialization	SCQ parents	0.1916	0.2584	0.0050	0.0502	0.5	0.0000
	Socialization	SCQ teachers	0.2601	0.2588	- 0.2258			0.2230
	Expressive	MCDI words	0.1202	0.2486	0.0466	0.0471	0.5	0 2171
Oosterling et al. (2010) [42]	Expressive	MCDI gestures	-0.0260	0.2528				0.2171
Because et al. (2012) [49]	Receptive	MCDI	-0.1874	0.2025	0.0100	0.0308	0.5	0.4555
Rogers et al. (2012) [48]	Receptive	MCDI phrases	-0.2343	0.2027	0.2108			0.1755
	Receptive	MSEL	0.1701	0.2016		0.0172	0.5	
	Receptive	MCDI	0.1181	0.1769	0.1190			0.1311
	Receptive	MCDI words	0.0713	0.1768	-			
Solomon et al. (2014) [53]	Expressive	MSEL	0.1559	0.2016		0.0289	0.5	
	Expressive	MCDI gestures	-0.2054	0.1772	0.0035			0.17
	Expressive	MCDI sentences	0.0598	0.3286	-			
	Expressive	MSEL	0.5418	0.4250	0.6506	0.1383	0.5	0.3718
	Expressive	PLS-5	0.7993	0.4337	- 0.6706			
Vernon et al. (2019) [58]	Receptive	MSEL	1.0305	0.4442		0.1431	0.5	
	Receptive	PLS-5	0.6820	0.4294	0.8563			0.3783
	Expressive	MSEL	-0.1517	0.4479	0.0500	0.1510	0.5	0.0007
	Expressive	SIB	0.2698	0.4494	- 0.0590			0.3886
Welterlin et al. (2012) [59]	Receptive	MSEL	0.0939	0.4475	0.1550	0.150/	0.5	0.3881
	Receptive	SIB	0.2218	0.4487	- 0.1579	0.1506		

Table A2. Cont.

VABS indicates Vineland Adaptive Behaviour Scale. MSEL indicates Mullen Scales of Early Learning. PLS-4 indicates Preschool Language scale. SCQ indicates Social Communication Questionnaire. SIB indicates Scales of Independent Behaviour scale.

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