

**Effectiveness of Early Parent-Mediated Autism Interventions in Improving Parent-Child**

**Interaction: A Systematic Review and Brief Meta-Analysis**



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### **Abstract**

The current systematic review and brief meta-analysis investigates the effects of parent-mediated autism interventions on different types of parent-child interaction (PCI) outcomes, specifically responsive interaction style, dialogue participation, and purpose of communicative acts. A systematic literature search was conducted and studies had to meet the following inclusion criteria: (a) age of the children ranged between 1 and 6 years old, (b) children had a confirmed diagnosis of autism spectrum disorder (c) interventions were delivered directly by the parent or the main caregiver, (d) quantitative assessment of PCI outcome (e.g., joint engagement, responsiveness, parental communication, sensitivity) was reported both preceding and following the intervention, (e) the study design was a randomized trial in which participants were randomly assigned to a treatment or control group (i.e., active control or treatment-as-usual). 20 studies reporting 30 independent effect sizes conducted between the years 2000 and 2022 were included in the final analyses. The synthesis of the results suggested positive, medium to large effects for the impact of parent-mediated autism interventions on the PCI outcomes. Furthermore, moderating effects of training dosage and type of control group were found. Future randomized controlled trials focusing on PCI outcomes should be conducted to further demonstrate how PCI can be characterized and targeted. Such studies would have implications on specific dimensions to be focused during parent-mediated interventions.

*Keywords:* autism spectrum disorder, parent-child interaction, responsiveness, child-initiations, shared attention, social-communicative acts

## **Effectiveness of Early Parent Mediated Autism Interventions in Improving parent-child interaction: A Systematic Review and Brief Meta-Analysis**

Autism Spectrum Disorder (ASD) is a pervasive neurodevelopmental disorder that is characterized by the presence of social communication deficits and restricted and repetitive behaviors. Once children exhibit having deficits in social emotional reciprocity, nonverbal communication skills, and difficulties with formation and maintenance of social relationships, they might meet the diagnostic criteria for ASD as defined by the Fifth Edition of American Psychiatric Association's Diagnostic and Statistical Manual, *DSM-V* (Copeland, 2018). In addition, a child might exhibit restrictive and repetitive behaviors listed in the classification list: stereotyped movements, insistence on sameness, fixated interests, and hyper/hypo-reaction to sensory input. Due to the wide range of behavioral symptoms stated in the description of autism, ASD is characterized as a spectrum. Thus, it is essential to understand that each child diagnosed with ASD has different behavioral manifestations. As such, autism is a continuum-based heterogeneous condition rather than a categorically distinct disorder, which differentiates it from other developmental disabilities. It is complex in nature in that there are no definite causes leading to autism and its treatment options are extensively studied leading and directing the field of interventions to employ a variety of developmental approaches (Charman, 2010). According to the most recent reports of Centers for Disease Control and Prevention (CDC), one in 54 children have been identified with ASD (*Autism Prevalence Rises in Communities Monitored by CDC*, 2020). This number has progressively increased throughout the years, which contributes to the complexity of understanding the definition of and various behavioral paths taken towards autism.

Early detection and diagnosis of ASD is critical in a child's developmental trajectory, as it enables children to be placed in early intervention programs that can greatly impact and improve a child's challenging behaviors (Nadel & Poss, 2007). Specifically, children exposed to early intervention programs before the age of 5 can demonstrate more distinguishable developmental benefits of early intervention programs (Birkan, 2013).

Communication is found to be a major area of concern in children with a diagnosis of ASD, which is why the field of developmental disabilities and intervention services have tried to address the social-communicative deficits. It is further observed that children with autism can demonstrate reduced instances of the way they express themselves via nonverbal communicative acts, which can be highlighted through individuals' inability to respond to and initiate joint attention, thereby with slower or delayed rates of language development (Lieberman & Yoder, 2012). Thus, social environments and adult communicative intentions can play a vital role in children's developmental trajectory, especially in their verbal and nonverbal communication skills (Lieberman & Yoder, 2012).

Considering the thriving importance of early detection and diagnosis of autism and the role of parents in fostering nonverbal and verbal communication, interventionists have focused on adopting parents as therapists to benefit autism related outcomes. A handful number of studies investigated the effects of parent involvement in autism interventions on a range of child related outcomes such as social communicative acts, language development and adaptive behavior (Mahoney & Perales, 2003). In addition, a few meta-analyses explored the effectiveness of such interventions, combining the data from a variety of studies (McConachie & Diggle, 2007; Oono et al. 2013; Beaudoin et al., 2014). However, there is no systematic review paper that presents and discusses the effect of parent-mediated interventions on specific parent-

child interaction (PCI) outcomes. In the current study, we conducted a systematic review and a brief meta-analysis of the causal effects of parent-mediated interventions on different PCI outcomes, specifically responsive interaction style, dialogue participation and purpose of communicative acts, by including studies with randomized controlled trials.

### **Parent-Mediated Interventions for Autism**

Early intervention is imperative to prevent an increasing gap in social communicative behaviors between typically developing children and children with autism. It can thus play an important role in changing the developmental trajectory of autism symptoms. Research suggests that early interventions targeting deficiencies in social interest, attention, and joint engagement may improve a child's language and communication skills by modifying the trajectory of a child's brain development (Dawson et al., 2002).

Evidence further demonstrates that the earlier a child gets exposed to early autism intervention, the more a child gains developmental advantages in terms of adaptive functioning skills as manifested in later years. Intensive early intervention seems to reduce challenging behaviors associated with autism and appears to have a positive effect on the development of young children (Rogers, 1996; Landa, 2018). Specifically, children receiving intervention have demonstrated an accelerated rate of learning and have improved in communication and language abilities (Rogers & Vismara, 2008). Yet, effectiveness can be achieved when children learn how to generalize skills across people, environments, and situations.

Dosage and frequency of applied interventions are important elements of parent-mediated interventions influencing the efficacy of such interventions. Although a long-sought discussion for policy makers, autism research community recommends children with autism to receive 25 hours of active intervention sessions per week for at least a year (National Research Council,

2001). Yet, research examining the average intervention intensity children receive have found that 25 hours was indeed ambitious to achieve, also considering the cost for such frequent sessions (Yoder et al., 2020). Within such a heterogenous condition, where children have differing levels of functionality across a variety of developmental milestones, it becomes difficult to determine the best intervention intensity, urging researchers to reach effectiveness via other sources, such as involving parents in autism interventions.

Parents are the first point of contacts to experience the psychological effects of their children's social communication-based impairment including usage of nonverbal gestures (e.g., referential pointing, sharing their interest with people surrounding them), and engagement in nonverbal joint attention (e.g., joint engagement, attention following, referential looking). They can thus act as change agents, which is why practitioners and educators have recently focused on incorporating parents into autism interventions and making them an integral part of their children's development.

Although a bidirectional phenomenon, representing a mutual influence between the parent and the child, PCI, specifically characteristics of mothers of children with ASD, have been widely studied (Paschall & Mastergeorge, 2015). Mostly lacking the integration of the bidirectional process of influence, studies have found remarkable results that poses a greater need for developmental practitioners to emphasize on involving parents in their children's intervention (Doussard-Roosevelt et al., 2003; Siller & Sigman., 2002; Bontinck et al., 2018). For example, several studies have found mothers of children with autism to be more directive and controlling while feeling high levels of stress and psychological distress, and low levels of self-efficacy and competence, thereby exhibiting negative parental behaviors, appearing to be using fewer social verbal approaches, and being less responsive and sensitive to their children's

needs compared to typical parent-child relationships (Bontinck et al., 2018; Doğan et al., 2016; Meirsschaut et al., 2011; Doussard–Roosevelt et al., 2003). Thus, evidence suggests that unresponsive and insensitive parental approaches can limit children’s opportunities to improve communicative abilities and should be an area of focus for practitioners (Hudry et al., 2013). On the other side of the coin, children’s limited social-communicative behaviors can have an influence on the level of responsivity and sensitivity of parents, impacting the dyadic relationship on a greater level.

Dating to 1970s, involving parents in intervention programs seem to be producing promising benefits for child development (Schopler & Reichler, 1971). Such efforts acknowledge parents as change agents as they allow children to practice the acquired skills and to master them through their daily routines. On a broader view, the above-mentioned interventions are called *Parent-Mediated Interventions* and are defined as a collaborative technique that aims to teach therapeutic skills used in autism interventions to parents (*Parent-Mediated Therapy in Autism*, 2017).

Several systematic reviews on the effectiveness of parent-mediated interventions have been published (McConachie & Diggle, 2007; Meadan et al., 2009; Oono et al. 2013; Beaudoin et al., 2014; Nevill et al., 2018; Shalev et al., 2019). Taken together, these studies have found moderate effects of parent-mediated interventions, suggesting that parents were able to successfully learn and implement therapy strategies into natural environments of children. Parent-mediated interventions were found to be practical and effective in improving children’s communication and interactive skills (Gulsrud et al., 2016; Kasari et al., 2010). When considering the implications of ASD, a complex developmental disorder demonstrating severe cognitive and social disabilities, early years might create opportunities for parents to have an

influence on their children's developmental trajectories. Thus, it is vital that these opportunities are seized and investigated from the lens of PCI.

### ***Parent-Mediated Interventions and Parent-Child Interaction Outcomes***

Child development is a product of continuous interaction of children's environment with the people surrounding those settings. Children are raised in social contexts in which parents act as the primary agents of developmental change. Concerning many child-environment researchers, the physical and social setting in which children are raised can influence the developmental process for typically developing children (Weinstein & David, 1987). Specifically, such environments can provide children with enriched and stimulating settings, where children are given opportunities for learning and exploring.

The social environments in which children with autism are raised, particularly parenting engagement, could also immensely influence children's developmental trajectory. As such, parenting behavior can be proposed as a mechanism behind parent-mediated autism interventions, where intervention effectiveness could be improved with enhanced parental responses towards their children (Dunst, 2002). Specifically, parent behaviors leading to positive PCI outcomes could be an essential product of parent-mediated interventions.

Empirical evidence on the relationship between parenting behavior and ASD development indicates that characteristics of PCI, such as shared attention, contingency, low levels of controlling behavior, high levels of responsiveness, sensitivity, and synchrony are associated with adaptive child outcomes (Bontinck et al., 2018; Siller & Sigman, 2002). In contrast, absence of parental communicative support, such as directiveness, controlling, and negativity are associated with behavioral problems (Keer et al., 2020).

As a complex and bidirectional phenomenon, PCI has been a focus of extensive research and several characteristics of PCI were identified (Doussard-Roosevelt et al., 2003; Blackwell et al., 2015). Responsiveness, purpose of communicative act, and dialogue participation particularly present the potential beneficial effects of parent involvement in child related outcome. Responsiveness, described as immediate, contingent, and affectively positive reactions to children's communicative and play-acts, is an integral component of positive PCI (Ruble et al., 2008; Mahoney & Perales, 2003). Thus, research examining the relationship between responsive parenting and child development is well documented, particularly with regards to the benefits of parental intentions that follow children's focus of attention and maintain children's engagement levels (Haebig et al., 2013; Steelman et al., 2002). Additionally, there is evidence demonstrating that responsiveness impacts child's play, language, and in turn child-initiations as well as child's pivotal behaviors including cognitive, communicative, and social functioning (Oono et al., 2013; Haebig et al., 2013; Steelman et al., 2002; Dyches et al., 2013; Hudry et al., 2013).

Children's improved ability to participate in a dialogue and taking conversational turns appears to be another developmental outcome targeted by positive PCI (Blackwell et al., 2015). Evidence suggests that lack of social initiations in children with ASD can interfere with their ability to establish interpersonal relationships (Mohammadzaheri et al., 2022). Therefore, child-initiated communicative acts can significantly impact children's subsequent social skills such as their language skills and collaborative play skills, including their verbal and non-verbal initiations, thereby affecting their overall quality of life in further years (Nelson, 2004). This demonstrates that parental involvement in autism interventions might positively impact the frequency and quality of their children's participation in verbal and nonverbal dialogues.

The purpose of communicative act, specifically sharing meaning, demonstrating intentions, and maintaining conversations, seems to be a further developmental outcome of improved PCI (Blackwell et al., 2015). As parents develop skills to notice and interpret their children's cues during intensive PCI focused intervention settings, they seem to create a window of opportunity for children to engage with the social partner and to coordinate their attention between the shared activity and the partner. Evidence suggests that improved bidirectional PCI is positively associated with the amount of time children spend jointly engaged thus with developmental gains in expressive language skills (Siller & Sigman 2002; Shire et al., 2016). All in all, observational and longitudinal studies looking at the effect of PCI have identified the presence of a potential positive association between parent involvement in autism interventions and improved PCI outcomes.

Systematic review studies investigating the effect of parent-mediated interventions are heterogeneous in terms of the targeted outcomes. A few of the studies focused on child related outcomes such as ASD symptom severity, communication, language, and socialization (Meadan et al., 2009; Nevill et al., 2018). Whereas a few reports concentrated on parental outcomes which consist of measures of parenting stress, parental wellbeing (McConachie & Diggle, 2007; Meadan et al., 2009; Oono et al. 2013; Beaudoin et al., 2014), parental anxiety, and demographic variables (Shalev et al., 2019). One of the review studies was specifically interested in the effect of dose of intervention on autism related child outcomes (Nevill et al., 2018). Although PCI was included in a few of the studies as a reported outcome variable, it was not a study inclusion criterion (Shalev et al., 2019; Meadan et al., 2009).

Shalev et al., (2019) was specifically interested in finding the role of parent characteristics on child outcomes. Although PCI outcomes were not among the targeted interests,

several PCI improvements were reported in the results section. The review concluded that increased parental responsiveness, sensitivity, and synchronization led to improved child outcomes. Thus, this review posed a greater need to identify parental factors, specifically PCI outcomes, that in turn influence children's subsequent treatment gains. Meadan et al., (2009) on the other hand, conducted a review based on twelve studies, focused on the effect of parent-mediated interventions on the development of social and communication skills of young children with a diagnosis of ASD or Pervasive Developmental Disorder (PDD).

For the systematic reviews that included a quantitative assessment of PCI, (McConachie & Diggle, 2007; Oono et al. 2013; Beaudoin et al., 2014) the measures comprised of qualities of PCI such as parental synchrony (McConachie & Diggle, 2007; Oono et al. 2013), communication style (McConachie & Diggle, 2007), shared attention (Oono et al. 2013), and parental engagement (Beaudoin et al., 2014). Specifically, McConachie and Diggle (2007) was interested in identifying the effectiveness of parent-implemented intervention for young children with ASD based on child related, parent related and PCI related outcomes across studies with and without random assignment. Interaction outcomes were specifically focused on PCI qualities such as child communication acts, parent synchrony, shared attention, happiness, interest, stress, and communication style and were not present for all the studies included in the review, and indeed were not listed as inclusion criterion for the selected studies. Although concluding that parent-mediated interventions were effective, the review study was not able to make conclusions about the effectiveness of parent-mediated interventions on enhancing PCI as the interaction outcomes were measured in only three of the twelve studies included in the review. Oono et al. (2013) conducted a systematic review on seventeen studies and was inconclusive for child related outcomes. Ten out of seventeen of the studies had a measure of PCI. Among these

studies, three of them investigated shared/joint attention, four of them examined child initiations, and three of them were interested in parent synchrony. The review was able to report small but significant effects for improved PCI following parent-mediated autism interventions.

Specifically, the study reached relative significance for shared/joint attention, no significance for child initiations, and large significance for parent synchrony. While the results of the review study proposed positive changes in PCI, most of the studies included in Oono et al., (2013) were published between the years 2010 and 2012, and 41% of the studies were published before the year of 2010 (7 studies, 41%). Beaudoin et al., (2014) on the other hand, performed a systematic review on fifteen studies with participants aging between 0 to 3 years old. Ten of the studies had quantitative results on PCI outcomes. The review found greater parental outcome effects of parental involvement than that of child outcomes, yet the results were mixed and inconclusive for PCI outcomes. Significance was reported only for parental responsiveness and positive affect, and no significant effect was found on directiveness and achievement orientation. Although in typically developing children, focusing on a narrow age range of 0 to 3 would be considered a developmental advantage, as it is a limited period where children jump onto the next developmental milestone within the blink of an eye, when concerning such a continuum-based condition as ASD, it is vital to acknowledge that the diagnosis of the condition varies across individuals and across developmental stages. Therefore, including a broader age range in the analysis concerning children with autism could lead to more effective and precise results. All together, these reviews pose a greater need to assess the effect of parent-mediated autism interventions on PCI outcomes. In addition, the studies in a few of the systematic reviews (Oono et al. 2013; Beaudoin et al., 2014) were mostly published between 2010 and 2012. One of the reviews limited their sample to children younger than 36 months of age and PCI outcomes were

not present for all the studies included in the review; thus, they ended up having inconclusive results (Beaudoin et al., 2014).

### **The Present Study**

This study investigates the effectiveness of parent-mediated autism interventions in fostering positive PCI, specifically responsiveness, child's dialogue participation and shared meaning. The study involves a brief meta-analysis which focuses on the main effect of parent-mediated autism interventions and two important moderators, one that is program-specific and one methodological. Specifically, the present study adds to the existing literature in several ways. First, it is specifically concentrated on the effect of parent-mediated interventions on specific types of PCI outcomes (i.e., responsiveness, child's dialogue participation, and purpose of the communicative act-shared attention). Second, it investigates the effects of parent-mediated interventions on PCI outcomes using causal evidence based on randomized controlled trials. Third, it updates the previous meta-analysis studies by including randomized studies that have been published after 2012 as well (13 studies). Fourth, it also considers the moderating roles of training dosage and the type of control group used in the trials. Our specific research questions are:

- (1) Are early parent-mediated autism interventions effective in improving different types of PCI outcomes, specifically, responsiveness, child's dialogue participation/conversational turns, and purpose of communicative act-shared attention?
- (2) Is the effectiveness of parent-mediated interventions in improving PCI outcomes differ across the levels of parent training dosage?

- (3) Are the effectiveness results of parent-mediated interventions in improving PCI outcomes differ across the type of control groups (active control vs. treatment-as-usual) used in the trials?

## **Method**

### **Inclusion and Exclusion Criteria**

To be included in the review, studies had to meet the following inclusion criteria: (a) age of the children ranged between 1 and 6 years old, (b) children had a confirmed diagnosis of ASD (c) interventions were delivered directly by the parent or the main caregiver, (d) quantitative assessment of the PCI outcome (e.g., joint engagement, responsiveness, parental communication, sensitivity) was reported both preceding and following the intervention, (e) the study design was a randomized trial in which participants were randomly assigned to a treatment or control group (i.e., active control or treatment-as-usual). Articles were excluded from the review if their sample included children at risk of having ASD and if PCI assessment was missing.

### **Search Strategy**

Table 1 describes the details of the study search, including the keywords used in the search and database sources. Google Scholar was included as a supplementary check and searches in the Cochrane Database of Systematic Reviews were further examined for systematic reviews. The search was limited to English articles published between January 2000 and May 2022. Reference lists of the articles that met the inclusion criteria and the bibliographies of systematic reviews were also examined to detect the articles that were not found through the database search. 48 additional studies were found from these sources. An initial search produced 28 studies to be further reviewed to be included in the study. Studies providing limited information on scores on pre-test, post-test, control and intervention groups were eliminated as

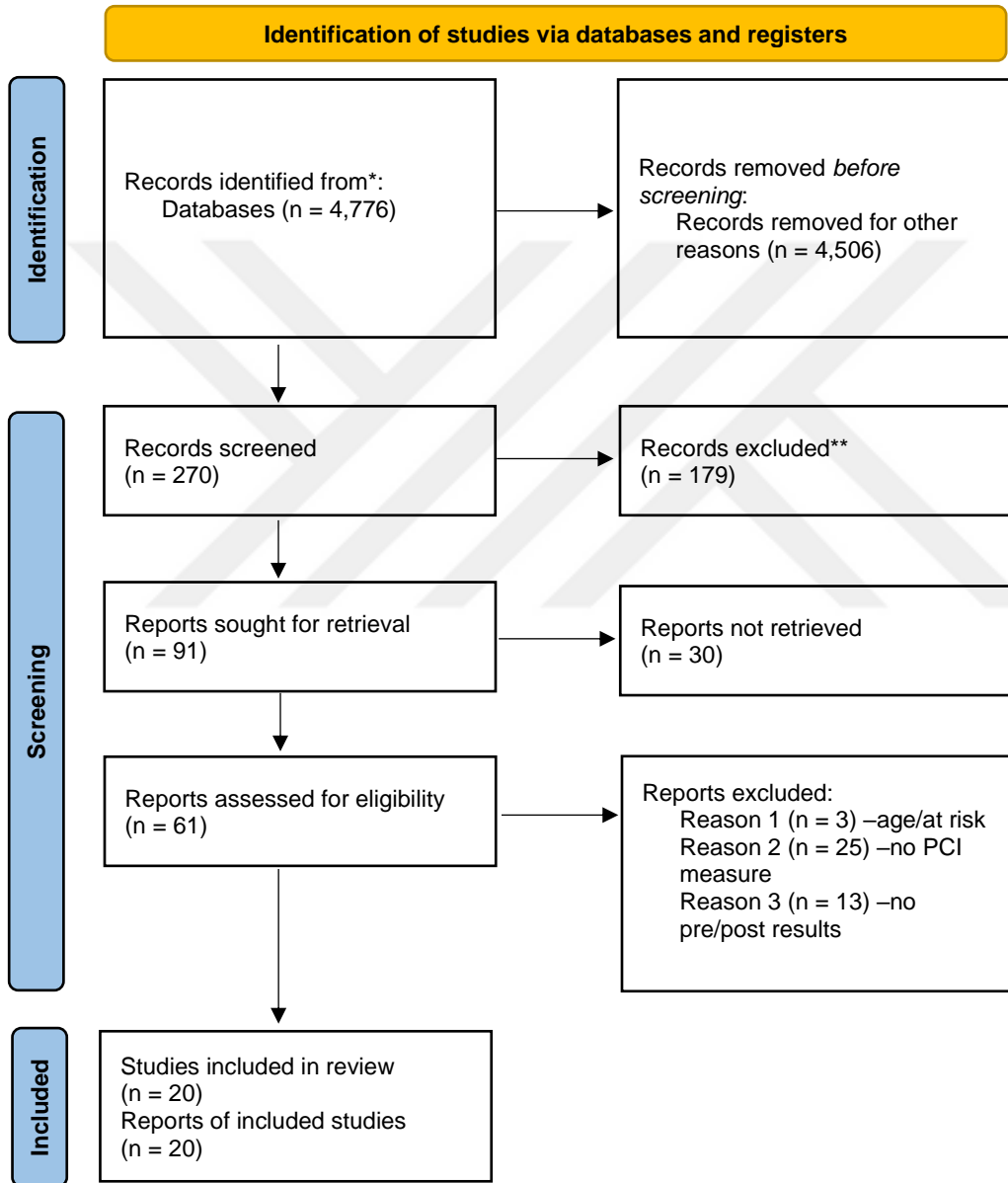
effect size calculations were not possible (Aldred et al., 2012; Alquraini et al., 2018a; Alquraini et al., 2018b; Harrop et al., 2016; Karaaslan & Mahoney, 2015; Mahoney & Solomon; 2016, Pickles et al., 2015; Rahman et al., 2016), leaving 20 studies reporting 30 independent effect sizes in total to be included in this review (see Figure 1 for the PRISMA flow diagram of study selection). An independent graduate research assistant reviewed 20% of the articles during the coding procedure. Inter-rater agreement for the coding of the articles was 100%.

**Table 1**  
*Search criteria*

Category	Keywords
Aim of the intervention	Parent mediated intervention; parent implemented intervention; caregiver mediated intervention; caregiver implemented intervention; parent delivered intervention; caregiver delivered intervention; parent education; parent training; parent based; parent directed; parent facilitated; caregiver facilitated
Intervention	Autism; autism spectrum disorder
Population	Young children
Measurement	Parent-child interaction (quantitative measurement of PCI)
Method	intervention; behavioral therapy; effectiveness; control; pre-test; post-test; randomized
Publication year	After January 2000
Source	Search term
-EBSCOhost	((“parent mediated intervention” OR “parent implemented intervention” OR “caregiver mediated intervention” OR “caregiver implemented intervention” OR “parent delivered intervention” OR “caregiver delivered intervention” OR “parent education” OR “parent training” OR “parent based” OR “parent directed” OR “parent facilitated” OR “caregiver facilitated”) AND (“autism spectrum disorder”) AND (“young children”) AND (“Parent-child interaction”) AND (intervention OR “behavioral therapy” OR effectiveness OR control OR pre-test OR post-test OR randomized))
-Web of Science	
-Google Scholar	
-Cochrane Database of Systematic Reviews	

**Figure 1**

*PRISMA Flow Diagram for the included studies*



### Risk of Bias

The risk of bias assesses the extent to which systematic error or deviation from the truth have affected the reported results of the intervention effects. It is a “risk of bias” assessment, as it is not possible to claim with certainty that studies are biased (Boutron et al., 2022). In this report, randomized control trials were included, therefore the criteria for RoB 2 (Sterne et al., 2019) was followed (see Table 2 for the criteria and their descriptions). Studies were concluded as having low, some concerns, and a high risk of bias according to RoB 2 criterion.

**Table 2**  
*Criteria of risk of bias (RoB 2, Sterne et al., 2019)*

Criterion	Assessment
Randomization	The systematic error between the experimental and comparison groups due to the allocation sequence and concealment of allocation.
Deviations from interventions	Bias in the results arising when there are deviations from intended interventions leading to influencing the outcome variables.
Missing data	Bias arising from missing data of participants without reporting the reasons.
Measures of outcomes	Systematic error in the outcome measurements due to the conditions of the participants (blind outcome assessors).
Selection of reported results	Bias arising from the selective reporting of results that could influence the overall findings.

### Outcome Variables

Although the studies included in this review and brief meta-analysis do not differentiate between the different characteristics of PCI outcomes, we believe it is of essence to identify which corresponding PCI characteristic is mostly influenced by the involvement of parents in the intervention programs. Following Blackwell et al. (2015), the following definitions were used to categorize the PCI styles: (a) responsive parenting interaction style: parent communicative acts

including synchrony, parent language, parent smiling, reciprocity including parental behaviors coded for follow-in commenting, linguistic mapping, expansions, prompts, and redirects; (b) dialogue participation: child-initiated communicative acts including child involvement, child responsiveness, and child initiations; and (c) purpose of communicative acts: shared communicative acts used to share meaning and maintain conversation including shared attention and joint engagement. A total of 18 different instruments were used to measure the outcome variables related to PCI style. Table 3 shows all outcome measures and how they were respectively categorized.

**Table 3***Measures used to assess the parent-child interaction outcomes in the included studies*

Study	Responsiveness	Dialogue Participation: Child-Initiations	Purpose of Communicative Act: Shared communicative acts
Aldred et al. (2004)	Frequency of parent-child interaction	Frequency of parent-child interaction	Frequency of parent-child interaction
Bartley (2013)	MAETS		
Brian et al. (2017)	Video-coded measure of parent smiling		
Carter et al. (2011)	PCFP	ESCS	
Casenhiser et al. (2011)	MEHRIT		
Green et al. (2010)	Frequency of parent-child interaction	Frequency of parent-child interaction	Frequency of parent-child interaction
Gulsrud et al. (2015)	Changes in parent child interaction strategy use		
Karaaslan et al. (2013)	MBRS		
Kasari et al. (2010)		Child frequency of IJA and RJA	Joint engagement
Kasari et al. (2014)		ESCS: Frequency of IJA	Joint engagement
Kasari et al. (2015)		Frequency of IJA	Duration of joint engagement
Oosterling et al. (2010)	Erickson Scales		
Pickles et al. (2016)	DCMA	DCMA	
Poslawsky et al. (2015)	EAS	EAS	
Scudder et al. (2019)	DPICS-IV		
Shire et al. (2016)	MBRS		
Siller et al. (2013)	Maternal synchronization		
Siller et al. (2014)	MCPA		
Solomon et al. (2014)	MBRS		
Venker et al. (2011)	SALT		

MAETS: Measurement of Active Engagement and Transactional Supports; PCFP: Parent-Child Free Play Procedure; ESCS: The Early Social Communication Scales; CBRS: Child Behavior Rating Scale; MBRS: Maternal Behavior Rating Scale; MEHRIT: The Milton and Ethel Harris Research Initiative Treatment; IJA: Initiation of joint attention; RJA: Response to joint attention; DCMA: Dyadic Communication Measure for Autism; EAS: Emotional Availability Scales; DPICS-IV: Dyadic Parent Child Interaction Coding Scale-IV; MCPA: Maternal Perception of Child Attachment; SALT: Systematic Analysis of Language Transcripts

The most often reported outcomes were for responsive parenting interaction style (17), followed by child-initiated interaction style (8), and shared communicative interaction style (5). A variety of PCI measures, including frequency of interaction styles and various widely utilized scales were used to assess responsive parenting, child-initiation of interaction, and shared communicative intents.

### **Moderators**

Regarding the effectiveness of parent mediated autism interventions on PCI outcomes, we examined the moderating roles of 1) *Dosage*, as we expected higher doses of parent training would have a greater effect on the PCI outcomes; and 2) *Active vs. treatment-as-usual control groups*, as studies with active control groups may indicate greater impact of the intervention on the outcomes.

### **Analytic Strategy**

#### ***Systematic Review***

Included studies were evaluated and synthesized to answer the research questions proposed in this study. Information from selected studies is summarized according to the study characteristics and intervention content to determine the ingredients and characteristics of parent-mediated autism interventions (see Table 4 for design characteristics of reviewed studies and Table 5 for intervention content and characteristics).

**Table 4***Design characteristics of reviewed studies*

Study	Intervention	Participant characteristics (age mean (SD), [range], % male)		Dose of parent training	Dose coding	Content of control condition
		INT	CT			
Aldred et al. (2004)	Communication focused intervention	51.4 (11.8), [24-60], 93%	50.9 (16.3), [24-60], 86%	12 h: 9 sessions (monthly therapist sessions for 6 months followed by three bi-monthly consolidation sessions)	< 20	TAU
Bartley (2013)	Early Social Interaction	19.64 (1.93), [17-20], 86% male	19.58 (1.42), [17-20], 86% male	60 h: 3 1-h weekly sessions for first 3 months, followed by 2 1-h weekly sessions for the next 3 months	≥ 20	AC
Brian et al. (2017)	Social ABC's Intervention	25.33 (3.49), [17-30], 81% male	25.19 (3.72), [16-30], 66% male	21 h: 12 weeks of 1.5-h home sessions with tapering intensity	≥ 20	TAU
Carter et al. (2011)	MTW	21.11 (2.71), [15.47-24.84], INT and CT combined: 82% male	21.51 (2.82), [16.30-24.97]	23 h: 8 2.5-h weekly group sessions and three 1:1 session	≥ 20	TAU
Casenhiser et al. (2011)	The Milton and Ethel Harris Research Initiative Treatment, MEHRIT	42.52 (8.76), [24-59]	46.38 (8.29), [24-59]	104 h: 2 h a week for 1 year	≥ 20	TAU
Green et al. (2010)	PACT	45, [26-60], 92% male	45, [24-60], 89% male	96 h: 6 months of biweekly 2-h therapy sessions and 6 months of booster session	≥ 20	TAU
Gulsrud et al. (2015)	JASPER	30.7 (3.5), %81 male	31.5 (3.2), %81 male	310 h: 30 h a week for 10 weeks and 1-h sessions of research protocol for 10 weeks	≥ 20	AC
Karaaslan et al. (2013)	RT	50.30 (1.28), 50% male	47.22 (1.33), [preschool age], 56.6% male	48 h: 2 1.5-h weekly sessions for 4 months	≥ 20	TAU
Kasari et al. (2010)	Joint Attention Intervention	30.35 (0.93), [21-36], %79 male	31.31 (0.90), [21-36], %74 male	12 h: 3 sessions a week for 8 weeks	< 20	AC
Kasari et al. (2014)	JASPER	41.9 (10.0), %83.3 male	42.8 (10.21), %82.7 male	24 h: 2 1-h sessions a week for 12 weeks	≥ 20	AC
Kasari et al. (2015)	JASPER	30.7 (3.5), [22-36], %81 male	32.3 (2.7), [22-36], %81 male	10 h: 2 30-min sessions per week for 10 weeks	< 20	AC
Oosterling et al. (2010)	Focus Parent Training	35.2 (5.5), 75% male	33.3 (6.4), 80.6% male	28 h: 4 2-h sessions weekly and 3-h home visits every 6 weeks in the first year	≥ 20	TAU
Pickles et al. (2016)	PACT	44.7 (7.8), [24-48], %92 male	45 (8.1), [24-48], 89% male	108 h: 12 2-h sessions followed by 20-30min per day for 6 months	≥ 20	TAU
Poslawsky et al. (2015)	Video-feedback Intervention to promote Positive Parenting	42.16 (9.02), [16-61], INT and CT combined: 86% male	43.80 (10.92), [16-61]	9.5 h: 7.5 h of home visits	< 20	TAU

Scudder et al. (2019)	adapted to Autism, VIPP-AUTI PCIT	67.33 (16.61), [54-83], 90% male	67.50 (17.49), [54-83], 88.9% male	16 h: weekly 1-h for 16 sessions	< 20	AC
Shire et al. (2016)	JASPER	31 (4), %84 male	32 (3), %71 male	10 h: 1-h session per week	< 20	AC
Siller et al. (2013)	FPI	58.3 (12.7), [33-82], INT and CT combined: 91% male	55.9 (11.9), [32-76],	6 h of Parent Advocacy Coaching over 4 monthly sessions on treatment and education planning	< 20	AC
Siller et al. (2014)	FPI	58.3 (12.7), (33-82)	55.9 (11.9), (32-76), -	18 h: 12 1.5-h sessions for 12 weeks	< 20	AC
Solomon et al. (2014)	PLAY	49.85 (10.43), [32-71], 79.7% male	50.53 (10.07), [32-71], 84.4% male	36 h: 3-h monthly sessions for 1 year (est. mean = 31.56 h; SD = 9.03)	≥ 20	AC
Venker et al. (2011)	MTW	41.14 (10.40), [28-68]	41.14 (10.40), [28-68]	14 h: 1-h sessions for 7 weeks	< 20	AC

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FPI: Focused Playtime Intervention; JASPER: Joint Attention Symbolic Play Emotion Regulation; MTW: More Than Words; PACT: Preschool Autism Communication Trial; PCIT: Parent Child Interaction Therapy; PLAY: Play and Language for Autistic Youngsters; RT: Responsive Teaching

**Table 5**  
*Intervention Characteristics*

Study	Intervention	Content	Targeted PCI Outcome	Structure
Aldred et al. (2004)	Communication focused intervention	Communication Focused Intervention focuses on increasing parent's communication with their child. Parent's intrusive and controlling comments are replaced with responses that facilitate child's communicative exchanges.	The intervention is social communication based, targeting shared attention, parental sensitivity, responsiveness, adapted communication strategies, and consolidation and elaboration.	Parents and child attend monthly sessions for 6 months followed by an additional 6 months of maintenance sessions. The therapist reviews the parent-child interaction videos and changes to parental strategies are provided for the parent. Parents are encouraged to practice skills every day for 30 minutes.
Bartley (2013)	Early Social Interaction	Early Social Interaction intervention is an activity-based intervention that is implemented in a child's natural environment. The content of the intervention is chosen according to the child's interest.	The intervention is based on a naturalistic developmental behavioral framework targeting parental responsiveness. It stresses the natural environments approach and is family centered.	The first part of the intervention lasts 6 months, with 3 weekly sessions (2 in home sessions and 1 in clinic session). In the second part of the intervention, parents receive 2 sessions per week for 3 months (1 in home session and 1 in clinic session).
Brian et al. (2017)	Social ABC's Intervention	The Social ABC's Intervention targets two key developmental outcomes: functional vocal communication and shared positive affect. Strategies are practiced in the context of play as well as during daily routines such as mealtime, diaper changing etc.	The intervention is based on social-communication behaviors and utilizes the method of pivotal response treatment. Such methods are found to be increasing parental responsiveness thereby child's motivation and adaptive behaviors.	The intervention lasts 12 weeks of 1.5 hour in home sessions with tapering intensity throughout the weeks. A manual supports teaching strategies and coaching is conducted live while the parent is practicing the strategies with the child.
Carter et al. (2011); Venker et al. (2012)	MTW	MTW focuses on teaching practical strategies for parents to increase children's communication in everyday routines. Such strategies target parental responsivity to children's communication attempts. They learn how to follow their child's lead, how to maintain interactions, how to observe, wait, and listen to their children. The aim is to improve two-way interaction between the parent and the child, to build social skills, and to improve children's understanding of language.	MTW stresses the importance of affect, predictability, structure, and the use of visual supports. It targets social-communicative acts, specifically parental responsivity and increasing child initiations.	The intervention lasts for 11 sessions: 8 group sessions with the parent and the interventionist, and 3 in home sessions with individualized parent-child structure. Group sessions had a more structured dynamic, while the individualized sessions gave parents the opportunity to transfer the skills to practical environments.
Casenhiser et al. (2011)	The Milton and Ethel Harris Research Initiative Treatment, MEHRIT	The focus of the MEHRIT program is to improve children's social interaction and communication abilities. The quality of a child's social interaction is of greatest interest.	MEHRIT is based on Developmental Social Pragmatic interventions that aim to teach children functional skills that are in line with typical child development. It is based on social communication	The intervention lasts for 12 months, with weekly 2 hour-long sessions. The therapist assesses the child's communication skills and teaches parents

<p>Green et al. (2010); Pickles et al. (2016)</p>	<p>PACT</p>	<p>PACT targets social interactive and communicative impairments, which are central to the symptomologies of autism. The intervention further aims to improve parental synchronous responses to the child's acts and to reduce parent's use of over directive responses. The intervention guides parents to create an interaction context that matches the child's developmental level by teaching them strategies to pick up the child's cues.</p>	<p>based framework and targets child language via increasing parental responsivity.</p>	<p>about their child's strengths and challenges.</p>
<p>Gulsrud et al. (2015); Kasari et al. (2014, 2015); Shire et al. (2016)</p>	<p>JASPER</p>	<p>JASPER aims to increase joint engagement, joint attention gestures and lay skills by teaching parents strategies to recognize their child's developmental level of play. Parents learn how to keep their child engaged by improving the frequency of social communicative gestures, play acts, and spoken words manifested by the child. Such strategies include modeling and prompting for joint attention, rearranging the play environment, and using developmentally appropriate language.</p>	<p>JASPER is based on naturalistic developmental behavioral framework by enforcing the use of naturalistic strategies to increase child's social communication foundations by focusing on increasing parent responsiveness and child's joint engagement.</p>	<p>PACT is conducted every 2 weeks for 1–2-hour long sessions and lasts about 6 months in addition to a 6-month long follow up phase. The initial visit focused on identifying parental beliefs about the etiology of their child's autism. Following sessions included a discussion of progress since the last session and planning of next sessions. Parents were encouraged to practice strategies learned in sessions every day. JASPER lasts for 10 weeks with 2 sessions per week (30 minutes per session). Strategies are introduced in a predetermined sequence. Interventionists modeled strategies and provided verbal feedback to the parent while the parent practices the interaction strategy with the child.</p>
<p>Karaaslan et al. (2013)</p>	<p>RT</p>	<p>Responsive Teaching (RT) encourages parents to engage in highly responsive interactions with their child. This intervention promotes responsiveness by teaching parents to use strategies promoting reciprocity, contingency, nondirectiveness, affect, and match. The sessions are designed to address children's cognition, communication, and social-emotional functioning.</p>	<p>RT stresses the importance of reciprocity, contingency, control, affect, and responsiveness, as they are thought to be the primary parental characteristics that influence the development of communicative skills. It is based on children's pivotal behaviors, such as initiation and motivation, thereby stressing the naturalistic developmental behavioral framework.</p>	<p>RT lasts 4 months, with 1 hour-long session per week. The sessions are conducted with the parent and child together and the interventionist models how to use strategies and provides feedback for parents.</p>
<p>Kasari et al. (2010)</p>	<p>Joint Attention Intervention</p>	<p>Joint Attention Intervention aims to keep the child engaged in play. The focus is on the development of play routines. Parents learn to follow their child's lead, talk about what the child is doing, and expand on what the child said.</p>	<p>The intervention is based on naturalistic developmental behavioral framework, aiming at building responsive and facilitative interactions between the parent and the child. It uses the ABA principles to engage the child and focuses on child initiations as well as shared attention.</p>	<p>The intervention lasted 8 weeks and consisted of 24 sessions in total (45 minutes per session). The interventionist modeled strategies and presented the content to the parent. The content was given in a written format as well.</p>
<p>Oosterling et al. (2010)</p>	<p>Focus Parent Training</p>	<p>The intervention focuses on stimulating parental skills to be used in parent-child interactions to promote developmental gains.</p>	<p>Focus Parent Training follows a social pragmatic and naturalistic developmental behavioral framework.</p>	<p>The intervention is a 2 year-long program. The first year consists of weekly 2 hour-long group sessions in addition to 3 hours in home sessions every 6 weeks. During the second year,</p>

Poslawsky et al. (2015)	Video-feedback Intervention to promote Positive Parenting adapted to Autism, VIPP-AUTI	The intervention focuses on enhancing parental sensitivity to child's signals. It provides opportunities for the parent to understand and manage symptoms related to autism via following in child's initiations.	The intervention is based on the foundation that maternal sensitivity and discipline are maternal characteristic qualities that reduce a child's externalizing behaviors, thereby increasing social-communicative abilities.	home sessions take place every 3 months.	The intervention lasts 3 months with 1-2 hour-long sessions every 2 weeks. The interventionist videotapes the parent child interaction each session and discussion and feedback based on video recordings of the interaction is provided.
Scudder et al. (2019)	PCIT	PCIT is focused on increasing the frequency of positive interactions between parent and child. It aims to stimulate parent's use of positive reinforcement. The intervention aims to teach parents how to respond to appropriate behaviors and how to ignore inappropriate behaviors.	PCIT is based on attachment and social learning principles and targets increasing parental responsiveness through social communication based approaches.	Weekly 1-hour sessions for 4 months. The intervention has 2 phases. In the first part (Child Directed Interaction), parents are taught to praise, reflect, imitate, describe, and enjoy the interaction. In the second part (Parent Directed Interaction), parents are taught to provide clear and direct commands.	
Siller et al. (2013, 2014)	FPI	FPI aims to explore the mechanism underlying responsive parental behaviors. The intervention does so through making sure parents are able to understand their child's communication skills (topic 3), are aware of their goals (topic 2), are competent enough to arrange the play environment (topic 3). The following topics are based on strategies such as coordinating attention, coordinating actions, and sharing control (topic 4-8).	FPI targets social communication based deficiencies and employs parents as the active agents of the intervention process and uses strategies such as feedback sessions and self-evaluation techniques to increase their responsiveness.	FPI consists of 12 in-home training sessions (90 minutes per session, for 12 weeks). First part of the session involves the parent, child, and the interventionist. Parents are given the opportunity to interact with their child under supervision of the interventionist. The interventionist demonstrates strategies to engage with the child and comments on the child's behaviors. The second part of the session involves only the parent and the interventionist, in which the parent learns strategies through video feedback, illustrated examples and assignments from a workbook.	
Solomon et al. (2014)	PLAY	PLAY aims to enhance children's developmental functioning by teaching their parents to engage in two-way interactions guided by responsiveness and affect. Enhancement in children's social engagement is targeted via parents use of interactional methods.	The PLAY Intervention is characterized as a relationship-based intervention that is based on naturalistic developmental behavioral framework with a focus in improving parental responsiveness.	Monthly 3-hour home visits for 12 months. The sessions were based on modeling, coaching, and video feedback.	

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*Meta-Analytic Procedures**Effect size Calculations*

Findings from the included studies were combined using meta-analytic methods to determine the effectiveness of parent-mediated interventions on PCI outcomes. The effect size calculations were based on random-effects model to estimate the mean of a distribution of effects rather than a true effect. As such, each study contributed with different effect sizes with an attempt to represent the included studies in summary estimate. Standardized mean differences ( $d_{ppc}$ ) for pretest-posttest-control designs were computed using Carlson & Schmidt (1999) and Morris's (2008) formula, which were then converted to Hedge's  $g$  for simplicity. Calculations were based on the sample mean and the pooled pretest standard deviation:

$$d_{ppc} = c \left( \frac{(M_{T2} - M_{T1}) - (M_{C2} - M_{C1})}{SD_{p1}} \right)$$

where the pooled standard deviation is defined as:

$$SD_{p1} = \sqrt{\frac{(n_T - 1)SD_{T1}^2 + (n_C - 1)SD_{C1}^2}{n_T + n_C - 2}}$$

and the correction for bias as suggested by Hedge & Olkin (1985) is defined as:

$$c = 1 - \frac{3}{4(n_T + n_C - 2) - 1}$$

This method allowed making a broader range of inferences. Thus, it allowed for accounting for variance at population level above and beyond the sampling error.

For studies reporting more than one PCI outcomes, the effect sizes were pooled to create a single effect size per outcome using the shifting unit of analysis method as the interest was the overall effect size. To minimize sampling error, the mean effect sizes were weighted according to the sample size, where the weight assigned to each study is the inverse of that study's variance

plus the variance between studies (Borenstein et al., 2009). Studies with larger sample sizes were weighted more than studies with smaller sample sizes as larger studies provide more accurate effect sizes.

Confidence Intervals (95% CIs) for the sample-weighted mean effect sizes were calculated using Borenstein et al., (2014) formula. CIs are used to give us inference about how the true effects are distributed among the sample-size-weighted mean effect size, thus the precision of the summary effect.

### ***Moderator Analysis***

Categorical moderator analysis was conducted using the ANOVA based approach (Williams, 2012) to identify how the effect sizes differed across the identified categories. With this approach, effect sizes were grouped based on the variable at interest, and heterogeneity was partitioned into within group and between group variances. Summary effects within subgroups were computed using random-effects model with a pooled estimate of  $\tau^2$  (within studies variance) Borenstein et al., 2009). For each subgroup,  $\tau^2$  is computed using the following formula:

$$T^2 = \frac{Q - df}{C},$$

where

$$df = k - 1,$$

and k is the number of studies in the subgroup, and

$$C = \sum w_i - \frac{\sum w_i^2}{\sum w_i}.$$

To compute a pooled estimate of  $\tau^2$ , each component of the equation was summed

$$T^2_{within} = \frac{\sum_{j=1}^p Q_j - \sum_{j=1}^p df_j}{\sum_{j=1}^p C_j}.$$

After computing the pooled estimate of  $\tau^2$  for each subgroup, a Z-test for was performed to capture the magnitude of heterogeneity by comparing the subgroup mean effects based on a 2-tailed  $p$ -value for Z.

### ***Assessment of Publication Bias***

To account for the selective publication bias, Rosenthal's (Orwin, 1983) fail-safe number calculation was applied, demonstrating the number of studies with an effect size of 0 that would have to exist before overall effect size becomes trivial. To calculate the fail-safe  $N$ , 3 critical minimum effect size values were used ( $d = 0.10, 0.30, 0.50$ ) using the following formula:

$$k_0 = k \left[ \frac{ES_k}{ES_c} - 1 \right]$$

Results suggested that 201, 54 and 24 studies with an effect size of zero would have to exist respectively to reach non-significant results from this review.

## **Results**

A total of 20 randomized controlled trials (RCTs) were included in this study. Across the included studies, 754 children and their parents received the parent-mediated intervention and 728 were in the control condition (active or treatment-as-usual). The sample sizes of the studies ranged from 7 to 85 in the intervention and control groups. More than half of the studies were conducted in the United States (Bartley, 2013; Carter et al., 2011; Gulsrud et al., 2016; Kasari et al., 2010, 2014, 2015; Scudder et al., 2019; Shire et al., 2016; Siller et al., 2013, 2014; Solomon et al., 2014; Venker et al., 2012). The remaining studies were conducted in the United Kingdom

(Aldred et al., 2004; Green et al., 2010; Pickles et al., 2016), Canada (Brian et al., 2017; Casenhiser et al., 2013), Turkey (Karaaslan et al., 2013), and the Netherlands (Oosterling et al., 2010; Poslawsky et al., 2015).

All studies included in this brief meta-analysis and systematic review had a pretest-posttest randomized control design. Studies providing limited information on scores on pre-test, post-test control and intervention groups were eliminated as effect size  $d_{ppc}$  was not possible to calculate (Aldred et al., 2012; Alquraini et al., 2018a; Alquraini et al., 2018b; Harrop et al., 2016; Karaaslan & Mahoney, 2015; Mahoney & Solomon, 2016; Pickles et al., 2015).

*Dosage of parent-mediated interventions.* Only 13 out of 20 studies shared information about the instructions they gave parents on how or when to apply the learned skills to their daily routine. 5 of 20 studies provided information on how much time they requested from parents to deliver the interventions (Aldred et al., 2004; Casenhiser et al., 2013; Green et al., 2010; Pickles et al., 2016; Solomon et al., 2014). 4 studies requested parents to spend 30 minutes or less daily alone with their child at home to practice the intervention strategies. Solomon et al., (2014) asked the parents to spend 2 hours with their children practicing the strategies per day. 8 studies explicitly requested from the parents to integrate the intervention techniques and skills into their daily activities without providing any specific information on the amount of time they would be spending with their children or applying the intervention techniques (Bartley, 2013; Brian et al., 2017; Gulsrud et al., 2016; Karaaslan et al., 2013; Kasari et al., 2010, 2014, 2015; Shire et al., 2016). The relationship between dose of parent-mediated intervention and respective PCI outcomes were analyzed based on the categorization of studies with providing more than or equal to 20 hours of intervention ( $k=11$ ) versus less than 20 hours of intervention ( $k=9$ )

throughout the whole duration of the study, as reported in their intervention design. Additional information on the characteristics of the dose of interventions is presented in Table 3.

*Control condition.* The control conditions consisted of active control ( $k=11$ ) or treatment-as-usual (TAU) ( $k=9$ ). Active control conditions included parent education, instruction, or coaching (Bartley, 2013; Gulsrud et al., 2016; Kasari et al., 2010, 2014, 2015; Scudder et al., 2019; Shire et al., 2016; Siller et al., 2013, 2014; Solomon et al., 2014; Venker et al., 2012).

*Effect of intervention by content and focus.* Table 5 displays the intervention content, approach and targeted PCI outcomes of the studies included in this review. Studies mainly categorized their intervention models as social communication based to target the core feature of ASD, specifically social-emotional reciprocity and non-verbal communicative behaviors used in social interactions or Naturalistic Developmental Behavioral Interventions, *NCBI*, implemented in children's natural settings, involving shared control between parent-child dyads.

*NCBI* follows a more naturalistic approach with a constant flow of engagement between the conversational partners (Landa, 2018). Interventions follow a structured yet adaptable format to meet the child's needs and gradual improvements, and can be implemented in children's natural settings, involving shared control between parent-child dyads (Birkan, 2013). It focuses mostly on getting the children to be actively involved, maintaining their attention and facilitating their learning through developmental sequences (Schreibman et al., 2015).

Social-communication based interventions, on the other hand, focus on the core feature of ASD, specifically social-emotional reciprocity and non-verbal communicative behaviors used in social interactions. Both intervention models include reinforcement, modeling, prompting, and providing visual support (Watkins et al., 2017).

Nine studies followed a naturalistic developmental behavioral approach (Bartley, 2013; Gulsrud et al., 2015, Kasari et al., 2010, 2014, 2015; Shire et al., 2016; Karaaslan et al., 2013; Oosterling et al., 2010; Solomon et al., 2014), while eleven studies focused on social communicative based framework thereby targeting the core deficit areas in ASD (Aldred et al., 2004; Brian et al., 2017; Carter et al., 2011; Casenhiser et al., 2011; Green et al., 2010; Pickles et al., 2016; Poslawsky et al., 2015; Scudder et al., 2019; Siller et al., 2013, 2014; Venker et al., 2012).

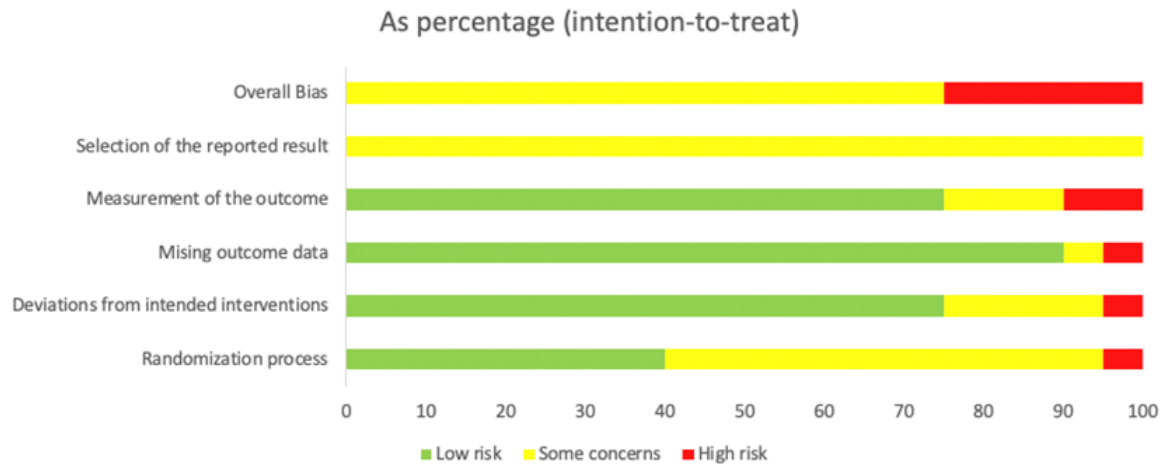
**Analysis of Risk of Bias**

**Figure 2**  
*Analysis of risk of bias*

Study ID	D1	D2	D3	D4	D5	Overall	
Aldred et al., 2004	+	+	+	+	!	!	+
Bartley, 2013	!	+	!	+	!	!	!
Brian et al., 2017	+	+	+	+	!	-	-
Carter et al., 2011	+	+	-	+	!	-	
Casenhiser et al., 2011	+	!	+	!	!	!	D1 Randomisation process
Green et al., 2011	+	+	+	!	!	!	D2 Deviations from the intended interventions
Gulsrud et al., 2015	!	+	+	+	!	!	D3 Missing outcome data
Karaaslan et al., 2013	!	+	+	+	!	!	D4 Measurement of the outcome
Kasari et al., 2010	!	+	+	+	!	!	D5 Selection of the reported result
Kasari et al., 2014	!	+	+	+	!	!	
Kasari et al., 2015	!	+	+	!	!	!	
Oosterling et al., 2010	-	-	+	+	!	-	
Pickles et al., 2015	!	+	+	+	!	!	
Poslawsky et al., 2014	+	+	+	+	!	!	
Scudder et al., 2019	!	!	+	-	!	-	
Siller et al., 2013	+	!	+	+	!	!	
Siller et al., 2014	!	+	+	+	!	!	
Shire et al., 2016	+	+	+	+	!	!	
Solomon et al., 2014	!	!	+	+	!	!	
Venker et al., 2011	!	+	+	-	!	-	

**Figure 3**

*Summary of the risk of bias (given in %) of the 20 selected studies*



*Note.* Selection of the reported results: Unclear risk of bias: 75%, High risk of bias: 25%; Measurement of the outcome: Unclear risk of bias: 100%; Missing outcome data: Unclear risk of bias: 20%, Low risk of bias: 75%, High risk of bias: 10%; Missing outcome data: Unclear risk of bias: 5%, Low risk of bias: 90%, High risk of bias: 5%; Randomization process: Unclear risk of bias: 55%, Low risk of bias: 40%, High risk of bias: 5%

The risk of bias analysis across all criteria demonstrated that more than half of the studies (13 studies, 65%) showed some concerns about the risk of bias while seven studies (35%) showing high risk of bias. There was no study showing low risk of bias.

The results demonstrated a similar pattern across the studies, while some studies consistently showing low risk of bias within certain criteria (e.g., deviations from the interventions), some showing some concerns on certain criteria (e.g., measurement of the outcome), and last but not the least some showing high risk of bias in a specific criterion (e.g., selection of the reported results).

As this report included studies with randomized control trials, eight studies (40%) presented low risk of bias in randomization process. Studies included specific information about the randomization process, thus they included information on requesting from parents to not

communicate their group assignment with other parents. As such, eleven studies (55%) showed some concerns, and one study showed a high risk of bias (5%). Although the allocation of participants within all studies was randomized, the above-mentioned studies did not report on whether they specifically requested parents to not disclose their assignment before the start of the intervention. Oosterling et al., (2010) specifically reported on the randomization process thereby informing us on randomizing participants based on the regions and neighborhoods they lived in. Thus, location-based characterizations, including socioeconomic status, education level of parents and children, as well as the content and quality of the previously received interventions might have influenced the outcome results, limiting the bias on randomization and allocation concealment.

Almost all studies (15 studies, 75%) had low risk of bias in deviations from the intended intervention with four studies (20%) showing some concerns, and one study showing high risk of bias (5%). It should be noted that parents actively involved in the intervention procedures and actively delivering the interventions were probably aware of their assigned group. Yet, there were probably no deviations from the intended intervention arising due to the trial context, therefore most studies had a low risk of bias in this criterion.

Similarly, almost all studies showed to have a low risk of bias in missing outcome data (18 studies, 90%). As all studies had multiple assessment periods, one prior the intervention and one following the intervention, with additional follow up and time-based assessments, it was probably not possible to keep all the parent-child dyads onboard. Therefore, although not explicitly disclosed, in most studies, there were fewer people at the end of the intervention compared to the beginning, and thus the data was available for only the dyads who stayed until the end of the intervention procedure. It is further assumed that missing outcome data is due to

losing parent-child dyads along the way instead of authors selecting on data that will favor the intervention outcome.

With regards to the measurement of the outcome, more than half of the studies (15 studies, 75%) showed to be having some concerns regarding the measurement of the outcome, whereas two studies (10%) having high risk of bias and three studies (15%) showing low risk of bias. This was mostly due to studies not presenting any information on the appropriateness of the methods used in measuring the PCI outcomes. However, as most studies reported incorporating blind assessors and coders, they were not rated as having high risk of bias, but rather showing some concerns on the dimensions of this criteria. For the studies showing high risk of bias, Scudder et al., (2019) did not mention whether the assessors were aware of the group assignment of the participants, and Venker et al., (2012) reported that assessors were aware of the group assignment, presenting a possibility of it influencing the assessment of the outcome variables.

As for the selection of the reported results, all studies (20 studies, 100%) showed some concerns. The reason was that studies did not report on their analysis scheme, nor did they report on their pre-registration plans. Hence, it is not possible to assess whether they presented the complete set of results or not.

### **Meta-analysis Findings**

Tables 6 to 10 present the summary data for the individual studies included in this meta-analysis and forest plots for different PCI outcomes. The tables display the effect sizes Hedges'  $g$  of the interventions, the significance values, the weight of the studies and the weighted average effect sizes. The tables also portray the sample sizes from each study, as they contribute to the overall effect, weight and 95% CI. The significance level is determined by the significance of the effect's corresponding z-score ( $p < 0.05$ ). Heterogeneity test values are also indicated (Hedges'

$Q$ -test and  $I^2$  index). Given the high variability in sample sizes both within studies and between studies, conclusions were based on weighted average effect sizes.

The overall results of the meta-analysis showed a significant association between parent-mediated autism interventions and PCI outcomes. The pooled results suggested an improved level of PCI outcomes following parent-mediated intervention (weighted  $g = 0.99$ , 95% CI:  $-0.95 - 3.16$ ,  $p < 0.05$ ). Intervention effect on child's dialogue participation/conversational turns was the only PCI outcome reaching non-significance. Intervention effects on all outcome domains except one were significantly different than zero. Large intervention effectiveness was found for responsiveness (weighted  $g = 1.04$ , 95% CI:  $-1.08 - 3.41$ ,  $p < 0.05$ ), whereas a medium effect size was established for child's dialogue participation/conversational turns (weighted  $g = 0.54$ , 95% CI:  $-2.67 - 3.77$ ,  $p > 0.05$ ) and shared communicative acts (weighted  $g = 0.73$ , 95% CI:  $-3.38 - 4.69$ ,  $p < 0.05$ ). Responsiveness domain had the highest number of studies contributing and therefore had the highest number of participants contributing to the meta-analysis. As seen in significant Hedges'  $Q$ -test, the responsiveness domain had a relatively high level of heterogeneity between effect sizes, suggesting the possibility of moderator effects.

**Table 6***Summary of findings for PCI outcomes*

Study	Nr of participants (studies)	Effect size (Hedges' <i>g</i> ) (95% CI)	<i>p</i>
Total	1482 (20)	0.99 (-0.95 – 3.16)	<i>p</i> < 0.05
Responsiveness	1253 (17)	1.04 (-1.08 – 3.41)	<i>p</i> < 0.05
Dialogue participation/conversational turns	520 (7)	0.54 (-2.67 – 3.77)	<i>p</i> > 0.05
Shared communicative acts	420 (5)	0.73 (-3.38 – 4.69)	<i>p</i> < 0.05

**Table 7**  
*Summary data and Forest plot for parent-child interaction across studies*

Mean difference, 95% CI	Study	INT <i>n</i>	CT <i>n</i>	Weight	<i>g</i>	95% CI	
						Lower	Upper
	Aldred et al., 2004	14	14	1.43	0.01	-0.73	0.75
	Bartley, 2013	41	39	1.65	0.12	-0.36	0.51
	Brian et al., 2017	30	32	1.60	0.75	-0.04	0.97
	Carter et al., 2011	15	12	1.41	-0.04	-0.79	0.73
	Casenhiser et al., 2011	25	26	1.55	1.41	0.33	1.49
	Green et al., 2010	77	75	1.71	1.29	0.42	1.08
	Gulrud et al., 2015	43	43	1.63	1.95	0.73	1.65
	Karaaslan et al., 2013	17	17	1.40	2.25	0.83	2.38
	Kasari et al., 2010	15	12	1.49	1.25	0.18	1.51
	Kasari et al., 2014	25	25	1.68	1.21	0.34	1.11
	Kasari et al., 2015	77	75	1.64	1.45	0.44	1.32
	Oosterling et al., 2010	27	23	1.57	0.39	-0.31	0.81
	Pickles et al., 2016	77	75	1.70	1.58	0.58	1.28
	Poslawsky et al., 2014	40	36	1.64	0.36	-0.23	0.67
	Scudder et al., 2019	10	9	1.30	0.02	-0.89	0.92
	Shire et al., 2016	85	85	1.19	6.68	0.79	1.44
	Siller et al., 2012	36	34	1.49	4.19	4.56	6.64
	Siller et al., 2014	36	34	1.71	1.90	2.15	3.47
	Solomon et al., 2014	57	55	1.69	0.31	-0.18	0.56
	Venker et al., 2011	7	7	0.74	2.79	2.02	5.50
	<b>Total (95% CI)</b>			-	<b>0.99</b>	<b>-0.95</b>	<b>3.16</b>

Heterogeneity: Hedges' *Q*-test = 184.86, *df* = 19, *p* = 0.00, *I*<sup>2</sup> = 89.18%.  
 Test for overall effect: *Z* = 5.43, *p* < 0.05.

**Table 8**  
*Summary data and Forest plot for responsive interaction style across studies*

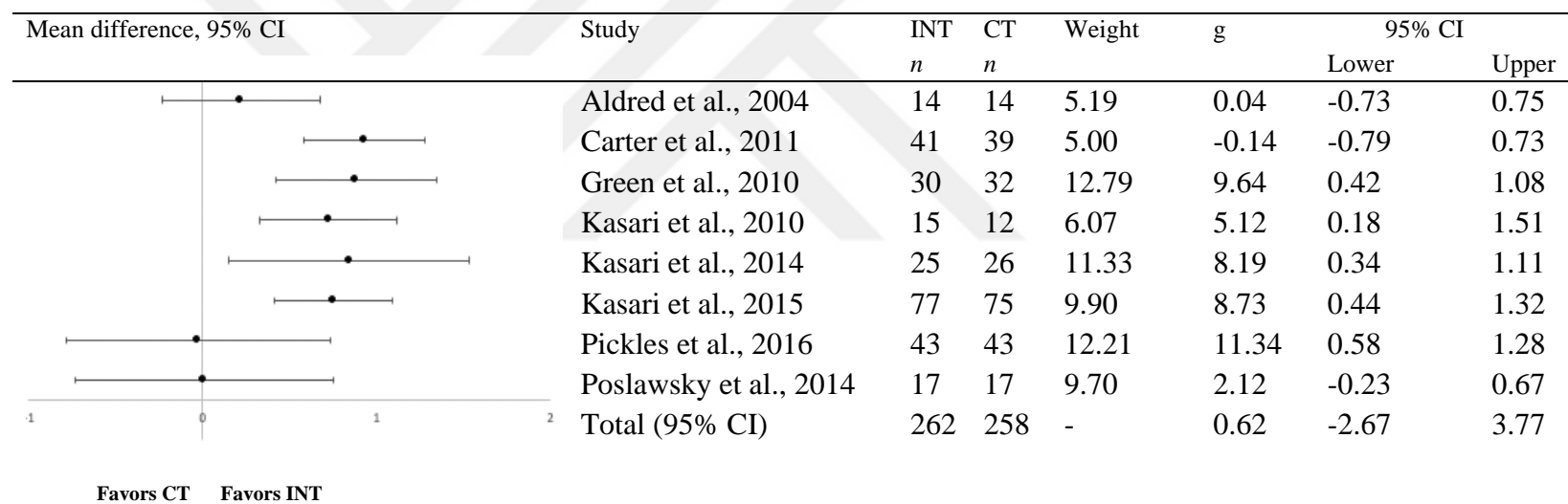
Mean difference, 95% CI	Study	INT <i>n</i>	CT <i>n</i>	Weight	<i>g</i>	95% CI	
						Lower	Upper
	Aldred et al., 2004	14	14	1.19	0.01	-0.73	0.75
	Bartley, 2013	41	39	1.34	0.10	-0.36	0.51
	Brian et al., 2017	30	32	1.31	0.61	-0.04	0.97
	Carter et al., 2011	15	12	1.18	-0.03	-0.79	0.73
	Casenhiser et al., 2011	25	26	1.28	1.17	0.33	1.49
	Green et al., 2010	77	75	1.38	1.04	0.42	1.08
	Gulsrud et al., 2015	43	43	1.33	1.59	0.73	1.65
	Karaaslan et al., 2013	17	17	1.18	1.89	0.83	2.38
	Oosterling et al., 2010	27	23	1.29	0.32	-0.31	0.81
	Pickles et al., 2016	77	75	1.38	1.28	0.58	1.28
	Poslawsky et al., 2014	40	36	1.34	0.29	-0.23	0.67
	Scudder et al., 2019	10	9	1.10	0.02	-0.89	0.92
	Shire et al., 2016	85	85	1.02	5.74	4.56	6.64
	Siller et al., 2012	36	34	1.24	3.48	2.15	3.47
	Siller et al., 2014	36	34	1.39	1.54	0.79	1.44
	Solomon et al., 2014	57	55	1.37	0.26	-0.18	0.56
	Venker et al., 2011	7	7	0.67	2.53	2.02	5.50
	<b>Total (95% CI)</b>	<b>637</b>	<b>616</b>	<b>-</b>	<b>1.04</b>	<b>-1.08</b>	<b>3.41</b>

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Heterogeneity: Hedges' *Q*-test = 184.54, *df* = 16, *p* = 0.00, *I*<sup>2</sup> = 90.79%.

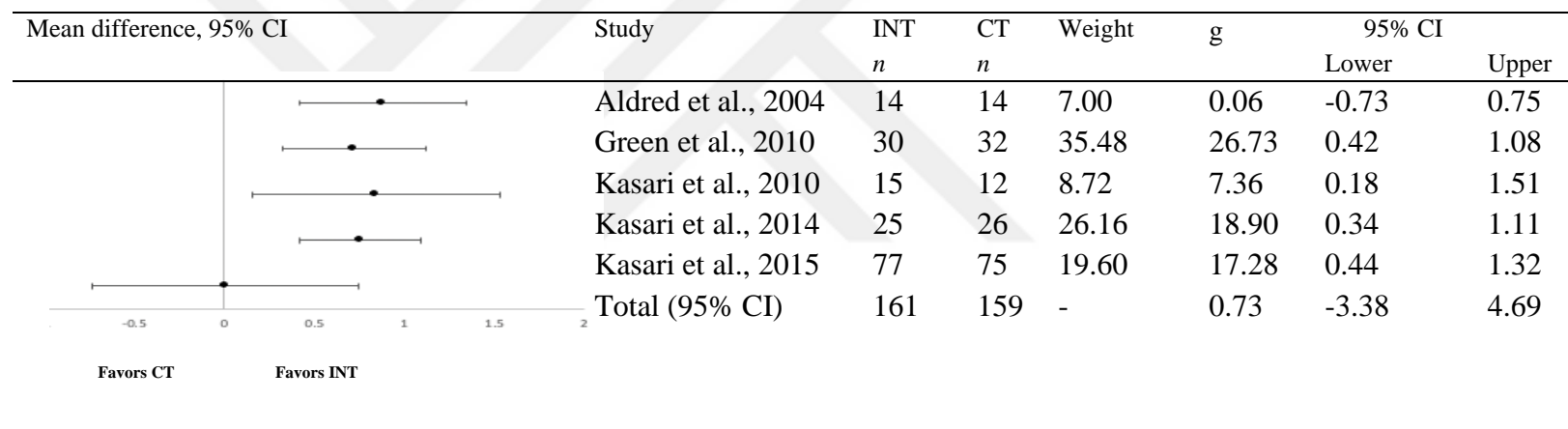
Test for overall effect: *Z* = 4.76, *p* < 0.05.

**Table 9**  
*Summary data and Forest plot for child’s dialogue participation/conversational turns interaction style across studies*



Heterogeneity: Hedges’  $Q$ -test = 13.7,  $df = 7$ ,  $p = 0.71$ ,  $I^2 = 41.6\%$ .  
 Test for overall effect:  $Z = 0.37$ ,  $p > 0.05$

**Table 10**  
*Summary data and Forest plot for shared communicative acts interaction style across studies*



Heterogeneity: Hedges'  $Q$ -test = 4.23,  $df = 4$ ,  $p = 0.00$ ,  $I^2 = -18.29\%$ .  
 Test for overall effect:  $Z = 7.14$ ,  $p < 0.05$

*Moderator Analyses*

**Effect of intervention by dosage of parent training.** Dose of parent training ranged from 6 hours to 310 hours across studies. Studies were coded as providing less than 20h ( $k=9$ ) or more than or equal to 20h of parent training ( $k=11$ ). Table 11 displays the results of subgroup meta-analysis based on the dose across each PCI outcome. There was a significant difference between studies providing less than 20h of parent training and more than or equal to 20h of parent training regarding effectiveness results. When the dosage of parent training was less than 20h, impacts of parent-mediated interventions were found to be higher for the outcome of responsiveness (weighted  $g = 1.71$  95% CI:  $-0.12 - 0.32$ ,  $p < 0.05$ ), as compared to child's dialogue participation/conversational turns (weighted  $g = 0.52$ , 95% CI:  $0.30 - 0.84$ ,  $p < 0.05$ ) and shared communicative acts (weighted  $g = 0.7$ , 95% CI:  $0.67 - 1.33$ ,  $p < 0.05$ ). In contrast, when the dosage of parent training is more than or equal to 20h, impacts of parent-mediated interventions turned out to be higher for the outcome of shared communicative acts (weighted  $g = 0.74$  95% CI:  $0.75 - 1.25$ ,  $p < 0.05$ ), as compared to child's dialogue participation/conversational turns (weighted  $g = 0.70$ , 95% CI:  $0.22 - 0.61$ ,  $p < 0.05$ ) and responsiveness (weighted  $g = 0.63$ , 95% CI:  $-0.07 - 0.22$ ,  $p < 0.05$ ). When the dosage of parent training is less than 20h, impacts of parent-mediated interventions is higher for the outcome of responsiveness (weighted  $g = 1.71$  95% CI:  $-0.12 - 0.32$ ,  $p < 0.05$ ), as compared to child's dialogue participation/conversational turns (weighted  $g = 0.52$ , 95% CI:  $0.30 - 0.84$ ,  $p < 0.05$ ) and shared communicative acts (weighted  $g = 0.7$ , 95% CI:  $0.67 - 1.33$ ,  $p < 0.05$ ).

**Table 11**  
*Effects of treatment based on dose of parent training*

Outcome variable	Dose (hours)	Contributing studies	<i>N</i>	Unweighted g	Weighted g	Z	95% CI	p
Responsiveness	Less than 20	7	228	1.17	1.71	0.89	-0.12 to 0.32	<i>p</i> < 0.05
	20 or higher	10	409	0.62	0.63	0.97	-0.07 to 0.22	
Dialogue participation/ conversational turns	Less than 20	4	123	0.53	0.52	4.19	0.30 to 0.84	<i>p</i> < 0.05
	20 or higher	4	139	0.75	0.70	4.14	0.22 to 0.61	
Shared communicative acts	Less than 20	3	106	0.7	0.7	5.94	0.67 to 1.33	<i>p</i> < 0.05
	20 or higher	2	55	0.74	0.74	7.85	0.75 to 1.25	

CI: confidence interval. *N* represents the number of participants in the treatment group.

**Table 12**  
*Effects of treatment in comparison to TAU versus active control group*

Outcome variable	Control condition	Contributing studies	<i>N</i>	Unweighted g	Weighted g	Z	95% CI	p
Responsiveness	TAU	9	322	0.63	0.57	0.96	-0.08 to 0.24	<i>p</i> < 0.05
	AC	8	315	0.98	1.61	0.86	-0.10 to 0.26	
Dialogue participation/ conversational turns	TAU	5	223	0.6	0.51	4.50	0.26 to 0.65	<i>p</i> < 0.05
	AC	3	122	0.8	0.81	3.70	0.24 to 0.77	
Shared communicative acts	TAU	2	91	0.63	0.63	6.52	0.70 to 1.30	<i>p</i> < 0.05
	AC	3	122	0.8	0.80	7.38	0.73 to 1.27	

CI: confidence interval; TAU: treatment-as-usual; AC: active control. *N* represents the number of participants in the treatment group

**Effect of intervention by type of control group.** The control groups were categorized as either having an active control group ( $k=14$ ) or TAU ( $k=16$ ). Table 12 displays the results of subgroup meta-analysis based on the type of control group across the PCI outcomes. When studies employed TAU as their control condition, impacts of parent-mediated interventions were found to be lower across the outcomes of shared communicative acts (weighted  $g = 0.63$ , 95% CI:  $0.70 - 1.30$ ,  $p < 0.05$ ), responsiveness (weighted  $g = 0.57$ , 95% CI:  $-0.08 - 0.24$ ,  $p < 0.05$ ) and child's dialogue participation/conversational turns (weighted  $g = 0.51$ , 95% CI:  $0.26 - 0.65$ ,  $p < 0.05$ ), as compared to studies employing an AC group as their control condition (responsiveness weighted  $g = 1.61$ , 95% CI:  $-0.10 - 0.26$ ,  $p < 0.05$ ; child's dialogue participation/conversational turns weighted  $g = 0.81$ , 95% CI:  $0.24 - 0.77$ ,  $p < 0.05$ ; and shared communicative acts weighted  $g = 0.80$ , 95% CI:  $0.73 - 1.27$ ,  $p < 0.05$  respectively).

### Discussion

The current brief meta-analysis and systematic review reports the findings of RCTs on the effects of parent-mediated interventions for children with ASD on PCI outcomes. The primary goal of the study was to explore the effect of parent-mediated autism interventions on responsive PCI, child-initiated PCI, and shared PCI. The secondary goal was to explore the effect of dose of parent training, more specifically to identify if studies delivering more than or equal to 20 hours of parent training reported greater effects than studies delivering less than 20 hours of parent training. Additionally, the methodological moderating role of control group type used in the effectiveness trials was also analyzed.

This study expands upon previous meta-analyses by focusing on different interaction styles. As suggested by Blackwell et al. (2015), PCI outcomes were characterized by responsiveness, specifically parental conversational replies in response to previous turn, by

dialogue participation, precisely the proportion of child-initiated conversations, and last but not the least by the purpose of communicative acts, specifically sharing meaning and intentions to maintain conversations. Representing a comprehensive review on the effectiveness of parent-mediated autism interventions on PCI outcomes, including examination of parent training dosage and the effect of control condition type, this study has meta-analyzed 20 studies representing 30 independent effect sizes. Among the analyzed studies meeting our inclusion criteria, only 10 studies overlapped with Nevill et al., (2018), (Aldred et al., 2004; Carter et al., 2011; Cassenhiser et al., 2013; Green et al., 2010; Kasari et al., 2010; Kasari et al., 2014; Kasari et al., 2015; Poslawsky et al., 2015; Siller et al., 2013; Solomon et al., 2014), 1 study overlapped with McConachie et al. (2007) (Aldred et al., 2004), 6 studies overlapped with Oono et al. (2013) (Aldred et al., 2004; Carter et al., 2011; Cassenhiser et al., 2013; Green et al., 2010; Kasari et al., 2010; Siller et al., 2013), and 3 studies overlapped with Beaudoinn et al. (2014) studies (Carter et al., 2011; Kasari et al., 2010; Oosterling et al., 2010). In total 6 new RCTs have been included in the current meta-analysis. Methodologi varied widely across studies. Combined samples contributing to different PCI outcome categories was large with samples ranging from 7 to 85. There was a significant variability in dose of parent training in intervention delivery, ranging from 6 to 104h. Thus, about 9 of the studies did not have an active control group and had included children who continued with TAU. Finally, there was a wide range of outcome measures used, including both parent related and child related outcomes. 3 out of 20 studies focused only on parent related outcomes (Kasari et al., 2010; Scudder et al., 2019; Shire et al., 2016), whereas 17 out of 20 studies chose to investigate both PCI outcomes as well as their relation to child related developmental outcomes. Contributing to the body of evidence supporting the long-term positive effects of parental involvement in autism programs, current

results suggest that parent-mediated autism interventions across RCTs investigating this effect in the last ten years have significant effects on PCI outcomes.

More precisely, this meta-analysis indicated that parent-mediated interventions resulted in significant yet small improvements on PCI outcomes. Supporting our hypothesis, PCI outcomes differed across levels of parent training dosage. Dose of parent training and delivery in intervention was associated with large effects only for the responsiveness domain. However, 17 out of 20 studies included in the meta-analysis had reported parental responsiveness as a targeted PCI outcome, meaning the sample contributing to this meta-analysis was larger than samples contributing to the meta-analysis of child's dialogue participation/conversational turns and shared communicative acts, presenting a possible mechanism explaining the discrepancy between the calculated effect sizes across the PCI outcome variables. As a widely studied research area, parental responsiveness is a dynamic phenomenon, where verbal responsiveness is linked to social-communicative gains (Shire et al., 2016). Literature on typically developing children demonstrates that children spend most of their play-based interactions with their parents in a jointly engaged state (Adamson et al., 2009). However, this is not an extensively observed pattern in autism, therefore when children with autism spend even a fraction of their time jointly engaged with their parents, developmental gains, specifically in the domains of language development and social initiations, are observed (Shire et al., 2016).

The only PCI domain not reaching significance was related to child's dialogue participation. When considering the ultimate goal of autism interventions, improving children's social-communicative behaviors, specifically increasing their initiations come to mind. However, research portrays that until children can initiate joint attention or verbal communication, children seem to develop an ability to respond to joint attention and respond to verbal/nonverbal

communicative acts (Adamson et al., 2009). One interpretation for the absence of an effect of parent involvement in improving child's dialogue participation could be that there is a foundational discrepancy between child initiations and child responsiveness. Child's dialogue participation can be perceived as a more complex set of skills that can be learned following the development of skills necessary to respond to verbal and nonverbal communicative acts.

Moreover, the non-significance of this PCI domain could also stem from the age range of children included in the analysis. For example, for typically developing children, communicative gesture use emerges as early as 8 to 10 months, where children start utilizing multimodal communication such as showing, pointing or vocalizations (Kuhn et al., 2014). However, when compared to age-matched group, children with ASD seem to have difficulties in communicating both verbally and nonverbally. As such, although for typically developing children child initiations can emerge in the first year, children with autism could develop such developmental skills in a later stage, which could explain why child initiations were not observed in this study.

Literature on parent-mediated autism interventions demonstrate the strength of involving parents in intervention procedures as they can create therapeutic experience across the child's daily routine and integrate intervention techniques into child's natural setting. Yet, it also poses challenges in assessing the overall effect of it as it seems to be difficult to keep track of as well as to quantify the amount parents spend with their child applying intervention techniques or creating a specified therapeutic environment. In order to explore the relationship between dosage of parent training and PCI, it is necessary to develop and employ a consistent system to quantify the time parent-child dyads spend together within an intervention context. Due to the variability in parent training as well as a lack of consistent reporting of the time parents engage with their

child, it was not possible to conclude whether dose of parent training and PCI outcomes are correlated.

Comparing parent-mediation to TAU versus active control across the PCI outcome variables, a significant difference between the intervention group and children receiving an active treatment or continuing with their regular treatment schedule. Larger treatment effectiveness was reached when the intervention was compared to AC rather than to AC for responsiveness. Yet, studies varied in the extent to which they were embedded in community services. Thus, it is important to mention that although studies included in this review were all RCTs, Oosterling et al., (2010) had compromised the randomization procedure, which raises questions concerning strict randomization and concealment of allocation as parents in both intervention and control groups are reported to meet in groups for support. With such a heterogeneous disorder, it is challenging to maintain the qualifications of good research design, by also adhering to strict specifications of control conditions, measurement tools and reporting, versus the consideration of the need for families to receive an ongoing support from each other.

### **Theoretical Implications**

Although reaching significant values for the effectiveness of parent-mediated autism interventions on PCI outcomes, studies included in this review had methodological flaws ranging from low sample sizes to reporting of insufficient information regarding reporting and measures. Specifically, employing AC in comparison to TAU as the control condition reached a large effect for all PCI outcomes. There is a need for RCTs with greater samples to increase power and detect a true effect size, if it thus exists. Research would further benefit from conducting longitudinal studies with follow ups, for at least a year with quantifiable measures of the time parents spend with their child creating a therapeutic experience.

Additionally, most studies did not include information of allocation concealment, which seems to be a limiting bias in RCTs. Thus, as mentioned above, most studies did not provide any information of missing outcome data as well as a pre-specified reporting plan of outcomes. Future studies could remediate the theoretical and methodological flaws by paying closer attention to such details. Last but not the least, the PCI reporting can be conducted in child's daily routine rather than pre-specified assessment timeslots, thereby presenting studies with better quality, stricter allocation concealment, and similar outcome measures that can be combined more strategically.

### **Practical Implications**

Previous studies have demonstrated sufficient evidence for the need for local practitioners and service providers to pay close attention to models including parents in autism interventions (Nevill et al., 2018; Oono et al., 2013; Beaudoinn et al., 2014). What professionals and policy has been trying to investigate is the specific intervention techniques that parents and children can benefit from, the possibility of a greater benefit for young children whose parents are involved in therapeutic programs at an earlier age, and the specific dose of parent training in order for these interventions to be effective. However, from the results proposed by this review study, there is mixed evidence suggesting that parent involvement in autism interventions could potentially improve PCI related outcomes. There is immense variability in the dosage of parent training as well as in intervention content and focus on top of the variability in characteristics of children and their parents. With such a heterogeneous group of individuals, these questions cannot be answered, therefore generalizations regarding the effectiveness of parent-mediated interventions on PCI outcomes cannot be made.

Supported by previous evidence on effective parental involvement on child related outcomes, further research would benefit from focusing on more mixed intervention programs, including various practices and focuses to target such a complex group of individuals. Researchers could specifically conduct analysis and review studies where child related outcomes, such as ADOS scores, are taken as moderators to conclude whether parental involvement has a stronger effect on PCI specifically for several autism related child variables. Thus, parental involvement, specifically parent training focusing on improving responsiveness, can become an integral part of intervention programs rather than a pure agent delivering the intervention to reach better, optimal and more promising results. Furthermore, it would be beneficial to investigate the longitudinal effects of parental involvement in interventions and characterize how PCI outcomes improve over time.

As suggested by review studies displaying the role of PCI in children's developmental outcomes following parent-mediated interventions, improved PCI is probably an attribute that will generalize therapy strategies into daily interactions. Local service providers can thus pay more attention to specific PCI parameters with a degree of flexibility and individualization and foster the integration of therapeutic approach into children's' daily routines.

The present study further adds on to previous evidence that parent involvement in autism interventions have been a recently focused aspect of intervention programs. There is a clear association between parent-mediated autism interventions and improved PCI. Responsive precisely can provide children with more opportunities to learn the behaviors required to reach higher levels of functioning and can further lead to long term benefits (Mahoney and Perales, 2003). Nonetheless, considering variability in characteristics of both parents and their children, it

is thus vital to individualize intervention modules and tailor according to techniques that fit into parent-child dyads.

Sequential Multiple Assignment Randomized Trial (SMART) designs, for example, can be developed for young children with autism to create a more adaptive intervention program addressing the complexity within such a heterogeneous group of people (Lei et al., 2012).

SMART designs consider the individual differences in response to interventions and pushes for an adoption of a subsequent intervention option. Additionally, as developmental outcomes are often central to autism interventions, SMART designs consider the changes in the effectiveness of interventions over time and adapts accordingly. Within the context of autism interventions, adaptive interventions can be tailored for the severity of children and capacity of parents and can lead to more promising results in improving the PCI.

### **Limitations**

The results for this review relied heavily on previously published data without having access to individual participant records. The individual studies included in this report targeted various child and parent related outcomes and utilized different tools used to assess these outcomes, limiting our capacity to make full use of the available published data. As such, we computed the analysis based on the combined data from studies with similar content and measures by specifically focusing on PCI outcomes.

The current study was prone to publication bias as it included published articles. Thus, a handful of studies were eliminated as they did not provide either pretest and/or posttest scores or sufficient information on the outcome measures to be converted into statistic comparable to the rest.

Additionally, analyzing within subgroups of dosage of parent training was challenging as studies did not report the exact amount of training parents received as well as a quantifiable measure of time spend between parent-child dyads. Categorization of PCI outcome measures has also limited our capacity to distinguish outcome variables as there were conceptual overlaps between the pre-specified characteristics of PCI outcomes.

For the sake of simplicity, this study had categorized the interventions either as NCBI or social-communicative focused framework. However, as the methodologies of such autism interventions differ immensely, the focus and content of each intervention has to be analyzed separately in order to conclude if several points of attention are more effective than others.

Another reason why the findings cannot be generalized is due to variations across control conditions. TAU conditions might have had variability in services across settings, context, and neighborhoods.

## **Conclusion**

It is agreed that parents are beneficial agents of change in interventions. This review found significant effects of parent-mediated autism interventions on PCI outcomes, despite the inconsistencies across studies in quantifying parent training as well as methodological flaws across studies. Yet, one should still be cautious in generalizing the effect of parent-mediated interventions on PCI, thus from reaching definitive conclusions. Nonetheless, it should be noted that PCI is only one aspect of autism interventions and in the case of such a complex condition as autism, parent training should not only be an integral component of initial training but should also be a key in the entire duration of autism interventions. In the future, researchers should pay closer attention to identifying these integral components of autism intervention to provide effective services for families.

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