REVIEW PAPER



A Systematic Review of Peer-Mediated Interventions for Preschool Children with Autism Spectrum Disorder in Inclusive Settings

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Abstract

Peer-mediated interventions (PMI) are implemented for skills teaching for children with autism spectrum disorder (ASD), particularly within the context of early learning environments. PMI have several potential advantages in comparison to adultled intervention; however, there is a lack of research evaluating the use of PMI with younger populations. This review aims to synthesize the literature regarding the use of PMI in skills teaching for children with ASD in preschool settings. A systematic search of the literature spanning 1980–2018 was conducted, and 31 articles were identified for inclusion. Results are discussed in relation to participant and peer characteristics, PMI procedures, target skills, intervention outcomes, and research strength. The effectiveness of PMI is discussed along with directions for future research.

Keywords Autism spectrum disorder · Peer-mediated interventions · Preschool · Skills teaching · Inclusion

One of the core diagnostic characteristics of autism spectrum disorders (ASD) is the presence of deficits in social and communication skill repertoires (American Psychological Association 2013). Inclusion within mainstream preschool settings has many benefits for children with ASD including providing peer models of developmentally appropriate skills and establishing opportunities to interact and develop skills with a variety of communication partners (Kohler and Strain 1990; Wang et al. 2011). High-quality early intervention has repeatedly been identified as important and effective in producing positive outcomes for children with ASD (Boyd et al. 2010) and preschool inclusion is widely recognized as promoting positive outcomes for all children in the preschool classroom (Barton and Smith 2015). Given these findings, preschool inclusion for children with developmental disabilities has been advocated for in federal law and policy worldwide, in turn leading to an increase in the numbers of children with ASD attending preschool settings (Camargo et al. 2014).

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With the increasing inclusion of children with ASD in mainstream preschool settings, there is growing concern regarding the potential for the social and communication deficits commonly observed in children with ASD to compromise successful integration (Camargo et al. 2014). Such skill deficits may negatively impact upon the development of peer relationships and act as barriers to learning and successful social inclusion for preschool children with ASD in inclusive settings (Dunlap et al. 2006; Lorah et al. 2014; Vo et al. 2012). Furthermore, the skill impairments experienced by children with ASD often hinder their ability to learn incidentally through exposure to their typical peers without specific supports in place (Camargo et al. 2014). It is increasingly recognized that such barriers exist and therefore, evidence-based interventions and strategies are necessary to support children with ASD to access the benefits of inclusive settings through supporting learning, skill acquisition, and successful inclusion (Shafer 1994; Wang et al. 2011). There is currently a lack of research investigating evidence-based interventions and implementation practices to support skill development for children with ASD within the inclusive preschool context (Barton and Smith 2015).

Peer-mediated interventions (PMI) represent a suite of skills teaching strategies, which also promote social interactions and social skill development (Watkins et al. 2015). Within PMI, typically developing peers are involved in skills teaching and such interventions have demonstrated success in

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teaching a wide range of skills to children with ASD and developmental disabilities (e.g., Hundert et al. 2014; Katz and Girolametto 2013; Mason et al. 2014; Trembath et al. 2009). Peers may take on a number of roles within PMI including providing models of appropriate behavior, initiating interactions, and prompting and reinforcing target behaviors (Odom and Strain 1984). Within the literature, PMI have demonstrated improvements in social, communication, academic, and play skills (Bene et al. 2014; Shivers and Plavnick 2015; Sperry et al. 2010) and are associated with a number of unique benefits. PMI provide opportunities for students with ASD to interact with and practice skills with a variety of communication partners, increasing the possibility of skill generalization and maintenance (Wang et al. 2011; Watkins et al. 2015). This also affords increased opportunities for social interactions and development of social skills within intervention (Watkins et al. 2015). Benefits for peers participating in PMI include increased positive interactions with peers with ASD, positive social validity outcomes, increased sensitivity to others, and academic gains (Carter et al. 2008; Odom et al. 1985). Furthermore, the involvement of peers in interventions can increase learning opportunities across contexts and potentially place fewer demands on therapists or teachers to serve as the sole interventionist (Chan et al. 2009).

PMI have been employed with populations across the lifespan including early childhood, school-age children, adolescents, and adults (e.g., Farmer-Dougan 1994; Harper et al. 2008; Mason et al. 2014). A number of systematic reviews and meta-analyses have been conducted with this literature and discuss the efficacy of PMI for children with ASD (Chan et al. 2009; Chang and Locke 2016; Watkins et al. 2015; Whalon et al. 2015; Zhang and Wheeler 2011). In terms of the development of social skills, PMI represent a robust treatment approach for targeting social deficits among children with ASD (McConnell 2002). Furthermore, within the National Autism Center's (NAC) National Standards Project Reports (phase 1, 2009; phase 2, 2015) and the National Professional Development Center's (NPDC) systematic literature reviews of evidence-based practices for children with ASD (Odom et al. 2010; Wong et al. 2015), PMI were identified as an established evidence-based practice for children with ASD aged 0-22 years.

Despite these positive findings, there remain several pertinent gaps in the literature regarding PMI with preschool age children in inclusive settings. Within the broad review of the literature carried out in phase 1 of the National Standards Project Report (NAC 2009, 2015), 33 studies supporting the evidence base for PMI were identified. Of these 33 studies, only 10 involved preschool age children with ASD (total *N* across studies = 31 children) and their peers in inclusive settings. In the NPDC updated report, Wong et al. (2015) identified 15 PMI studies, of which 8 involved preschool age children with ASD and their peers in inclusive settings. However,

only four of these studies had not previously been included in the National Standards Project Report (NAC 2009). Therefore, across the 54 years covered by these broad evidence-based practice reviews, a total of 14 studies (total N = 40 children with ASD) investigating PMI with preschool age children in inclusive settings were identified. Given the comprehensive and broad nature of these reviews, the authors suggest that future research should extend to more detailed analyses of treatments identified as established with specific populations (age, diagnosis, etc.) and in different settings (NAC 2009).

In their broad review and meta-analysis of behaviorally based interventions to improve social interaction skills for children with ASD, Camargo et al. (2014, 2016) identified five studies utilizing PMI, with three of these occurring with preschool children within inclusive settings. While preschool age children with ASD were the largest cohort included in these reviews (N=35), only nine of these children experienced PMI. The authors highlighted further the importance of identifying intervention components that are most effective for varying age groups and within different contexts. Furthermore, Camargo et al. (2016) identified peer training and peer implementation of intervention strategies as important areas for future research. Additionally, most focused systematic reviews of PMI published to date have focused on school-aged and adolescent populations, with little attention given to PMI involving preschool age participants. In a review of 42 studies involving preschoolers to adolescents (mean age 8.6 years old), Chan et al. (2009) found PMI to be a potentially versatile and effective intervention for children with ASD. However, of the included studies, only eight (19%) included preschool age children, thus limiting the generalization of overall study findings to this population. Similarly, in their review of PMI within inclusive settings, Watkins et al. (2015) reported positive results overall; however, only three studies (21%) involved preschool age participants. Given the vast body of research supporting the effects of early intervention, the unique benefits associated with PMI and the suitability of PMI to the preschool environment (which is specifically designed to support social interactions and development), and the relative underrepresentation of such studies in previous reviews, a focused systematic review of the existing studies evaluating the application of PMI with preschool age children is warranted.

Watkins et al. (2015) suggested that future investigations should examine the most effective strategies to develop peer networks, which would support maximization of the potential benefits of PMI. Their review of PMI demonstrated higher success when utilized with younger children than in adolescent populations (Wang et al. 2011; Zhang and Wheeler 2011) and highlighted that specific intervention characteristics related to efficacy warrant further research to identify the participant and intervention factors that support positive outcomes in PMI. Furthermore, despite the potential advantages of PMI for preschool age children, there exist a number of questions that

warrant a synthesis of PMI research for preschool children. Concerns over treatment integrity have been raised as a potential limitation associated with PMI (Chan et al. 2009). Additionally, Watkins et al. (2015) posited that higher levels of support, training, and resources may be required in PMI with preschool age participants to safeguard treatment fidelity and efficacy in comparison to PMI with older participants. Previous research has also highlighted concerns regarding the potential for stigmatization of children with ASD to occur within PMI (Chan et al. 2009) and, as such, a synthesis of the measurement of social validity within PMI is warranted. Given the importance of generalization and maintenance of intervention outcomes, particularly for individuals with ASD (Camargo et al. 2016; Neely et al. 2015) and the suggested efficacy of PMI to support these outcomes (Wang et al. 2011; Watkins et al. 2015), an analysis of such findings with preschool age children with ASD is warranted.

The current review aims to evaluate the use of PMI with preschool children with ASD within inclusive educational settings. The effectiveness of PMI in skills teaching for preschool children with ASD will be evaluated through examination of intervention outcomes and the strength of the research studies included. Characteristics of PMI will be examined in terms of participant and peer characteristics, skills targeted with PMI within this educational context, PMI strategies and training employed, and measures of generalization, maintenance, treatment integrity, and social validity employed within PMI.

Method

Systematic Search Procedures

Systematic searches were conducted for this review using the following five databases: Education Resources Information Center (ERIC), PsycINFO, Scopus, Web of Science and Psychology, and Behavioral Sciences Collection (EBSCO). Combinations of the following terms were inputted into each database: (1) "autis*" or "asperger*", (2) "communication skills" or "social skills" or "play" or "skills teaching", (3) "peer mediation" or "peer training" or "peer tutoring" or "peer modeling" or "buddy system", (4) "preschool" or "kindergarten" (i.e., "autis*" AND "communication skills" AND "peer modeling" AND "preschool"). Initial online searches yielded 2361 articles for potential inclusion. In order to identify relevant studies, which may have been undetected during electronic searches, the reference sections of studies identified as meeting the inclusion criteria were also examined.

Inclusion Criteria

To be included in the current review, studies must have described the use of a peer-mediated intervention. Studies were excluded if peer behavior and/or involvement in intervention was not explicitly stated (Caballero and Connell 2010). Studies were also excluded if the intervention involved a treatment package including peer-mediated components, but the effects of the peer-mediated component on outcomes could not be extracted for analysis (e.g., Kohler et al. 2001).

In addition to this, articles were required to meet a number of inclusion criteria: (a) the study had to evaluate a skills teaching intervention for a child/children with a diagnosis of ASD (if a study included data for individuals with disabilities other than ASD, only data for individuals with ASD were examined); (b) all participants in the included studies with ASD had to be under 6 years old and in attendance in a preschool service (group-based childcare setting); (c) the intervention must have occurred in an inclusive setting; a mainstream classroom, an integrated classroom, or a special educational setting, which incorporated integration with typically developing peers; (d) studies had to employ an experimental research design (i.e., group or single subject research designs) that demonstrated experimental control, allowing for direct analysis of the impact of intervention on behavior; and (e) the study must have been published in a peer-reviewed journal. Only studies published in English between 1980 and 2018 were included.

Previous reviews and meta-analyses have primarily focused on the application of PMI in targeting social skills (McConnell 2002; Wang et al. 2011; Watkins et al. 2015; Whalon et al. 2015). A review by Chan et al. (2009) included a wide range of skills and found that the most common dependent variable assessed was social interaction (88% of studies). However, given the potential benefits of PMI for skill acquisition across skill domains and the limited numbers of studies employing PMI with preschool children identified in previous reviews which focused on specific skill repertoires (Watkins et al. 2015), there was no restriction by target skill in the current review.

Titles and abstracts were screened against the inclusion and exclusion criteria, which resulted in the identification of 46 articles for inclusion. The full text of each article was then screened against the inclusion criteria which resulted in the identification of 31 articles which met the inclusion criteria and were included in the current review.

Interrater Reliability A second rater independently completed the searches across three of the databases (ERIC, Scopus, and Web of Science) and independently screened the titles and abstracts of the search results against the inclusion criteria to provide iinterrater reliability (IRR) for the initial title and abstract screen. IRR was calculated at this stage by comparing the articles identified for inclusion from these searches by the first rater to those identified by the second rater and dividing the number of agreements (articles identified for inclusion by both raters) by the total number of articles identified for inclusion. Interrater agreement across the total of 33 articles identified by the 2 raters was 82%. The full texts of these articles were then screened against the inclusion criteria and the first and second raters discussed any disagreements with the third and fourth rater, which resulted in 100% agreement on the inclusion of 17 articles.

Throughout the current review, the second author completed the data extraction with the first author acting as second rater. The first author independently extracted the relevant information and applied the coding systems for a proportion of the included studies. After this was completed, IRR agreement was calculated between the first and second rater and any disagreements were discussed with the third and fourth authors (as third and fourth raters) until 100% agreement was reached.

Data Extraction

Each study included in the review was summarized in terms of (a) participant characteristics; (b) type of preschool setting; (c) target skill(s) for participant(s) with ASD; (d) intervention results for target skills for children with ASD; (e) peer characteristics (*N*, age, and gender) and peer selection criteria; (f) peer training procedures; (g) peer-mediated intervention procedure; (h) peer outcome variables and results; (i) research strength and design; and (j) measures of generalization, maintenance, treatment integrity, and social validity.

IRR The second rater independently extracted the information regarding skills targeted in intervention for 24 of the included studies (75%). IRR was calculated by dividing the number of agreements between the first and second raters by the total number of agreements and disagreements resulting in interrater agreement of 100%.

Participant Characteristics The number, gender, and age of participants with ASD were noted. Any co-occurring disorders were also noted. Where functioning level was reported for participants based on an assessment (e.g., the Childhood Autism Rating Scale (CARS); Schopler et al. 1986), this was noted. If information from such an assessment was not included, functioning level was reported based on the scale developed by Reichow and Volkmar (2010) where these data were available. Participants categorized as lower functioning had limited or no verbal language skills and had an IQ < 55. Those categorized as moderate functioning had an IQ of 55-85 and basic verbal communication skills. Those categorized as higher functioning had IQ > 85 and typically verbal communication. Where provided, specific selection criteria (further than participants being in attendance in preschool and having a diagnosis of ASD) including prerequisite skills required for participants to be able to access intervention or specific skill deficits for target within intervention were recorded.

Type of Preschool Setting The description of the preschool setting of each included study was noted. Mainstream preschools referred to those in which the majority of children were typically developing. Integrated or inclusive preschools included those in which there were equitable numbers of children with ASD or disabilities and typically developing children. Special education preschools included those which catered primarily for children with disabilities and or developmental delays.

Intervention Outcome The participant and peer outcomes of each study were coded using the coding system developed by Bennett and Dukes (2014). Results were coded as positive if all skills increased for all participants over baseline. Results were coded as negative if all skills for all participants remained unchanged from baseline or declined. Results were coded as mixed if some of the participant's target skills improved, while others remained unchanged from baseline or declined. It is important to note that this analysis did not indicate the magnitude of change demonstrated following intervention.

IRR The second rater independently coded the intervention outcomes for children with ASD for 19 of the included studies (59%). IRR was calculated by dividing the number of agreements between the two raters by the total number of agreements and disagreements resulting in interrater agreement of 84%. The second rater independently coded the outcome of the intervention for peer outcomes for 24 of the included studies (75%). IRR was calculated as previously described resulting in 88% agreement between the two raters.

Peer Training Procedure The procedure used in each study to teach peers to implement PMI was examined. The specific behavioral skills training components utilized (e.g., instructions, modeling, roleplay, prompting, corrective feedback) were noted as well as the number of components used in combination. Furthermore, studies were examined in relation to whether peer training occurred only prior to PMI sessions with children with ASD present, or if continuous training and/ or support was provided in-vivo during PMI sessions.

IRR The second rater independently extracted the peer training information for 19 of the included studies (59%). Within this code, there were 14 training procedures that the raters identified as either absent or present for each study. Across 266 possible agreements, IRR was calculated by dividing the number of agreements between the 2 raters by the total number of agreements and disagreements resulting in interrater agreement of 82%.

Peer-Mediated Intervention Procedure Each study was coded using the categorization of PMI utilized by Watkins et al. (2015), and based on Odom and Strain (1984). A study was coded as proximity if peer involvement was limited to being placed in proximity to participants with ASD in order to provide a model of target behaviors, without any specific prompts to interact. A study was coded as prompting and reinforcing if peers were specifically trained to prompt a target behavior and/or to deliver reinforcement contingent on the occurrence of a target behavior. A study was coded as initiation if peers were trained to make an initiation toward participants with ASD, for example, invitations to play.

IRR The second rater independently coded the PMI procedure for 18 of the included studies (56%). IRR was calculated by dividing the number of agreements between the two raters by the total number of agreements and disagreements resulting in interrater agreement of 72%.

Strength of the Research and Research Design The strength of research was determined in accordance with guidelines set out by Reichow et al. (2008) on evaluating evidencebased practice. The strength of studies utilizing single subject research designs were assessed on a number of primary quality indicators: participant characteristics, independent and dependent variables, baseline condition, visual analysis, and demonstration of experimental control. Secondary quality indicators for single subject research included evidence of interobserver agreement, kappa, fidelity, blind raters, generalization, maintenance, and social validity. No study included in the current review used a group research design.

Strength of research was determined based on the presence of quality indicators, resulting in ratings of strong, adequate, or weak. Studies rated as strong received highquality ratings on all primary indicators, and showed evidence of at least three secondary indicators. Studies that received ratings of adequate received high-quality ratings on at least four primary indicators with no unacceptable ratings and presented results of at least two secondary quality ratings. Finally, studies rated as weak showed evidence of high-quality ratings on fewer than four primary quality indicators and less than two secondary indicators. Research design was also noted.

IRR The second rater independently evaluated the strength of research in accordance with the Reichow et al. (2008) guidelines for 19 of the included studies (59%). For each study, there were 11 potential agreements/disagreements. Across 209 items, IRR was calculated by dividing the number of agreements between the first and second raters by the total number of agreements and disagreements resulting in interrater agreement of 93%. Generalization, Maintenance, Treatment Integrity, and Social Validity The presence or absence of measures of generalization and maintenance of intervention outcomes, treatment integrity, and social validity was recorded for each study.

The presence of a measure of generalization was coded if the target skill was measured in a context that was different to the intervention context (e.g., a different setting or with different peers). Strategies employed within intervention to program for generalization were also coded according to the presence of Stokes and Baer's (1977) nine technologies of generalization: (a) train and hope (TH); (b) sequential modification (SM); (c) introduce natural maintaining contingencies (NC); (d) train sufficient exemplars (SE); (e) train loosely (TL); (f) use of indiscriminable contingencies (IC); (g) program common stimuli (PCS); (h) mediate generalization (MG); and (i) train "to generalize" (TG). The presence of a measure of maintenance of intervention results was coded if the intervention outcomes were measured after the intervention had concluded. Where studies reported maintenance outcomes, the number of maintenance probes and length of time since termination of intervention condition was also recorded.

If measures of treatment integrity were taken within a study this was coded. Methods used to monitor treatment integrity included (a) criterion-based pre-intervention training of peers; (b) direct observation, with or without feedback and/or interobserver agreement on occurrence of target behaviors; and (c) intervention fidelity checklists measuring strategy use or steps completed correctly, completed during intervention by peer interventionists or other independent observers. This coding system is based on a system employed by McCoy et al. (2016). Each study was also coded for the presence or absence of a measure to monitor intervention satisfaction or social validity. The stakeholders involved who completed measures of social validity were also noted.

IRR The generalization promotion strategies employed were independently coded by the second rater for 19 of the included studies (59%). Within this code, there were nine items for potential agreement/disagreement for each study. Across a possible 171 agreements, IRR was calculated by dividing the number of agreements between the first and second raters by the total number of agreements and disagreements resulting in interrater agreement of 98%.

Results

A total of 31 articles (32 experiments) evaluating PMI with preschool children with ASD in inclusive settings were included in the current review. The current review spans 31 years of PMI research with the earliest study included in the current review published in 1986 (Odom and Strain 1986) and the most recent study published in 2017 (Thiemann-Bourque

et al. 2017). Figure 1 displays the number of articles employing PMI to teach skills for preschool children with ASD published per decade between 1980 and 2018. The number of articles published utilizing PMI with preschool children with ASD increased between the 1980s and the 1990s, with a further slight increase in the 2000s. Interestingly, the current figure for 2010–2018 represents a decrease in the number of articles published in this area in comparison to the previous decades. It is important to note that searches for the current review were completed up to March 2018.

Table 1 displays the descriptive information for each study included in the current review regarding the participants with ASD, intervention setting, target skills, and intervention outcomes.

Participants with ASD

A total of 85 children with ASD received intervention within the included studies. Where gender was reported, 88% (N= 66) of participants were male and 12% (N=9) were female. All studies included preschool aged children, ranging in age from 2 years 9 months to 5 years 11 months. All of the included children had a diagnosis of autism spectrum disorder. Three studies (9%) included participants who presented with cooccurring diagnoses. Ganz and Flores (2008) included a child with autism who was diagnosed at the age of two with a speech delay. Petursdottir et al. (2007) included a child with ASD and co-occurring developmental delay. Lee and Lee (2015) included a participant with co-occurring diagnoses of autism, global developmental delay, and microtia. Eight studies (25%) did not report data to indicate participants' functioning levels. Seven studies (25%) included only children who



Fig. 1 Number of studies per decade employing PMI to teach skills for preschool children with ASD

were categorized as lower functioning, four studies (13%) included only children who were identified as functioning within the moderate range, and one study (3%) included solely a child who was identified as higher functioning. The largest proportion of studies (10; 31%) included both children who were identified as functioning within the severe range and children who were identified as functioning within the mild-moderate range. One study (3%) included participants whose functioning levels varied from one another, ranging from severe to high functioning.

Specific selection and inclusion criteria for participants were reported in seven studies (22%). The remaining studies did not report specifications beyond diagnosis and participant availability. Criteria in relation to prerequisite skills included demonstrating ability to follow simple requests, comprehe nsible expressive language of one-to-two word statements, ability to perform simple tasks, ability to imitate adults, and interest in engaging with other children (Carr and Darcy 1990; Ganz and Flores 2008; Garfinkle and Schwartz 2002; Nelson et al. 2007). Inclusion criteria relating to skills deficits included poor observational learning skills, deficits in and low levels of peer interactions, poor social skills, difficulty with social communication initiations, difficulty in transitioning, and individual education plan objectives related to the target skills (Carr and Darcy 1990; Garfinkle and Schwartz 2002; Hundert et al. 2014; Kern and Aldridge 2006; Nelson et al. 2007; Sainato et al. 1987).

A number of studies did not report specific inclusion criteria, but reported that participants presented with skill deficits relating to target behaviors for intervention, for example, children infrequently interacted with peers appropriately and/ or spontaneously (Belchic and Harris 1994; Haring and Lovinger 1989), shared food or toys with peers only when prompted (Lee and Lee 2015), and participants did not make any initiations toward peers or siblings (Zanolli et al. 1996).

Settings

The 32 studies included in this review were conducted within preschool settings where children with ASD were included with typically developing peers. The majority of studies (63%, N=20) occurred in integrated or inclusive preschool settings in which there were approximately equal numbers of children with and without developmental disorders or other disabilities. Five studies (16%) were carried out in mainstream preschool services in which the majority of children were typically developing. Participants in Haring and Lovinger (1989) attended special education preschools, but were integrated into mainstream preschools for one-to-one and a half hours per day. One study (3%) was carried out across both mainstream and integrated settings (Nelson et al. 2007). Two studies (6%) were carried out in special education settings in which children were

References	Participants	Target skills and setting	Results
Belchic and Harris (1994)	3 M 4:3, 5:4, 5:8 years old	Social interactions (initiation, response, extended interaction)	Positive
	Autistic disorder Mild-moderate (CARS)	Integrated preschool	
Bellini et al. (2016)	3 M 4;9, 5;2, 5;8 years old	Social engagement, social initiations, social responses	Positive
	Autism Lower-high functioning	Public preschool setting (predominantly children with disabilities with some typically developing peers)	
Carr and Darcy (1990)	3 M 4 years old Autism	Motor imitation Day school program for children with developmental disabilities	Positive
	Lower-moderate functioning		
Ganz and Flores (2008)	2 M 4:5, 4:6 years old	Play related conversation (Scripted phrases, unscripted phrases, context-related comments, responses)	Mixed
	Moderate-high (GARS)	Spare classroom in mainstream preschool setting	
Garfinkle and Schwartz (2002)	3 M 3:7, 4:10, 5:5 years old	Peer imitation; initiations, responses, non-social engagement, proximity to peers	Mixed
	Autism Lower functioning	Integrated university affiliated preschool	
Goldstein et al. (1992)	3 M 2:9, 3:7, 3:9 years old Autism	Social interaction, social behaviors and communicative acts Spare room in two integrated preschool classrooms	Mixed
	Mild-moderate, severe (CARS)		
Haring and Lovinger 1989; Experiment 1	1 M 4:8 years old	Initiations toward peers and play responses	Positive
	Autism and developmental delays Lower-moderate functioning	Special education preschool and general education preschool	
Haring and Lovinger 1989; Experiment 2	1 F 4:8 years old	Initiations toward peers, duration of interactions and play responses	Positive
	Autism Lower-moderate functioning	Self-contained special education classroom and general education kindergarten	
Hundert et al. (2014)	1 M 2 F 4:8, 5:10, 5:11 years old ASD	Interactive play, peer interactions General education preschool or kindergarten classrooms	Positive
	Lower-moderate functioning		
Jones and Schwartz (2004)	1 M and 2 F 3:9, 3:11, 5:2 years old ASD	Language (labeling stimulus sets) Integrated, urban, university-based early childhood education preschool and kindergarten	Positive
	Functioning NR		
Katz and Girolametto (2013)	2 M 1 F 4:1, 4:9, 5:1 years old ASD	Extended social interactions Three early childcare center integration classrooms	Positive
	Mild-moderate (CARS)		
Kern and Aldridge (2006)	4 M 3:9, 3:4, 4, 4:9 years old Autistic disorder	Positive interactions, play and engagement Community-based inclusive childcare setting	Mixed
	Mild-moderate, severe (CARS)		
Kohler et al. (2007)	1 F 4:9 years old	Social interactions (initiations and responses)	Positive
	Autism Functioning NR	Half-day inclusive preschool for children with special needs and typical developing children	
Kohler et al. (1995)	3 M 4 years old	Social interactions (initiations and responses)	Positive
	Autism	Two classrooms within a half-day integrated preschool	

 Table 1
 Descriptive summary of included studies

Table 1 (continued)

References	Participants	Target skills and setting	Results
Kohler et al. (1997)	Lower functioning 10 (gender NR) 3y 7m; 3y 8m; 4y 6m; 5y 10m; 4y 10m; 3y 11m; 5y 4m; 3y 2m; 3y 3m; 3y 10m Autism	Social interactions and IEP objectives Half-day integrated preschool	Positive
Kohler et al. (1990)	Mild-severe (CARS) 2 M 4 years old	Social interactions (initiations and responses) Half-day integrated preschool	Mixed
Laushey and Heflin (2000)	Autism Lower-moderate functioning 1 M 5:8 years old Autism	Social skills (asking for object and responding according to answer, getting attention appropriately, waiting for a turn, orienting toward a speaker)	Positive
	Severe (CARS)	Mainstream kindergarten classes with one child with autism	
Lee and Lee (2015)	1 M 1 F 3:9–3:10 years old	Reciprocal social interactions and verbal interactions	Positive
	1 autism 1 mild autism with global developmental delay and microtia	Mainstream Montessori preschool	
Lefebvre and Strain (1989)	Functioning NR 1 M 4:5 years old	Social interaction skills (initiations, responses and play organizing statements)	Positive
	ASD Moderate functioning	Integrated mainstream preschool classroom	
McGee et al. (1992)	3 M 3:7, 4:1, 5:11 years old	Reciprocal interactions (social behavior: motor/gestural or verbal/vocal and positive/negative)	Positive
	Autism Functioning NR	Integrated preschool (composed of 6 typically developing children, 2 with ADHD and 3 with Autism)	
McGrath et al. (2003)	1 M 4:11 years old Autistic disorder	Reciprocal social interactions (initiation, response) and play Mainstream preschool	Positive
Nelson et al. (2007)	Functioning NR 4 M 3:9, 4:1, 4:3, 4:5 years old Autism	Play initiations (Keys to Play or other strategy) Preschool settings: Two Head Start classes, a community preschool class and an integrated special education class with majority of	Positive
Odom and Strain (1986)	Mild-moderate, severe (CARS) 3 M 4 years old	children typically developing Reciprocal social interaction (Play organizer, share/request, assist/request, compliment, affection)	Positive
	Autism		
Odom and Watts (1991)	Severe (CARS) 3 M 3:6, 5:0, 5:0 years old	Preschool center for emotionally disturbed children Reciprocal social interaction (Play organizer, share/request, assist/request, compliment, affection)	Positive
	Autism Lower-moderate functioning	Integrated special education classroom with 6 children with disabilities and 4 typically developing children	
Petursdottir et al. (2007)	1 M 5 years old Autism and developmental delay	Social interactions Special education class in integrated Kindergarten	Mixed
	High functioning		
Sainato et al. (1992)	3 M 3:7, 4:2, 4:8 years old	Social behavior (attention getter, play organizer, share, responses, other)	Positive
	Autism Moderate (CARS)	Integrated preschool, in a large urban elementary school	
Sainato et al. (1987)	3 M	Transitioning between activities	Mixed

 Table 1 (continued)

References	Participants	Target skills and setting	Results
	3:7, 4:0, 4:1 years old Autism	Integrated preschool (5 disabled and 6 non-disabled children in total)	
	Severe (CARS)		
Sawyer et al. (2005)	1 M 4 years old Autistic disorder	Verbal and physical sharing Integrated preschool classroom within a primary school for children with developmental disabilities	Positive
	Functioning NR		
Strain et al. (1994)	3 M 3, 4, 5 years old Autism	Positive social interactions Integrated preschool	Positive
	Lower functioning		
Thiemann-Bourque et al. (2017)	2 M 1 F 4;5, 4:6, 4;7 years	Communication, reciprocity and engagement	Positive
	Autism Lower functioning	Integrated preschool classroom	
Trembath et al. (2009)	3 M 3, 4, 5 years old Autism	Communicative behaviors 3 different inclusive preschools	Mixed
	Functioning NR		
Zanolli et al. (1996)	2 M 4:2, 4:10 years old	Initiations toward peers (verbal or nonverbal) University preschool classroom	Mixed
	Autism		
	Functioning NR		

NR indicates that data were not reported in a study

joined by typically developing children for a period of each day (Carr and Darcy 1990; Petursdottir et al. 2007). One study (3%) was conducted within a preschool service for emotionally disturbed children, in which typically developing children with behavioral problems supported children with ASD (Odom and Strain 1986).

Target Skills

A wide range of skills were targeted within the studies included in this review. Several studies targeted specific skills, for example, play skills (Hundert et al. 2014), sharing (Sawyer et al. 2005), and conversation (Ganz and Flores 2008). Broad skill repertoires were also targeted in several studies, for example, imitation (Carr and Darcy 1990; Garfinkle et al. 2002) and social interactions (e.g., Belchic and Harris 1994; Kern and Aldridge 2006). Kohler et al. (1997) targeted several areas including imitation, cooperative nonverbal interactions and verbal exchanges, and individual education plan (IEP) goals achieved.

Social, communication, and play skills, targeted alone or in combination, were the most common skills targeted (29 studies; 91%). A number of studies targeted social skills, including reciprocal interactions, initiations, and responses (e.g., Belchic and Harris 1994; Katz and Girolametto 2013; Kohler et al. 2007; Sainato et al. 1992; Zanolli et al. 1996). Some studies targeted a range of social and communicative behaviors, including "Keys to Play" strategy targeting social communication skills to enter play groups (Nelson et al. 2007) and sharing and play organizing (e.g., Goldstein et al. 1992; Odom and Watts 1991). Four studies focused intervention on communication skills, with Ganz and Flores (2008) teaching scripted phrases in play. An incidental teaching approach was used by McGee et al. (1992) to teach requesting skills to gain access to preferred items. Within this study, peers were also taught to prompt turn-taking to increase incidental teaching opportunities. Trembath et al. (2009) and Thiemann-Bourque et al. (2017) taught peers to teach communication using a speech generating device. Laushey and Heflin (2000) targeted a range of social and communication skills, including gaining attention, waiting for turn, requesting and responding appropriately to answer, and attending to a speaker. Three studies focused on social and play skills (Haring and Lovinger 1989; Kern and Aldridge 2006; McGrath et al. 2003).

Three studies targeted other skill repertoires through PMI. Carr and Darcy (1990) targeted imitation and Jones and Schwartz (2004) aimed to increase labeling of stimulus sets. Sainato et al. (1987) targeted transitioning between activities.

Intervention Outcomes for Children with ASD

Positive results were demonstrated in 23 studies (72%) with increases across target skills for all participants. Mixed results were reported in nine studies (28%). No study was identified as demonstrating negative results.

With regard to participant functioning level, the study which included one child who was identified as high functioning demonstrated mixed results (Petursdottir et al. 2007). All four of the studies including children who were identified as functioning within the moderate range demonstrated positive results (100%). Of the seven studies that solely included children who were identified as lower functioning, five studies (71%) demonstrated positive results. Six of the ten studies (60%) that included both children who were lower functioning or severe as well as children who were identified as moderate demonstrated positive results. The study that included participants who were identified as functioning at different levels (from mild to severe) demonstrated positive results.

Peer Characteristics

Table 2 presents the descriptive information for peers, peer training, and PMI procedures included in the studies in the current review. Over 242 peers participated in the studies included in the current review. The number, gender, and/or age of peers was not reported in all studies. Where this information was available, 54 male peers and 53 female peers were included in the studies in the current review. All peers attended preschool services and ranged in age from 2 to 6 years 4 months. Peers included in the majority of the studies in the current review were matched in terms of age and gender to the children with ASD with many studies also including additional peers of different ages and genders. Of the 22 studies (68%) where peers were matched in age to children with ASD, 14 (64%) demonstrated positive results.

Inclusion criteria for peers were reported in 30 studies (94%). Across most studies, criteria for peers included being typically developing and in attendance at the same preschool as the participant with ASD. Eighteen studies (86%) that included peer availability or attendance as an inclusion criteria demonstrated positive results. Specifically, Strain et al. (1994) indicated that peers had to be in attendance in the preschool for at least 5 months prior to the study. In addition to requiring peers to be typically developing, several studies reported ageappropriate or advanced cognitive abilities and IQ, language repertoires, and school performance as selection criteria. Of the studies where typical development and/or age-appropriate skill repertoires were identified as peer selection criteria, 14 studies (67%) demonstrated positive results. Ten studies identified a history of compliance with instruction as a peer selection criteria and nine (90%) of these studies demonstrated positive results. Kern and Aldridge (2006) included all children in the research setting as peers, including children with and without disabilities. Typically developing children who presented with behavioral problems were included as peers in Odom and Strain (1986), with one peer dropping out of the study prematurely as he became disruptive and refused to engage with the child with ASD.

Twelve studies (38%) reported that peers were selected based on having social competencies (e.g., age-appropriate social skills (Katz and Girolametto 2013) or enthusiasm in social interactions (e.g., Trembath et al. 2009). Furthermore, four studies (13%) required the peers to have had positive social interactions with or social interest in the child with ASD, with Zanolli et al. (1996) measuring this at baseline. Of these studies, ten (71%) demonstrated positive results. Three studies required peers to have no social history (Goldstein et al. 1992; Petursdottir et al. 2007) or no negative social history (Lee and Lee 2015) with the child with ASD. McGee et al. (1992) selected high status peers based on peer and teacher report sociometrics.

Fifteen studies (47%) utilized either teacher report measures or teacher nomination to select peers to participate in the studies. Four studies (13%) reported that peers were selected based on their motivation to take part in the research. The majority of the means of assessing peer eligibility were subjective involving teacher report or recommendation of typical development, with the exception of seven studies (22%) in which standardized measures were used: Carr and Darcy 1990 (Standord-Binet IQ); Goldstein et al. 1992 (Learning Accomplishment Profile); Odom and Strain 1986 and Odom and Watts 1991 (California Preschool Social Competency Scale); Sainato et al. 1987, 1992 (McCarthy Scales of Children's Abilities); Trembath et al. 2009 (Type Token Ratio; Number of Different Words). Trembath et al. (2009) supported subjective teacher reports of peer suitability for inclusion with caregiver reports and direct observations made by the researcher during initial visits to the preschools.

Peer Training Procedures

All studies in the current review incorporated elements of behavioral skills training (instructions, modeling, roleplay, prompting, corrective feedback) to train peers. All studies excluding one (Petursdottir et al. 2007) provided peers with instructions in the form of an introduction, description, and/or explanation of the intervention target skills and/or rationale. Most involved verbal discussion with a number of studies presenting information to peers using illustrated storybooks (e.g., Trembath et al. 2009). The majority of studies (25; 76%) involved adult modeling and/or roleplay of intervention procedures and target skills. In Lee and Lee (2015), puppets were used during adult modeling and roleplay to teach target skills to peers. Peer-peer role play and/or practice was facilitated in six studies (19%). Peer-participant role play was

Table 2Table of peer information from the included studies

References	Peer information and peer selection criteria	Peer similarity to children with ASD	Peer training	PMI procedure	Peer outcome variables and results
Belchic and Harris (1994)	 3 M and 2 F 3:8-4:7 years Teacher nomination Regular attendance Compliance with adult instructions History of positive social behavior with classmates At least average school performance Willingment to restrict the table 	Younger Gender matched (+ F)	N/A	Proximity	NR
Bellini et al. (2016)	 Whilinghess to participate in the study 2 Gender and age NR Typically developing peers in the preschool class 	NR	Instructions Modeling Roleplay Prompting Corrective feedback	Initiation; prompting and reinforcement	NR
Carr and Darcy (1990)	 M years old Availability (selected based upon) Highly reinforced by adult attention Compliance Average IQ 	Older Gender matched	In-vivo training Instructions Modeling Roleplay Prompting Corrective feedback In-vivo training	Prompting and reinforcing	NR
Ganz and Flores (2008)	 Average Rg 1 M and 3 F 4, 4, 4, 5 years old Age No identified disabilities or delays Ability to produce four-word sentences 	Age matched Gender matched (+F)	Instructions Modeling Prompting Corrective feedback In-vivo training	Initiation	NR
Garfinkle and Schwartz (2002)	• Good attendance Gender and N NR 3–6 years old NR	Age matched	Visual supports Instructions Prompting Corrective feedback In-vivo training Visual supports	Proximity	NR
Goldstein et al. (1992)	 5 M and 5 F 3:3–6:4 years old Normal or above normal cognitive abilities Age-appropriate language skills Observed prior to study as rarely initiating toward the child with ASD 	Age matched (+ older) Gender matched (+ F)	Instructions Modeling Roleplay Prompting Corrective feedback In-vivo training Visual supports Conditioned reinforce- ment	Initiation	Social behaviors and strategy use: Positive
Haring and Lovinger 1989; Experiment 1	 5 (Gender and age NR) Nominated by teacher as being highly interactive during play times Responsive to adult instruction 	NR	Instructions Corrective feedback Prompting In-vivo training Conditioned reinforce- ment	Prompting and reinforcing	Responsivity of peers to participant's initiations; mixed
Haring and Lovinger 1989; Experiment 2	5 (gender and age NR)Typical developmentAvailabilityVolunteered to take part	NR	Instructions Prompting Corrective feedback In-vivo training	Prompting and reinforcing	Responsivity of peers to participant's initiations: Positive

Table 2 (continued)	Table 2 (continued)							
References	Peer information and peer selection criteria	Peer similarity to children with ASD	Peer training	PMI procedure	Peer outcome variables and results			
			Conditioned reinforce- ment					
Hundert et al. (2014)	41 (classmates)Gender and age NRTypically developingIn attendance at same preschool	NR	Instructions Modeling Roleplay Prompting Corrective feedback In-vivo training Visual supports Conditioned reinforce- ment	Initiation; proximity	NR			
Jones and Schwartz (2004)	 2 M and 1 F 4 years old Attendance in same preschool class Teacher report that peer was a friend of the child with ASD and/or was 	Age matched Gender matched (+ M, - F)	Instructions Prompting Corrective feedback Prior training	Proximity	NR			
	someone the child with ASD often spent time with							
Katz and Girolametto (2013)	2 M and 4 F 4:0, 4:8, 4:1, 4:11, 5:5, 5:6 years old • Teacher nomination • Typical language development (teacher-report	Age matched Gender matched (+ F)	Instructions Roleplay Prompting In-vivo training	Initiation; proximity	NR			
	 Typical social skills (teacher-report) Attendance in same class Interest in interacting with the child with ASD 		Visual supports					
Kern and Aldridge (2006)	 32 (classmates with and without disabilities) including 8 peer buddies 2–5 years old Teacher nomination Interest in music Social skills 	Age matched (+ younger)	Instructions Modeling Roleplay Prompting Corrective	Proximity	Peer task behavior and positive peer interactions: Mixed			
	 Relationship with the child with ASD Motivation to participate and interact with the child with ASD 		feedback In-vivo training					
Kohler et al. (2007)	 M and 5 F years old Good attendance Age-appropriate play and social skills High levels of compliance with teacher directions 	Age matched Gender matched (+ M, + F)	Instructions Modeling Roleplay Prompting Corrective feedback Prior training Visual supports Conditioned reinforce- ment	Initiation; proximity	Social overtures directed to child: Positive			
Kohler et al. (1995)	6 M; 3:4–5:2 years oldTypically developingIn attendance at same preschool	Age matched Gender matched (+ M)	ment Instructions Modeling Roleplay Prompting Corrective feedback In-vivo training Conditioned reinforce- ment	Initiation	Peer supportive initiations and responses: Positive			
Kohler et al. (1997)	22 (gender NR)	Age matched	Prompting	Proximity	NR			

Table 2 (continued)

References	Peer information and peer selection criteria	Peer similarity to children with ASD	Peer training	PMI procedure	Peer outcome variables and results
	3:1–5:2 years old • Age-appropriate skills in most or		In-vivo training		
Kohler et al. (1990)	all developmental domains 7 (gender NR) 3–4 years old • Typically developing • In attendance at same preschool	Age matched (+younger)	Instructions Modeling Roleplay Prompting Corrective	Initiation	Peer supportive initiations and responses: Positive
			feedback In-vivo training Conditioned reinforce- ment		
Laushey and Heflin (2000)	Gender and <i>N</i> NR5:2–6:3 years oldTypically developingIn attendance at same preschool	Age matched	Instructions Prompting In-vivo training Conditioned reinforce- ment	Initiation; proximity	NR
Lee and Lee (2015)	9 (gender NR)	Age matched (+ older)	Instructions	Prompting and	Reciprocal social
	3:8-4:3 years oldTeacher nominationRegular school attendanceCompliant behavior		Modeling Roleplay Prompting Corrective feedback	Initiation; proximity	Positive
	Age-appropriate social communication skills		In-vivo training		
	No negative social history with participants		Visual supports Conditioned reinforce- ment		
Lefebvre and Strain (1989)	 3 M and 3 F 3:7, 4:6, 4:5, 4:7, 4:1, 5:5 years old Regular attendance Age-appropriate play and levels of social initiations 	Age matched Gender matched (+M, +F)	Instructions Modeling Roleplay Prompting	Initiation; proximity; prompting and reinforcing	Appropriate peer initiations and responses towards child: Positive
	•General compliance with teacher directions		Corrective feedback In-vivo training Conditioned reinforce- ment		
McGee et al. (1992)	3 F	Age matched	Instructions	Prompting and	Peer initiations towards
	4:5-4:11 years oldEldest typical developing children in preschool	Gender not matched	Modeling	Tennorenig	responses to target child: Positive
	 Regular attendance High level of compliance Age-appropriate language skills (teacher-report) High status among peers 		Roleplay Prompting Corrective feedback In-vivo training		
McGrath et al. (2003)	(teacher- report and peer sociometrics) 10 M and 8 F 3–4 years old • Regular attendance • Teacher nomination	Younger Gender matched (+ M, + F)	Visual supports Instructions Modeling Roleplay Prompting Corrective feedback Invivo training	Initiation; proximity; prompting and reinforcing	Reciprocal social interactions: Positive
Nelson et al. (2007)	Gender, N and age NR	NR	Visual supports Instructions	Proximity	NR

Table 2 (continued)						
References	Peer information and peer selection criteria	Peer similarity to children with ASD	Peer training	PMI procedure	Peer outcome variables and results	
	 Typically developing In attendance at same preschool 		Modeling Roleplay Prompting Corrective feedback In-vivo training Visual supports			
Odom and Strain (1986)	 3 M and 1 F 4–5 years old Peers attending center for emotionally disturbed children (all had behavioral problems) Displayed age-appropriate language, communicative and social skills Typically complied with adult requests 	Age matched Gender matched (+F)	Instructions Modeling Roleplay Prompting Corrective feedback In-vivo training Visual supports Conditioned reinforce-	Initiation	Positive initiations to children and total positive responses to children's initiations: Positive	
Odom and Watts (1991)	 2 M and 2 F 4, 5, 5, 5 years old Displayed age-appropriate language and cognitive skills 	Age matched Gender matched (+ F, - M)	ment Instructions Modeling Roleplay Prompting Corrective feedback	Initiation	Positive social initiations and interactions by peers to children: Positive	
	• In attendance at the same preschool		In-vivo training Conditioned reinforce- ment			
Petursdottir et al. (2007)	3 M 5 years old	Age matched Gender matched	Prompting Corrective feedback	Proximity	Social interactions: Mixed	
	 Teacher nomination as a peer who might work well with the child with ASD No history of playing with the child 		In-vivo training Conditioned reinforce- ment			
Sainato et al. (1992)	1 M, 2 F and two gender NR	Age matched	Instructions	Initiation	Total strategy use during free play: Positive	
	3:10, 4:2, 4:7, 3:10, 4:2 years old	Gender matched (+ F, - M)	Modeling			
	• Identified as more compliant (teacher)		Roleplay Prompting			
	Displayed appropriate play skills		In-vivo training Visual supports Conditioned reinforce- ment			
Sainato et al. (1987)	 3 M and 3 F 4:2–5:0 years old Selected as the only typically developing children in attendance at the same preschool 	Older Gender matched (+ F)	Instructions Modeling Roleplay Prompting In-vivo training Visual supports	Proximity	NR	
Sawyer et al. (2005)	Gender NR 3–5 peers in each session Age NR • Absence of disabilities • In attendance at same preschool	NR	Instructions Modeling Roleplay Prompting Corrective feedback	Proximity	Peer sharing: Positive	
Strain et al. (1994)	10 (gender NR)	Age matched	Instructions	Initiation;	NR	

 Table 2 (continued)

References	Peer information and peer selection criteria	Peer similarity to children with ASD	Peer training	PMI procedure	Peer outcome variables and results	
	3–5 years old		Modeling	Prompting and		
	 Availability (in same classroom as participants) Had attended preschool for at least 5 months prior to the study 		Roleplay Prompting Corrective feedback In-vivo training Visual supports Conditioned reinforce- ment Self-monitoring	remiorcing		
Thiemann-Bourgue	1 M and 2 F	Age matched	Instructions	Initiation: Proximity	Social communication:	
et al. (2017)	4:5-4:6 years	Gender matched	Modeling	,	Positive	
	 Age-appropriate social skills (teacher report) 	(+ F, - M)	Roleplay			
	 Consistent attendance Ability to attend to teacher directed lessons for a minimum of 20 min 		Prompting Corrective feedback			
			In-vivo training			
	 Expressed a willingness to participate 		Visual supports			
Trembath et al.	3 M and 3 F	Age matched	Instructions	Initiation; proximity;	Peer-participant	
(2009)	5, 5, 4, 5, 3, 4 years old	Gender matched	Modeling	prompting and reinforcing	communicative behavior: Positive	
	Teacher nomination	(+F)	Roleplay			
	• Age-appropriate language skills		Prompting			
	• Active participants in preschool activities		Prior training			
	 Able to follow instruction and routines Generally enthusiastic in interactions with other children 					
Zanolli et al. (1996)	4 M and 6 F	Age matched (+older)	Instructions	Prompting and reinforcing	Unprompted peer delivery	
	4, 6, 4, 4, 4, 5, 4–6 years old	Gender matched	Roleplay	-	of consequences	
	 Approached either child with ASD during pre-baseline sessions 	(+M, +F)	Prompting		(delivers tangibles and responds	
	• Verbally expressed interest in either child with ASD		Corrective feedback		to participant initiations):	
	 Observed to play frequently with the child with ASD's preferred activities Good social skills (based on teacher 		In-vivo training		Positive	
	nominations)					

NR indicates that data were not reported in a study. (+) denotes that other peers were included in a study in addition peers who were matched to the child/ children with ASD on age/gender

facilitated in 12 studies (38%). Katz and Girolametto (2013) provided opportunities for role play of new skills through use of puppets which were featured in illustrated books introducing the intervention. Prompting was used in 31 studies (97%) and corrective feedback was employed in 25 studies (78%).

The majority of studies (19; 59%) employed these five components of behavioral skills training (instructions, modeling, roleplay, prompting, corrective feedback) in combination. Of these studies, 15 (79%) reported positive results. Thirteen studies (41%) used less than 5 of these components of behavioral skills training in combination. Of these studies, eight (62%) reported positive results. Twenty-three studies (72%) incorporated additional supports for peers (e.g., visual supports (e.g., Katz and Girolametto, 2013); conditioned reinforcement systems (e.g., Hundert et al. 2014); selfmonitoring (Strain et al. 1994)). Of these studies, 17 (74%) reported positive results.

A distinction was noted between studies in which peer training occurred only prior to PMI sessions with children with ASD present, and studies in which in-vivo training or support was provided. The majority of studies (28; 88%) incorporated in-vivo support or training for peers. Of these studies, 20 (71%) reported positive results.

Peer-Mediated Intervention Procedures

The PMI procedures were employed in isolation in 21 studies (66%). Proximity was the most common PMI procedure

employed alone in nine studies (28%) with five of these studies (56%) demonstrating positive results. Seven studies (22%) employed initiation strategies alone with three studies (43%) demonstrating positive outcomes. Initiation strategies involved teaching peers to engage in behaviors such as tapping a child on the shoulder to get their attention (McGrath et al. 2003; Sainato et al. 1992), to engage him/her in play (Odom and Watts 1991), and to initiate conversation (Goldstein et al. 1992). Prompting and reinforcing was the sole PMI procedure employed in five studies (16%) with positive results demonstrated in four studies (80%). Prompting and reinforcing procedures included incidental mand training involving providing full vocal prompts and providing mand-specific reinforcement (McGee et al. 1992).

Eleven studies (34%) used a combination of 2 or more PMI procedures. Initiation and proximity were utilized together in five studies with positive outcomes demonstrated in each of these studies (100%). Two studies employed initiation and prompting and reinforcing procedures with positive results in both studies (100%). Four studies employed the three PMI procedures together with three studies demonstrating positive results (75%).

Peer Outcome Variables

Nineteen studies (59%) reported results on outcome variables relating to peers. Peer outcome variables included targets similar to those for children with ASD, for example, social interactions (e.g., Goldstein et al. 1992; Kohler et al. 1995), social initiation (Kohler et al. 2007), communicative behavior (e.g., Thiemann-Bourque et al. 2017; Trembath et al. 2009), and sharing (Sawyer et al. 2005). Peer skills relating to implementation of intervention were also reported, including task behavior (Kern and Aldridge 2006), strategy use (Goldstein et al. 1992; Sainato et al. 1992), unprompted delivery of consequences and responding appropriately to participant initiations (Zanolli et al. 1996), and responsiveness to participant initiations (Haring and Lovinger 1989). Of the 19 studies reporting on peer outcomes, positive results were demonstrated in 16 studies (84%) with increases across peer outcome variables. Mixed results were reported for peer outcome variables in three studies (16%).

Strength of Research Studies

Relevant information regarding study design, strength ratings, and presence or absence of generalization, maintenance, treatment integrity, and social validity measures are presented in Table 3. As previously outlined, each study was evaluated using Reichow et al. (2008) criteria for measuring the strength of research. Within the current review, five studies (16%) were rated as strong. Sixteen studies (50%) were rated as adequate and 11 studies (34%) were rated as weak.

Generalization, Maintenance, Treatment Fidelity, and Social Validity

All studies (100%) employed a combination of three or more technologies of generalization to programme for generalization (Stokes and Baer 1977). The most commonly employed generalization promotion strategy was programming for common stimuli which was coded for all studies given that peers were present in both training and generalization settings in each study in the current review. The majority of studies trained sufficient exemplars to programme for generalization of skills. For instance, a number of studies conducted training sessions across settings (e.g., Kohler et al. 1990) and across activities or materials (e.g., Belchic and Harris 1994). Introduction to natural maintaining contingencies (e.g., fading of contrived reinforcement) was also employed in the majority of studies. Training loosely involving teaching under more variable conditions and this strategy was used within 21 studies (66%). The strategies of sequential modification, training to generalize and utilizing indiscriminable contingencies to programme for generalization were employed in fewer studies within the current review. Haring and Lovinger (1989) employed natural and indiscriminable contingencies as well as training to generalize through teaching peers to respond to only 50% of participant's initiations. This represented the intermittent schedules of reinforcement found within the natural environment and promoted generalization of skills across individuals as the participant had to initiate toward another peer when a peer did not respond.

Fifteen studies (47%) presented data measuring generalization. Generalization of the participants' skills was measured across settings (e.g., Belchic and Harris 1994; Carr and Darcy 1990), novel peers (e.g., Petursdottir et al. 2007; Trembath et al. 2009), and materials or activities (e.g., Ganz and Flores 2008; Hundert et al. 2014). Sainato et al. (1992) measured generalization of peer's strategy use to novel children with ASD and across activities. Belchic and Harris (1994) measured generalization of skills to the playground setting, with untrained children with autism and with the participants' siblings in the home.

Fifteen studies (47%) included data on maintenance of intervention outcomes. Where latency to maintenance data collection was reported, these data were collected after varying periods of time post completion of intervention and over different numbers of sessions. Ten studies (31%) assessed maintenance of skills immediately following the completion of intervention and/or once stable performance at mastery criteria was achieved, and measured maintenance of skills over several weeks. McGee and colleagues (1992) programmed for maintenance by systematically fading out teacher prompts for peers. Lee and Lee (2015) included an intervention-fading phase, following completion of peer training. This phase involved gradually fading out teacher prompting. Four studies

References	Design	Strength of research	Generalization promotion	Assessment included			
			strategies	Generalization	Maintenance	Treatment integrity	Social validity
Belchic and Harris (1994)	MB/MP	A	NC; PCS; SE; TG	•	•		
Bellini et al. (2016)	MB	А	NC; SE; TL; IC; PCS; TG		•	•	•
Carr and Darcy (1990)	MB	А	NC; SE; PCS	•	•	•	
Ganz and Flores (2008)	CC	А	NC; SE; PCS	•	•	•	
Garfinkle and Schwartz (2002)	MB	W	SE; TL; PCS	•	•	•	•
Goldstein et al. (1992)	R	А	NC; SE; TL; PCS			•	
Haring and Lovinger 1989; Experiment 1	MB	W	NC; SE; TL; IC; PCS	•			
Haring and Lovinger 1989; Experiment 2	MB	W	NC; SE; TL; IC; PCS	•			
Hundert et al. (2014)	MB	А	NC; TL; PCS	•		•	
Jones and Schwartz (2004)	PT	А	NC; SE; PCS		•	•	
Katz and Girolametto (2013)	MB	А	NC; SE; TL; PCS		•	•	•
Kern and Aldridge (2006)	MB	W	NC; SE; TL; PCS			•	
Kohler et al. (2007)	MB	А	NC; SE; TL; PCS		•	•	
Kohler et al. (1995)	W	S	NC; SE; TL; PCS			•	
Kohler et al. (1997)	MB	W	NC; SE; TL; PCS		•	•	
Kohler et al. (1990)	AT	S	NC; SE; TL; PCS	•		•	
Laushey and Heflin (2000)	R	S	NC; SE; TL; PCS; IC	•	•	•	•
Lee and Lee (2015)	MB	А	NC; SE; TL; PCS		•	•	•
Lefebvre and Strain (1989)	W	W	NC; SE; TL; PCS			•	
McGee et al. (1992)	MB	А	NC; SE; TL; PCS; IC	•	•	•	
McGrath et al. (2003)	AB	W	NC; SE; TL; PCS			•	•
Nelson et al. (2007)	MP	А	NC; SE; PCS		•	•	•
Odom and Strain (1986)	AT	S	NC; SE; TL; PCS			•	
Odom and Watts (1991)	MB	S	NC; SE; TL; PCS				
Petursdottir et al. (2007)	W/MB	W	NC; SE; TL; PCS; IC	•		•	•
Sainato et al. (1992)	MB	А	SM; NC; SE; TL; PCS	•		•	
Sainato et al. (1987)	AT	W	NC; SE; PCS	•		•	
Sawyer et al. (2005)	ABCB	W	NC; SE; PCS		•		•
Strain et al. (1994)	MB	А	NC; SE; PCS; TL				
Thiemann-Bourque et al. (2017)	MP	А	NC; SE; TL; IC; PCS; MG; TG	•		•	
Trembath et al. (2009)	MB	А	NC; SE; TL; PCS	•		•	
Zanolli et al. (1996)	MB/MP	W	NC; SE; PCS		•	•	

 Table 3
 Table of research design, strength ratings (Reichow et al. 2008), strategies to program for generalization, and inclusion of generalization, maintenance, treatment integrity and social validity measures

Under research design, MB denotes multiple baseline, MP denotes multiple probe, W denotes withdrawal design, R denotes reversal, AT denotes alternating treatments, PT denotes parallel treatments, and CC denotes changing criterion design. Under strength of research, S indicates a strong rating, A indicates an adequate rating, and W denotes a weak rating, based upon Reichow et al. (2008). Strategies to program for generalization are presented as train and hope (TH); sequential modification (SM); introduce to natural maintaining contingencies (NC); train sufficient exemplars (SE); train loosely (TL); use of indiscriminable contingencies (IC); program common stimuli (PCS); mediate generalization (MG); and train "to generalize" (TG). Reporting of generalization, maintenance, treatment integrity, and social validity data are represented by a filled black circle

(13%) assessed maintenance following an extended period of time after termination of experimental condition; including 4to 5-week post-intervention, over two sessions (Katz and Girolametto 2013); 6- to 8-week post-intervention, over four sessions (Kohler et al. 1997); within 6 weeks into new school year (Laushey and Heflin 2000); and 40 and 60 days postintervention (Sawyer et al. 2005).

The majority of studies (26; 81%) collected data on treatment integrity and positive results for treatment integrity were reported in the majority of studies measuring treatment

integrity. Thirteen studies (41%) included pre-intervention training to a pre-determined mastery criterion. Five studies (16%) carried out pre-intervention peer training but did not specify the mastery criteria. A number of studies assessed treatment integrity through direct observation, with or without feedback, and/or interobserver agreement on occurrence of target behaviors (e.g., Garfinkle and Schwartz 2002; Lefebvre and Strain 1989). In Zanolli et al. (1996), the integrity of teacher's delivery of peer training was assessed. Nine studies (28%) used fidelity checklists to assess peer implementation completed by an observer (e.g., Bellini et al. 2016; Petursdottir et al. 2007; Thiemann-Bourque et al. 2017) and one study incorporated staff and peers' selfevaluation of implementation of the strategies (Sainato et al. 1992). In Sainato et al. (1992), mean agreement between peer and researcher ratings ranged from 77 to 93%. In some studies in which treatment integrity was found to be poor, additional training was provided (e.g., Garfinkle and Schwartz 2002). Seven studies (22%) did not measure treatment integrity beyond initial peer training lessons.

Specific measures of social validity were presented in nine studies (28%). Eight studies measured social validity from staff and one study included parent-report. Two studies involved independent observers blind to treatment conditions in the assessment of social validity who viewed videotapes across pre- and post-intervention phases. The majority of studies in the current review (88%) met the criteria set out by Reichow et al. (2008) for social validity. These studies incorporated a number of factors, which established the social validity of research. Factors include research having been carried out in the natural environment, use of socially acceptable intervention procedures, and producing clinically significant behavior change. For example, Laushey and Heflin (2000) selected socially significant target skills through multidisciplinary collaboration with a team of early years' educators.

Discussion

The current review aimed to evaluate the use of PMI with preschool children with ASD within inclusive educational settings. Thirty-one articles (32 studies) meeting the inclusion criteria were identified and included in the current review. Positive outcomes were reported for all participants across all outcome variables in 23 studies (72%). Similarly, positive gains were demonstrated across all peers in 16 of the 19 studies (84%), which presented data on peer outcomes. The majority of studies (21; 66%) achieved research strength ratings of strong or adequate (Reichow et al. 2008). These positive findings lend support to the certainty of evidence demonstrated for PMI for preschool children with ASD in the current review with regard to the

reported participant and peer outcomes. Furthermore, social, communication, and play skills were targeted in 29 studies (91%) within the current review which lends support to the suggestion that PMI may be a particularly suitable intervention to support social development and social inclusion within inclusive preschool services (Watkins et al. 2015).

This review further explored various intervention characteristics within PMI for preschool children with ASD. With regard to the use of PMI in skills teaching for preschool children with ASD, the positive results demonstrated in the current review support the use of PMI to teach a broad range of skills across the domains of communication and social competence for children with ASD aged between 3 and 5 years. However, further research is warranted employing PMI to teach other skill repertoires (e.g., preacademic skills, imitation) given the limited number of studies that targeted such skills in the current review. Furthermore, it warrants mention that analysis employed in the current review to identify study results as positive, mixed, or negative did not indicate the magnitude of the intervention gains. Future research should employ further analyses and meta-analytic techniques (e.g., nonoverlap of pairs (NAP); Tau-U) to investigate this further. Within their review of PMI for children with ASD, Watkins et al. (2015) noted a limitation regarding the generalization of findings to broader ASD populations beyond the predominantly moderate-high functioning population included in their review. Interestingly, in the current review, the moderate-high functioning population represented the minority, with the majority of the participants identified as functioning within the lower functioning or severe and moderate ranges. Within the current review, of 17 studies including children with lower functioning profiles, 11 studies reported positive results lending preliminary support to the application of PMI with preschool age children with ASD and lower cognitive functioning profiles. A small number of studies also demonstrated positive results for children with co-occurring difficulties and, as such, future research is warranted to further evaluate the efficacy of PMI for preschool children with ASD with varying functioning profiles and co-occurring diagnoses and to investigate and develop enhanced supports within PMI for these populations.

The findings regarding peer characteristics in the current review are interesting and have important implications for future research and practice. Previous research has outlined possible reservations regarding the abilities of preschool age children to implement PMI (Chan et al. 2009; Watkins et al. 2015). Within the current review, preschool age peers demonstrated exceptional abilities to acquire new skills and support learning for children with ASD. For example, Trembath et al. (2009) demonstrated that peers successfully learned to use a speech generating device (SGD) and teach children with ASD how to use it despite having had no prior experience using an SGD previously. The majority of studies matched peers to some extent to participants in terms of age and gender which demonstrated positive results. The majority of studies also reported details of additional selection criteria for peers (e.g., age, availability, age-appropriate skills, good attendance, compliance). Preliminarily, the success rates demonstrated respectively by studies requiring peers to (a) be in attendance in the same preschool as the child with ASD, (b) have developmentally appropriate cognitive and language abilities, (c) have a history of compliance, and (d) demonstrate social competence and enthusiasm in social interactions suggest that these are important, relevant criteria for selecting peers for PMI at preschool stage. Both of the studies that included children with behavioral or developmental difficulties as peers demonstrated mixed results, which may suggest that further supports are warranted where peers have skill deficits in particular areas. Future PMI research should continue to provide detailed information about peers and the peer selection process to allow for further analysis of the impact of peer characteristics on intervention outcomes and to inform identification of prerequisite skills for peers within PMI. Future research is also warranted to identify the optimum levels of training and support for peers with different abilities to maintain intervention success and treatment fidelity within PMI.

With regard to peer training procedures, a number of common characteristics of peer training protocols were noted. The majority of studies included (a) instructions, (b) modeling, (c) roleplay, (d) prompting, (e) corrective feedback, (f) visual supports, and (g) conditioned reinforcement systems, which demonstrated positive results. Furthermore, the majority of studies included in-vivo training for peers with the children with ASD as well as initial training sessions, which also demonstrated success. These comprehensive approaches to peer training are promising and future research should continue to further evaluate and develop training protocols for preschool age peers within PMI and, in particular, additional supports for peers with differing skill levels and abilities. Analysis of the resource and time intensity required for such training procedures was beyond the scope of the current review and this remains an important area for future research regarding the efficiency of PMI at preschool stage.

In the current review, peers were taught to use each of the PMI procedures outlined by Odom and Strain (1984) and Watkins et al. (2015). Proximity and initiation procedures were employed commonly across studies, whereas prompting and reinforcing was employed in a smaller number of studies in the current review. Interestingly, where these procedures were employed in isolation, prompting and reinforcing

demonstrated the highest success rate (80% across five studies). Success rates were higher where studies employed a combination of two or more PMI procedures in comparison to the use of the PMI procedures in isolation. However, given the unequal number of studies within each of these categories, these findings should be regarded as preliminary. Future research should further evaluate the comparative success rates of the PMI procedures alone and in combination for preschool children. It would also be pertinent to evaluate the level of training and support required for preschool peers to successfully use each PMI procedure in order to identify a "best fit" in terms of PMI procedure efficacy and training efficiency for preschool children.

Across studies employing PMI with preschool children with ASD in the current review, the collection of data regarding generalization and maintenance of intervention outcomes, social validity, and treatment fidelity was also evaluated. Measures of generalization were included in half of the included studies with measures of maintenance included in less than half of the studies. Given the importance of generalization and maintenance of intervention outcomes as an indicator of intervention success and in ensuring that the target skills occur across time and contexts as necessary (Bellini et al. 2007), this finding is disappointing and lends little to an analysis of the overarching success of PMI in supporting generalization and maintenance outcomes. However, all of the studies included in the current review were identified as having programmed for generalization by employing a combination of the generalization promotion strategies outlined by Stokes and Baer (1977) including programming for common stimuli, training multiple exemplars, and introducing natural maintaining contingencies. Future research should continue to employ and evaluate these strategies within PMI and incorporate measures of generalization of the target skills across a broad range of settings, communication partners, and activities as well as evaluating maintenance of intervention outcomes over prolonged periods of time, for example, following children's transition into new school environments.

Previous research has raised concerns regarding the ability of young children to correctly implement interventions within PMI (Chan et al. 2009). Therefore, it is a positive finding that measures of treatment integrity were reported in the majority of studies in the current review. Treatment integrity was measured using a variety of methods, including mastery criteria during peer training, direct observation during PMI sessions, and peer self-evaluation. Positive results for treatment integrity were reported in all studies lending further support to the ability of preschool children to acquire the necessary skills to become effective interventionists. However, treatment integrity was not consistently measured across conditions, with seven studies not measuring treatment integrity beyond initial peer training lessons. This raises concerns regarding potential inconsistency in the delivery of intervention. The role of peer self-monitoring and self-evaluation of strategy use was evaluated by Sainato et al. (1992). Sainato et al. (1992) incorporated staff and peers' self-evaluation of implementation of the strategies and found positive mean agreement between peer and researcher ratings ranging from 77 to 93%. Future research could employ similar procedures and should ensure that peers are trained to criterion prior to commencing PMI sessions. Furthermore, fidelity checks should be conducted regularly, with additional training and support provided as necessary.

The perceived social validity of treatment procedures and outcomes is an important indicator of future support for an intervention. If the participants, teachers, parents, and others involved in the intervention report positive outcomes and experiences, the likelihood that the interventions will continue to be implemented may increase (Kennedy 2002). In the current review, the majority of studies met the criteria for social validity set out by Reichow et al. (2008) in designing procedures and choosing target skills which were socially acceptable. However, direct measures of social validity were only included in nine studies and the majority of these studies evaluated staff perceptions of the PMI. The positive findings from these measures suggest that PMI was often perceived to be an acceptable intervention for use in inclusive preschool settings, was considered beneficial to both participants and peers, and was supported by preschool staff. It is imperative for future research to include direct measures of social validity of PMI with preschool children across stakeholders (preschool staff, parents, children, and peers) to evaluate the efficacy, suitability, and acceptability of these strategies. Furthermore, given the increased interactions between peers that occur within PMI, additional measures of sociometrics, social interactions, and friendships before, during, and after intervention are warranted to further evaluate the social significance of PMI.

As previously outlined, a number of limitations regarding PMI applications have been raised in previous research and the current review aimed to investigate these within PMI for preschool age children. Chan et al. (2009) suggested that peers involved in PMI may miss out on instructional time. However, the findings from the current review indicated that most intervention sessions lasting between 10 and 15 min and were typically carried out during "free-play" time. Furthermore, PMI may be particularly suitable for preschool settings in this regard given the lower emphasis on curricular targets and increased time devoted to social interaction and development in preschool settings in comparison to later school settings. Watkins et al. (2015) suggested that PMI may be inefficient for preschool children in that implementation with this population may require considerably more time and resources than interventions with older children or adult interventionists. As previously mentioned, detailed analysis of the time and resource intensity required to implement PMI with this population was beyond the scope of the current review; however, descriptions of the training for peers outlined in the included studies indicated that peer training for preschool children in PMI may require considerable time and resources. Comparisons of the resources required for skills teaching with adult interventionists versus peers and intervention outcomes, efficacy and feasibility, as well as a cost-benefit analysis of the additional gains in terms of social interaction associated with PMI are important areas for future research in this regard. Future research should also prioritize developing strategies for peer training within PMI for preschool children which may reduce the time and resources required while maintaining treatment integrity. Concerns have also been raised in the literature regarding the potential for the skill deficits and challenges experienced by participants with ASD to be highlighted inadvertently through the use of PMI (Chan et al. 2009). A number of studies in the current review aimed to minimize this potential issue by involving all children in a class-wide buddy system so as to prevent the stigmatization of any children with ASD (Hundert et al. 2014). Similarly, Garfinkle and Schwartz (2002) included all participants and peers in intervention, with each child taking turns imitating the actions of their classmates. It is recommended that future research continue to employ such strategies and include measures of peer-child social interactions outside of intervention sessions to examine if PMI can potentially reduce stigmatization of children with ASD and support the development of friendships through positive interactions.

Given that 32 studies that employed PMI with preschool age children were identified from a 31-year period, and considering the decreasing trend suggested in Fig. 1, it would appear that the presumed limitations and concerns regarding the use of PMI with preschool children may be relatively prevalent today. However, findings from the current review suggest that the evidence does not support these concerns. Across the studies included in the current review, a wide range of skills were targeted and improved for preschool children with ASD within inclusive settings through interventions involving their peers. Predominantly, positive results were demonstrated for both children with ASD and their peers and interventions were considered socially valid. As outlined previously, there is a need for evidence-based interventions to support skill development for preschool children with ASD so that they can access the learning opportunities afforded by inclusive education and develop critical skill repertoires for later success at this early stage (Barton and Smith 2015; Camargo et al. 2014; Wang et al. 2011). PMI represent an important area for future research in this regard as they have the potential to provide unique benefits as empirically supported strategies for skill development, which also increase opportunities for social interaction.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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