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A Systematic Review and Meta-analysis of Interventions to Improve Play Skills in Children with Autism Spectrum Disorder

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Abstract

Children with autism spectrum disorders (ASD) experience difficulty with play, and a number of different interventions have been developed and evaluated to address this deficit. This systematic review of randomized controlled trials identified 19 studies reporting on play-based interventions for children with ASD aged 2–12 years. The components of each study, including elements of the interventions and methodological quality, were examined. A meta-analysis was completed for 11 studies, and a small but significant treatment effect was identified (Hedges' $g = 0.439$). The current review supports future development of interventions with a focus on the child with ASD across social environments. Outcome measures and comprehensive reporting of intervention components are important considerations in future intervention development and testing. Significance for clinicians and future research is discussed. PROSPERO registration number: RD42015026263.

Keywords Play · Autism Spectrum disorder · Intervention · Systematic review · Meta-analysis · Child

Introduction

Children with autism spectrum disorders (ASD) often experience difficulties with play and forming and maintaining peer relationships. Research has demonstrated that these social difficulties persist into adolescence and young adulthood (Schall and McDonough 2010). This review will focus on interventions that target play in children with ASD. For the purpose of

this review, play is defined as a transaction between the individual and the environment which includes "...the presence of three elements: intrinsic motivation, internal control, and the freedom to suspend reality" (Skard and Bundy 2008, p. 71). Additionally, it needs to be apparent to both the players and observers that this transaction is playful, by the cues the players give and read—Bundy (2012) identifies this as being in the play frame. This definition of play is both contemporary and comprehensive, is appropriate across different ages and stages of development, and has been used by many observation and intervention studies in the past. Play is an important aspect of childhood, and there are many benefits in promoting play. Play is the context in which most childhood friendships are formed, from early preschool years through to adolescence (Bundy 2012). Play is essential to childhood development and provides an ideal opportunity and context for parent and peer engagement. Play, as an independent occupation, not just a means to promote other skills or development, is a legitimate and necessary outcome because it is a critical element of the human experience (Parham et al. 1996). Despite this importance, play may have diminished social validity or priority (Foster and Mash 1999). Certainly, time available for play has been significantly reduced for some children as other areas of development, such as academic outcomes, are increasingly valued (Ginsburg 2007).

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The three elements are not fixed, but rather move depending on the child's experience, and can tilt the transaction away from non-play to play. If children in the play frame have reduced internal control or intrinsic motivation, then play can tilt back to work (Bundy 2012). As play is defined as an intrinsically motivated transaction, simply providing toys in an engaging environment will not necessarily guarantee a child will play (Bundy 2011). Similarly, it is not enough for the study to say it was a play intervention if the transaction was highly structured or if the child was required to follow a set play routine. Furthermore, the complexity and constantly changing nature of play make measuring play ability difficult for educators, clinicians, and researchers (Brooke 2004). Frequently, measures are of readily observable social skills or children's behavior from the perspective of a parent or teacher, rather than a child's play ability (McAloney and Stagnitti 2009). Observation of unstructured play in a natural play context would support an accurate and authentic assessment (Ray-Kaeser and Lynch 2017). This assessment would be reliant on the assessor's definition and reporting of play skills to assure valid and reliable results and comparisons across individuals, context, and studies (Ray-Kaeser and Lynch 2017).

Children with ASD have difficulty with components of play, specifically, turn taking, changing activities away from preferred interests, reduced symbolic quality, and relinquishing control of preferred play activities (MacDonald et al. 2009). For children with ASD, improvements in play skills lead to increased positive social interactions, as well as decreased inappropriate behaviors (Jung and Sainato 2013). Specifically, children with ASD with average cognitive functioning have been reported to have difficulties in social initiation and in social-emotional understanding (Sigman et al. 1999). It is this reduced social understanding, rather than social disinterest or insensitivity, that is the primary deficit for social play (Sigman et al. 1999). As a result of their social play challenges and subsequent lack of opportunity, these children can be caught in a cycle of social isolation. Given that children with ASD who do not acquire age appropriate social skills may lack opportunities for positive peer interactions, explicit training in social play with peers is a necessary intervention (Bauminger 2002; Jordan 2003; Jung and Sainato 2013).

Several different approaches to interventions have been developed to address impaired social interactions and play in children with ASD. These different approaches include coaching the child with ASD, identifying and addressing individual play skills and interests, and developing supportive relationships and environments. Peer-focused interventions, including integrated play groups, peer buddy systems, and group interventions, represent the largest type of social play intervention for children with ASD (Bass and Mulick 2007). The inclusion of peers in the intervention helps support generalization of skills to other environments and creates a more authentic social environment for children with ASD to

develop their social play skills (Chan et al. 2009). The use of typically developing peers in interventions is further supported as friendships are associated with prosocial behaviors and act as a protective factor against rejection and bullying, especially in the preschool and school environments (Chang et al. 2015). Although promoting play has been largely neglected in school contexts due to the focus by teachers on academic outcomes, some interventions focus on upskilling teachers to be able to provide intervention to the child with ASD and to create a supportive social environment (Kossyvaki and Papoudi 2016). Parents are also frequently a focus of interventions, especially with younger children (McConachie and Diggle 2007), as the social behavior of a child with ASD has been shown to be significantly enhanced by the interaction style of the parent or caregiver adapting to the child's play level (Freeman and Kasari 2013; Meirsschaut et al. 2010).

To date, no researchers have conducted systematic reviews of play-based interventions for children with ASD tested using randomized controlled trials (RCTs). Previous systematic reviews have investigated social developmental outcomes in children with ASD, including pragmatic language interventions (Parsons et al. 2017), after school programs for personal and social skills (Durlak et al. 2010), and early behavior interventions (Warren et al. 2011) with outcomes that included improvements in cognitive performance, language skills, and adaptive behavior skills. A recent systematic review of RCTs for preschool children with ASD included interventions addressing behavioral, communication-focused, and developmental outcomes of ASD general symptoms, but not interventions addressing play outcomes (Tachibana et al. 2017). A review of 13 play-based intervention studies for children with ASD identified improvements when the intervention built upon the child's existing play repertoire (Luckett et al. 2007). However, effectiveness of these interventions could not be determined as the majority of the 13 studies used single case study designs (Luckett et al. 2007). Since the Luckett et al. study was published (2007), more than a decade ago, a number of researchers have published RCTs of play interventions for children with ASD (Corbett et al. 2016, b; Kasari et al. 2014, b). To date, no systemic reviews have been conducted of play-based interventions for children with ASD that have been investigated using RCTs.

Objectives

This systematic review focuses on the efficacy of play-based interventions to address the play skills of children with ASD. This systematic review aimed to summarize key characteristics of a range of play-based interventions for children with ASD and assess the quality of published RCTs. This meta-analysis addressed the following research questions: (1) are play interventions effective in improving play outcomes when compared to a non-play intervention or treatment as usual control group? and (2) do the following intervention

characteristics mediate intervention effects: (a) focus of intervention (i.e., child, parent, peer, teacher or combination), (b) intervention setting, and (c) group or individual therapy?

Method

Protocol and Registration

The methodology and reporting of this systematic review were based on the PRISMA and PRISMA-P statement (Moher et al. 2009; Shamseer et al. 2015), and the review was registered with PROSPERO (registration number RD42015026263; Booth 2013).

Eligibility Criteria and Study Selection

Studies were included if they met four inclusion criteria: (1) participants must include children who have a diagnosis of ASD according to the DSM-III-R, DSM-IV, or DSM-5 criteria; (2) study designs were RCTs; (3) the interventions included play as per the definition adopted in this study; and (4) treatment outcomes were assessed using play measures. Multimodal

intervention programs in which the play-based intervention was part of a variety of social or behavioral components were also included. These criteria were selected to identify play-based intervention studies for children with ASD that are classified as level II on the National Health and Medical Research Council (NHMRC) Hierarchy of Evidence (NHMRC 2011). The Australian NHMRC developed the NHMRC Hierarchy of Evidence to rank and evaluate the evidence of healthcare interventions. According to the NHMRC Hierarchy of Evidence, level II studies are well-designed RCTs (NHMRC 2011).

Information Sources and Search

Studies were identified through the following two-step procedure. First, an electronic database search was conducted using PubMed, Embase, PsychINFO, CINAHL, and ERIC. These databases are where social interventions are most likely to be found. Two categories of subject headings were used in combination: (1) disorder (autism spectrum disorder; ASD) and (2) randomized controlled trials. Free text searches were also conducted for all four databases on September 4, 2017. Both subject headings and free text terms with limitations are described in Table 1. Secondly, identified studies were then

Table 1 Search terms

Database and search terms (subject headings and free text words)

CINAHL: (((MH "Autistic Disorder") OR (MH "Child Development Disorders, Pervasive") OR (MH "Pervasive Developmental Disorder-Not Otherwise Specified") OR (MH "Asperger Syndrome") OR (MH "Rett Syndrome"))) AND (MH "Randomized Controlled Trials") OR ((autism OR autistic OR ASD OR PDD OR PDD-NOS OR pervasive OR Asperger OR Rett OR (childhood AND disintegrative AND disorder*)) AND (RCT OR (Randomized AND Controlled AND Trial) OR (Randomised AND Controlled AND Trial) OR (Randomized AND Clinical AND Trial) OR (Randomised AND Clinical AND Trial) OR (Controlled AND Clinical AND Trial)) Limiters—Published Data: September 1, 2016–September 31, 2017)

Embase: ((autism/OR "pervasive developmental disorder not otherwise specified"/OR Rett syndrome/OR childhood disintegrative disorder/) AND (randomization/or randomized controlled trial/OR "randomized controlled trial (topic)"/OR controlled clinical trial/)) OR((autism OR autistic OR ASD OR PDD OR PDD-NOS OR pervasive OR Asperger OR Rett OR (childhood AND disintegrative AND disorder*)) AND (RCT OR (Randomized AND Controlled AND Trial) OR (Randomised AND Controlled AND Trial) OR (Randomized AND Clinical AND Trial) OR (Randomised AND Clinical AND Trial) OR (Controlled AND Clinical AND Trial)) limit to yr="2017-Current")

Eric ((DE "Autism" OR DE "Pervasive Developmental Disorders" OR DE "Asperger Syndrome") AND (RCT OR (Randomized AND Controlled AND Trial) OR (Randomised AND Controlled AND Trial) OR (Randomized AND Clinical AND Trial) OR (Randomised AND Clinical AND Trial) OR (Controlled AND Clinical AND Trial))) OR ((autism OR autistic OR ASD OR PDD OR PDD-NOS OR pervasive OR Asperger OR Rett OR (childhood AND disintegrative AND disorder*)) AND (RCT OR (Randomized AND Controlled AND Trial) OR (Randomised AND Controlled AND Trial) OR (Randomized AND Clinical AND Trial) OR (Randomised AND Clinical AND Trial) OR (Controlled AND Clinical AND Trial)) Limiters—Date Published: September 1, 2016–September 31, 2017)

PsycINFO: ((DE "Autism Spectrum Disorders" OR DE "Rett Syndrome") AND (RCT OR (Randomized AND Controlled AND Trial) OR (Randomised AND Controlled AND Trial) OR (Randomized AND Clinical AND Trial) OR (Randomised AND Clinical AND Trial) OR (Controlled AND Clinical AND Trial))) OR ((autism OR autistic OR ASD OR PDD OR PDD-NOS OR pervasive OR Asperger OR Rett OR (childhood AND disintegrative AND disorder*)) AND (RCT OR (Randomized AND Controlled AND Trial) OR (Randomised AND Controlled AND Trial) OR (Randomized AND Clinical AND Trial) OR (Randomised AND Clinical AND Trial) OR (Controlled AND Clinical AND Trial)) Limiters –Published Date: September 1, 2016–September 31, 2017)

PubMed: (("Autistic Disorder"[Mesh] OR "Child Development Disorders, Pervasive"[Mesh] OR "Rett Syndrome"[Mesh] OR "Asperger Syndrome"[Mesh]) AND ("Randomized Controlled Trial" [Publication Type] OR "Randomized Controlled Trials as Topic"[Mesh] OR "Controlled Clinical Trial" [Publication Type] OR "Pragmatic Clinical Trials as Topic"[Mesh])) OR ((autism OR autistic OR ASD OR PDD OR PDD-NOS OR pervasive OR Asperger OR Rett OR (childhood AND disintegrative AND disorder*)) AND (RCT OR (Randomized AND Controlled AND Trial) OR (Randomised AND Controlled AND Trial) OR (Randomized AND Clinical AND Trial) OR (Randomised AND Clinical AND Trial) OR (Controlled AND Clinical AND Trial)) Filters: Publication date from September 1, 2016–September 5, 2017)

searched for inclusion of play (see Fig. 1). Gray literature was searched using Google Scholar for disorder, RCT, and play.

Synthesis of Results and Methodological Quality

Data across all studies were extracted independently by the first author using data extraction tables. Intervention

characteristics were extracted for the following: (1) focus of the intervention and play skills targeted; (2) interventionists and procedure described in the study; and (3) setting, mode of delivery, and duration. Data on study characteristics were then extrapolated and synthesized into several categories: (1) group design and participant group numbers, (2) play as primary or secondary focus of study, (3) age range (means and standard

Fig. 1 PRISMA flow chart

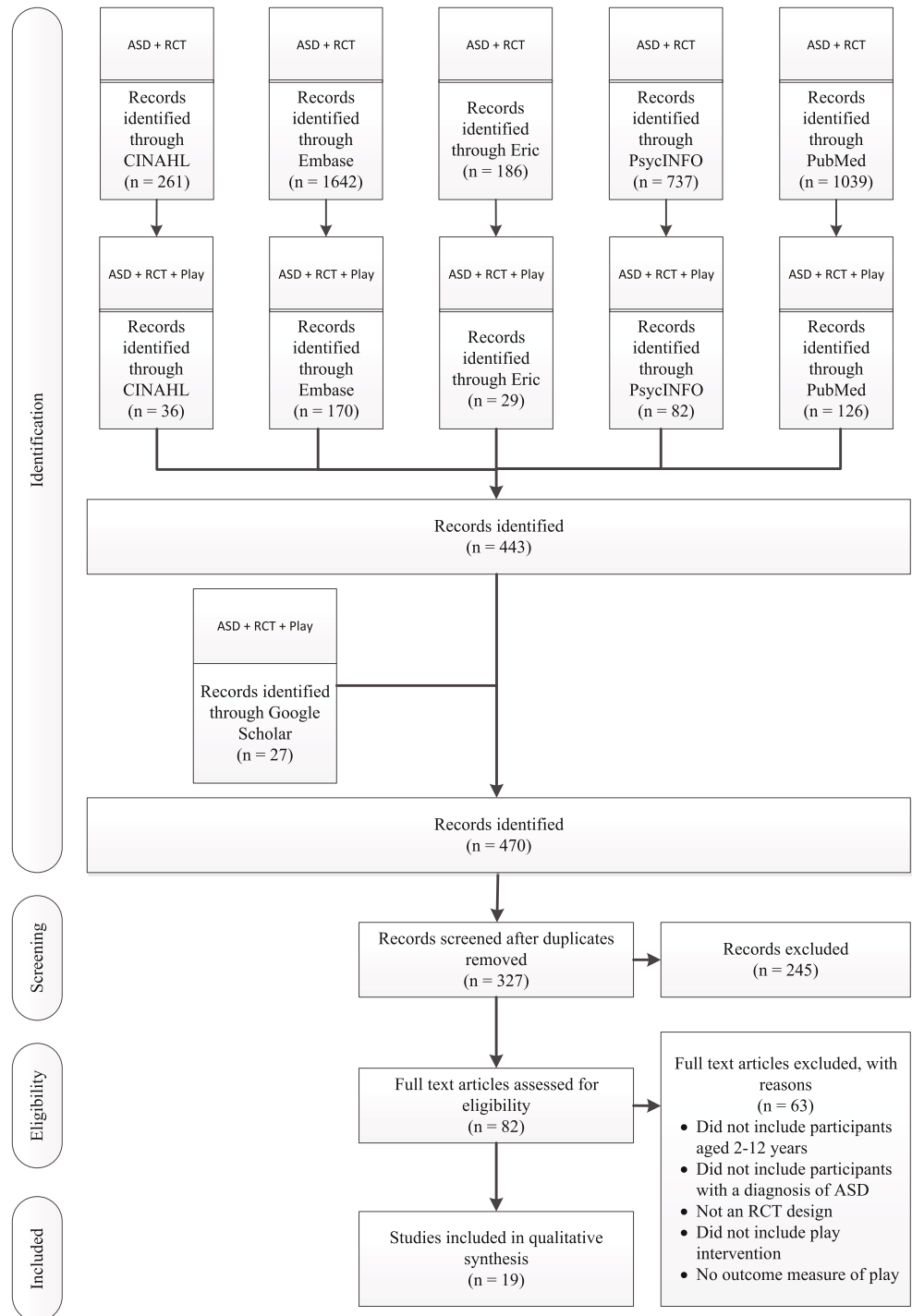


Figure 1. PRISMA Study selection diagram

deviations), (4) inclusion and exclusion criteria for participants, and (5) the play outcome measure used and results of the treatment.

The QualSyst critical appraisal tool was used to assess the methodological quality of the included studies (Kmet et al. 2004). The 14-item checklist has a three-point ordinal scoring system (yes = 2, partial = 1, no = 0) that provides a systematic, reproducible, and quantitative means of assessing the quality of research. The total QualSyst score can be converted to a percentage score, with a QualSyst score of $\geq 80\%$ considered strong quality, a score of 60–79% considered good quality, a score of 50–59% considered adequate quality, and a score of $< 50\%$ was considered to have poor methodological quality. All included studies were reviewed by two assessors and interrater reliability was established for ratings.

Meta-analysis

A meta-analysis and overall treatment effects were calculated for play-based interventions on pre-post outcome measures. Between-group analyses were also conducted to compare post-intervention scores with control groups that included another intervention or treatment as usual comparator group. Studies that included no treatment or delayed control group were removed from between-group analyses (Corbett et al. 2016, b; Frankel et al. 2010, b; Kasari et al. 2010, b). Subgroup analyses were conducted to compare the effect as a function of intervention characteristics: (1) groups or individual, (2) focus of intervention (i.e., child, parent, peer, or teacher), and (3) setting (i.e., clinic, home, or school setting).

A meta-regression analysis was conducted to determine whether focus of intervention, setting, or group or individual therapy mediated intervention effects. The study sample size (eight studies) allowed for multivariate analysis involving up to two covariates without compromising power (Borenstein et al. 2011), so one model addressed the interaction between group vs individual and setting and the other addressed the interaction between the focus of the intervention vs setting.

To compare effect sizes, pre- and post-intervention means, standard deviations, and sample sizes were extracted. If the data required for meta-analysis calculations were not reported, attempts were made to contact authors to request the data. When multiple outcome measures of play were reported for one intervention, the measure that evaluated the highest level of play skills was extracted for analysis (e.g., symbolic play types were selected over functional play types in a structured play assessment).

Extracted means, standard deviations, and sample sizes for pre- and post-intervention measures were entered into comprehensive meta-analysis, version 3.3.070 (Borenstein et al. 2005). A random effects model was used to generate effect size. The Hedges' *g* formula for standardized mean difference with a confidence interval of 95% was used to report effect

size. Using Cohen's *d* convention for interpretation, an effect size of < 0.2 reflects negligible difference, between 0.2 and 0.49 is small, between 0.5 and 0.79 is moderate, and > 0.8 is large (Cohen 1988).

Given that studies that report large and significant treatment effects are more likely to be selected for publication (Borenstein et al. 2005), it is possible that some low-effect or non-significant interventions are missing from the meta-analysis. The presence of publication bias was assessed using classic fail-safe *N*. The test calculates the number of additional studies that, if included in the analysis, would nullify the measured effect (*N*). If *N* is large, it can be considered unlikely that there would be so many unpublished low-effect studies and it can be assumed that the meta-analysis is not compromised by publication bias (Borenstein et al. 2005).

Results

Study Selection

A total of 327 papers were identified and screened through the subject heading and free text searches (see Fig. 1). The first author assessed all 327 abstracts for inclusion, and the fourth author assessed a random selection of 40% for interrater reliability; weighted Kappa 0.88 (95% CI [0.7, 61.00]). A total of 82 full text articles were accessed to determine if the studies met the inclusion criteria. Specifically, further information was needed regarding the description of the intervention and the outcome measures to determine if studies met the inclusion criteria. Of these, 63 studies were excluded for one or more than one of the following reasons: 10 did not include children aged 2 to 12 years of age; 3 did not include participants with ASD; 26 were not a RCT study design; 26 did not include a play-based intervention as defined by our study; and 46 did not have an outcome measure for play (see Table 2).

A total of 19 studies were selected for this systematic review based on the inclusion criteria. All the selected studies included participants aged 2–12 years with a diagnosis of ASD, used an RCT study design, investigated a play-based intervention, and reported on play outcomes that aligned with the definition of play adopted for this review.

Study Characteristics

Participants The 19 studies that met the eligibility criteria included a total of 1149 participants aged between 2 and 12 years. Of these, 11 studies included only preschool-aged children (2 to 5 years of age) involving 670 participants and nine studies included only primary school-aged children (5 to 12 years of age) with a total of 479 participants. Treatment group sample size ranged from 4 to 76 participants.

Table 2 Excluded studies

No.	Reference	Child 2–12	ASD	RCT	Play int.	Play outcome
1	Almirall, D., et al. (2016). Longitudinal Effects of Adaptive Interventions With a Speech-Generating Device in Minimally Verbal Children With ASD. <i>J Clin Child Adolesc Psychol</i> 45(4): 442–456.	1	1	0	1	1
2	Amir, N. and C. T. Taylor (2012). Interpretation training in individuals with generalized social anxiety disorder: A randomized controlled trial. <i>Journal of Consulting and Clinical Psychology</i> 80(3): 497–511.	0	1	1	0	0
3	Andrews, L., Attwood, T., & Sofronoff, K. (2013). Increasing the appropriate demonstration of affectionate behavior, in children with Asperger syndrome, high functioning autism, and PDD-NOS: A randomized controlled trial. <i>Research in Autism Spectrum Disorders</i> , 7(12), 1568–1578. doi: https://doi.org/10.1016/j.rasd.2013.09.010	1	1	1	0	0
4	Aresti-Bartolome, N., & Garcia-Zapirain, B. (2015). Cognitive rehabilitation system for children with autism spectrum disorder using serious games: A pilot study. <i>Biomed Mater Eng</i> , 26 Suppl 1, S811–824. doi: https://doi.org/10.3233/bme-151373	1	1	0	0	0
5	Beaumont, R., & Sofronoff, K. (2008). A multi-component social skills intervention for children with Asperger syndrome: the Junior Detective Training Program. <i>J Child Psychol Psychiatry</i> , 49(7), 743–753. doi: https://doi.org/10.1111/j.1469-7610.2008.01920.x	1	1	1	1	0
6	Bieleninik, L., et al. (2017). “Effects of Improvisational Music Therapy vs Enhanced Standard Care on Symptom Severity Among Children With Autism Spectrum Disorder: The TIME-A Randomized Clinical Trial.” <i>Jama</i> 318(6): 525–535.	1	1	1	0	0
7	Bremer, E., Balogh, R., & Lloyd, M. (2015). Effectiveness of a fundamental motor skill intervention for 4-year-old children with autism spectrum disorder: A pilot study. <i>Autism</i> , 19(8), 980–991. doi: https://doi.org/10.1177/1362361314557548	1	1	0	1	1
8	Charman, T. (2012). Modest size RCT indicates that short-term joint attention and symbolic play intervention improves shared positive affect in social interactions for preschool children with autism. <i>Evidence-Based Communication Assessment and Intervention</i> , 6(2), 63–65. doi: https://doi.org/10.1080/17489539.2012.692933	1	1	0	0	0
9	Charman, T., et al. (2005). Outcome at 7 years of children diagnosed with autism at age 2: predictive validity of assessments conducted at 2 and 3 years of age and pattern of symptom change over time. <i>J Child Psychol Psychiatry</i> 46(5): 500–513.	1	1	0	0	0
10	Dallaire, C. W. and L. Schreibman (2003). Joint attention training for children with autism using behavior modification procedures. <i>Journal of Child Psychology and Psychiatry and Allied Disciplines</i> 44(3): 456–468.	1	1	0	0	0
11	Drew, A., Baird, G., Baron-Cohen, S., Cox, A., Slonims, V., Wheelwright, S., ... Charman, T. (2002). A pilot randomised control trial of a parent training intervention for pre-school children with autism. Preliminary findings and methodological challenges. <i>Eur Child Adolesc Psychiatry</i> , 11(6), 266–272. doi: https://doi.org/10.1007/s00787-002-0299-6	0	1	1	1	0
12	Eikeseth, S., Smith, T., Jahr, E., & Eldevik, S. (2007). Outcome for children with autism who began intensive behavioral treatment between ages 4 and 7: a comparison controlled study. <i>Behav Modif</i> , 31(3), 264–278. doi: https://doi.org/10.1177/0145445506291396	1	1	0	0	0
13	Escalona, A., et al. (2001). Brief report: improvements in the behavior of children with autism following massage therapy. <i>J Autism Dev Disord</i> 31(5): 513–516.	1	1	1	0	1
14	Fisher, W. W., Luczynski, K. C., Hood, S. A., Lesser, A. D., Machado, M. A., & Piazza, C. C. (2014). Preliminary findings of a randomized clinical trial of a virtual training program for applied behavior analysis technicians. <i>Research in Autism Spectrum Disorders</i> , 8(9), 1044–1054. doi: https://doi.org/10.1016/j.rasd.2014.05.002	0	1	0	0	0
15	Fletcher-Watson, S., Petrou, A., Scott-Barrett, J., Dicks, P., Graham, C., O’Hare, A., ... McConachie, H. (2016). A trial of an iPad intervention targeting social communication skills in children with autism. <i>Autism</i> , 20(7), 771–782. doi: https://doi.org/10.1177/1362361315605624	1	1	1	0	0
16	Fox, S. A. (2017). An Early Start Denver Model-Based Group Intervention for Parents of Very Young Children Diagnosed with or at Risk for Autism Spectrum Disorder. <i>Ann Arbor, State University of New York at Albany</i> . 10602934: 158.	1	1	1	1	0
17	Garcia-Villamisar, D. A. and J. Dattilo (2010). Effects of a leisure programme on quality of life and stress of individuals with ASD. <i>J Intellect Disabil Res</i> 54(7): 611–619.	0	1	1	1	0
18	Ginn, N. C., et al. (2017). Child-Directed Interaction Training for Young Children With Autism Spectrum Disorders: Parent and Child Outcomes. <i>Journal of clinical child and adolescent psychology: the official journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53</i> 46(1): 101–109.	1	1	1	1	0
19	Gulsrud, A. C., Hellemann, G. S., Freeman, S. F. N., & Kasari, C. (2014). Two to ten years: Developmental trajectories of joint attention in children with ASD who received targeted social communication interventions. <i>Autism Research</i> , 7(2), 207–215. doi: https://doi.org/10.1002/aur.1360	1	1	1	0	0
20	Gulsrud, A. C., Kasari, C., Freeman, S., & Paparella, T. (2007). Children with autism’s response to novel stimuli while participating in interventions targeting joint attention or symbolic play skills. <i>Autism</i> , 11(6), 535–546. doi: https://doi.org/10.1177/1362361307083255	1	1	1	1	0
21	Holt, S. and N. Yuill (2014). Facilitating other-awareness in low-functioning children with autism and typically-developing preschoolers using dual-control technology. <i>J Autism Dev Disord</i> 44(1): 236–248.	1	1	0	0	0

Table 2 (continued)

No.	Reference	Child 2–12	ASD	RCT	Play int.	Play outcome
22	Ingersoll, B. (2010). Brief Report: Pilot Randomized Controlled Trial of Reciprocal Imitation Training for Teaching Elicited and Spontaneous Imitation to Children with Autism. <i>Journal of Autism and Developmental Disorders</i> 40(9): 1154–1160.	1	1	1	1	0
23	Ingersoll, B. (2012). Brief report: Effect of a focused imitation intervention on social functioning in children with autism. <i>Journal of Autism and Developmental Disorders</i> , 42(8), 1768–1773. doi: https://doi.org/10.1007/s10803-011-1423-6	1	1	0	0	0
24	Ingersoll, B., & Gergans, S. (2007). The effect of a parent-implemented imitation intervention on spontaneous imitation skills in young children with autism. <i>Res Dev Disabil</i> , 28(2), 163–175. doi: https://doi.org/10.1016/j.ridd.2006.02.004	1	1	0	0	0
25	Iwanaga, R., et al. (2014). Pilot Study: Efficacy of Sensory Integration Therapy for Japanese Children with High-Functioning Autism Spectrum Disorder. <i>Occupational Therapy International</i> 21(1): 4–11.	1	1	0	1	0
26	Jelveh, M. (2003). A play-based treatment model for improving the social play development of children with autism spectrum disorder. (64), ProQuest Information & Learning, US. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2003-95015-093&site=ehost-live Available from EBSCOhost psych database.	1	1	0	1	1
27	Kaale, A., Smith, L., & Sponheim, E. (2012). A randomized controlled trial of preschool-based joint attention intervention for children with autism. <i>Journal of child psychology and psychiatry, and allied disciplines</i> , 53(1), 97–105.	1	1	1	1	0
28	Kasari, C., Freeman, S., Paparella, T., Wong, C., Kwon, S., & Gulsrud, A. (2005). Early intervention on core deficits in autism. <i>Clinical Neuropsychiatry: Journal of Treatment Evaluation</i> , 2(6), 380–388.	1	1	1	1	0
29	Kern, J. K., Garver, C. R., Mehta, J. A., Hannan, P. A., Bakken, L. E., Vidaud, A. M., ... Daoud, Y. (2013). Prospective, blinded exploratory evaluation of the PlayWisely program in children with autism spectrum disorder. <i>Yale J Biol Med</i> , 86(2), 157–167.	1	1	1	0	0
30	Kim, J., Wigram, T., & Gold, C. (2008). The effects of improvisational music therapy on joint attention behaviors in autistic children: A randomized controlled study. <i>Journal of Autism and Developmental Disorders</i> , 38(9), 1758–1766. doi: https://doi.org/10.1007/s10803-008-0566-6	1	1	1	1	0
31	Kim, J., Wigram, T., & Gold, C. (2009). Emotional, motivational and interpersonal responsiveness of children with autism in improvisational music therapy. <i>Autism</i> , 13(4), 389–409. doi: https://doi.org/10.1177/1362361309105660	1	1	1	1	0
32	Kok, A. J., Kong, T. Y., & Bernard-Opitz, V. (2002). A comparison of the effects of structured play and facilitated play approaches on preschoolers with autism. A case study. <i>Autism</i> , 6(2), 181–196.	1	1	0	1	1
33	Kroeger, K. A., Schultz, J. R., & Newsom, C. (2007). A comparison of two group-delivered social skills programs for young children with autism. <i>Journal of Autism and Developmental Disorders</i> , 37(5), 808–817. doi: https://doi.org/10.1007/s10803-006-0207-x	1	1	0	1	1
34	Lawton, K., & Kasari, C. (2012). Brief report: longitudinal improvements in the quality of joint attention in preschool children with autism. <i>J Autism Dev Disord</i> , 42(2), 307–312. doi: https://doi.org/10.1007/s10803-011-1231-z	1	1	1	1	0
35	Lawton, K., & Kasari, C. (2012). Teacher-implemented joint attention intervention: pilot randomized controlled study for preschoolers with autism. <i>Journal of Consulting and Clinical Psychology</i> , 80(4), 687–693.	1	1	1	1	0
36	Locke, J., Shih, W., Kretzmann, M., & Kasari, C. (2016). Examining playground engagement between elementary school children with and without autism spectrum disorder. <i>Autism</i> , 20(6), 653–662. doi: https://doi.org/10.1177/1362361315599468	1	1	0	0	1
37	Lydon, H., Healy, O., & Leader, G. (2011). A comparison of video modeling and Pivotal Response Training to teach pretend play skills to children with autism spectrum disorder. <i>Research in Autism Spectrum Disorders</i> , 5(2), 872–884. doi: https://doi.org/10.1016/j.rasd.2010.10.002	1	1	0	1	1
38	MacDonald, R., Pary-Cruwys, D., Dupere, S., & Ahearn, W. (2014). Assessing progress and outcome of early intensive behavioral intervention for toddlers with autism. <i>Research in Developmental Disabilities</i> , 35(12), 3632–3644. doi: https://doi.org/10.1016/j.ridd.2014.08.036	1	1	0	1	1
39	Magiati, I., Charman, T., & Howlin, P. (2007). A two-year prospective follow-up study of community-based early intensive behavioural intervention and specialist nursery provision for children with autism spectrum disorders. <i>Journal of Child Psychology and Psychiatry and Allied Disciplines</i> , 48(8), 803–813. doi: https://doi.org/10.1111/j.1469-7610.2007.01756.x	1	1	0	1	1
40	Mahoney, G., & Solomon, R. (2016). Mechanism of Developmental Change in the PLAY Project Home Consultation Program: Evidence from a Randomized Control Trial. <i>Journal of Autism and Developmental Disorders</i> , 46(5), 1860–1871. doi: https://doi.org/10.1007/s10803-016-2720-x	1	1	1	1	0
41	McDuffie, A. S., Lieberman, R. G., & Yoder, P. J. (2012). Object interest in autism spectrum disorder: a treatment comparison. <i>Autism</i> , 16(4), 398–405. doi: https://doi.org/10.1177/1362361309360983	0	1	1	1	1
42	Meyer, L. H., Fox, A., Schermer, A., Ketelsen, D., Montan, N., Maley, K., & Cole, D. (1987). The effects of teacher intrusion on social play interactions between children with autism and their nonhandicapped peers. <i>J Autism Dev Disord</i> , 17(3), 315–332.	1	1	0	1	1
43	Mohammadzahari, F., Koegel, L., Rezaee, M., & Rafiee, S. (2014). A Randomized Clinical Trial Comparison Between Pivotal Response Treatment (PRT) and Structured Applied Behavior Analysis (ABA) Intervention for Children with Autism. <i>Journal of Autism & Developmental Disorders</i> , 44(11), 2769–2777. doi: https://doi.org/10.1007/s10803-014-2137-3	1	1	1	1	0

Table 2 (continued)

No.	Reference	Child 2–12	ASD	RCT	Play int.	Play outcome
44	Newman, A. K., et al. (2017). The relationship of sociodemographic and psychological variables with chronic pain variables in a low-income population. <i>Pain</i> 158(9): 1687–1696.	0	0	1	0	0
45	Noterdaeme, M. (2013). A controlled pilot study of the effect of group training of parents of pre-schoolers with autism on social communication and parenting stress. <i>Developmental Medicine and Child Neurology</i> , 55, 7. doi: https://doi.org/10.1111/dmcn.12256	1	1	0	0	0
46	Oono, I. P., et al. (2013). Parent-mediated early intervention for young children with autism spectrum disorders (ASD). <i>Cochrane Database Syst Rev</i> (4): Cd009774.	1	1	0	1	1
47	Roeyers, H. (1996). The influence of nonhandicapped peers on the social interactions of children with a pervasive development disorder. <i>J Autism Dev Disord</i> , 26(3), 303–320.	1	1	1	1	0
48	Rogers, S. J., Estes, A., Lord, C., Vismara, L., Winter, J., Fitzpatrick, A., ... Dawson, G. (2012). Effects of a brief Early Start Denver Model (ESDM)-based parent intervention on toddlers at risk for autism spectrum disorders: A randomized controlled trial. <i>Journal of the American Academy of Child & Adolescent Psychiatry</i> , 51(10), 1052–1065. doi: https://doi.org/10.1016/j.jaac.2012.08.003	0	1	1	1	1
49	Schaaf, R., Benevides, T., Mailloux, Z., Faller, P., Hunt, J., Hooydonk, E., ... Kelly, D. (2014). An Intervention for Sensory Difficulties in Children with Autism: A Randomized Trial. <i>Journal of Autism & Developmental Disorders</i> , 44(7), 1493–1506. doi: https://doi.org/10.1007/s10803-013-1983-8	1	1	1	1	0
50	Sezici, E., et al. (2017). Use of play therapy in nursing process: A prospective randomized controlled study. <i>Journal of Nursing Scholarship</i> 49(2): 162–169.	1	0	1	1	0
51	Shire, S. Y., Goods, K., Shih, W., Distefano, C., Kaiser, A., Wright, C., ... Kasari, C. (2015). Parents' Adoption of Social Communication Intervention Strategies: Families Including Children with Autism Spectrum Disorder Who are Minimally Verbal. <i>J Autism Dev Disord</i> , 45(6), 1712–1724. doi: https://doi.org/10.1007/s10803-014-2329-x	1	1	1	0	0
52	Shire, S. Y., Gulsrud, A., & Kasari, C. (2016). Increasing Responsive Parent-Child Interactions and Joint Engagement: Comparing the Influence of Parent-Mediated Intervention and Parent Psychoeducation. <i>Journal of Autism and Developmental Disorders</i> , 46(5), 1737–1747. doi: https://doi.org/10.1007/s10803-016-2702-z	0	1	1	1	0
53	Solomon, R., Van Egeren, L. A., Mahoney, G., Huber, M. S. Q., & Zimmerman, P. (2014). PLAY Project Home Consultation intervention program for young children with autism spectrum disorders: A randomized controlled trial. <i>Journal of Developmental and Behavioral Pediatrics</i> , 35(8), 475–485. doi: https://doi.org/10.1097/DBP.0000000000000096	1	1	1	1	0
54	Solomon, R., Van Egeren, L., & Huber, M. Q. (2015). Comment on article entitled: 'PLAY Project Home Consultation intervention program for young children with autism spectrum disorders: A randomized controlled trial': Authors' response. <i>Journal of Developmental and Behavioral Pediatrics</i> , 36(3), 225–225. doi: https://doi.org/10.1097/DBP.0000000000000154	1	1	0	1	1
55	Soorya, L. V., Siper, P. M., Beck, T., Soffes, S., Halpern, D., Gorenstein, M., ... Wang, A. T. (2015). Randomized comparative trial of a social cognitive skills group for children with autism spectrum disorder. <i>Journal of the American Academy of Child & Adolescent Psychiatry</i> , 54(3), 208–216. doi: https://doi.org/10.1016/j.jaac.2014.12.005	1	1	1	1	0
56	Thomeer, M. L., Smith, R. A., Lopata, C., Volker, M. A., Lipinski, A. M., Rodgers, J. D., ... Lee, G. K. (2015). Randomized controlled trial of Mind Reading and in vivo rehearsal for high-functioning children with ASD. <i>Journal of Autism and Developmental Disorders</i> , 45(7), 2115–2127. doi: https://doi.org/10.1007/s10803-015-2374-0	1	1	1	0	0
57	van Ginkel, J. R., & Kroonenberg, P. M. (2015). Comment on article entitled: 'PLAY Project Home Consultation intervention program for young children with autism spectrum disorders: A randomized controlled trial.'. <i>Journal of Developmental and Behavioral Pediatrics</i> , 36(3), 225–225. doi: https://doi.org/10.1097/DBP.0000000000000137	1	1	0	1	1
58	Whalen, C., & Schreibman, L. (2003). Joint attention training for children with autism using behavior modification procedures. <i>J Child Psychol Psychiatry</i> , 44(3), 456–468.	1	1	0	0	0
59	Wijnhoven, L. A., et al. (2015). The effect of the video game Mindlight on anxiety symptoms in children with an Autism Spectrum Disorder. <i>BMC Psychiatry</i> 15: 138.	1	1	1	0	0
60	Wong, V. C. N., & Kwan, Q. K. (2010). Randomized controlled trial for early intervention for autism: a pilot study of the autism 1-2-3 project. <i>Journal of Autism & Developmental Disorders</i> , 40(6), 677–688. doi: https://doi.org/10.1007/s10803-009-0916-z	1	1	1	0	1
61	Wood, J. J., Fujii, C., Renno, P., & Van Dyke, M. (2014). Impact of Cognitive Behavioral Therapy on Observed Autism Symptom Severity during School Recess: A Preliminary Randomized, Controlled Trial. <i>Journal of Autism and Developmental Disorders</i> , 44(9), 2264–2276.	1	1	1	1	0
62	Yoo, H. J., Bahn, G., Cho, I. H., Kim, E. K., Kim, J. H., Min, J. W., ... Laugeson, E. A. (2014). A randomized controlled trial of the Korean version of the PEERS® parent-assisted social skills training program for teens with ASD. <i>Autism Research</i> , 7(1), 145–161. doi: https://doi.org/10.1002/aur.1354	0	1	1	1	1
63	Yun, S. S., et al. (2017). Social skills training for children with autism spectrum disorder using a robotic behavioral intervention system. <i>Autism Research</i> 10(7): 1306–1323.	1	1	1	0	0
Total		10	3	26	26	46

Intervention A detailed description of each intervention is provided in Table 3. Interventions focused on the child with ASD, a parent or caregiver, teacher, or typically developing peers of the child with ASD. Ten interventions occurred in the preschool or school setting, one in the community, five in the clinic, two in the home, and one with a combination of both clinic and home sessions.

Comparator Group All participants included in control groups had a diagnosis of ASD. Across the 19 studies, there were three different types of comparator group: wait-list control group, non-play-based intervention control group, and an alternative play-based intervention control group. Seven studies assigned control participants to wait-list control groups who served as a no-treatment comparison during the intervention phase of the project then went on to receive the intervention at a later stage. Control participants in four studies attended intervention for the same duration as the intervention group but participated in activities that did not meet the definition for a play-based intervention. Control groups in six studies were assigned to an alternative play-based treatment. A further three studies included both an alternative play-based intervention and a wait-list comparator group.

Outcome Measures All outcome measures reported on play outcomes that matched the definition of play used in this study. Of the studies included, one used a parent-report questionnaire and 18 used observations of the child's behavior, 13 of which used a validated outcome measure with published psychometric properties. Fifteen studies showed significant improvements in treatment outcomes between groups for their selected play outcome measure; four did not identify any significant difference between the groups. Further details on characteristics of included studies are reported in Table 4.

Results of Individual Studies

Meta-Analysis: Synthesis of Results

Eleven of the 19 studies eligible for the systematic review were included in the meta-analysis (see Fig. 2). The remaining eight studies could not be included in the meta-analysis as they did not contain data required for calculations. One study reported individual scores. We contacted the remaining seven authors to collect the required data needed for the meta-analysis. Six authors did not respond, and one author no longer had access to the database.

Effect sizes ranged from 0.033 to 1.898 in the pre-post intervention within-group analysis, as shown in Fig. 2. The overall intervention effect was small but significant ($z(11) = 3.744$, $p < 0.001$, Hedges' $g = 0.439$, 95% CI [0.209, 0.669]). The within group heterogeneity was not

significant ($Q(11) = 17.210$, $p = 0.070$), and 41.9% of true variability (I^2) could be explained by individual study characteristics.

A small but significant between-group total effect size favored play-based interventions for children with ASD ($z(8) = 2.611$, $p = 0.009$, Hedges' $g = 0.335$, 95% CI [0.083, 0.586]). Interventions delivered to the individual demonstrated a significant, small effect size ($z(8) = 2.846$, $p = 0.004$, Hedges' $g = 0.444$, 95% CI [0.138, 0.749]), compared with a group setting ($z(8) = 0.170$, $p = 0.170$, Hedges' $g = 0.035$, 95% CI [-0.366, 0.436]), which demonstrated a negligible and not significant effect size. The three interventions that focused on the child demonstrated a significant, large effect size ($z(3) = 2.954$, $p = 0.003$, Hedges' $g = 0.903$, 95% CI [0.304, 1.501]), whereas the three interventions that had a combination of child and parent focus demonstrated a significant, small effect size ($z(3) = 2.387$, $p = 0.017$, Hedges' $g = 0.291$, 95% CI [0.052, 0.529]). There was only one intervention that focused on a combination of the child and peer and only one that focused on the teacher included in analysis, both demonstrated a negligible effect size that was not significant ($z(1) = 0.094$, $p = 0.925$, Hedges' $g = 0.033$, 95% CI [-0.663, 0.730]) and ($z(1) = 0.142$, $p = 0.887$, Hedges' $g = 0.036$, 95% CI [-0.455, 0.526]) respectively. No effect size for the clinic, home, or school setting was significant (clinic $z(2) = 1.221$, $p = 0.222$, Hedges' $g = 0.887$, 95% CI [-0.537, 2.311]; home: $z(2) = 1.402$, $p = 0.161$, Hedges' $g = 0.286$, 95% CI [-0.114, 0.685]; school: $z(4) = 1.469$, $p = 0.142$, Hedges' $g = 0.259$, 95% CI [-0.087, 0.605]).

Following the subgroup analysis of intervention characteristics, a meta-regression analysis was performed on eight studies to further explain variability of the results (Chang et al. 2016, b; Goods et al. 2013, b; Kasari et al. 2006, b, 2012, b, 2014, b, 2015, b; Poslawsky et al. 2015, b; Quirnbach et al. 2009, b). The analysis of intervention characteristics indicated that intervention setting and group vs individual were not significant mediators of intervention effects (see Table 5). However, focus of the intervention (i.e., child, parent, peer or teacher) was found to be a significant mediator of play outcomes ($Q(3) = 8.52$, $p = 0.036$).

Methodological Quality

Table 4 contains a description of the methodological quality and QualSyst ratings of the included studies. Two studies had adequate quality using the QualSyst checklist, and three studies had good quality. The remaining 14 studies had strong quality. Interrater agreement for overall scores of methodological quality of included studies was Kappa 0.884 (95% CI [0.755, 1.000]).

Table 3 Play intervention characteristics

Reference	Interventionists and procedure	Setting
	<ul style="list-style-type: none"> • Focus of intervention • Play skills targeted • Intervention active ingredients 	<ul style="list-style-type: none"> • Setting • Mode of delivery • Duration
Field, Field, Sanders, and Nadel (2001, b)	<p>Unfamiliar adult (no further details were reported). Procedure had 4 phases of 3 min each.</p> <p>1st phase: child enters room alone, adult sat still on sofa like a statue and her face was still with no expression.</p> <p>2nd phase: adult either imitated all of the child's behaviors or was contingently responsive to child's behaviors without imitating behaviors.</p> <p>3rd phase: adult returned to sitting still on sofa.</p> <p>4th phase: spontaneous play interaction</p> <p>Clinicians (graduate students in educational psychology) JASPER</p> <p>Clinicians used toys representing the child's interests within their mastered and emerging play levels. Most participants were at a requesting level of gesture use. Toys used to help the child create play routines facilitating joint engagement (activity centered reciprocal interaction between interventionist and child).</p> <p>Opportunities embedded within play routines to elicit targeted communication skill including waiting before performing steps of a routine, expanding play within routines, and using balanced turns.</p> <p>Trained experimenters (graduate students in educational psychology experienced with children with autism)</p> <p>Each child received approximately 5 to 8 min direct trial training at the table to "prime" the treatment goal followed by semi-structured floor session A prompt hierarchy (verbal/physical prompt, model, and positive reinforcement used to achieve the child's appropriate response). The floor session was child-driven and included environmental manipulations. Systematic prompting and reinforcement of target skill continued in floor session, but the experimenter used naturally occurring opportunities, similar to milieu teaching. Principles used included following the child's lead and interest in activities; talking about what the child was doing, repeating back and expanding on what the child said, giving corrective feedback, sitting close to the child and making eye-contact, and making environmental adjustments to engage the child.</p> <p>Clinician</p> <p>Lego therapy</p> <p>A typical Lego therapy project would aim to build a Lego set with a social division of labor. In a group of 3 (which could be comprised of children with autism, peers and/or adults), one person is the "engineer," one the "supplier," and the other the "builder." Individuals communicate and follow social rules to complete the Lego build. The therapist's role was to highlight the presence of a social problem, and help children come up with their own solutions.</p> <p>Children started off building quick and simple models in pairs of threes with constant adult supervision and once proficient in a small group, they moved on to build more complex models over a few sessions. Eventually, children were</p>	<ul style="list-style-type: none"> • Clinic • Individual • Participant one on one with unfamiliar adult in room with sofa and toys. • On the table were two sets of identical toys: balls, dolls, slinkies, hats, sunglasses, stuffed animals, cups, plates, balloons and umbrellas
Goods, Ishijima, Chang, and Kasari (2013, b)	<p>Focus</p> <ul style="list-style-type: none"> • Child <p>Play skills</p> <ul style="list-style-type: none"> • Social <p>Active ingredients</p> <ul style="list-style-type: none"> • Imitation <p>Focus</p> <ul style="list-style-type: none"> • Child <p>Play skills</p> <ul style="list-style-type: none"> • Social <p>Active ingredients</p> <ul style="list-style-type: none"> • Coaching child • Individual play skills/interests identified and addressed 	<ul style="list-style-type: none"> • Preschool • Individual • 30 min sessions, twice a week for 12 weeks
Kasari, Freeman, and Paparella (2006, b)	<p>Focus</p> <ul style="list-style-type: none"> • Child <p>Play skills</p> <ul style="list-style-type: none"> • Social <p>Active ingredients</p> <ul style="list-style-type: none"> • Coaching child • Individual play skills/interests identified and addressed 	<ul style="list-style-type: none"> • School • Individual • 30 min daily sessions intervention lasted on average 5–6 weeks depending on the child's stay in the Early Intervention Program (EIP)
Owens, Granader, Humphrey, & Baron-Cohen (2008)	<p>Focus</p> <ul style="list-style-type: none"> • Child <p>Play skills</p> <ul style="list-style-type: none"> • Social <p>Active ingredients</p> <ul style="list-style-type: none"> • Develop supportive relationships 	<ul style="list-style-type: none"> • Clinic • Group • Children attended therapy for 1 h per week for 18 weeks. Taking into account the holidays, the total duration of the study was 5.5 months

Table 3 (continued)

Reference	Focus of intervention	Interventionists and procedure	Setting
Quirmbach, Lincoln, Feinberg-Gizzo, Ingersoll, and Andrews (2009, b)	<ul style="list-style-type: none"> • Play skills targeted • Intervention active ingredients 	<p>able to build together with minimal adult intervention and were given “Freesty/le” less structured, more challenging way of working together.</p> <p>Clinician</p> <p>Social story: focused on four targeted game play skills and adhered to Gray’s social story ratio. Play skills included (a) greeting behaviors, (b) requesting to play a game, (c) asking another person what they want to play, and (d) accepting another’s choice of game.</p> <p>A maximum of 3 games were played in each play session.</p> <p>Prior to the 5th and final play session on each intervention day, the research assistant in the play room switched the game set for the generalization trial.</p> <p>Clinicians (allied health professionals) and teaching assistants</p> <p>JASPER</p> <p>Use naturalistic strategies to target children’s social engagement. Teaching assistants focused on engaging the child by creating play routines through imitation and modeling of new play acts. Furthermore, Teaching assistants expanded children’s initiations of play as well as nonverbal and spoken communication.</p>	<ul style="list-style-type: none"> • Mode of delivery • Duration • Clinic • Individual • Reading room and play room (included 6 different games within reach of child). Each participant went to the reading room 4 times/day and the play room 5 times/day
Shire et al. (2017)	<ul style="list-style-type: none"> • Focus • Child • Play skills • Social • Active ingredients • Coaching child 	<p>Use naturalistic strategies to target children’s social engagement. Teaching assistants focused on engaging the child by creating play routines through imitation and modeling of new play acts. Furthermore, Teaching assistants expanded children’s initiations of play as well as nonverbal and spoken communication.</p>	<ul style="list-style-type: none"> • Preschool • Group (5), with one-on-one support from teaching assistant for each child in group • 30 min, 4 times per day (following 90 min verbal ABA program)
Corbett et al. (2016, b)	<ul style="list-style-type: none"> • Focus • Child/peer • Play skills • Social • Active ingredients • Coaching child • Develop supportive relationships 	<p>Peer</p> <p>Twelve trained peers paired with participants with ASD- when possible this was with same-gender, same age peers.</p> <p>Peer training over 2 days consisted of PowerPoint presentations, videos, and guest lectures on ASD behavioral strategies (e.g., positive reinforcement, shaping, redirection), and modeling techniques (live and video modeling). A review of the 10 core SENSE Theater principles: Provide social support; Create a fun, enjoyable and playful environment; Model warm, appropriate social interaction; Encourage and motivate interaction using behavioral techniques; Engage in directed communication; Use gestures and nonverbal communication in directed ways; Engage in imaginative play; Empathic responding; Learning as an active process; Advance learning], ethics training (e.g., confidentiality), and practice of the theatrical games, improvisation, and play that would be taught to the participants.</p> <p>SENSE Theater comprised of theatrical games, role-playing, exercises and preparation of a role for a play.</p> <p>Video Modeling: Participants instructed to practice (approximately 15 min per day) with 20 videos of target behaviors, role-plays, and songs by current typical peers, placed on a password protected website.</p>	<ul style="list-style-type: none"> • Community (theater group) • Group • 10 4 h sessions
Kamps et al. (2015)	<ul style="list-style-type: none"> • Focus • Child/peer • Play skills • Social • Active ingredients 	<p>Teachers</p> <p>10-min adult-led discussion and definitions of the target social communication skill followed by child-adult practice of the target skills, using written and picture cues; and child peer practice with adult feedback: 15-min play/game</p>	<ul style="list-style-type: none"> • School • Group • 30 min peer-network sessions occurred approximately 3 times per week with approximately 6 months of scheduled intervention. Average number of sessions was 50 sessions for kindergarten and 47 sessions for first grade

Table 3 (continued)

Reference	Interventionists and procedure	Setting • Mode of delivery • Duration
	<ul style="list-style-type: none"> • Focus of intervention • Play skills targeted • Intervention active ingredients 	
	<ul style="list-style-type: none"> • Coaching child • Develop supportive relationships 	
Kasari et al. (2016)	<p>activities with peer prompting skill use, and 5-min teacher reinforcement and feedback.</p> <p>Text cues using words and pictures were used to teach the skill by teachers and peers by pointing at the cues to prompt the child with ASD to use the skill.</p> <p>Graduate student researchers and research assistants.</p> <p>Collective establishment of a daily schedule to encourage cohesiveness among group. Activities included conversational exercises, structured games, free play, improvised storytelling, and music. Peers encouraged to lead their own groups with adult supervision as needed. Typically developing peers viewed as positive role models (2–3 classmates to each child with ASD) selected friendship survey results and teacher nominations.</p> <p>The social group targeted peer engagement and acceptance using shared interests to provide the context for interactions.</p> <p>Activities were classroom and playground based. The group leader facilitated play as needed and faded as soon as the children played independently.</p>	<ul style="list-style-type: none"> • School, • Group during morning or lunchtime recess • Total of 16 sessions (2 times per week for 8 weeks), and each session was 30–45 min long
Kasari, Rotheram-Fuller, Loeke, and Gulsrud (2012, b)	<p>Peer</p> <p>Study staff and teachers selected 3 peer models per classroom based upon their social network salience, and teacher opinion of appropriateness.</p> <p>Peers were taught how to identify isolated children and given strategies to engage them. Peers were taught to lend social support via direct instruction, modeling, role playing, and rehearsal to any children in their class that might have social difficulties. The target child with ASD was never directly identified to maintain confidentiality.</p> <p>Clinician (Psychologist)</p> <p>Natural play learning context. Stimulus items included toys and actions. Natural reinforcers. Child-centered, flexible teaching approach.</p> <p>No further details of procedure were provided.</p>	<ul style="list-style-type: none"> • School • Group • Peers met with a trained interventionist for 20 min twice weekly during recess or lunchtime
Bernard-Opitz, Ing, & Kong (2004)	<p>Focus</p> <ul style="list-style-type: none"> • Child/parents <p>Play skills</p> <ul style="list-style-type: none"> • Social <p>Active ingredients</p> <ul style="list-style-type: none"> • Coaching child <p>Develop supportive relationships</p> <p>Focus</p> <ul style="list-style-type: none"> • Child/parents <p>Play skills</p> <ul style="list-style-type: none"> • Social <p>Active ingredients</p> <ul style="list-style-type: none"> • Individual play skills/interests identified and addressed 	<ul style="list-style-type: none"> • Clinic and home • Individual • Each condition lasted 5 weeks with a total of 30 h per child per intervention in the clinic. Parents involved in all sessions and provided 10 additional hours of therapy per week.
Frankel et al. (2010, b)	<p>Focus</p> <ul style="list-style-type: none"> • Child/parents <p>Play skills</p> <ul style="list-style-type: none"> • Social <p>Active ingredients</p> <ul style="list-style-type: none"> • Coaching child • Individual play skills/interests 	<ul style="list-style-type: none"> • Clinic, • Group, • 12 weekly sessions, 60 min in length

Table 3 (continued)

Reference	Interventionists and procedure	• Setting • Mode of delivery • Duration
	<ul style="list-style-type: none"> • Focus of intervention • Play skills targeted • Intervention active ingredients 	
	<p>identified and ad-dressed</p> <p>were coached to make relevant comments, praise the children who were playing, and to join in the play.</p> <p>Parent session: 4 segment including review of parent/child performance on previous homework; handout of new skill reviewed with group; next socialization homework given, and specific concerns were discussed/addressed by facilitator; homework set with children.</p>	
Kasari, Gulsrud, Paparella, Hellemann, and Berry (2015, b)	<p>Parents</p> <p>JASPER</p> <p>Intervention sessions based on developmental and behavioral principles consistent with JASPER. Parents first taught to recognize the child's current developmental level of play and use of social communication gestures. Capitalizing on the child's current level of play and interests, caregivers provided opportunities for the child to initiate interest in a toy/activity and to establish jointly engaged play routines. Parents taught and then used strategies in a structured sequence to keep children engaged, improve their frequency of social communication gestures, spoken words, and play acts.</p>	<ul style="list-style-type: none"> • Clinic • Individual • Parent and child for 1 h/week for 10 weeks (two sessions of 30 min per week) with active coaching of the parent by a trained interventionist. A total of 20 sessions were completed
Kasari, Gulsrud, Wong, Kwon, and Locke (2010, b)	<p>Parents</p> <p>Facilitate development of joint engagement play routines in which the parent could follow the child's interests, maintain, and then expand upon their play activities. These expansions encouraged longer "topics" in which children had more opportunities to communicate.</p>	<ul style="list-style-type: none"> • Clinic • Individual
Kasari et al. (2014)	<p>Caregiver</p> <p>JASPER</p> <p>The interventionists followed a manualized intervention focused on establishing dyadic engagement during 3 routines at home; 1 routine involved play and 2 others involved everyday activities and grooming.</p> <p>Active coaching of caregivers to use strategies for setting up the learning environment, modeling and prompting for joint attention, expanding play, and using developmentally appropriate language.</p>	<ul style="list-style-type: none"> • Home • Individual • Two 1 h sessions per week for 12 weeks
Poslawsky et al. (2015, b)	<p>Parent</p> <p>Focus</p> <p>Parent</p>	<ul style="list-style-type: none"> • Home • Individual

Table 3 (continued)

Reference	Interventionists and procedure	• Setting • Mode of delivery • Duration
	<ul style="list-style-type: none"> • Focus of intervention • Play skills targeted • Intervention active ingredients 	
	<p>Play skills</p> <ul style="list-style-type: none"> • Social <p>Active ingredients</p> <ul style="list-style-type: none"> • Coaching child • Develop supportive relationships • Individual play skills/interests identified and addressed 	<ul style="list-style-type: none"> • Five home visits of 60–90 min each at a 2-weekly frequency over 3 months
Kretzmann, Shih, & Kasari (2015)	<p>Teachers</p> <p>Intervention included information sharing, active coaching on the playground and support fading. Coaching included helping identify children unengaged; modeling how to set up playground and strategies to help children engage with each other; and knowing when to facilitate and fade support for children.</p> <p>Teachers</p> <ul style="list-style-type: none"> • School • Group • Daily active coaching on the playground by researchers to train para-professionals over 1 term (between 8 and 10 sessions). 	
Chang, Shire, Shih, Gelfand, and Kasari (2016, b)	<p>Teacher (coached by clinician)</p> <p>JASPER</p> <p>6 activity centers each targeting a separate area: symbolic play, independent play, communication, fine motor, independent activities, and snack</p> <p>Teachers coached to be: less directive and use environmental strategies provision of appropriate toys and seating arrangements for small groups to support child's sequence of development. Teachers coached in strategies to increase awareness and initiations of peer-to-peer interactions, including becoming highly responsive to initiations of play and communication from children, expanding initiation attempts and providing fewer verbal prompts of play acts.</p> <p>Focus</p> <ul style="list-style-type: none"> • Teacher <p>Play skills</p> <ul style="list-style-type: none"> • Social <p>Active ingredients</p> <ul style="list-style-type: none"> • Develop supportive relationships • Individual play skills/interests identified and addressed 	<ul style="list-style-type: none"> • Preschool • Small group or one-on-one at each station • 15 min on site live intervention coaching sessions were provided for 8 weeks (maximum of 60)
Wong (2013)	<p>Teachers coached by trained interventionists</p> <p>JASPER</p> <p>Using both behavioral strategies and principles of milieu teaching with an emphasis on embedding strategies targeting symbolic play (4 sessions) and joint attention (4 sessions) into teachers' everyday classroom routines and activities. Includes an individualized approach where teachers could choose to implement activities for the whole class, in small groups, and/or in a one-on-one setting.</p> <p>Focus</p> <ul style="list-style-type: none"> • Teachers <p>Play skills</p> <ul style="list-style-type: none"> • Symbolic <p>Active ingredients</p> <ul style="list-style-type: none"> • Develop supportive relationships 	<ul style="list-style-type: none"> • Preschool classroom • Group • Weekly session including 10–15 min observation by the interventionist in the classroom followed by 1 h training session at a convenient time

Table 4 Characteristics of included studies

Reference	Methodological quality (QualSyst) on play	Study outcome focus	Age years (mean ± SD)	Inclusion/exclusion criteria	Play outcome measure	Treatment outcome
Bernard-Opitz, Ing, & Kong (2004)	<ul style="list-style-type: none"> • Good quality: 71% • Play 1 vs play 2 	Primary—plus other primary outcome of joint attention measures	<p>Play/behavior group = 3.3 ± 0.95</p> <p>Behavioral/play group = 3.2 ± 0.4</p>	Autism diagnosis on ADI-R. One child did not meet one criterion by 1 point.	<p>Prelinguistic-ADOS SPT</p> <p>5-min video interactions coded for compliance, attending behavior and communication</p>	<p>Five participants (children 1, 2, 3, 6, and 7) gained an average of 8.1 months on the SPT. Two children (4 and 8) who started with the lowest scores (< 12 months age equivalent) did not show any improvement in performance on the test. Child 5 obtained a lower post-intervention test score.</p> <p>Children in imitation group vs children in contingently responsive play group showed more time engaging in reciprocal play ($t = 4.06, p < 0.001$).</p>
Field, Field, Sanders, and Nadel (2001, b)	<ul style="list-style-type: none"> • Adequate quality: 64% • Play 1 vs play 2 • Contingent responsiveness group, $N = 10$ • Imitation group, $N = 10$ 	<p>Primary—“reciprocal play” was one of 14 coded behaviors. Others included stereotypes, inactivity, playing alone, accepting object, playing with object, looking at adult, mirror play, smiling/laughing</p>	<p>Contingent responsiveness group mean = 5.6 ± 1.2</p> <p>Imitation mean = 5.2 ± 1.5</p>	<p>DSM-IV diagnosis of autism recruited from a school for children with autism.</p> <p>Non-verbal. Children were middle socioeconomic status ($M = 2.9$ on the Hollingshead Index) and varied on ethnicity</p>	<p>Video recorded sessions coded for behaviors every second over the 12 min.</p>	<p>Children in imitation group vs children in contingently responsive play group showed more time engaging in reciprocal play ($t = 4.06, p < 0.001$).</p>
Kasari et al. (2016)	<ul style="list-style-type: none"> • Strong quality: 93% • Play 1 vs play 2 • Engage, N (entry) = 82 • Skills, N (exit) = 76 • Skills, N (entry) = 66 • Skills, N (exit) = 57 	<p>Secondary—primary outcome was social network connections from peer nomination measure</p>	<p>Engage = 8.13 ± 1.55</p> <p>Skills = 8.23 ± 1.63</p>	<p>Diagnosis of autism confirmed by ADOS and social communication questionnaire; $IQ > 65$ (abbreviated Stamford Binet-5); aged 6–11 years; elementary school (grades 1–5) in a general education classroom for a minimum of 80% of the school day</p>	<p>POPE: interval coding system that identifies durations of joint engagement with peers or solitary play.</p>	<p>Children in the skills group improve significantly more than the children in the engage group ($F(1,121) = 4.32, p = 0.040$).</p> <p>Children in the skills group significantly decreased in the percentage of time spent in isolation compared to the children in the Engage group. ($F(1,121) = 10.01, p = 0.002$).</p>
Kasari et al. (2014, b)	<ul style="list-style-type: none"> • Strong quality: 89% • Play 1 vs play 2 • CMM N (entry) = 60 • CEM N (exit) = 59 • N (entry) = 52 • N (exit) = 48 	<p>Primary—as well as joint engagement and joint attention</p>	<p>CMM = 41.9 ± 10.0</p> <p>CEM = 42.8 ± 10.21 (months)</p>	<p>Aged between 2 and 5 years; Mullen mental age above 12 months; independent assessors confirmed clinical diagnosis of ASD using the ADOS exclusion children who had known genetic comorbidities.</p>	<p>SPA: functional and symbolic play types.</p>	<p>Neither group exhibited significant treatment or maintenance effect in functional play types.</p> <p>The difference in change in symbolic play between the two groups (more than doubling for the CMM group) yielded a moderate effect size, 0.30.</p> <p>The effect of CMM on symbolic play was not maintained at the 3 month follow-up.</p>
Kasari, Rotheram-Fuller, Locke, and Gulsrud (2012, b)	<ul style="list-style-type: none"> • Strong quality: 85% • Play 1 vs play 2 • Child $N = 15$ • Peer $N = 15$ 	<p>Secondary—social skills and social network salience were primary outcomes</p>	<p>Child = 8.23 ± 1.48</p> <p>Peer = 7.60 ± 1.35</p>	<p>Met criteria for ASD on the ADI-R and the ADOS; fully included in a regular education classroom for at least 80% of a school day; between the ages of 6 and 11 years old; in</p>	<p>POPE: time interval behavior coding system. Independent, blinded observers of target child in the playground for 40 consecutive seconds and then coded for 20 s, during the</p>	<p>There was a faster decline over time in solitary engagement in the playground for children randomized for the peer condition than for children not randomized for the peer condition. Solitary engagement at the</p>

Table 4 (continued)

Reference	Methodological quality (QualSyst) on play	Study outcome focus	Age years (mean \pm SD)	Inclusion/exclusion criteria	Play outcome measure	Treatment outcome
	<ul style="list-style-type: none"> • Methodological quality (QualSyst) on play • Group design • Participant groups (<i>N</i>) 					
Chang, Shire, Shih, Gelfand, and Kasari (2016, b)	<ul style="list-style-type: none"> • Strong quality: 89% • Play 1 vs no intervention • Immediate treatment = 38 • Wait-list control = 28 	Primary—plus other primary outcome of joint attention measures	<p>Immediate treatment = 48.87 \pm 6.30</p> <p>Wait-list control = 51.64 \pm 6.46 (months)</p>	<p>grades 1–4; had an IQ of 65 or higher (independently assessed using the WISC-IV); did not have additional diagnosis</p> <p>Diagnosis of ASD confirmed by ADOS-Second edition; aged 3–5 years of age; enrolled in autism specific preschool program with ABA based curriculum</p>	<p>recess or lunch play period (average of 15 min/observation). Playground engagement states were expressed as the percentage of intervals the target child spend in solitary play (i.e., unengaged with others) and jointly engaged with others (i.e., turn taking in games with rules and engagement with conversations or joint activities).</p> <p>SPA: number of unique spontaneous play types and frequency of simple, combination plus presymbolic and symbolic play</p>	<p>end of treatment was not different for either group but was significant at follow-up for peer group, but not for child group.</p> <p>No significant differences in joint engagement at post treatment for either group however, joint engagement was significantly higher at follow-up for peer group but not for child group.</p> <p>Greater rate of improvement in simple and functional play types, from start of treatment to exit as compared to the wait-list control group's rate of change, $F(1,57) = 7.07, p = 0.010$; $F(1,57) = 8.77, p = 0.0045$. No significant effect of treatment for change in symbolic play types, $F(1,57) = 2.12, p = 0.151$.</p>
Corbett et al. (2016, b)	<ul style="list-style-type: none"> • Good quality: 79% • Play 1 vs no intervention • Immediate treatment = 17 • Wait-list control = 16 	Secondary—primary was social ability	<p>Immediate treatment = 11.27 \pm 2.51</p> <p>Wait-list control = 10.74 \pm 1.89</p>	<p>ASD diagnosis corroborated by ADOS administered by research-reliable personnel; IQ \geq 70 as measured by the WISC-IV</p>	<p>Peer interaction paradigm: 20 min semi-structured playground interaction in which child with ASD engaged in play with two trained, gender-and-age-matched peers. Peer 1 (novel peer in the pretest and returned as familiar peer during post-test) elicited play as directed by periodic ear-bud from out-of-sight research personnel. Peer 2 was a different novel peer during each playground visit. Continuous timed event coding of group and equipment play was conducted from video recordings. Group play was defined as the duration of activity when the participant is</p>	<p>IT, group play preintervention: mean = 61.9 (SD 28.44)</p> <p>WLC group play, mean = 60.8 (SD38.42)</p> <p>Pretest adjusted post mean differences: group play, immediate treatment, 62.75 (SD30.03)</p> <p>WLC, 39.64 (SD30.02)</p> <p>$F(1,27) = 4.35, p = 0.04, d = 0.77$.</p>

Table 4 (continued)

Reference	Methodological quality (QualSyst)	Study outcome focus	Age years (mean ± SD)	Inclusion/exclusion criteria	Play outcome measure	Treatment outcome
<p>Frankel et al. (2010, b)</p> <ul style="list-style-type: none"> • Strong quality: 86% • Play 1 vs no intervention • Children's friendship training = 35 • Delayed treatment control = 33 	<p>Primary—as well as other social measures</p>	<p>Children's friendship training = 8.6 ± 1.3</p> <p>Delayed treatment control = 8.5 ± 1.3</p>	<p>Satisfied ADOS-Generic and ADI-R criteria for ASD; currently, 2nd through 5th grade regular classroom for most of the school day without a “shadow”/adult close by; not currently prescribed psychotropic medication; Verbal IQ > 60; able to follow others child's lead to switch conversation; adequate knowledge of rules for at least two common age-appropriate board games and to play common school yard games; absence of a thought disorder; free of clinical seizure disorder, gross neurologic disease or other medical disorder</p>	<p>engaging with the group together in an activity by using the same types of equipment or toys as other members of the group.</p> <p>Quality of Play Questionnaire—Parent</p>	<p>Significant change in host and disengage subscales. No significant change for guest, conflict or engage subscales.</p> <p>Host: $[F(1, 61) = 25.29, p < 0.0001]$</p> <p>Guest: not significant</p> <p>Conflict: $[F(1, 59) = 3.44, p = 0.069]$</p> <p>Engage: not significant</p> <p>Disengage: $[F(1, 59) = 28.08, p < 0.0001]$</p>	
<p>Kamps et al. (2015)</p> <ul style="list-style-type: none"> • Strong quality: 89% • Play vs no intervention • Experimental group, $N = 56$ • Comparison group, $N = 39$ <p>Note: block-randomization procedure (by class) was used for this study.</p>	<p>Primary—total communicative acts (initiations and responses) during naturally occurring social times (e.g., recess, lunch) with peers.</p>	<p>Experimental group = 5.8 (range 5.17 to 6.8)</p> <p>Comparison group = 5.8 (range 5.21 to 6.8)</p>	<p>Fully or partially included in regular kindergarten in public school system with access to typically developing peers; 2–3-word phrases to make requests (based on teacher report/researcher observation); follow simple directions were of natural interactions</p> <p>A standard score of 50 or higher on the Peabody Picture Vocabulary Test 4; educational determination of ASD</p> <p>Exclusion criteria: severe cognitive disability as</p>	<p>Generalization probe; 10 min operation using the <i>Noldus</i> observation protocol. In naturally occurring social times (e.g., recess, lunch). No instruction, adult prompts, or reinforcement occurred during these probes. Observations were of natural interactions between the child with ASD and any peer nearby (trained or untrained).</p>	<p>Significant differences were noted for the experimental group for growth over time (increase initiations with peers) compared to the control group (not for responses or total communication). $\beta = 0.078$; SE = 0.026; $p = 0.003$</p>	

Table 4 (continued)

Reference	Methodological quality (QualSyst)	Study outcome focus	Age years (mean \pm SD)	Inclusion/exclusion criteria	Play outcome measure	Treatment outcome
Kasari, Gulsrud, Wong, Kwon, and Locke (2010, b)	<ul style="list-style-type: none"> Strong quality: 86% Play vs no intervention Immediate Treatment $N = 19$ Wait-list $N = 19$ 	Secondary—joint attention was primary	Immediate Treatment = 30.35 ± 0.93 Wait-list = 30.31 ± 0.90 (months)	determined by teachers or educational records. Younger than 36 months; Met criteria for autism following DSM-IV criteria by an independent clinician, parents were interviewed with the ADI-R to validate clinical diagnosis of autism; Did not have additional syndromes	15-min video-taped interaction between caregiver and child. Caregivers were asked to engage in free play with their child with autism as they normally would at home using a standard set of toys. Videos were coded for the percentage of time in engagement states. Child's activity was segmented into unengaged/other engagement, object--engagement, or joint engagement.	Children in the IT group engaged in significantly less object-focused play ($F(3,34) = 4.45, p < 0.01$) and significantly more joint-engagement ($F(3,34) = 3.21, p < 0.05$) compared to children in the WL group. There was no significant difference between groups for the category for unengaged/other-engagement. Children in the IT group also displayed significantly more types of functional play acts compared to the WL group. ($F(3,34) = 6.21, p < 0.05$). Children in the IT group did not show increased diversity of symbolic play compared to children in the WL group.
Kretzmann, Shih, & Kasari (2015)	<ul style="list-style-type: none"> Strong quality: 93% Play vs no intervention Immediate treatment = 13 Wait-list control = 11 	Primary—peer engagement	8.3 ± 1.3	Included in the general curriculum, 20 received a diagnosis of ASD by psychologists or psychiatrists using DSM-IV-Text Revised criteria according to school record review. 4 children did not have a diagnosis for ASD but were assessed with the ADOS and met the criteria for ASD.	POPE. The main variable derived from the POPE for this study was the duration of peer engagement (amount of time actively engaged in games, conversations, interactions with peers). Symbolic play type refers to the total number of different novel, child-initiated symbolic play acts. Symbolic play type refers to the total number of different novel, child-initiated symbolic play acts.	Significant effect on treatment and time effect with children in the treatment immediately (IT) group. $F(91, 108) = 10.68, p = 0.002$. The difference in peer engagement by the end of treatment more than doubled for the IT group and corresponded to a strong treatment effect of 1.27. In a separate analysis, the effect of treatment for the IT group was maintained at follow up, $F(1,35) = 6.76, p = 0.014$.

Table 4 (continued)

Reference	Methodological quality (QualSyst)	Study outcome focus	Age years (mean ± SD)	Inclusion/exclusion criteria	Play outcome measure	Treatment outcome
	<ul style="list-style-type: none"> • Methodological quality (QualSyst) on play • Group design • Participant groups (N) 					
Shire et al. (2017)	<ul style="list-style-type: none"> • Strong quality: 93% • Play vs no intervention • JASPER, N = 56 Treatment as Usual Wait-List, N = 59	Secondary—primary was joint engagement	JASPER = 31.71 ± 2.94 Treatment as usual wait-list = 31.54 ± 3.17 (months)	Program enrolment was the only criteria for study inclusion; Eligible children included those who demonstrated a delay of at least two standard deviations in one functional domain or lesser delays in more than one functional domain; Minimum of 24 months of age to enter and aged out at approximately 36 months.	Children's play videos were examined for spontaneous play types. Each play type was coded as one of four play levels, including simple, combination, presymbolic, and symbolic play. Combination and presymbolic categories were combined into functional play.	Rate of improvements during the treatment phase were not statistically significant across groups for responsive $F(1,229) = 0.5, p = 0.48$, or strategic behaviors $F(1,229) = 1.97, p = 0.16$. Overall, responsive strategy use scores were significantly improved over time for paraprofessionals in the IT group compared to the WL group, $F(1, 173) = 14.88, p < 0.001$, with a strong treatment effect of 1.05. The treatment effect was not maintained as the IT group did not maintain significant gains at follow-up compared to entry, $F(1, 139) = 1.86, p = 0.1743$. There was no overall effect of time or treatment for simple play. There was a significant effect of time for functional $(F(1,91) = 18.67, p < 0.001, ES = 0.45)$ and symbolic play $(F(1,91) = 35.48, p < 0.001, ES = 0.62)$, where children in both groups improved their diversity of functional play, but no treatment difference was found for either level.
Goods, Ishijima, Chang, and Kasari (2013, b)	<ul style="list-style-type: none"> • Strong quality: 86% • Play vs non-play • JASPER treatment group, N = 7 ABA therapy control group, N = 8	Primary—as well as other social measures	JASPER = 48.73 ± 11.68 ABA = 54.68 ± 10.25 (months)	Between 3 and 5 years old; Clinical diagnosis of autism; Attended non-public school; Used less than 10 communicative words by parent and teacher report and during the baseline and entry assessments.	SPA: coded for play types, a measure of play diversity which sums the number of unique spontaneous and functional play acts.	Significant difference in diversity of spontaneous play ($p = 0.04$), effect size $d = 0.81$.
Kasari, Gulsrud, Paparella, Hellemann, and Berry (2015, b)	<ul style="list-style-type: none"> • Strong quality: 93% • Play vs non-play • JASPER N = 43 	Secondary—joint engagement was primary outcome	JASPER = 30.7 ± 3.5 Psychoeducational intervention = 32.3 ± 2.7 (months)	Younger than 36 months; Clinical diagnosis of ASD confirmed by independent testers with the ADI-R and ADOS; no significant physical	Child's play behaviors during the mother-child interaction were coded for types of functional and symbolic play acts. Highest play level that the	Using the Poisson model, there was a significant treatment by time interaction for the highest play level achieved. [0.36, 95% CI (0.11, 0.61), $F(1, 84) = 9.07, p < 0.01$], such that

Table 4 (continued)

Reference	Methodological quality (QualSyst) on play	Study outcome focus	Age years (mean \pm SD)	Inclusion/exclusion criteria	Play outcome measure	Treatment outcome
	<ul style="list-style-type: none"> • Methodological quality (QualSyst) on play • Group design • Participant groups (<i>N</i>) 					
	<ul style="list-style-type: none"> • Adequate quality: 64% • Play vs non-play • Lego, <i>N</i> = 16 • Social Use of Language Program, <i>N</i> = 15 	<p>Psychoeducational intervention <i>N</i> = 43</p> <p>Secondary—Vineland Adaptive Behavior Scale and Social Interaction subscale of Gilliam Autism Rating Scale was primary outcome measure</p>	<p>Lego = 99.13 \pm 20.14</p> <p>Social Use of Language Program = 97.33 \pm 22.33 (months)</p>	<p>disabilities; parent and child were available for follow-up assessments</p> <p>Current diagnosis of HFA, ASD, autism or AS by clinical psychologist, psychiatrist or pediatrician. Diagnoses were confirmed using the ADI-R; Between 6 and 11 years; IQ > 70; able to speak in phrases; currently receiving no other behavioral interventions or attending social skills groups; attending mainstream education or an inclusion unit within a mainstream school; no additional diagnoses of childhood psychiatric disorders.</p>	<p>child was observed to maintain during the interaction was assigned a numerical value for subsequent analysis.</p> <p>Highest play level achieved is a function of functional and symbolic play acts.</p> <p>Direction observation in the school playground at break time, 10-min of suitable data available for each child.</p>	<p>the JASPER group increased more than the psychoeducational intervention group in highest play level achieved, although the effect size was small (Cohen's $f^2 = .11$). At follow-up, the difference between the treatment groups was no longer significant, and there were no overall sustained treatment gains</p> <p>No significant differences between the two groups at "time one" or "time two". However, a trend for the Lego group to improve more in the mean duration of social interactions than the SULP group and within group analysis showed a significant increase in duration of interactions for the Lego group ($z = -1.988$, $p < 0.05$, n-ties = 10) but not for the SULP group, though the magnitude of this change was small.</p>
Postlawsky et al. (2015, b)	<ul style="list-style-type: none"> • Strong quality: 96% • Play 1 vs non-play • VIPP-AUTI, <i>N</i> = 40 • Care as usual, <i>N</i> = 38 	<p>Secondary—parent/child interaction and Autism symptomatology are primary outcomes</p>	<p>VIPP-AUTI = 42.16 \pm 9.02</p> <p>Care as usual = 43.80 \pm 10.92 (months)</p>	<p>Diagnosed with autistic disorder or pervasive developmental disorder not otherwise specified at the university hospital; aged 0–5 years; primary caregiver had a permanent residence and child and caregiver lived at the same address</p> <p>Exclusion criteria: primary caregivers who did not speak or understand the Dutch language; primary caregivers who did not care for the child themselves; children with interfering co-morbid medical problems.</p>	<p>Child play behavior was videotaped (15 min free-play session) at the university hospital and at home by the researchers.</p> <p>The children were provided with a standardized set of toys.</p> <p>The parent was instructed to passively monitor while the child was playing. When the child was seeking contact or interaction, the parent was allowed to respond in a natural way. Video segments were coded by trained students for toy-preference and level of play category; (a)</p>	<p>No significant intervention effect was found on children's play behavior. Children in both groups showed the same levels of play and variation in play.</p>

Table 4 (continued)

Reference	Methodological quality (QualSyst)	Study outcome focus	Age years (mean ± SD)	Inclusion/exclusion criteria	Play outcome measure	Treatment outcome
Kasari, Freeman, and Paparella (2006, b)	<ul style="list-style-type: none"> • Strong quality: 86% • Play 1 vs play 2 vs no intervention • Joint attention = 20 • Play group = 21 • Control = 17 	Primary—as well as other social measures	<p>Joint attention = 43.20 ± 7.05</p> <p>Symbolic play = 42.67 ± 6.93</p> <p>Control = 41.94 ± 4.93 (months)</p>	<p>3 or 4 years of age, clinical diagnosis of autism confirmed with ADOS assessment and ADI-R administered to parents by blind trained assessors.</p> <p>Excluded were children who had seizures, were 5 years of age or older, had additional medical diagnoses (e.g., genetic syndromes), were geographically inaccessible for follow-up visits (e.g., international families), or did not plan to stay in Early Intervention Program for at least 4 weeks</p>	<p>manipulative, (b) relational, (c) functional, (d) symbolic play, every 10 s during 15 min. The highest level of play shown and variation in play by toy preference were using in analysis.</p> <p>SPA: functional play types, symbolic play types, and play level (represents the highest, most frequent, and flexible level at which the child played with mastery, ranging from 1 physical and conventional combinations to 14 sociodramatic and thematic/fantasy play).</p>	<p>Compared to both the joint attention group (EF 0.51) and the control group (EF 1.13); the play group improved their levels of play significantly more over the course of the intervention.</p>
Quirnbach, Lincoln, Feinberg-Gizzo, Ingersoll, and Andrews (2009, b)	<ul style="list-style-type: none"> • Good quality: 79% • Play 1 vs play 2 vs no intervention • Standard = 15 • Directive = 15 • Control = 15 	Secondary—social skills are primary	<p>Standard = 9.49 ± 2.09</p> <p>Directive = 10.33 ± 2.53</p> <p>Control = 8.85 ± 1.59</p>	<p>Aged 7–14 years, recruited through several agencies in San Diego that provides services to families who have children with autism, confirmed with ADOS, had to have at least a first grade reading level on the reading recognition and reading comprehension subtest of the PIAT-R</p>	<p>Social skills score based on 4 individual behavioral scores (coded by independent raters): (a) greeting behaviors, (b) requesting to play a game, (c) asking another person what they want to play, (d) accepting another's choice of game.</p>	<p>Significant main effect for condition, $F(2, 42) = 4.31, p < 0.05$. Children who received either the standard or directive social story intervention showed significant higher game play skill scores than the children who received the control story. No significant difference between the standard or directive groups.</p>
Wong (2013)	<ul style="list-style-type: none"> • Strong quality: 89% • Play 1 vs play 2 vs no intervention • SP-JA = 5 teachers, 10 children • JA-SP = 4 teachers, 14 children 	Secondary—primary is engagement states (child and another person are actively involved in the same object or toy) and joint attention (child responds to another's bid for joint attention or initiates a bid for joint attention)	<p>Children</p> <p>JA-SP = 4.7 ± 0.87</p> <p>SP-JA = 4.5 ± 0.4</p> <p>Wait-list control = 5.0 ± 0.9</p>	<p>Preschool aged children diagnosed with autism (validated with the CARS)</p>	<p>Classroom observations: Symbolic play Functional play SPA: structured play—play level</p>	<p>SPA play level—no control scores reported. Comparison of SP-JA and JA-SP groups at pre and post, but not mid-intervention before crossover of intervention styles.</p> <p>SP-JA treatment group made significant greater increase in Symbolic play acts/min ($p < 0.05$; effect size $d = 0.51$). No significant difference between groups for functional play</p>

Table 4 (continued)

Reference	Methodological quality (QualSyst)	Study outcome focus	Age years (mean ± SD)	Inclusion/exclusion criteria	Play outcome measure	Treatment outcome
	<ul style="list-style-type: none"> • Methodological quality (QualSyst) on play • Group design • Participant groups (N) 					
		Control = 5 teachers, 10 children				acts/min or play level.

ABA applied behavior analysis, *ADLR* Autism Diagnosis Interview—Revised, *ADOS* Autism Diagnosis Observation Schedule, *ASD* autism spectrum disorder, *CEM* Caregiver Education Module, *CMM* Caregiver Mediated Module, *DSM-IV* Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, *JA-SP* Joint attention followed by Symbolic Play Intervention, *JASPER* Joint Attention, Symbolic Play, Engagement, and Regulation, *POPE* Playgroup Observation of Peer Engagement, *SP-JA* Symbolic Play followed by Joint Attention intervention, *SPT* Symbolic Play Test, *SPA* Structured Play Assessment, *VIPP-AUTI* Video-feedback Intervention to promote Positive Parenting adapted to Autism, *WISC-IV* Wechsler Intelligence Scale for Children, Fourth Edition

Risk of Bias within Studies

The fail-safe N calculated during meta-analysis is 67, indicating a low-risk of publication bias. This means that we would need to locate and include 67 “null” studies for the combined 2-tailed *p* value to exceed 0.050.

Discussion

The aim of this study was to review and analyze the evidence for interventions to improve social play skills in children with ASD. A systematic review and meta-analysis of RCT studies were completed using the PRISMA and PRISMA-P statement as guides (Moher et al. 2009; Shamseer et al. 2015). The present study included 19 RCTs with a total of 1149 participants investigating the effectiveness of interventions to improve social play in children aged 2 to 12 years with ASD. When comparing individual child vs group interventions, the meta-analysis of 11 of these studies identified a small but significant effect size in favor of interventions focused on the individual child, as compared with group interventions. In terms of the focus of the intervention, the meta-analysis demonstrated significantly better outcomes if the focus of the intervention was the child with ASD, as opposed to parents, peers, or teachers. The meta-analysis in this review showed that it is not one intervention characteristic, but the combination of different intervention components that lead to the development of improved play skills.

This systematic review allows clinicians to identify combinations of intervention components that may be effective to use with children with ASD to improve play outcomes and provide recommendations for future research. However, the definition of play and how it is measured are inconsistent across different studies. This inconsistency of definition and reporting is a challenge for clinicians when attempting to identify effective play interventions for children with ASD. Similarly, further investigations require consistent understanding and clear reporting of what play is to allow researchers to develop and test the multimodal and active ingredients in effective play interventions. The findings of the meta-analysis show a small effect size which indicates that play interventions are feasible and achievable in clinical practice; however, there is a continued need to add to the evidence for play based-interventions to further strengthen them.

Intervention Approaches

The most commonly used approaches to improve play skills across studies included: twelve studies created supportive environments and relationships by upskilling peers, parents or teachers; ten studies used coaching the child with ASD; ten studies identified and developed individualized play skills and

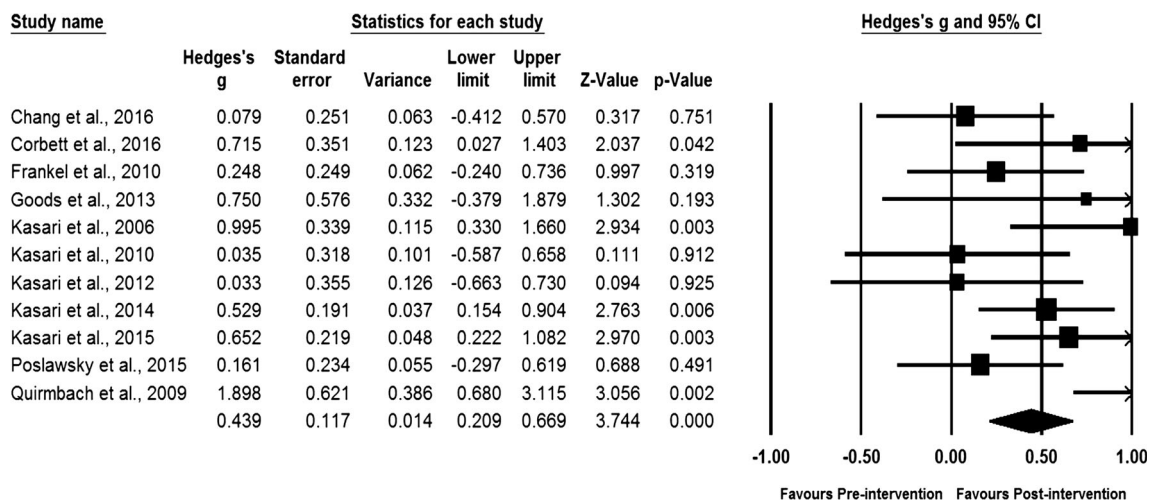


Fig. 2 Within-group pre-post intervention meta-analysis

interests for each individual child on a case-by-case basis; one study investigated only adult imitative behavior of the child (as opposed to developing the child’s skills) (Field et al. 2001, b); and one study used social stories (Quirnbach et al. 2009, b).

It is difficult to identify which approaches are essential in improving play skills. One study that demonstrated significant large treatment effects utilized both coaching of the child with ASD and identifying and developing individual play skills (Kasari et al. 2006, b). The researchers did this by utilizing specific techniques using naturally occurring opportunities to prompt a particular treatment goal, such as imitating child’s actions on toys and using the child’s activity interests to develop play routines. Of the three studies that demonstrated significant moderate treatment effects, two included both supportive environment and relationships and development of individual play skills (Kasari et al. 2014, b, 2015, b). Both approaches in these studies used specific techniques to create opportunities of establishing jointly engaged play routines. The third study with moderate treatment effects included the

approaches of supportive environment and relationships and coaching of the child with ASD (Corbett et al. 2016, b). Techniques included the use of video modeling and peer mediators (Corbett et al. 2016, b). Creating supportive relationships through the upskilling of parents, teachers, and peers in interventions may also provide support for generalization of play skills across environments and with other people. These relationships are frequently responsible for creating the social environment for interaction and transaction for the child with ASD. Parent, peer, and teacher mediated interventions show promise and require further development and investigation.

Intervention Dosage

Intervention dosage refers to the quantity of treatment provided and can be reported as total hours or over a set period of time, such as 1-h session per week (Linstead et al. 2017). Ten of the 19 studies reviewed reported either one or two sessions per week and four of the five effective interventions with the

Table 5 Regression analysis

Main results for model 1, random effects (MM), Z-distribution, Hedges' g								
	Covariate	Coefficient	Standard error	95% lower	95% upper	Z value	1-sided P value	Set
Focus	Intercept	1.7304	0.6046	0.5454	2.9154	2.86	0.0042	
	Child vs parent	-1.4693	0.6416	-2.7268	-0.2118	-2.29	0.0220	Q = 8.52, df= 3, p = 0.0364
	Child vs peer	-0.6363	0.4554	-1.5289	0.2562	-1.40	0.1623	
	Child vs teacher	-0.6343	0.3793	-1.3777	0.1091	-1.67	0.945	
Setting	Clinic vs home	0.0433	0.2606	-0.4674	0.5541	0.17	0.8679	Q = 2.55, df= 3, p = 0.2800
	Clinic vs school	-1.0606	0.6684	-2.3706	0.2494	-1.59	0.1125	
	Intercept	-0.0621	0.5480	-1.1362	1.0120	0.11	0.9098	
Delivery	Individual vs group	0.6380	0.4541	-0.2519	1.5280	1.41	0.1600	
Setting	Clinic vs home	-0.2968	0.3916	-1.0644	0.4780	-0.76	0.4485	Q = 1.06, df= 2, p = 0.5897
	Clinic vs school	0.0968	0.4682	-0.8209	1.0144	0.21	0.8363	

largest effect sizes, utilized either daily or twice weekly sessions over multiple weeks (six to 12 weeks; Corbett et al. 2016, b; Kasari et al. 2006, b, 2014, b, 2015, b). Multiple opportunities over time are needed to allow for practice of social play skills from joint engagement to initiating play to joining in with peers who are already playing. This is similar to findings from the 2005 review of play therapy that identified the efficacy of treatment delivered by a therapist increases with the number of sessions (up to a range of between 30 and 35 sessions; Bratton et al. 2005).

The session duration for the majority of interventions in this review was between 30 min and an hour. Play interventions in this review were less time intensive when compared to weekly social skills training interventions. Social skills training intervention session duration ranged from 1 to 3 h across eight studies, and in another review focusing only on group interventions, session duration ranged from 1 to 1.5 h across five RCT studies (Rao et al. 2008; Reichow et al. 2013). This difference in time may be reflective of the age of participants in the play interventions (ranging from 2 to 12 years). Using shorter session for younger participants is developmentally more appropriate to support engagement and learning, compared with the older participants in the social skills interventions (ranging from 6 to 18 years). Regardless, the play intervention session duration range in this review appears to be feasible.

In considering what the optimal dosage may be, the current review identified that three of the five interventions with large effect sizes involved sessions of between 30 min and an hour with multiple sessions per week and a total number of intervention hours ranging from 10 to 15 h (Kasari et al., 2006, b, 2014, b, 2015, b). Kasari et al. (2006, b) compared daily 30 min sessions in a preschool setting (focusing on symbolic play, as compared to a joint attention intervention of the same duration and a no treatment control group), whereas Kasari et al. (2015, b) compared a twice weekly 30-min play session with a weekly 60-min parent only psychoeducational intervention. Kasari et al. (2014, b) compared a twice-weekly 60-min play session with the child and parent in the home with a weekly 2-h parent only education group program. Authors of a 2017 review of behavioral interventions for children with ASD in a clinical setting found a linear relationship between treatment intensity and treatment outcomes (Linstead et al., 2017). Linstead et al. (2017) examined results of 726 children with a mean age of 7.1 years and found the intensity of the intervention accounted for 35% of the variance in treatment outcomes. Multiple sessions over time allow for complex skills to be developed, reviewed, and assimilated, supporting possible generalization of play skills to other environments and with other social partners. Importantly, as social play interactions become more complex across early and middle childhood, intervention

components need to change and meet the demands of the increasingly complex contexts and skills required for successful engagement (Del Giudice, 2014).

Setting

The current review found that the play setting did not seem to favor the effectiveness of the interventions. It may be helpful to consider implementing interventions across various naturalistic settings to reinforce treatment principles and promote generalization of treatment effects. A naturalistic play environment provides the opportunity to develop play skills and interests, assisting with skill generalization across contexts and outside the intervention context. These results are consistent with the results of a previous review of school-based social skills interventions for children with ASD (Bellini, Peters, Benner, & Hopf, 2007). Using meta-analysis analysis of 55 single subject design studies, Bellini et al. (2007) recommended educators in school settings select interventions that could be implemented in naturalistic settings, as opposed to removing children from the classroom or playground for the intervention. Bellini et al. (2007) suggested that the familiarity and inclusion in real social situations had a positive effect on treatment outcomes. Further research is required to investigate contextual factors that influence outcomes. As such, clinicians and educators should not limit their choice of interventions to improve play skills in children with ASD based on setting. Unfortunately, reporting of generalization of play skills across environments has been neglected in the studies included in this review. The lack of reporting of generalization of skills is consistent with other psychosocial interventions for children with ASD (Rao et al., 2008; Reichow et al., 2013). Interventions that provide opportunities to develop skills in real social situations and across different contexts need to be balanced with what is feasible and practical for families, clinicians, and researchers.

Outcome Measures

Play is frequently used to improve other developmental areas, rather than being the focus of the study (Wong et al., 2015). Many studies using a play-based intervention to improve communication and social skills in children with ASD did not use a play outcome measure, resulting in their exclusion from this analysis. These excluded studies typically reported on aspects of social communication, such as joint attention, but not a comprehensive measure that captures the complex skills involved in play.

Play as an independent outcome may have diminished social validity as it is not researched as much as other related skills, such as language and general social skills. Social validity is the significance of the intervention strategies and treatment objectives and refers to the perceived social importance

of the intervention results (Foster & Mash, 1999). Certainly, social interactions with peers have demonstrated social validity but this is not necessarily associated with play skills (Watkins et al., 2015). Furthermore, reduced social validity is often related to reduced treatment fidelity, which, in turn, may influence treatment effects (Callahan et al., 2017). Therefore, there is a need to educate parents, teachers, clinicians, and researchers on the importance of improved play outcomes in and of itself. Clinicians and researchers should consider the feasibility of including additional education and resources for parents and teachers on the importance of improving play as an outcome of the intervention.

Even when studies met the inclusion criteria for this review, play outcomes were not necessarily the primary focus of the intervention. This may be due to reduced social validity of play with clinicians and researchers. An alternative explanation may be that the outcomes focused on foundation level social skills that are easier to observe and therefore measure. For example, joint attention, behavior, and communication outcomes are frequently the outcomes that were measured in play-based interventions. However, it is difficult to say if improvements in these foundation skills contribute to the development of more complex play skills without therapists and researchers also reporting on play outcomes. Using outcome measures that report on play will support the social validity of play and encourage researchers, clinicians, and families to take play seriously (Bundy, 1993). Reporting on both play and social outcomes allows researchers to develop interventions that are more closely aligned with outcomes that families' value and which will impact on peer engagement.

Observation was the most frequent means of measuring play in this review; however, not all observations were reported using validated measures with published psychometric properties. An example of an appropriate norm-referenced standardized assessment is the Child-Initiated Pretend Play Assessment (CHIPPA; Stagnitti, 2007; Uren & Stagnitti, 2009). The CHIPPA measures the complexity of a child's play skills, their ability to use symbols, and being reliant on someone else for play ideas. A possible explanation for why researchers are creating outcome measures specific to the study and not using preexisting outcome measures with proven psychometric properties is because of the difficulty of measuring play in a natural setting, given the complexity and intrinsic motivation inherent to play (Bundy, 1993, 2011). As such, measuring playfulness may provide a consistent, valid, and reliable alternative (Bundy, 1993, 2011). Playfulness is defined as a disposition to engage in play and has been shown to be responsive to change following intervention (Bundy, 2010). The Test of Playfulness is an appropriate outcome measure for observing play in natural settings with robust psychometric properties (Bundy, 2010; Skard & Bundy, 2008).

Recommendations

The continued development of play interventions for children with ASD using RCTs is important. Researchers conducting RCTs need to clearly report the intervention components following the CONSORT statement, so play-based intervention research can be advanced and potentially be adapted to different settings.

Consistent and comprehensive reporting of play outcomes using valid and reliable measures when investigating a play-based intervention is needed. The use of play outcomes by researchers and clinicians will support the social validity of play and allow for balanced comparisons between interventions. Future research should also consider identifying and comparing the active ingredients within an intervention. Specifically, further investigation is recommended into the use of peers and how they could be more effectively utilized to support the child with ASD to improve their play.

Finally, while the current review included children aged 2 to 12 years, there was significant variability in the inclusion criteria of participants of the studies, including developmental ability of the study participants. We recommend that future investigations include descriptive information of participants' language and social skills to enable clinicians to determine if the intervention would be appropriate to their client's needs.

Limitations

The inclusion criteria requiring the studies to report on play outcomes were necessary to be able to compare across studies; however, they were potentially restrictive, and effective play intervention studies may have been missed in this review because they did not explicitly report on play outcomes. While similarities of participant demographics between intervention and comparison groups remained similar across the different studies, there was some variability in the type of comparison groups. Seven of the studies used a wait-list, no treatment control group, while the remaining studies used an alternative treatment comparison group. Due to the differences in these comparison group types, and to make balanced comparisons between the studies, we included only alternative treatment comparison groups' studies used in meta-regression. This ensured homogeneity between comparison groups and outcomes but limited the number of combinations that could be assessed due to collinearity. As a result, significant relationships between study components may not have been identified.

Conclusion

The results of this systematic review and meta-analysis suggest that play-based interventions produced small to medium treatment effects between 0.083 and 0.586 for children with

ASD (Hedges' $g = 0.335$, 95% CI [0.083, 0.586]). Interventions reported on a variety of different approaches and focus of the intervention. There was a significant difference when the intervention focused on the individual child with ASD as opposed to their parent, teacher, or peers or when the intervention was delivered in a group setting. Play is important for children with ASD, but very few social interventions focus on play as an outcome of the interventions. Although 19 studies met the criteria for the systematic review, due to their design or gaps in reporting, they could not be included in the meta-analysis. These findings support the continuing development of interventions with a focus on play skill development in children with ASD that adhere to reporting protocols for RCTs.

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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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