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School-Based Peer-Related Social Competence Interventions for Children with Autism Spectrum Disorder: A Meta-Analysis and Descriptive Review of Single Case Research Design Studies

Kelly J. Whalon · Maureen A. Conroy · Jose R. Martinez · Brittany L. Werch

Abstract The purpose of this review was to critically examine and summarize the impact of school-based interventions designed to facilitate the peer-related social competence of children with autism spectrum disorder (ASD). Reviewed studies employed a single-case experimental design, targeted peer-related social competence, included children 3–12 years old with an ASD, and took place in school settings. Articles were analyzed descriptively and using the evaluative method to determine study quality. Additionally, effect size estimates were calculated using nonoverlap of all pairs method and Tau-U. A total of 37 studies including 105 children were reviewed. Overall, ES estimates ranged from weak to strong, but on average, the reviewed interventions produced a moderate to strong effect, and quality ratings were generally in the acceptable to high range. Findings suggest that children with ASD can benefit from social skill interventions implemented with peers in school settings.

K. J. Whalon (✉)
College of Education, Florida State University, 1114 W. Call Street, P.O. Box 3064450, Tallahassee, FL 32306-4450, USA
e-mail: kwhalon@fsu.edu

M. A. Conroy · J. R. Martinez · B. L. Werch
College of Education, University of Florida, Tallahassee, FL, USA
e-mail: mconroy@coe.ufl.edu

J. R. Martinez
e-mail: j.martinez36@gmail.com

B. L. Werch
e-mail: blwerch@gmail.com

Introduction

Social competence is a critical developmental feature (see Flavel 1977; Piaget 1926; Vygotsky 1978). Defined as the ability "to successfully and appropriately select and carry out interpersonal goals" (Guralnick 1990, p. 4) such as forming and maintaining relationships with others (Cook and Oliver 2011; Stichter and Conroy 2006). Social competence is crucial for succeeding in life. As a child interacts with others, social competence skills begin to develop early and continue to evolve throughout one's life. Social competence is demonstrated in one's interactions with peers including the choice of behaviors used and ability to accomplish a predetermined social goal (Brown et al. 1986; Odom et al. 2008). Although many individuals develop social competence without explicit instruction, for individuals with autism spectrum disorders (ASD) the acquisition of social competence can be quite challenging. In fact, deficits in the area of social competence are considered the most foundational characteristic used to diagnose ASD (American Psychiatric Association 2013; National Research Council 2001). Without learning the skills needed to successfully interact with others in their environment, children with ASD are at a distinct disadvantage in accessing critical learning opportunities required for success later in their lives.

Since the 1960's researchers have investigated select interventions designed to improve social competence skills in children and youth with developmental disabilities, including ASD (see Goldstein and Kaczmarek 1992; McEvoy et al. 1992; Ostrosky et al. 1993; Odom and Brown 1993; Strain 1983). Many of these earlier interventions were conceptualized using an ecobehavioral analytic approach and include systematic manipulation of the social context and/or the social contingencies within that

context (for a discussion see Brown and Conroy 2002, 2012; Brown et al. 2008; McConnell 2002). For example, Strain (1983) demonstrated that when children with ASD are placed in playgroups with typically developing youngsters, they are likely to increase and generalize their peer-related interaction skills. In addition to interventions that modify the social environment, which may serve an evocative effect, researchers have manipulated social contingencies to increase and maintain peer-related social interactions. For instance, Odom and Strain (1986) employed systematic prompting and contingent praise to increase the social initiations displayed by children with ASD toward their peers. Strain et al. (1977) taught typically developing peers to initiate to fellow classmates with ASD, encouraging their social responding and engagement. Stemming from these early investigations, research evolved from isolated practices to intervention packages that combine a variety of practices. For example, Goldstein and colleagues developed a social skills peer intervention program (i.e., Buddy Skills Training Program), which taught children with ASD and their peers how to socially relate and interact with each other (English et al. 1997; Goldstein et al. 1997; Kohler et al. 2007).

Over the past 15 years, as the prevalence of individuals with ASD has increased and the spectrum broadened to include individuals who have Asperger syndrome and who perform well academically, intervention practices targeting social competence have expanded (see Reichow and Volkmar 2010). Not surprisingly, the foci of these social communication interventions and social skills targeted have grown in scope to address the variability represented in the full autism spectrum. For example, the use of video modeling and video self-modeling interventions to teach social competence has increased (for a review, see Bellini and Akullian 2007) along with the use of social stories (e.g., Hanley-Hochdorfer et al. 2010) and other cognitive-based interventions (Cappadocia and Weiss 2011; Wood et al. 2011).

Clearly, intervention research addressing the social deficits of individuals with ASD has advanced over the past several decades. However, given the severity of the deficits and the importance of social competence in overall functioning, progress has been somewhat sparse and the research that has been conducted lacks a systematic framework for building social competence in individuals with ASD. Many of the current investigations teach isolated skills or use isolated intervention strategies that address a single aspect of social competence. In spite of repeated demonstrations of the effectiveness of individual intervention approaches targeting isolated skills, many of these interventions were conducted in controlled settings by researchers, limiting the generality and maintenance of the findings to more authentic settings, such as schools, where many social skills are learned through naturally occurring social interactions with peers. Consequently, little is known about effective social competence interventions that are appropriate for use in school settings during naturally occurring social exchanges with peers.

Peer related social competence is defined as the ability to engage in reciprocal interactions and form relationships with peers (Stichter and Conroy 2006). Researchers report that children with ASD typically display low rates of appropriate social behavior with their peers (Ozonoff and South 2001; Zhang and Wheeler 2011), and consequently form few friendships (Carter et al. 2005). With the increasing number of children with ASD served in school settings, there is a need to examine "what works" when children interact with their peers in school-based environments. The purpose of this review is to critically examine and summarize the current research in this area to provide direction for future research and intervention. Previous reviews have synthesized the literature broadly (e.g., Reichow and Volkmar 2010; McConnell 2002) or targeted specific interventions such as peer-mediated interventions (e.g., Zhang and Wheeler 2011), social stories (e.g., Test et al. 2011), video modeling (e.g., Shukla-Mehta et al. 2010), and social skills groups (e.g., Cappadocia and Weiss 2011). In a previous review of school based interventions, Bellini et al. conducted a meta-analysis of 52 single-case design studies investigating the impact of school-based interventions on the social skills of children with ASD. The authors found that overall, studies had a questionable effect (PND $M = 70$ %) and there was much variability across studies (PND range 17–100 %; Bellini et al. 2007a). To specifically address the peer related social competence of children with ASD, we (1) narrowed the developmental range of participants (preschool through elementary years) as expectations for peer related social competence shift as children age (Kaczmarek 2002), and (2) focused specifically on studies that sought to enhance the social engagement or interaction of children with ASD and their typically developing peers. Thus, we conducted a systematic literature review of school-based interventions that facilitate the peer-related social competence of children with ASD.

Method

Search Procedures and Criteria

To identify appropriate studies for review, the electronic databases ERIC, PsychINFO, and Education Full Text were searched for peer-reviewed articles containing the following search terms: (1) "autism" or "Asperger", (2) "social", (3) "preschool" or "early childhood" or "early

intervention" or "elementary", and (4) "intervention". Additionally, an archival review of the reference list of 16 literature reviews investigating social skills, social competence, or social interactions was completed. A total of 772 articles were screened for inclusion.

To examine the peer-related social skill intervention research conducted in school settings with preschool or elementary-aged children with ASD, we included studies that met the following criteria: (1) employed a single-case experimental design, (2) targeted peer-related social competence (i.e., at least one outcome variable measured interactions/engagement with typically developing peers), (3) included children 3–12 years of age with an ASD diagnosis (i.e., autism, Asperger syndrome, PDD-NOS), (4) took place in a preschool or elementary school, (5) occurred between 2000 and October 2013 (following previous seminal reviews including McConnell 2002; National Research Council 2001), and (6) were published in a peer-reviewed journal. Also, studies were excluded if social competence outcomes were not addressed, or addressed only between children with ASD and adults. Criteria only had to be met for one or more participants for inclusion. For example, if target behaviors varied by participant (e.g., time sitting; Crozier and Tincani 2007), only participants with a target behavior related to social competence are described in this review. Similarly, if the intervention occurred in a non-school setting (e.g., home or community; Parker and Kamps 2011; Shabani et al. 2002), only participants who received the intervention at school were included. Studies without experimental control were excluded (i.e. AB designs). A total of 37 articles met the inclusion criteria.

Review Procedures

All 37 articles were initially coded descriptively for the following elements: (1) experimental design, (2) participants, (3) setting, (4) intervention, (5) assessment procedures, (6) target behaviors, and (7) findings. After the initial descriptive review, articles were reviewed using a rubric based on the Evaluative Method (see Reichow et al. 2008; Reichow 2011) to determine study quality. The Evaluative Method is comprised of 12 primary (i.e., participant characteristics, independent and dependent variables, baseline condition, visual analysis, and experimental control) and secondary (i.e., interobserver agreement, Kappa, blind raters, fidelity, generalization or maintenance, social validity) indicators. Using a rubric of methodological quality, primary indicators were coded as high, acceptable, or unacceptable and secondary ratings as either providing or not providing sufficient evidence of the specified indicator (See Reichow 2011). This method was selected because (1) it was designed to assess the rigor of studies targeting individuals with ASD, (2) there is evidence it is a reliable tool (see Cicchetti 2011), and (3) the criteria align well with quality indicators for single-case design studies (Cicchetti 2011; Wendt and Miller 2012). The rubric used for scoring the articles specified the criteria established by Reichow (2011) to increase reliability among coders. Two raters independently coded each article, and discussed any discrepancies until consensus was reached.

Data Extraction

Biosoft's UnGraph for Windows (version 5.0) was used to extract the data from.pdf files of all reviewed studies. Although the data from UnGraph is often reliable and valid, in some instances symbols overlap and UnGraph can miss or misrepresent data points (See Shadish et al. 2009). Two raters compared the data extracted from UnGraph with visual analysis to ensure reliability and validity. Any errors were confirmed by both raters and changed to better represent visual analysis. UnGraph data representing the number of sessions, frequency counts, and percentages were rounded to the nearest whole number (Shadish et al. 2009).

Effect Size Estimates

To illustrate the effectiveness of each study, two non-overlap ES estimates were calculated. To date, there is no agreed upon ES estimate as all have advantages and disadvantages, so for now it is best to calculate more than one (Brossart et al. 2014). Also, until ES estimates fully address the complexity of single case research design (i.e., issues stemming from autocorrelation, variability, number of available data points), it is important that reviews of the literature pair ES estimates with visual analysis of the data (Maggin and Odom 2014; Manolov et al. 2014). Non-overlap methods were chosen because they closely align with visual analysis (Heyvaert et al. 2014), and do not require some of the assumptions associated with parametric statistics (Carter 2013). To provide an estimate of the magnitude of the intervention effect of each study, effect sizes (ES) were calculated using non-overlap of all pairs method (NAP; Parker and Vannest 2009), and Tau-U. NAP and Tau-U are considered a "complete" index because they include all data points making them less influenced by outliers and a small number of data points (Parker et al. 2011b). Both NAP and Tau-U yield stronger statistical power than other non-parametric ES estimates. NAP is a percentage of nonoverlapping data that compares each data point from phase A (e.g., baseline) to each in phase B (e.g., intervention) to obtain a percentage of nonoverlapping data that shows improvement [i.e., (Pos + .5 X Tie)/Pairs;

Parker et al. 2011a]. Tau-U is the percent of data that demonstrate improvement over time by comparing all data points in each phase [(Pos–Neg)/Pairs; Parker et al. 2011b]. Tau-U and NAP are similar, but NAP is the percentage of nonoverlap whereas Tau-U is the percentage of nonoverlap minus overlap with the ability to control for trend (Parker et al. 2011a) making Tau-U the more conservative estimate (Brossart et al. 2014). ES estimates were calculated using a web-based calculator (www.singlecasedesignresearch.org).

Findings

A total of 37 studies investigating the impact of school-based, peer-related social competence interventions with 105 (3–12 years old) children with ASD were reviewed. The majority of studies employed a multiple baseline or probe design (n = 32; 87 %), 4 (11 %) applied a reversal design, and 1 (3 %) an alternating treatment design. A range of 1–5 children participated in these studies with a median number of three children with a mean age of six. Table 1 provides descriptive information of study participants. Target behaviors varied, but generally fit in one of 4 categories: (1) initiations, (2) responses, (3) interactions, and (4) engagement. Table 2 is a summary of the outcome measures designated in each of these categories. Only 6 (17 %) described an assessment process used to determine the target behavior. In 4 of these studies, researchers conducted interviews and observations to identify the target behavior and outcome measure prior to intervention (Crozier and Tincani 2007; Harper et al. 2008; Sansosti and Powell-Smith 2006, 2008), and in 2 the need to address the target behavior was confirmed through interviews and/or observations (Apple et al. 2005; Delano and Snell 2006).

Table 1 Participant characteristics

Intervention type	Number of participants (M/F)	Mean age (range)	Diagnosis	Social behavior
Child specific	n = 62 53/9	6.1 (3–11)	AS = 19 (31 %)[a] Aut = 34 (55 %)[b] PDD = 9 (15 %)[c]	Low initiator = 48 (77 %) Initiator = 7 (11 %) 7 NP (11 %)
Peer mediated	n = 14 12/2	6.57 (4–10)	AS = 1 (7 %) Aut = 12 (86 %) PDD = 1 (7 %)	Low initiator = 14 (100 %)
Collateral skill	n = 7 6/1	7.29 (5–12)	Aut = 3 (43 %) PDD = 4 (57 %)	Low initiator = 7 (100 %)
Multi-component	n = 22 20/2	6.73 (3–11)	AS = 2 (9 %) Aut = 16 (73 %) PDD = 4 (18 %)	Low initiator = 19 (86 %) Initiator = 3 (14 %)
Totals	105 91/14	6.38 (3–12)	AS = 22 (21 %) Aut = 65 (62 %) PDD = 18 (17 %)	Low initiator = 87 (83 %) Initiator = 11 (11 %) NP = 7 (7 %)

[a] Denotes Asperger's syndrome

[b] Denotes autism

[c] Denotes pervasive developmental disorder not otherwise specified

[d] Denotes not reported

Table 2 Definitions of target behavior categories

Target behavior	Defined	Frequency
Initiations	Spontaneous attempts (verbal/nonverbal) to gain attention/response from a peer (e.g., giving compliments; making comments, sharing, requesting, touching, approaching peers to play). Some definitions required appropriate or relevant initiations	n = 23 (62 %)
Responses	Verbal/nonverbal response immediately following an initiation from a peer	n = 10 (27 %)
Interactions	Verbal/nonverbal combination of initiations and responses (e.g., coding scheme including seeking attention, initiating comments, contingent responses); maintaining conversation; appropriate social interactions in a game (e.g., turn-taking, asking to join); decreasing negative interactions	n = 13 (35 %)
Engagement	Appropriately and actively participating/interacting with a peer in play or an activity	n = 8 (22 %)

Reviewed studies are categorized using an adapted version of McConnell's (2002) framework that captures the varied social competence interventions designed for children with ASD including: (1) child-specific, (2) peer-mediated, (3) multicomponent, and (4) collateral skill interventions. Child-specific interventions are adult-directed and include instructional/reinforcement methods used to enhance or develop the social skills of children with ASD. Because child-specific studies encompassed a range of intervention strategies, they were further characterized as adult-mediated, video-modeling, or social narrative. Peer-mediated interventions involve teaching typically developing peers how to apply instructional/interaction strategies while engaging with their peers with ASD to encourage social interaction. Multi-component interventions combine child-specific and peer-mediated interventions, whereas collateral skill studies directly target a skill other than social communication (e.g., play, academics) while indirectly impacting social competence. Twenty studies (54 %) applied child-specific, 6 (16 %) peer-mediated, 8 (22 %) multicomponent, and 3 (8 %) collateral skill interventions. Table 3 is a synthesis of study components from the descriptive review, and Table 4 provides a summary of primary and secondary quality ratings.

Child-Specific Interventions

Child-specific interventions were the most frequently used (n = 20; 54 %) to promote social competence. Sixty-two children (59 %) participated in child-specific interventions, with an average age of 6.1 (range 3–11). Child-specific interventions were comprised of a variety of instructional practices including adult-mediated instruction (n = 6; 30 %), social narratives (n = 6; 30 %), and video/video-self modeling (VM/VSM; n = 5; 25 %). Additionally, 3 (15 %) studies used a combination of adult-mediated, VM/VSM, and/or social narratives.

Adult-Mediated Interventions

Nineteen (18 %) children participated in adult-mediated (AM) interventions. Children ranged in age from 3 to 8, 8 (42 %) were described as functioning in the average range, 3 (18 %) had a cognitive delay, and no information about cognitive ability was provided for 8 (42 %) children. Sixteen (84 %) children were reported to rarely initiate social interaction with others, 2 (11 %) as initiating toward adults, and 1 (5 %) as engaging in inappropriate interactions that peers avoided. Dependent variables included initiations (n = 4; 80 %), responses (n = 4; 80 %), interactions (n = 2; 40 %), and reading faces (n = 1; 20 %).

In four studies (67 %) school personnel (i.e., teacher; teaching assistants) delivered the intervention, and in 2 studies (33 %) the researchers provided instruction. Adult-mediated instruction occurred in the child's typical classroom (n = 5; 83 %) or in a pull out setting (n = 1; 17 %). Four studies applied a combination of systematic prompting and reinforcement (i.e., praise; edible) to teach social competence. Three studies used prompting [i.e., verbal (Licciardello et al. 2008); verbal or manual guidance (Gena 2006); least-to-most prompting hierarchy (Garfinkle and Schwartz 2002)] followed by contingent praise to teach children with ASD to imitate (Garfinkle and Schwartz 2002) or initiate (Gena 2006; Licciardello et al. 2008) an interaction with peers. In addition to prompting and contingent praise, immediately before a play session, Licciardello et al. (2008) pre-taught children with ASD to initiate an interaction through modeling, behavior rehearsal, and praise. Another study paired most-to-least prompting with systematic fading (i.e., verbal to tactile prompt; Shabani et al. 2002).

Laushey et al. (2009) used direct instruction (e.g., defining target skills, practicing skills during a structured game) to teach children with ASD and a group of typically developing peers a concept mastery routine during their existing lunch bunch group. Only one study taught teachers to use naturalistic teaching strategies (i.e., introducing novelty, joining in play, choice making, incidental teaching, commenting/questioning, expansions, and initiating) through training and ongoing consultation and feedback (Kohler et al. 2001).

Quality Ratings Five of the 6 (83 %) adult-mediated studies received an acceptable or high rating on all primary indicators suggesting that in general the studies were described with replicable precision, and that the intervention showed a notable impact on target behaviors. Only one study received an unacceptable rating for both visual analysis and experimental control (Garfinkle and Schwartz 2002). All studies measured interobserver agreement and 5 of 6 (83.33 %) studies included measures of treatment integrity, which suggested an adequate level of agreement (i.e., >80 %), and interventions were delivered as intended. No studies included Kappa values or kept raters blind to the purpose of the study. Five of 6 (83.33 %) studies provided evidence of social validity, 3 (50 %) included measures of generalization and yielded mixed results, and 2 (33.33 %) showed some evidence of maintenance.

Effect Size Estimates Overall, adult-mediated interventions had a positive impact on the social interactions of children with ASD with a mean NAP of .93 (range .59–1.0) and Tau-U of .85 (range .15–1.0). Mean ES estimates for initiations (NAP mean = .99; Tau-U mean = .97) and responses (NAP mean = .93; Tau-U mean = .86) were moderate to high. One study resulted in a modest effect on

Table 3 Components of reviewed studies

Reference	n	Age	Design	Intervention	No. of sessions	Target behavior(s)	NAP	Tau-U
Adult-mediated studies								
Apple et al. (2005)	4 M; 1 F	4–5	MBL across participants	CS AM +VM	9	Initiations Responses	Initiations = .85 Responses = 1.0	Initiations = .70 Responses = 1.0
Bellini, Peters, et al. (2007)	2 M	4–5	MBL across participants	CS VSM	17	Engagement	Engagement = .92	Engagement = .85
Bock (2007)	4 M	9–10	MBL across settings	CS SN	4–12	Engagement	Engagement = 1.0	Engagement 1.0
Boudreau and Harvey (2013)	3	4–7	MBL across participants	CS VSM	10–20	Initiations	Initiations = .98	Initiations = .97
Buggey (2012)	3 M	3–4	MBL across participants	CS VSM	8	Initiations	Initiations = .57	Initiations = .13
Buggey et al. (2011)	2 M; 2F	3–4	MBL across participants	CS VSM	10	Initiations	Initiations = .83	Initiations = .66
Chan and O'Reilly (2008)	2 M	5–6	Multiple probe across behaviors	CS AM + SN	13–18	Initiations interactions	Initiations = .98 Interactions = 1.0	Initiations = .98 Interactions = 1.0
Crozier and Tincani (2007)	2 M	3–5	Reversal	CS SN	11–17	Initiations engagement	Initiations = .88 Engagement .98	Initiations = .71 Engagement = .87
Delano and Snell (2006)	3 M	6–9	Multiple probe across participants	CS SN	15	Interactions engagement	Interactions = .91 Engagement = .98	Interactions = .82 Engagement = .96
Garfinkle and Schwartz (2002)	3 M	3–5	MBL across participants	CS AM	10–20	Interactions	Interactions = .59	Interactions = .15
Gena (2006)	2 M; 2F	4	MBL across participants	CS AM	7–12	Initiations responses	Initiations = 1.0 Responses = .99	Initiations = 1.0 Responses = .97
Hanley-Hochdorfer et al. (2010)	2 M; 1F	6–11	MBL across participants	CS SN	9–13	Initiations responses	Initiations = .56 Responses = .67	Initiations = .12 Responses = .34
Kohler et al. (2001)	2 M	4	MBL across participants	CS AM	13–15	Interactions	Interactions = .98	Interactions = .96
Laushey et al. (2009)	4 M	Gr. 1–4	MBL across behaviors	CS AM	2–4	Initiations responses reading faces	Initiations = 1.0 Responses = .98 Reading faces = 1.0	Initiations = .90 Responses = .96 Reading faces = 1.0
Licciardello et al. (2008)	3 M; 1F	6–8	MBL across participants	CS AM	2–13	Initiations responses	Initiations = .98 Responses = .89	Initiations = .97 Responses = .77
Sansosti and Powell-Smith (2006)	3 M	9–11	MBL across participants	CS SN	13–20	Interactions	Interactions = .81	Interactions = .62

Table 3 continued

Reference	n	Age	Design	Intervention	No. of sessions	Target behavior(s)	NAP	Tau-U
Sansosti and Powell-Smith (2008)	3 M	6–9	MBL across participants	CS SN + VM	9–18	Interactions	Interactions = .91	Interactions = .83
Scattone et al. (2006)	2 M	8	MBL across participants	CS SN	13–28	Interactions	Interactions = .68	Interactions = .37
Shabani et al. (2002)	2 M	6–7	Reversal	CS AM	6–10	Initiations responses	Initiations = 1.0 Responses = .86	Initiations = 1.0 Responses = .72
Simpson et al. (2004)	2 M; 2F	5–6	Multiple probe across students	CS VM	5–20	Initiations	Initiations = .99	Initiations = .94
Peer-mediated studies								
Harper et al. (2008)	2 M	8–9	MBL across participants	PM	7	Initiations interactions	Initiations = .85 Interactions = 1.0	Initiations = .71 Interactions = 1.0
Katz and Girolametto 2013	1F 2 M	4–5	MBL across participants	PM	12	Interactions	Interactions = .98	Interactions = .94
Kohler et al. (2007)	1F	4	MBL across play triads	PM	8	Interactions	Interactions = .98	Interactions = .93
Laushey and Heflin (2000)	2 M	5	Reversal	PM	6–10	Interactions	Interactions = 1.0	Interactions = 1.0
Lee et al. (2007)	3 M	7–9	MBL across participants and settings	PM	16–19	Engagement	Engagement = 1.0	Engagement = 1.0
Owen-DeSchryver et al. (2008)	3 M	7–10	MBL across behaviors	PM	7–14	Initiations responses	Initiations = .81 Responses = .88	Initiations = .63 Responses = .72
Multi-component studies								
Banda et al. (2010)	2 M	6	MBL across participants	MC PM + CS (AM)	5–12	Initiations responses	Initiations = 1.0 Responses = 1.0	Initiations = 1.0 Responses = 1.0
Jung et al. (2008)	3 M	5–6	MBL across participants	MC PM + CS (AM)	13–19	Initiations responses	Initiations = 1.0 Responses = 1.0	Initiations = 1.0 Responses = 1.0
Kravits et al. (2002)	1F	6	MBL across settings	MC PM + CS (PECS)	13–18	Initiations	Initiations = .97	Initiations = .93
Morrison et al. (2001)	2 M; 1F	10–11	MBL across skills; Reversal	MC PM + CS (AM)	15–56	Initiations	Initiations = .98	Initiations = .93
Nelson et al. (2007)	4 M	3–4	MBL probe across participants and settings	MC PM + CS (AM)	10–60	Initiations	Initiations = .81	Initiations = .59
Parker and Kamps (2011)	1 M	9	MBL probe across activities	MC PM + CS (AM)	4–25	Initiations engagement	Initiations = .76 Engagement = .99	Initiations = .52 Engagement = .97

Table 3 continued

Reference	n	Age	Design	Intervention	No. of sessions	Target behavior(s)	NAP	Tau-U
Thiemann and Goldstein (2001)	3 M	6–8	MBL across skills	MC PM + CS (AM; SN)	4–15	Initiations responses	Initiations = .93 Responses = .80	Initiations = .78 Responses = .60
Thiemann and Goldstein (2004)	5 M	6–9	MBL across participants and skills	MC PM + CS (AM)	4–18	Initiations interactions	Initiations = .94 Interactions = .87	Initiations = .86 Interactions = .73
Collateral skill studies								
Boyd et al. (2007)	3 M	5	Alternating treatment	Preferred interests	11–19	Engagement	Engagement = .85	Engagement = .70
Koegel et al. (2012)	2 M; 1F	9–12	MBL across participants	Preferred interests	8–22	Initiations engagement	Initiations = 1.0 Engagement = 1.0	Initiations = 1.0 Engagement = 1.0
Petursdottir et al. (2007)	1 M	5	Reversal	Peer tutoring	13–17	Interactions	Interaction = .66	Interaction = .23

CS child specific, *AM* adult mediated, *VM* video modeling, *VSM* video self-modeling, *SN* social narratives, *PM* peer mediated, *MC* multi component

responses, which may be attributed to two participants responding at a moderate level during baseline and having a relatively short intervention period (e.g., 2–5 sessions; Licciardello et al. 2008). Effects of adult-mediated interventions on interactions were more variable (NAP .59–.98; Tau-U .15–.96). Although participants in one study showed some improvement, gains were highly variable and failed to maintain (Garfinkle and Schwartz 2002).

Social Narratives

Six (30 %) of the child-specific studies employed social narratives. Seventeen children (16 %) ages 3–11 participated in these studies. The majority of participants were diagnosed with AS (n = 11; 65 %) and the remaining had a diagnosis of autism (n = 6; 35 %). All children used verbal language to communicate. Seven (41 %) children were described as rarely initiating social interaction, and 5 (29 %) as initiating interactions that were either not reciprocated or about topics of interest. Information pertaining to social competence was not provided for 5 (29 %) children. The majority of participating children were described as functioning in the average to above average range (n = 11; 67 %), 4 (23 %) were depicted as performing below grade level, 1 child had an IQ score below 70 (i.e., 67), and the cognitive ability of one child was not reported. Outcome measures included initiations (n = 2; 33 %), responses (n = 1; 16 %), engagement (n = 3; 50 %), and interactions (n = 3; 50 %).

Social narratives were constructed to target two categories of behavior: (1) initiating interactions with others (e.g., securing attention, initiating, responding, maintaining a conversation; Bock 2007; Crozier and Tincani 2007; Delano and Snell 2006; Hanley-Hochdorfer et al. 2010; Sansosti and Powell-Smith 2006; Scattone et al. 2006), and (2) appropriately participating in activities with peers (e.g., cooperative learning, playing a game, sportsmanship; Bock 2007; Crozier and Tincani 2007; Sansosti and Powell-Smith 2006). Social narratives followed Gray's Social Story guidelines (See Gray 2000; n = 5; 83 %) or were written to encompass all of the components of a social behavioral learning strategy called SODA (n = 1; i.e., Stop, Observe, Deliberate, and Act; Bock 2007). Social Stories included a specified ratio of sentence types (i.e., descriptive, perspective, affirmative, and directive) to create a story that fully illustrated the targeted context, expected behavior, and consequent reactions from others (e.g., thoughts/feelings). SODA stories were comprised of 4 strategies: (1) *stop* and describe the context, (2) *observe* what is happening, (3) *deliberate* about what action to take, and (4) *act* on a plan. In SODA, each step is narrated to include self-questions and corresponding responses.

Table 4 Summary of quality ratings

Rating	Participants	DV	IV	BL	VA	EC
Primary quality ratings						
High	29 (78 %)	32 (87 %)	32 (87 %)	19 (51 %)	16 (43 %)	19 (51 %)
Acceptable	3 (8 %)	3 (8 %)	5 (14 %)	18 (49 %)	17 (46 %)	15 (41 %)
Unacceptable	5 (14 %)	2 (5 %)	0	0	4 (11 %)	3 (8 %)
Meet criteria	IOA	Kappa	Blind raters	TF	G/M	SV
Secondary quality ratings						
Number	36	2	1	28	28	30
Percentage	97 %	5 %	3 %	76 %	76 %	81 %

DV dependent variable, *IV* independent variable, *BL* baseline, *VA* visual analysis, *EC* experimental control, *TF* treatment fidelity; *G/M* generalization and/or maintenance, *SV* social validity

In some studies, researchers interviewed others (i.e., teacher, parent, and/or peers) to help construct the narrative (Bock 2007; Crozier and Tincani 2007; Delano and Snell 2006; Sansosti and Powell-Smith 2006). Information gained in peer interviews was used to phrase initiations/comments embedded within the social story, and information from teachers/families helped to determine target behaviors and/or develop story content. Social narratives were presented in the form of text (Bock 2007; Crozier and Tincani 2007), a book (Hanley-Hochdorfer et al. 2010; Sansosti and Powell-Smith 2006; Scattone et al. 2006), or text with symbols (Delano and Snell 2006), In 5 (83.33 %) studies, an adult checked for understanding by asking comprehension questions (Bock 2007; Delano and Snell 2006; Hanley-Hochdorfer et al. 2010; Scattone et al. 2006).

In 5 studies (83.33 %), the story was read at school (i.e., quiet part of the classroom, hallway, resource room) immediately before the child was expected to engage in the target behavior, and in one study (Sansosti and Powell-Smith 2006), the child's caregiver read the story before and after school. In 4 (66.67 %) studies, the adult read the story to the child, in one study the child read the story independently (Bock 2007), and in one study the teacher read the story to the child until the child responded to comprehension questions at a predetermined criterion at which point the child read independently (Scattone et al. 2006).

Quality Ratings The majority of primary indicator quality ratings were in the acceptable to high range on all variables with the exception of visual analysis. Two studies received an unacceptable rating because of a minimal shift in level and/or trend from baseline to intervention for the majority of participants (Hanley-Hochdorfer et al. 2010; Scattone et al. 2006). In a third study, visual analysis showed a social story alone was ineffective for one participant, but the addition of adult prompting led to an increase in target behaviors (Crozier and Tincani 2007). All social narrative studies included evidence of interobserver agreement and treatment integrity at acceptable levels (>80 %). Kappa values were included in one study, and raters were kept blind to the study purpose in one. Maintenance data were

collected and varied in 5 (83.33 %) studies, and evidence of generalization was provided in one study.

Effect Size Estimates Social narrative studies produced mixed findings with a mean NAP of .83 (.56–1.0) and Tau-U of .65 (.12–1.0). ES estimates for social narratives targeting engagement were high (mean NAP = .99 and Tau-U = .94), but more variable for interactions (mean NAP = .80 and Tau-U = .60), initiations (mean NAP = .64; Tau-U = .42), and responses (NAP = .67 and Tau-U = .34). Thirteen of the 17 (76 %) participants demonstrated improved outcomes with all children showing gains in two studies (Bock 2007; Delano and Snell 2006), 2 of 3 in two studies (Sansosti and Powell-Smith 2006; Scattone et al. 2006), and no children in one study (Hanley-Hochdorfer et al. 2010).

VM/VSM

Sixteen children (15 %) ages 3–7 participated in the five included VM/VSM studies. Eight were diagnosed with PPD-NOS, and eight with autism. All children used verbal language, and were described as rarely initiating socially. The cognitive ability of participants was not discussed. Dependent variables fell into two categories: initiations and engagement.

In the VSM interventions, the child with ASD was videotaped while being prompted to engage in the target behavior, and the videotape was edited to remove prompting to appear as though the child demonstrated the behavior independently (Bellini et al. 2007a; Boudreau and Harvey 2013; Buggey et al. 2011, 2012). In the VM study, same age peers were filmed exhibiting the target behaviors during routine school activities in which the child with ASD was expected to perform the focal behaviors (Simpson et al. 2004). In VSM/VM studies modeled behaviors included initiating (Boudreau and Harvey 2013), initiating and responding (Bellini et al. 2007), initiating and appropriate play (Buggey et al. 2011, 2012), and sharing, following directions and greeting (Simpson et al. 2004).

Videos varied in length from approximately 2.0–3.5 min (Bellini et al. 2007; Buggey et al. 2011, 2012) to 6–7 min (Boudreau and Harvey 2013; Simpson et al. 2004). In the VM study (Simpson et al. 2004) a 4 video hyper studio presentation was developed with voice over to read the title, identify and define the target behavior, and summarize the video (Simpson et al. 2004). In two VSM studies, the videos were presented as 2 ½ to 3 ½ min movies with voice over to read the title and provide praise when the movie showed the child with ASD engaged in the target behavior (Buggey et al. 2011, 2012). In one VSM study, 3 video clips highlighting the target behavior were developed and rotated on subsequent days (Bellini et al. 2007), and in another 6–9 clips (varied by participant) were shown together (Boudreau and Harvey 2013).

Videos were presented on a television (n = 1; Boudreau and Harvey 2013), or computer (n = 4; Bellini et al. 2007; Buggey et al. 2011, 2012; Simpson et al. 2004) and shared by a school staff member (Bellini et al. 2007; Buggey 2012; Simpson et al. 2004) or researcher (Boudreau and Harvey 2013; Buggey et al. 2011) in a room outside of the classroom (Bellini et al. 2007; Boudreau and Harvey 2013), or a quiet area within the classroom (Buggey et al. 2011, 2012; Simpson et al. 2004). In two studies, verbal prompts were used if the child with ASD became disengaged while viewing the video (Bellini et al. 2007; Boudreau and Harvey 2013). Children were provided an opportunity to engage in the target behavior immediately following the video (Bellini et al. 2007; Boudreau and Harvey 2013; Simpson et al. 2004), or 1 h later (Buggey et al. 2011, 2012.

Quality Indicators VM/VSM quality ratings for primary indicators were generally in the acceptable or high range. Visual analysis and experimental control were rated as unacceptable in one study as a result of consistent overlap between baseline and intervention conditions (Buggey 2012). Maintenance data was collected in 4 (80 %) studies, and participants who benefited from the intervention maintained increases above baseline levels. No studies included generalization measures, and 5 (80 %) provided evidence of social validity. Data on the fidelity of implementation was collected in only two studies (40 %), and results suggested the intervention was implemented as intended (Bellini et al. 2007; Simpson et al. 2004). Interobserver agreement was calculated in all studies and agreement was consistently higher than 80 %.

Effect Size Estimates Results from VSM/VM studies were mixed (mean NAP = .86 and mean Tau-U = .71) with a variable range of ES estimates (NAP = .57–.99; Tau-U = .13–.97). Of the 16 participants, change in target behavior was observed for 12 (75 %). One VSM study produced no change in the social initiations of 3 young children (3–4 years) with PDD-NOS (NAP = .57; Tau-U = .13; Buggey 2012), and findings from another study were variable with 3 of 4 young children (3–4 years) with PDD-NOS increasing the frequency of their social initiations (Buggey et al. 2011). Remaining VM/VSM studies had an overall positive impact with NAP ranging from .92 to .99 and Tau-U from .85 to .97.

Combined Child-Specific Studies

Three (15 %) studies combined two or more child specific interventions. Ten (10 %) children participated in these studies of which 4 (40 %) had AS, and 6 (60 %) autism, and all used verbal language to communicate. Information about the social communication/competence of participating children was reported for eight children (80 %). Seven (70 %) were described as rarely initiating social interaction, and 1 (10 %) as initiating interactions about a topic of interest. Information about cognitive ability was reported for 6 (60 %) children, and all performed in the average range. Outcome measures included initiations (n = 2; 67 %), responses (n = 1; 33 %), and interactions (n = 2; 67 %). In two studies, the intervention occurred in a separate classroom setting prior to (i.e., at the start of the school day; or immediately before) the activity (e.g., circle time, centers, play) during which the child was expected to engage in the target behavior (Apple et al. 2005; Chan and O'Reilly 2008). In the 3rd study, intervention occurred in the classroom just before unstructured play times (Sansosti and Powell-Smith 2008).

Chan and O'Reilly (2008) developed an intervention package combining social stories with adult-mediated instruction. Created social stories followed Gray's (2000) guidelines, and the researcher read the story at the start of the school day (1–4 days a week). After reading, children answered comprehension questions and role-played the story content with prompting and provided praise as needed (Chan and O'Reilly 2008).

Sansosti and Powell-Smith (2008) paired video modeling and social stories (i.e., Gray 2000) by creating a self-advancing multimedia PowerPoint presentation consisting of 5–9 slides. The presentation included a voice over reading of the social story and ended with a 1 min video of a peer demonstrating the target behavior (i.e., VM). Adult prompting was added for two participants when there was no change in the target behavior (Sansosti and Powell-Smith 2008).

Apple and colleagues conducted two experiments measuring the impact of VM paired with positive reinforcement on compliment giving behaviors. The first experiment included VM and positive reinforcement, and the second study added self-management. Four videos were created of

a peer responding to an initiation with a compliment (e.g., "Look" followed by "That's cool."), or initiating a compliment (e.g., child is playing with an airplane and the peer initiates "Neat airplane!"). Adults were included in the video to narrate the rules of compliment giving behavior (e.g., "When someone says, 'Look,' we can say, 'Cool.'").

Quality Indicators Quality ratings for 2 of the 3 studies were in the acceptable to high range across primary indicators, and the 3rd study was in the acceptable to high range for the majority of indicators with the exception of participants and dependent variable which lacked details necessary for a high rating (Chan and O'Reilly 2008). Visual analysis and experimental control received acceptable to high ratings across studies. In one study, visual analysis yielded a notable increase in the target behavior after adding a condition that included adult prompting (Sansosti and Powell-Smith 2008). All studies reported interobserver agreement and treatment integrity at acceptable levels (>80 %), and included evidence of maintenance and social validity. Two studies (66.67 %) provided evidence of generalization that was mixed, and no studies included kappa values or raters blind to the purpose of the study.

Effect Size Estimates The average NAP was .95 (.85–1.0) and Tau-U .90 (.79–1.0). The average ES for initiations was .82 (n = 1), interactions .92 (n = 2), and responses 1.0 (n = 1). Generally, ES estimates were high across target behaviors, and there was a notable change in behavior in two studies once new conditions were introduced (i.e., reinforcement, self-management and/or prompting; Apple et al. 2005; Sansosti and Powell-Smith 2008).

Peer-Mediated Interventions

Six (16 %) studies utilized peer-mediated interventions. A total of 14 (13 %) children ages 4–10 participated in these studies, and 12 (85 %) were identified as having autism, 1 (7 %) AS, and 1 (7 %) PDD-NOS. All children rarely initiated social interaction with peers prior to intervention, and of these children, two were further described as avoiding social interactions, and two as engaging in negative social interactions. Eleven (79 %) of the children used verbal language as their primary mode of communication, and 3 (21 %) were described as unable to communicate their needs/wants verbally. No description of cognitive ability was provided for 1 (7 %) child, 7 (50 %) were performing in the average range, and 3 (21 %) as below average/grade level. In one study (Lee et al. 2007), the researchers were unable to obtain an accurate measure of cognitive ability for one child (7 %), and two (14 %)

children were described as having a moderate/severe cognitive disability. Outcome measures included initiations (n = 2; 40 %), interactions (n = 4; 67 %), responses (n = 1; 20 %), and engagement (n = 1; 20 %).

Peers served as the intervention agents in all studies. Peer training occurred for 15–45 min over 3–8 sessions. In three studies (50 %), peers were directly taught how to engage children with ASD in social interaction, and in three studies (50 %) children with ASD and their peers learned interaction strategies together (Laushey and Heflin 2000; Katz and Girolametto 2013; Kohler et al. 2007). In one study (17 %), a classroom participated in the intervention, and in the remaining five (83 %) studies, peers were selected based on regular attendance, willingness to participate, compliance with teacher instructions, age-appropriate social skills, typical language development, good play skills, and/or gender. Studies paired at least two peers to every child with ASD.

In 5 (83 %) studies, peers were taught strategies for sharing, suggesting ideas for play, joining in and/or maintaining play, initiating talk during play, assisting/offering help, and/or being affectionate, and in the 6th study, peers learned pivotal response training (PRT) strategies including gaining attention, varying activities, narrating play, reinforcing play attempts, and turn taking (Harper et al. 2008). In all studies, training consisted of a combination of adult-mediated instructional strategies (e.g., modeling, role-playing, and feedback), and 5–20 min free play sessions/activities that included adult reminders to play (i.e., verbal prompting and/or visual cue cards). In 4 studies (66.67 %), a description of the need or importance of the intervention was provided through a discussion of difference (Laushey and Heflin), the importance of play (Lee et al.), or developing friendships. In two studies, these discussions were organized through a storybook reading (Katz and Girolametto 2013; Owen-DeSchryver, et al.) or circle of friends (Owen-DeSchryver et al.). A research team member delivered the training in all studies, and in one study the classroom teacher also helped facilitate training (Katz and Girolametto 2013).

Quality Ratings

Descriptions of the participants, intervention, and dependent variables were rated as acceptable or high across studies, which suggests peer-mediated studies were described with replicable precision. Baseline phases, visual analysis, and experimental control were all rated as acceptable or high. All children benefited from peer-mediated interventions and acceptable ratings reflect some variability or design limitations that generated 2 instead of 3 replications of an effect (e.g., multiple baseline across two participants). No studies included blind raters or kappa

values, and interobserver agreement was acceptable across studies (>80 %). Five (83 %) studies provided evidence that participants maintained gains and/or generalized results to new settings, other behaviors, or untrained peers. Treatment integrity was demonstrated in all studies using a variety of methods (i.e., intervention protocols, and/or evidence of peer strategy use). Evidence of social validity was included in 3 (50 %) studies.

Effect Size Estimates

Results from peer-mediated studies were positive with an average NAP of .95 (.85–1.0) and Tau-U of .87 (.71–1.0). ES estimates for initiations averaged a NAP of .83 and Tau-U of .67, and interactions a NAP of .99 and Tau-U of .98. Engagement (NAP and Tau-U of 1.0) and responses (NAP = .88 and Tau-U = .72) were measured in only one study. Studies with a moderate ES showed greater variability with some intervention data points overlapping with baseline (Harper et al. 2008; Owen-DeSchryver et al. 2008).

Multicomponent Interventions

Multicomponent interventions are a combination of child-specific and peer-mediated interventions. Eight (22 %) studies fit in this category, and 22 (21 %) children ages 3–11 participated. Of these children, 16 (73 %) had a diagnosis of autism, 4 (18 %) PDD-NOS, and 2 (9 %) AS. The majority of children were described as rarely initiating social interactions (n = 19; 86 %), and three (14 %) were reported to initiate inappropriate interactions (e.g., rough play, verbal perseverations). Descriptions of cognitive ability were not provided for 7 (32 %) children, 7 (32 %) were described as preforming/functioning in the average range, 5 (23 %) as performing/functioning below average, and 3 (14 %) as having significant cognitive delays. The majority of children were reported to use verbal language to communicate (n = 20; 91 %), one child (5 %) was described as nonverbal, and one (5 %) as speaking in 1–2 word utterances that were often unintelligible. Seven (88 %) studies measured the impact of the intervention on social initiations, 2 (25 %) responses, 1 (13 %) interactions, and 1 (13 %) social engagement.

Multicomponent interventions occurred in the child's typical classroom (n = 5; 63 %), in a pull-out setting (e.g., school media center; n = 1; 38 %), or in multiple settings (e.g., school/home; school/community; n = 2; 25 %). The number of sessions ranged from 5–60 and lasted 5–45 min. Only two studies (25 %) incorporated adult- and peer-mediated instruction alone (Banda et al. 2010; Jung et al. 2008), and the remaining studies embedded additional strategies such as visual supports (n = 4; 50 %), scripts

(n = 3; 38 %), self-monitoring (n = 2; 25 %), task analysis (n = 1; 13 %), picture exchange communication system (PECS; n = 1; 13 %), and social stories (n = 1; 13 %). Researchers either taught peers and children with ASD simultaneously (Banda et al.; Morrison et al. 2001; Parker and Kamps 2011), peers and children with ASD separately (Kravits et al. 2002; Nelson et al. 2007), or peers first and then peers and children with ASD together (Jung et al.; Thiemann and Goldstein 2001, 2004). Target behaviors included initiating (Banda et al. 2010; Kravits et al. 2002; Morrison et al.; Nelson et al.; Parker and Kamps; Thiemann and Goldstein 2001, 2004), responding (Banda et al.; Jung et al.; Kravits et al.; Parker and Kamps; Thiemann and Goldstein 2001, 2004), sharing (Kravits et al.; Morrison et al.), securing attention (Parker and Kamps; Thiemann and Goldstein 2001), and/or turn-taking (Kravits et al.; Thiemann and Goldstein 2001).

Both researchers and peers served as the intervention agents in multicomponent studies. In one study, the entire class participated in the intervention (Nelson et al. 2007), and in other studies, peers were selected based on demonstration of age appropriate social skills, ability to follow teacher directions, peer nominations, and/or regular attendance. The peer selection process was not discussed in two studies (Banda et al. 2010; Kravits et al. 2002). Every study used direct instruction (i.e., a combination of defining the target skill, providing examples, modeling, role-playing, prompting, feedback, praise, and/or positive reinforcement) to teach the child with ASD and/or peer the target skill(s). Two of these studies incorporated systematic fading of either prompts (Parker et al. 2011b) or reinforcement (Morrison et al. 2001). Only one study (Nelson et al. 2007) included incidental teaching techniques (i.e., motivating materials, following the child's lead, prompting hierarchy, and natural reinforcement).

In all studies, instruction was followed by an opportunity to apply the newly acquired skills in a 10–30 min free play or a social activity. In 6 (75 %) studies free play sessions involved prompting children with ASD by an adult (Banda et al. 2010; Thiemann and Goldstein 2004), peers (Morrison et al. 2001), or adult and peers (Parker et al. 2011a; Nelson et al. 2007; Thiemann and Goldstein 2001). In one study, peers were taught to keep the child with ASD engaged (Kravits et al. 2002), and in another peers modeled contingent responding following adult generated high/low probability requests (Jung et al. 2008).

Quality Indicators

All primary quality indicators were rated as high or acceptable with the exception of participants in two studies because participating peers were not described (Banda et al. 2010; Kravits et al. 2002). In 4 (50 %) studies, visual

analysis was rated as acceptable as a result of some variability. Experimental control was rated as high in 3 (38 %) of 8 studies, and the remaining studies (n = 5; 63 %) received acceptable ratings (i.e., fewer than 3 demonstrates of an effect, or a delay in change following introduction of the independent variable). All studies measured interobserver agreement, and agreement was above acceptable levels (>80 %) in all but one study (Banda et al. 2010). No studies calculated kappa values or included raters blind to the purpose of the study. Treatment fidelity was monitored in 5 (63 %) studies, and data indicated the interventions were applied as intended. Generalization and/or maintenance were measured in 5 (63 %) studies, and data were positive or mixed. Evidence of social validity was provided in 6 (75 %) studies.

Effect Size Estimates

The mean ES NAP was .93 (range .76–1.0) and Tau-U .84 (range .52–1.0) for multi-component studies. ES mean estimates by target behavior were .92 (NAP) and .83 (Tau-U) for initiations, and .93 (NAP) and .87 (Tau-U). Engagement (NAP = .99 and Tau-U = .97) and interactions (NAP = .87; Tau-U = .73) were only measured in one study.

Collateral Skill Interventions

Three (8 %) studies applied collateral skill interventions. Seven (7 %) children ages 5–12 participated in these studies of which 3 (43 %) had a diagnosis of autism and 4 (57 %) PDD-NOS. All participants used verbal language to communicate, and were reported to rarely initiate social interaction. Five (71 %) children were described as performing in the average range, 1 (14 %) below average, and the cognitive ability of 1 (14 %) child was not provided. Outcome measures assessed engagement (n = 2; 67 %), initiations, (n = 1; 33 %), and/or interaction (n = 1; 33 %).

All 3 interventions are considered collateral skill interventions because although social competence was measured, the interventions targeted a different skill (i.e., reading, or preferred interests). One study consisted of a peer tutoring intervention (K-PALS) followed by free play sessions (Petursdottir et al. 2007). Two conditions were employed. First, the authors measured the effect of peer tutoring on social interactions during free play using a reversal design. Next, a withdrawal design was used to determine the impact of adding an opportunity to play with common stimuli (e.g., after reading a line of text, connecting a piece of a marble track to another piece of a marble track) during the peer tutoring session with one peer on the frequency of social interactions with all three peers during free play.

Incorporating interests was a primary feature of the remaining two (66.67 %) interventions. In one study, participants were provided a choice of preferred or less preferred items during play (Boyd et al. 2007), and in the second, preferred interests were identified and served as the theme for a social club (Koegel et al. 2012). Both used a pre-assessment process to determine the preferences of children with ASD (Boyd et al. 2007; Koegel et al. 2012).

All three studies included free play sessions between children with ASD and their peers. Intervention sessions occurred in either an alternate classroom (Boyd et al. 2007), or child's typical classroom settings (e.g., classroom, lunchroom, recess; Koegel et al. 2012; Petursdottir et al. 2007). Free play lasted from 5 to 45 min and the number of sessions ranged from 8 to 22. The teacher/researcher facilitated the free play session by either encouraging play without any direct prompting or reinforcement (Petursdottir et al. 2007), creating the activity, explaining the directions, and answering questions (Koegel et al. 2012), or setting up the play setting, and directing the peer to present play options, and respond to all initiations of the target child (Boyd et al. 2007). Although levels of facilitation varied, none of the collateral intervention studies included any direct instruction of social communication skills, and peers served as play partners, but were not explicitly taught how to engage children with ASD.

Quality Indicators

Participant and dependent variable quality ratings were high across studies, and independent variables were rated as acceptable or high. Ratings of visual analysis were acceptable because of some variability or overlap between intervention and baseline, and a limited change in level/trend following the intervention in one of the three replications. Two studies received a high rating for experimental control and the third, acceptable (two clear demonstrations of an effect). Interobserver agreement showed acceptable levels of reliability between observers (>.80) across studies. No studies reported Kappa values or indicated raters were kept blind to the purpose of the study. Treatment integrity was demonstrated in two studies, and all studies provided evidence of social validity. Maintenance data was not collected, and limited generalization to other peers was reported in one study.

Effect Size Estimates

Average ES estimates were .88 (NAP; range .66–1.0) and .73 (Tau-U; range .23–1.0). In one study, the ES estimates were low (NAP = .66; Tau-U = 2.3; Petursdottir et al. 2007), in one moderate (NAP = .85; Tau-U = .70; Boyd et al. 2007) and in one strong (NAP and Tau-U = 1.0; Koegel et al.

Table 5 ES estimates by characteristics and intervention type

Characteristics	Child-specific		Peer-mediated		Multi-component		Collateral skill	
	NAP	Tau-U	NAP	Tau-U	NAP	Tau-U	NAP	Tau-U
Age								
Ages 3–5	.87	.75	.99	.94	.87	.73	.81	.59
	n = 28 (45 %)		n = 6 (43 %)		n = 5 (23 %)		n = 4 (57 %)	
Above age 5	.89	.79	.89	.78	.94	.85	1.0	1.0
	n = 31 (50 %)		n = 8 (57 %)		n = 17 (77 %)		n = 3 (43 %)	
Cognitive ability								
Average	.92	.84	.96	.90	.91	.82	.95	.89
	n = 25 (40 %)		n = 7 (50 %)		n = 7 (32 %)		n = 5 (71 %)	
Below average	.76	.53	.84	.68	.93	.85	1.0	1.0
	n = 8 (13 %)		n = 3 (21 %)		n = 8 (36 %)		N = 1 (14 %)	
Significant cognitive disability	N/A	N/A	1.0	1.0	1.0	1.0	N/A	N/A
	n = 0		n = 2 (14 %)		n = 3 (14 %)		n = 0	
Social								
Low initiator	.89	.79	.95	.87	.93	.85	.88	.73
	n = 48 (77 %)		n = 14 (100 %)		n = 19 (86 %)		n = 7 (100 %)	
Initiator	.89	.65	N/A	N/A	.87	.85	N/A	N/A
	n = 7 (11 %)		n = 0		n = 3 (14 %)		n = 0	

2012). Unique to the Koegel et al. study, free play activities were structured to encourage social interaction.

ES by Characteristics and Intervention Type

Forty-three (41 %) preschool age (3–5), and 59 (56 %) school age (over 5 years old) participated in the included studies. One study provided an age range (4–7) only (Boudreau and Harvey 2013). Regardless of age, peer-related social competence interventions produced a moderate ES estimate. The average NAP for children under 5 years old was .88 and Tau-U .76, and for children over 5 years old NAP was .91 and Tau-U .82. Similarly, ES estimates for preschool and school age children were moderate to high across intervention type (See Table 5).

Descriptions of cognitive ability were provided for 66 (63 %) participating children, 44 (42 %) were described as performing in the average range, 17 (16 %) as below average or as having a mild cognitive delay, and 5 (5 %) as having a moderate to severe cognitive disability. Descriptions of cognitive ability were not provided for 39 participants (37 %). ES estimates for participants described as performing in the average range were strong (NAP = .95; Tau-U = .86), for children reported to be performing below average ES estimates were moderate (NAP = .88; Tau-U = .68), and for all 5 children described as having moderate to severe cognitive disabilities NAP and Tau-U were 1.0 (See Table 5).

The authors of the included studies described the social behavior of 98 (93 %) participating children. Based on the

provided descriptions, children with ASD were classified as either initiators (i.e., attempted to socially initiate but unsuccessfully; n = 10; 10 %) or low initiators (e.g., rarely initiated toward peers; n = 88; 84 %). Interventions produced a moderate impact for children described as both initiators (NAP = .82; Tau-U = .62) and low initiators (NAP = .91; Tau-U = .82) across intervention types (See Table 5).

Discussion

Overall, peer-related social competence interventions delivered in school settings produced a moderate to high impact regardless of intervention type (i.e., child-specific, peer-mediated, multi-component, and collateral skill), child characteristics (e.g., social initiations prior to intervention, cognitive ability, age), or outcome measure. ES averages for adult-mediated (NAP = .93; Tau-U = .85), combined child specific (NAP = .95; Tau = .90), peer-mediated (NAP = .95; Tau-U = .87), and multi-component studies (NAP = .93; Tau-U = .84) were all strong, and estimates for social narratives (NAP = .83; Tau-U = .65), VM/VSM (NAP = .86; Tau-U = .71), and collateral skill interventions (NAP = .88; Tau-U = .73) fell in the moderate range.

Quality of Studies

Based on the primary quality indicator ratings (Reichow 2011), the majority of the studies were of high or

acceptable quality. Five studies received an unacceptable rating for participant descriptions, and two for independent variables indicating these studies failed to provide the detail necessary for replication. Only four child-specific studies received unacceptable ratings for visual analysis, and three for experimental control. Two of these studies were social narrative studies, one VSM, and one adult-mediated. Very few studies included Kappa values or kept raters blind to the purpose of the study. The majority of studies included and met criteria (>80 %) on measures of interobserver agreement and treatment integrity. All studies were conducted in natural settings (i.e., child's school/classroom), and many assessed whether participants generalized their newly learned skills to other settings, peers, etc. In addition, many studies measured maintenance and/or provided evidence of social validity.

Intervention Impact

Overall, child-specific studies had a moderate to strong impact on a number of behaviors initiations (NAP = .89; Tau-U = .76), responses (NAP = .90; Tau-U = .78), engagement (NAP = .97; Tau-U = .92), and interactions (NAP = .84; Tau-U = .68). Adult-mediated interventions produced positive findings, but some researchers noted that fading adult supports (e.g., prompting, reinforcement) was difficult (e.g., Garfinkle and Schwartz 2002; Shabani et al. 2002). Although many children with ASD may require adult support or structured activities initially, plans for fading can facilitate independent use of the newly acquired skill(s) (Lang et al. 2011).

Social narrative ES estimates were highly variable ranging from (NAP ranging from .56 to 1.0; Tau-U from .12 to 1.0). This finding is consistent with previous reviews (e.g., Kokina and Kern 2010; Test et al. 2011) suggesting that social stories should not yet be considered an evidence-based practice (Test et al. 2011) to enhance peer-related social competence. Findings from VM/VSM studies were also inconsistent ranging from weak (NAP = .57; Tau-U = .13) to strong (NAP = .99; Tau-U = .97). VSM studies producing more minimal or variable effects provided an opportunity for participants to use the modeled skill approximately 1-h after showing the video, whereas in studies producing a notable change opportunities were given immediately after the child viewed the video. It may be that time between viewing the video and providing an opportunity to engage in the modeled behavior is important in school settings as a variety of activities are likely to occur in an hour. Equally variable were the VM/VSM intervention procedures used including video presentation (e.g., voice over, powerpoint) and length, as well as the number of videos shown in a single session. Similar differences were noted in past reviews, and make it difficult to combine findings or make recommendations without further research (Reichow et al. 2008; Shukla-Mehta et al. 2010). Additionally, only 2 (40 %) VM/VSM studies measured treatment integrity. Future VM/VSM research should attempt to establish effective and reliable implementation guidelines.

As noted in past reviews, VM/VSM and social narratives are often part of an intervention package (Kokina and Kern 2010; Reichow and Volkmar 2010; Shukla-Mehta et al. 2010). The three reviewed combined child specific studies paired social stories and/or VM with adult-mediated strategies (i.e., role play, prompting, reinforcement). In two of these studies, prompting or reinforcement was added in a phase change, which resulted in greater improvement (Apple et al. 2005; Sansosti and Powell-Smith 2008). More research is needed to determine if other interventions are essential to the effectiveness of social stories (Shukla-Mehta et al. 2010) and VM/VSM for some participants with ASD.

Studies including peer-mediated instruction (i.e., peer-mediated and multi-component interventions) consistently resulted in positive findings, which suggests using peers to promote the social competence of children with ASD should be considered an evidence-based practice (Odom et al. 2010; Reichow and Volkmar 2010). Peer-mediated studies had a moderate to large effect on the initiations (mean NAP = .83; Tau-U = .67), responses (NAP = .88; Tau-U = .72), and interactions (NAP = .99; Tau-U = .98). In multi-component studies, adult- and peer-mediated instruction were combined. Multi-component studies had a moderate to strong impact on initiations (NAP = .92; Tau-U = .83), responses (NAP = .90; Tau-U = .80), engagement (NAP = .99; Tau-U = .97), interactions (NAP = .87; Tau-U = .73). The majority of these studies (n = 6; 75 %) included additional strategies (e.g., task analysis, self-monitoring, social stories) creating a treatment package, which makes it difficult to determine which intervention components generated the greatest impact.

Only 3 studies included collateral skill interventions and produced a moderate to strong effect on initiations (NAP = 1.0; Tau-U = 1.0), and engagement (NAP = .93; Tau-U = .85). No studies measured responses and only one study assessed interactions and had a weak impact (.66; Tau-U = .23). More studies are needed to determine the extent to which collateral skill interventions benefit children with ASD as these interventions have potential utility when applied in school-based settings given the emphasis on comprehensive interventions that not only target the core challenges of children with ASD but also academic achievement.

Findings by outcome measure also indicate a moderate to strong effect with the average ES for initiations

(NAP = .90; Tau-U = .79), responses (NAP = .92; Tau-U = .83), interactions (NAP = .87; Tau-U = .75), and engagement (NAP = .96; Tau-U = .91) in the moderate to strong range. Consistent with Zhang and Wheeler (2011), initiation ES estimates were variable indicating a need for more research on the effects of social skills interventions on the social initiations of children with ASD. This variability may be impacted by a number of factors including participant characteristics, effectiveness of the independent variable, or appropriateness of the dependent variable.

Limitations and Suggestions for Future Research

It is important to note that the majority of participants were described as performing in the average range academically, verbal, and rarely initiating social interactions. More research is needed to determine the impact of school-based interventions on the social competence of children with ASD who demonstrate a range of cognitive abilities and communication skills.

Research suggests the social development of children with ASD is influenced by a number of factors including cognitive and communication skills (Constantino 2011), yet consistent with previous reviews (e.g., Ferraioli and Harris 2011; Wang et al. 2013) information pertaining to these characteristics were at times under reported or minimally described. For example, the cognitive ability of 37 % of participating children was not described in the included studies. Limited descriptions of participants make it difficult to detect patterns between intervention effectiveness and participant characteristics.

Additionally, given the heterogeneity associated with ASD, it is surprising that an assessment process was not used/described to determine and define the target behaviors. Although all children with ASD will experience difficulty interacting with others, the way these challenges manifest varies (Constantino 2011). Future research should include procedures for individualizing social interventions and outcome measures based on participant need. Such procedures can avoid potential design issues (e.g., participants demonstrating a target behavior in baseline, neglecting to teach important prerequisite skills), and inform practice.

Also, few studies measured the quantity and quality of observed behaviors or impact of the intervention on friendships/social networks. Because social skills interventions are designed to target the skills necessary to create and maintain relationships with others, future research should extend outcome measures to emphasize quality and include more global social competence measures (Rotherman-Fuller and Kasari 2011). Future research should also investigate the practicality and feasibility of teachers or other school personnel implementing social skills interventions in school settings. In the majority of the reviewed studies, researchers were the sole implementer or partnered with the teacher to deliver the intervention. Researcher implementation is critical to determine effectiveness; however, examining the efficacy of these interventions as they are implemented by teachers and peers in authentic school settings during naturally occurring social opportunities is also needed.

One possible threat to the validity of all research reviews is publication bias (Rothstein et al. 2005). Publication bias can occur if researchers neglect to publish negative findings or journals reject studies that fail to produce positive results (Sutton 2009). Findings reported in this review should be interpreted with the understanding that publication bias may have influenced the results. Additionally, the use NAP and Tau-U to calculate ES estimates is relatively new. In this analysis, Tau-U was the more conservative estimate. Both NAP and Tau-U calculations were supported by our visual analysis.

Conclusions

Findings herein suggest that children with ASD can benefit from social skills interventions that target peer interactions at school. Some strategies (i.e., peer-mediated, multi-component, adult-mediated interventions) garnered more evidence for the promotion of peer interactions in school settings than others, and some require additional study for the purpose of teaching peer-related social competence (i.e., social narratives and VM/VSM).

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