Effectiveness of behavioral interventions for autism spectrum disorder: A systematic review

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Research article

Keywords: Systematic review, Behavioral interventions, Children, Autism Spectrum Disorders

DOI: https://doi.org/10.21203/rs.3.rs-16918/v1

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Abstract

Background: Autism Spectrum Disorder (ASD) is identified by a group of neurodevelopmental disorders. Given the importance and demand for behavioral interventions in autism disorder as well as the need for new intervention programs, a detailed evaluation of the outcomes of interventions for the ongoing impact of behavioral interventions for autism spectrum disorder is essential. In view of the importance of, and demand for, novel behavioural interventions in autism disorder, a comprehensive evaluation of the outcomes of interventions for the ongoing impact of behavioral interventions for autism spectrum disorder is necessary.

Method: A systematic search of the electronic databases including PubMed, Embase, Scopus, Sciencedirect, ISI Web of Science, and Biomedcentral were conducted to find evidences for the effectiveness of behavioral interventions for autism spectrum disorders. The search strategy was based on exploring studies published in different global languages from the earliest to 2019 databases. In addition to the databases mentioned above, relevant studies were searched using forward and backward citation tracing.

Results: In the present review, 48 randomized controlled trials (RCTs), and 44 quasi-experimental articles matched the defined evaluation criteria. Eighty-three out of 93 studies were conducted in high-income countries, the results of which raised the challenges associated with acceptability of conducting those studies in low- and middle-income countries. The majority of those studies (93.5%) were classified as having either low or medium quality. From those studies, 32 studies used integrative programs, and 30 studies used social skills development interventions. The majority of the studies were based on integrative programs designed to foster social skills development interventions. The results of the study showed that social skills development interventions were effective in changing the desired outcomes. The results showed that, regardless of the study design and the type of intervention used, the possibility for success of interventions were greater in changing the participants' social skills.

Conclusions: There were inconsistent evidence on the effectiveness of interventions in providing changes in targeted outcomes. There is a need for further investigation in behavioral interventions for autism spectrum disorders. Further research is needed to understand the effectiveness of other interventions and finding a quality interventions to achieve more significant results.

Background

Autism Spectrum Disorder is a neurodevelopmental disorder marked by social-communication impairment, restricted, repetitive and stereotyped patterns of behavior, and repetitive and stereotyped movements [1]. In addition to these main features, other behavioral problems such as anxiety, depression, sleep and nutrition disorders, attention disorder, and self-injurious and aggressive behaviors are detected in these children [2]. There has been a growing trend in the prevalence of autism. The US Centers for Disease Control and Prevention (CDC) reported a prevalence of 1 in 110 children from 2004 to 2006 [3], 1
in 110 children in 2012 [4], and 1 in 59 children in 2014. Studies in Iran indicated an increasing trend of autism spectrum disorders in children. According to one study, the prevalence of autism disorder was 26.6 per 10,000 children in 2007 [5], and 95.2 per 10,000 children in 2014 [6].

While there is no existing treatment for autism spectrum disorder, it is generally believed that early diagnosis and treatment seem to recover many people with autism over time [7]. Therefore, how different interventions could help to improve the functional ability of people with autism spectrum disorder is essential for families, health professionals, and policymakers [2]. Over the past 30 years, various treatments have been suggested to alleviate and recover symptoms associated with autism spectrum disorder. Current treatments include medications, diet changes, vitamin therapy, rehabilitation therapies, and behavioral, and developmental interventions [8]. Most interventions vary, depending on the theoretical framework, type of presentation, severity of intervention, the level of parent involvement, and comprehensive intervention used. In addition, interventions are very expensive and necessitate a large number of well-trained staff and technical infrastructure [9].

Based on the performance shown in the experimental studies, interventions included in the continuum of behavioral interventions are the dominant treatment approach to improve social, adaptive, and behavioral performance of people with autism spectrum disorder [10]. These interventions are guided by a therapist and are seeking to improve social and behavioral skills in children and their families. While behavioral interventions may be provided up to long hours per week, there is a debate about the intensity needed to achieve positive outcomes and the effectiveness of different approaches [11]. A comprehensive evaluation of review studies conducted on behavioral interventions in autism spectrum disorders reveals that most of these studies have methodological flaws, which is led to the weakness of their validity [2, 9]. We identified one recent review on the effectiveness of behavioral interventions for Autism Spectrum Disorder among children's [2]. These reviews included various designs, such as randomized controlled trials (RCTs), controlled clinical trials (CCTs) or observational analytical studies (i.e., prospective or retrospective cohort studies with comparison groups) and reported data on the effects of a behavioral or developmental intervention in individuals with ASD until 2008 [2]. However, none of those reviews assessed the methodological quality of the included studies. There is also evidence of positive outcomes for many of the interventions reviewed in systematic review conducted on autism disorder. Therefore, further investigation is required to evaluate the effectiveness of behavioral interventions for autism spectrum disorder using rigorous scientific methods. Physicians, educators, and families of people with autism need to make informed decisions about treatment options. In this regard, clinical and research questions about the benefits of the related interventions need to be addressed and responded. Given the importance of current increasing trend in the novel intervention programs, a detailed evaluation of the effects of interventions on the continuing impact of behavioral interventions for autism spectrum disorder will provide the necessary information for policymakers, researchers, health care providers, and families. This systematic review aimed to identify, evaluate, and integrate evidence on the effects of behavioral interventions to improve the primary symptoms associated with autism spectrum disorders.
Methods

In the current systematic review, PRISMA checklist was used to report the findings of the study.

Search strategies

Database articles, including BioMed Central (BMC), PubMed, Sciencedirect, Embase, Web of Science, and Scopus were reviewed using the search strategy used in the related studies [2]. The search strategy in the scientific databases is set out in Appendix A, and according to the search requirements at each of the databases mentioned, necessary changes were made while searching websites.

Trial selection

All articles identified from various sources were first collected by a researcher using Endnote software. After integrating the articles from all the cited databases and deleting duplicate articles, the two researchers of the current study, independently reviewed all the articles and excluded the articles that were not relevant to the subject and the inclusion criteria. The abstracts of remaining articles were independently studied by two researchers. Then, the full text of the relevant articles was reviewed by two researchers and the articles that were fully consistent with the criteria were identified. Using forward citation and backward citation reviews, additional articles were added to the resource collection. Data were extracted by two researchers. At all stages, disagreements were resolved through consensus-based discussion and, finally, through the opinion of the third researcher.

Inclusion criteria

The PICO index (study population, type of study, type of intervention and type of outcome) was used to evaluate the inclusion and exclusion criteria [12].

- Type of Study: Types of RCTs and Quasi-Experimental Studies (cPPI and PPI).

Study population: Children, caregivers and families of children of all ages and both sexes who were involved with autism spectrum disorders and problems.

- Type of intervention: This included the evaluation of an intervention program at national, regional, organizational, community, or individual levels for the autism spectrum disorder.

Type of Outcomes: Studies with subjective outcomes (such as the use of questionnaires for reporting) and objective outcomes (such as the use of observation and surveys) for autism spectrum disorders.

- Study period: Studies from the first years of publication in the scientific database

- Studies published in all languages of the world.

Exclusion criteria
- Type of Study: Descriptive, Qualitative, Review, Structured Review, Meta-Analysis and Protocol.

- Study population: Studies conducted in other groups with developmental problems.

- Type of Intervention: Studies that have performed interventions for autism spectrum disorders along with other interventions for other developmental problems.

- Type of Outcome: Studies that their results are evaluated using qualitative data and the results of the evaluation cannot be compared.

**Data extraction**

The final articles after reviewing were summarized in predefined tables and finally the articles were analyzed according to goals and objectives. The information in the table included:

- Full name of the first author of the study, year of publication of study and country of study

- The study design consists of two general groups of controlled trial studies and quasi-experimental studies. Quasi-experimental studies were divided into two types controlled pretest/post-test interventions (cPPI) and pretest/post-test interventions (PPI)

- Target group of the intervention programs: Studies were investigated based on conducting on children, family and child caregivers and a combination of child/family and caregivers.

- Sample size and its properties

- Type of Intervention: To categorize the interventions in the results, the framework presented in the study of Ospina et al. who classify the interventions for autism spectrum disorder in 8 groups, including Applied Behavior Analysis interventions, Communication-focused interventions, Contemporary Applied Behavior Analysis interventions, Developmental approaches, Environmental modification programs, Integrative programs, Sensory-motor interventions and Social skills development interventions was applied [2].

- Duration of intervention and follow-up

- Models and theories used

- Results of the studies: The studies were evaluated in terms of achieving results and reported as significant, increase of positive percentages, and increase of favorable cases and decrease of unfavorable cases.

**Quality assessment**

In order to determine the quality of the articles, two trained researchers reviewed the articles. To evaluate the quality of the studies, the EPHPP tool developed by the National Collaboration Center for Methods and Tools (NCCMT) for all types of studies was used [13]. By application of this tool, one of the qualities,
i.e., strong, medium and poor were considered for each of the articles. The quality assessment based on this tool is based on an evaluation of 6 components, including sample selection bias, type of study, confounders, blinding, data collection methods, and sample dropout and exclusion. The quality assessment of the studies based on the tools was separately carried out by two researchers and finally, to determine the quality of the studies, the disagreement between the two researchers was resolved by consensus-based discussion. Kappa coefficient was used to evaluate the agreement between the two evaluators [14]. No studies were excluded because of poor quality.

Results

A total of 37200 references were identified and reviewed: 36990 references from the main sources, and 210 references from other sources. From these references, 1290 were selected for abstract review. After, In-depth abstract review of the abstracts, 365 references met the inclusion criteria and were selected for full review. Eventually, after ensuring that inclusion criteria were satisfied, 93 studies were included in this review (See Fig. 1).

A summary of the included articles is provided in Table 1.

The majority of studies identified were randomized trials. Forty nine studies were randomized controlled interventions [15-63]. Nine studies were controlled pretest/post-test interventions [64-72], thirty five studies were pretest/post-test interventions [73-107]. In this line of studies, from 2009, seventy-nine other studies were also published [15-17,19-24,26,27,29-32,34-45,47-77,79,80,83,84,88-94,96,98-102,104-107], and fourteen studies were published from 1994 to 2009 [18,25,28,33,46,78,81,82,85-87,95,97,103]. Forty-one of the above mentioned studies were conducted in USA [18,19,21,23,24,30,32,34,37,38,42-47,49,50,53-56,60,61,63,74-79,83-90,94,95,97-100,102,107], seven were conducted in Australia [16,36,41,52,70,92,101], six were conducted in Canada [20,35,39,40,59,62], three were conducted in France [17,80,96], three were conducted in UK [15,25,28], three were conducted in Netherlands [22,57,58], two were conducted in Japan [29,82], two were conducted in Germany [81,91], two were conducted in Iran [51,64], two were conducted in Korea [33,99], two were conducted in Sweden [48,72], and one was conducted in India [65], Hong Kong [71], Taiwan [67], Nigeria [31], Switzerland [26], Spain [69], United Arab Emirates [27], Amman [68], Brazil [66], and Turkey [73], respectively. Most studies had a small sample size, so that the number of participants in thirty - five studies was less than 20 [17,25,27,29,33,59,62,66,69,73-78,80-86,89-91,93-96,99,100,103-105,107], and in thirty studies, it was between 20 to 50 [18,19,21,24,35,38,39,42,46,48,50,51,53,55,57,61,63,64,67,68,79,88,92,97,98,102,106].

Follow-up was often quite short, in the 16 studies follow-up immediately [46,53,66,73,75,76,84,85,89,90,93,94,99,100,103,107], in 30 studies, it was three months and less [15,16,21,23,24,26,32,33,35,39,40,47,48,51,52,55-57,59,61,62,65,67,70,72,74,79,83,86,98,101,102,104,105], and in 20 studies, it was more than three months [17-20,22,25,28,31,36,37,41,43,44,49,54,58,60,78,80,88,91]. In 27 studies, the duration of follow-up of the intervention was unknown [27,29,30,34,38,42,45,50,63,64,68,69,71,76,77,81,82,84,87,89,92,94-97,100,106]. Of the studies obtained, 20 studies focused on children and parents...
three studies was focused on children and teachers [28,30,42], and others studies were focused on the children with autism spectrum disorder.

Communication-focused interventions was used in twenty one studies [15,21,26,31,46,50,51,54,55,66,67,75,76,82,91,93-95,104]. Thirty-two studies used integrative programs [18,20,24,25,28,30,33,35-37,40,52,58,60,62,63,71,74,77-79,81,86,89,92,96,98,100-103,107]. Also, thirty studies used social skills development interventions [16,17,19,22,23,29,32,34,38,39,45,47,48,56,57,59,61,64,65,69,72,73,80,83-85,90,97,99,105]. Six studies included sensory motor interventions [42,49,53,70,87,106]. Two studies were focused on contemporary applied behavior analysis (ABA) interventions [41,88]. Two studies were based on Environmental modification programs [43,44]. As noted, most studies were focused solely on integrative programs and social skills development interventions. The procedures included social stories, parent and child education programs, speech therapists and occupational therapists, small educational groups, home-based, and home visiting programs, solving social problems, using dolls, and holding workshops.

The results of the included studies were mainly based on observed data and only in fourteen studies, self-reported of participants’ practices were used to evaluate the effects of interventions [23,34,40,45,58,61,64,65,70,72,77,79,100,101]. Of the included studies, only twelve (12.9%) used theories and models. Theory of Mind was the most frequent theoretical framework employed [19,21,39,56-58,64,67]. Other theories included behavioral cognitive theory [59], the DIR theory [87], social learning theory [105], and social motivation model [38]. Theoretical frameworks in the studies were used only to guide the intervention development.

Of the 21 studies that were used for the communication-focused intervention approach, 16 studies were significantly reached in all outcomes. Five studies only examine the impact of the intervention on communication skills of the participants [46,51,54,75,76], three studies on language skills [27,50,55], two studies on collaborative interaction [67,93], one study on emotional understanding [82], one study on emotion regulation [26], one study on communicative utterances [31], one study on communication symptoms [21], one study on expressive communication [94], and one study on communicative behaviors [95]. But, four studies reported that some of the expected outcomes created significant differences [15,68,91,104], and in one study, the intervention was not successful [66].

Of the 32 studies that had used for integrative approach, 28 studies were significantly reached in all outcomes. Four studies only examined the impact of the intervention on communication and behavior skills of participants [62,92,102,107], four studies on emotional and social skills [71,79,96,101], eight studies on social and communication skills [35,30,33,35,36,81,86,100].

Three studies on social skills [18,20,89], three studies on emotional and communication skills [40,77,78], three studies on social behavior skills [58,60,98], two studies on daily living skills [24,37], and one study on social communication [103]. But, two studies reported that some of the expected outcomes created significant change [28,63], and in two studies, the intervention was not successful for changes [52, 74].
Of the 30 studies on the social skills development intervention approach, 28 studies were significantly reached in all outcomes. 32 studies only examined the impact of the intervention on the social skills of the participants [16,17,22,23,29,32,34,39,47,48,59,64,65,69,72,73,80,83-85,90,99,105], three studies on behavior and social skills [45,57,97], one study on social motivation [38], and one study on social engagement [61]. But, only two studies reported that some of the expected outcomes created significant change [19,56].

From the six studies on the sensory-motor intervention approach, five studies were significantly reached all outcomes. Only two studies examined the impact of the intervention on the joint attention of the participants [42,53], one study on functional emotion [87], one study on social functioning [70], and one study on joint attention and joint engagement [49]. But, one study reported that some of the expected outcomes create significant change [106].

Of the two studies that had used for contemporary applied behavior analysis interventions approach, one study reported that some of the expected outcomes created significant change [41], and in one study, the intervention was not successful [88].

From the two studies on environmental modification programs, both studies significantly reached in all outcomes. Both studies examined the impact of an intervention on environmental enrichment of the participants [43,44].

We addressed the quality of randomized trials and non-randomized interventions (i.e. cPPI and PPI) separately. The majority of the RCTs (42/49) [15,16,18,19,21-30,32-40,42-51,53,55,57,63] were at moderate risk of bias. Six RCTs [17,20,31,41,52,56] were classified as strong quality, and only one RCT [54] had a relatively high risk of bias and was classified as low quality. The majority of non-randomized intervention studies (42/44) [66-107] were assessed as having high risk of bias (low quality) and remaining non-randomized trials were classified as moderate quality [64,65]. None of these studies were classified as high-quality evidence. The most general issues with quality were associated with confounders, data collection methods, and withdrawals.

Inter-rater agreement (Table 2) varied across EPHPP component ratings. For withdrawals and dropouts, there was a good agreement (0.636), and for other components, ratings were classified as very good agreement (k = 0.80 to 1.00).

Discussion

Although there are very limited number of review studies mentioned in the current review, there has been no systematic review that comprehensively examines the effectiveness of behavioral interventions to improve the primary symptoms associated with autism spectrum disorders in children. Thus, this study was conducted to eliminate the knowledge gap in this field.
Following article reviews conducted by the researchers, finally 93 studies were identified for evaluation in this systematic review. 49 studies were randomized trial, and the rest were quasi-experimental. The sample size of most studies was small, and the follow-up duration of interventions was largely short and unclear. Also, the outcomes measured in the studies were mainly based on observation. The intervention approach used in the 32 studies was integrative, and the majority could significantly provide changes in all outcomes. Twelve studies used models and related theories, and 43 studies were poor in terms of quality. For these reasons, we can conclude that these studies provide no convincing evidence about interventions conducted.

Most studies were randomized trials. According to a similar systematic review, most studies have been conducted on behavioral interventions in children with autism spectrum disorder [2]. If appropriately used, conducting these studies can provide sufficient information in this area. Most studies were based on integrative and behavioral interventions and social skills development. These studies used a variety of strategies, and its result is in line with a study on behavioral interventions among children with autism spectrum disorder [2].

This review study displays that there are limited studies in this field in middle and low-income countries. Despite the fact that, fewer people live in high-income countries compared to middle- and low-income countries, the majority of studies were conducted in high-income countries; this may be due to better identification of children with autism spectrum disorder in those countries. Moreover, our study showed that, from the eight RCT studies, seven of the articles were conducted in high-income countries, showing the importance of conducting such studies in low- and middle-income countries. However, since the majority of studies in high-income countries have been conducted by different types of research strategies, the evidence about studies of high-income countries is likely to be appropriate in low- and middle-income countries as well.

It is expected that the Integrated and combined interventions produce more positive outcomes than other interventions; though, the current review study revealed that such interventions, in changing the targeted goals, were less successful compared to social skills development intervention. Interventions that work on only one outcome in children with autism show better and more important outcomes than interventions that evaluate and assess multiple outcomes. Moreover, the results of these studies showed that few participants took part in the study and the length of follow-up was short. Hence, studies with methodological weakness, few participants, and relatively short-term follow-up may not show the real effects of behavioral interventions on improving the primary symptoms associated with autism spectrum disorders.

Regardless of the study design and type of intervention used, our study showed that interventions have been successful in improving the skills of children with autism spectrum disorder, especially social skills. Therefore, this clarifies the need for effective interventions and follow-up in children with autism spectrum disorders. The results of this review study indicated that the most effective behavioral
treatments for ASD include interventions that address behavioral, social, and communication deficits associated with the disorder.

The results of the current review revealed that the majority of studies did not explicitly use models and theories related to autism spectrum disorders. It is now clear that addressing social and behavioral science theories in designing a health plan could be related to the efficiency of the interventions. These frameworks help to recognize the different skills and conditions (such as the cultural, economic, and social conditions) in which the behavior occurs.

Some of the mentioned studies in the current review had poor and moderate design, and the majority of studies were classified as low quality. Almost half of the studies discussed in this review, were quasi-experimental, and other trial studies had some deficiencies in the method of work and presentation of results. This in turn had a negative effect on the quality of the mentioned studies.

Several factors contributed to the limitations of this systematic review including: Using different study designs, including randomized controlled trials and quasi-experimental studies resulting in a variety of outcomes. These limitations lead to the impossibility of conducting a meta-analysis. Another limitation of this study could be a diffusion bias due to overlooking gray sources to evaluate the effectiveness of the interventions.

Conclusion

To increase effectiveness of behavioral interventions for Autism Spectrum Disorders in Children, the following measures could be considered: application of randomized trial studies instead of quasi-experimental studies, increasing the duration of interventions and follow-ups, use of other intervention approaches, increasing sample size in studies for achieving the desired results, use of theory, models, and educational frameworks for creating novel pathways.

Abbreviations

ASD
Autism Spectrum Disorder;

RCTs
Randomized Controlled Trials;

CDC
Disease Control and Prevention;

CCTs
Controlled Clinical Trials;

cPPI
controlled Pretest/Post-Test Interventions;

PPI
Pretest/Post-Test Interventions;
NCCMT
National Collaboration Center for Methods and Tools

Declarations

Ethical approval
The ethics code of Hamadan University of Medical Sciences was IR.UMSHA.REC.1398.287.

Consent for publication
Not applicable.

Availability of data and material
All data generated or analyzed during this study are included in this published article.

Competing interests
The authors declare that they have no competing interests.

Funding
This work was supported by Hamadan University of Medical Sciences [reference number: 9804112817]. The funder had no role in the design of the study, data collection, analysis, interpretation of the data, writing of the manuscript, or the decision to publish.

Authors' contributions
All authors read and approved the final manuscript. SB, MA, EJ and AM conceived of the study and participated in the design, data collection and analysis as well as preparation. MA, EJ and AM participated in the data analysis and preparation. MA participated in data collection.

Acknowledgments
This project has been approved by the Research and Technology Deputy of Hamadan University of Medical Sciences.

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Table 1. Effectiveness of behavioral interventions for Autism Spectrum Disorder
| Authors/Country | Design | Participants | Intervention | Response percentage and duration of follow-up, theory and model used | Outcome measurement | Significant results | Study quality |
|----------------|--------|--------------|--------------|-------------------------------------------------------------------|---------------------|-------------------|--------------|
| Acare et al., 2016/ Turkey | PPI | N= 3 children I: n =3 | - I: mother-developed and delivered social stories and video, modeling in teaching social skills, sessions once a day in three consecutive days at the homes of each dyad | -100% response rate - Immediate follow-up by observation - No theoretical and model | - Social Skills | - Interventions were effective in teaching social skills to children | Weak |
| Yoo et al., 2018/ Korea | PPI | N= 9 children I: n =9 | - I: preliminary pilot of a rhythm-mediated music therapy intervention measured changes in social skills. Each participant received a total of eight 30-minute individual sessions | -100% response rate - Immediate follow-up by observation - No theoretical and model | - Joint engagement | - Greater engagement in joint action following the intervention | Weak |
| Stavrou et al., 2018/ USA | PPI | N= 7 children I: n =7 | - I: program was 12 weeks, at a frequency of 3 sessions per week of 40-45 minutes each time. | -100% response rate - Immediate follow-up by observation - No theoretical and model | - Communicatio n and behavior skill | - Significant improvement in communication and behavior skill | Weak |
| Cardoso et al., 2010/ Brazil | cPPI | N= 16 children I: n = 8 C: n = 8 | - I: Once a week, specialized language therapy by a speech-language pathologist for a period of at least six month | -100% response rate - Immediate follow-up by observation - No theoretical and model | - Social cognitive profile and the Social-Communicative adaptation | - No significant statistical differences in the social cognitive profile between the two groups. | Weak |
| Study                                      | Design | N= | Type of Treatment                                                                 | Follow-up | Outcome Measures                                                                 | Strength |
|-------------------------------------------|--------|-----|-----------------------------------------------------------------------------------|-----------|----------------------------------------------------------------------------------|----------|
| Choque Olsson et al., 2017/ Sweden        | cPPI   | 296 | 12 sessions of manualized Social skills group training (“KONTAKT”) were delivered by regular clinical staff. | 3-month   | Social skills                                                                     | Weak     |
| Yuan & Shing Ip, 2018/ Hong Kong           | cPPI   | 72  | Developed a VR-enabled training program to examine its efficacy on emotional and social skills with six VR scenarios depicting the daily lives of typical children | self-report | Emotional and social skills                                                        | Weak     |
| Yoder & Stone, 2006/ USA                   | RCT    | 36  | Three 20-min intervention sessions per week for 6 months.                          | Observation | Communication skills                                                              | Moderate |
| Adams et al., 2012/ UK                    | RCT    | 88  | Children in the social communication condition received up to 20 sessions of direct intervention from a specialist research speech and language therapist working with supervised assistants. | Observation | Social Communication and speech therapy                                           | Moderate |
| Adibsereshkiet al., 2015/ Iran            | cPPI   | 24  | 3 times a week for 15 sessions of ToM training                                     | Self-report| Social skills                                                                     | Moderate |
| Study | Design | N | Group Description | Intervention Details | Outcome | Effect Size |
|-------|--------|---|-------------------|---------------------|---------|-------------|
| Waugh and Peskin 2015/ Canada | RCT | 49 children | I: n = 19, I: n = 11, C: n = 19 | - I: children were taught to identify and consider their peer’s mental states, while learning friendship-making skills and strategies, through the use of visual scaffolds in story format. | -95.9% response rate, -3-month follow-up by observation, -Theory of Mind | - Social Skills in the experimental groups were significantly more than the control group | Moderate |
| Welterlin et al., 2012/ USA | PPI | 20 parent and children | I: n = 20 | - Intervention including treatment (Home teaching Program) and 12 week | -100% response rate, -4-month follow-up by observation, -No theoretical and model | - Child and parent behavior | Weak |
| Roberts et al., 2011/Australia | RCT | 85 children | I: n = 28, I: n = 28, C: n = 29 | - I: an individualized home-based program (HB), a small group center-based program for children combined with a parent training and support group (CB) had 12-month programs | -98.8% response rate, -6-month follow-up by observation, -No theoretical and model | -Social and communication skill development | Moderate |
| Albasha et al., 2016/ USA | PPI | 9 children | I: n = 9 | - I: each child attended one, 25-minute session per week for 8 weeks. The children were assigned to have their first 4 weeks with the dog and the next 4 with the human proxy, or vice versa. | -100% response rate, -1-month follow-up by observation, -No theoretical and model | -Social initiation behaviors | Weak |
| **Wright et al., 2016/ USA** | RCT | N= 50 children | I: n = 25  
C: n = 25 | - I: The intervention was a goal-setting session followed by an annualized toolkit for creating Social Stories™  
-100% response rate  
- Un-known follow-up by self-report  
- No theoretical and model  
- Behavior and social skills | - High levels of completion rates and appeared to be capturing social and behavior skills targeted by the use of social stories. |  
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| **Wong 2013/ USA** | RCT | N= 33 teacher and children | I1: n = 10  
I2: n = 14  
C: n = 9 | - I: in three groups: (1) symbolic play then joint attention intervention, (2) joint attention then symbolic intervention, and (3) control group  
- Teachers participated in eight weekly individualized 1-h sessions  
-100% response rate  
- Un-known follow-up by observation  
- No theoretical and model  
- Play and joint attention | - Implement an intervention to significantly by teachers  
- Improve joint engagement significant increases in joint attention and symbolic play skills |  
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| **Vernon et al., 2019/ USA** | RCT | N= 28 parent and children | I: n = 10  
C: n = 9 | - I: Treatment condition received 6 months (26 weeks) of the PRISM treatment model. They were allocated 10 h a week of intervention: 8 h of one-on-one clinician-implemented treatment and 2 h of parent education in the intervention strategies with the child present  
-82.1% response rate  
- Un-known follow-up by observation  
- Social Motivation model  
- Social motivation | - Effect Pivotal response treatment for social motivation in children |  
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| **Wood et al., 2017/ Australia** | PPI | N= 45 children | I: n = 45 | - I: an average 20 hr. of intervention per week for  
-71.1% response rate  
- Un-known follow-up by  
- Expressive language, cognitive behavior skills  
- Statistically significant increases in receptive and expressive language skills | - Expressive language, cognitive behavior skills |
| Study                          | Design | Participants | Intervention Details                                                                 | Outcome Measures                                                                 | Conclusion |
|-------------------------------|--------|--------------|---------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------|
| Woo and Leon 2013/ USA        | RCT    | N= 28 children | I: n = 15 received daily olfactory/tactile stimulation along with exercises that stimulated other paired sensory modalities | -100% response rate -6-month follow-up by observation - No theoretical and model | Moderate   |
|                               |        | C: n = 13    |                                                                                        | - Environmental enrichment                                                       |            |
|                               |        |              |                                                                                        | - Significant gains in environmental enrichment                                    |            |
| Woo et al., 2015/ USA         | RCT    | N= 50 parent and children | I: n = 22 received either daily sensorimotor enrichment, administered by their parents, along with standard care | -100% response rate -6-month follow-up by observation - No theoretical and model | Moderate   |
|                               |        | C: n = 28    |                                                                                        | - Environmental enrichment                                                       |            |
|                               |        |              |                                                                                        | - Significant gains in their IQ scores, a decline in their atypical sensory responses, and an improvement in their receptive language performance |            |
| Willemin et al., 2018/ Germany| PPI    | N= 14 children | I: n = 14 social-emotional impact of eight one-hour sessions of a novel dyadic within-group drumming program called drumtastic at a four-week summer camp | -100% response rate -6-month follow-up by observation - No theoretical and model | Weak       |
|                               |        |              |                                                                                        | - Social emotion                                                                |            |
|                               |        |              |                                                                                        | - Children significantly higher on the posttest on Smiley-o-meter, and fun-o-meter |            |
|                               |        |              |                                                                                        | - Not elicit a statistically significant change in children's social and personal skills. |            |
| Alzrayer et al. 2017/ USA     | PPI    | N= 4 children | I: An Apple iPad II with Proloquo2Go software was used for navigation and symbol combination skills across three | -100% response rate -Immediate follow-up by observation - No theoretical and model | Weak       |
|                               |        | C: n = 4     |                                                                                        | - Communicating skill                                                            |            |
|                               |        |              |                                                                                        | - Participants were successful to varying degrees in navigating across pages and combining symbols to request |            |
| Study | Design | Participants | Intervention | Follow-up | Outcomes |
|-------|--------|--------------|--------------|-----------|----------|
| Andrews et al., 2013/ Australia | RCT | N= 58 children | - I: including greater use of visual content, including parents in the program, and experiential learning through role play | - 98.3% response rate - 3 month follow-up by observation - No theoretical and model | - Affectionate communication and friendship skills |
| Wetherby and Woods 2006/ USA | PPI | N= 4 children | - I: consisted of five research assistants-four certified as speech-language pathologists and one early childhood education specialist. | - 100% response rate - Immediate follow-up by observation - No theoretical and model | - Social communication |
| Herbrecht Et al., 2009/ Germany | PPI | N= 17 children | - I: Treatment according to the annualized Frankfurt Social Skills Training (KONTAKT). | - 100% response rate - Un-known follow-up by observation - No theoretical and model | - Social and communication skills |
| Beaudoin et al., 2019/ Canada | RCT | N= 19 children | - I: Using a 12-week parent-mediated intervention | - 100% response rate - 3 month follow-up by observation - No theoretical and model | - Improve parent-child engagement and behavioral outcomes |
| Laugeson et al., 2014/ USA | RCT | N= 73 children | - I: Participants were assigned to the PEERS® treatment condition or an alternative social skills curriculum. Instruction | - 100% response rate - Un-known follow-up by Self-report - No theoretical and model | - Social skills |

**Outcomes:**
- Improved parent-child engagement and behavioral outcomes
- Significant improvements in social skills
- Significant improvement in the overall appropriateness of their affectionate behavior
- Significant improvement on 11 of 13 social communication measures
- Significant improvement on language skills and social skills
- Improved toddlers’ motor skills and a trend toward improvement in social adaptive behaviors
- Improved parent-child engagement during the intervention
- Significant improvement in social skills knowledge and frequency of hosted and invited get-togethers with friends

**Moderate**
| Study                        | Design | N     | Intervention                                                                 | Response Rate | Outcome Measures                                                                 | Findings                        | Effect Size |
|------------------------------|--------|-------|-----------------------------------------------------------------------------|---------------|---------------------------------------------------------------------------------|---------------------------------|-------------|
| Guivarch et al., 2017/ France| PPI    | N= 17 children I: n = 17 | - I: including strategy games, board games, and individual games that we transformed into cooperative games | -100% response rate - 22 weeks follow-up by observation - No theoretical and model | - Social skills - A significant increase in overall adaptation and social skills | Weak               |
| Wichnick-Gilliset al., 2016/ USA | PPI    | N= 3 children I: n = 3 | - I: During a given teaching session, printed scripts were superimposed upon the five teaching stimuli | -100% response rate - Immediate follow-up by observation - No theoretical and model | - Social interaction skills - A significant increase in social interaction skills | Weak               |
| Begeer et al., 2011/ Netherlands | RCT    | N= 36 children I: n = 19 C: n = 17 | - I: includes 16 weekly sessions of approximately 1.5 h each, provided to 5 or 6 children simultaneously, with a mutual age difference that does not exceed 3 years. | -95.9% response rate - Between 6 and 12 weeks later follow-up by self-report - Theory of Mind | - Social behavior | Moderate        |
| Beaumont and Sofronoff 2008/ USA | RCT    | N= 49 parent and children I: n = 26 C: n = 23 | - I: including Junior detective computer game. Group therapy sessions were conducted to facilitate participants’ generalization of computer game content and teach | -100% response rate - 22 weeks follow-up by observation - No theoretical and model | - Social skills - Greater improvements in social skills - Significant improvements in social functioning | Moderate        |
| Study                                    | Design | N= | Intervention Details                                                                 | Follow-up Details | Outcome Measurements | Effectiveness |
|-----------------------------------------|--------|-----|---------------------------------------------------------------------------------------|-------------------|-----------------------|--------------|
| Dekker et al., 2019/ Netherlands        | RCT    | 122 | I: including 15-session social skills group training (SST) with and without parent and teacher involvement | -85.5% response rate - Immediate and 6 month follow-up by observation - No theoretical and model | Social skills | Moderate     |
|                                        |        |     | I1: n = 47 I2: n = 51 C: n = 24                                                      |                   |                       |              |
| Wichnick et al., 2010/ USA             | PPI    | 3   | - I: When teaching sessions began, voice-over-recording devices with pre-recorded scripts were added to seven of the 10 bags containing pairs of toys | -100% response rate - Immediate follow-up by observation - No theoretical and model | Social interaction skills | Weak         |
|                                        |        |     | I: n = 3                                                                             |                   |                       |              |
| Alzrayer 2019 USA                      | PPI    | 3   | - I: Use of systematic instruction on teaching multistep social communication skills using an iPad® loaded with Proloquo2Go™ | -100% response rate - Immediate follow-up by observation - No theoretical and model | Social Communication Skills | Weak         |
|                                        |        |     | I: n = 3                                                                             |                   |                       |              |
| Ichikawa et al., 2013 Japan            | RCT    | 11  | - I: The program involved comprehensive group intervention and featured weekly 2-hour sessions, totaling 20 sessions over six months | -100% response rate - Un-known follow-up by observation - No theoretical and model | Social skills | Moderate     |
|                                        |        |     | I: n = 5 C: n = 6                                                                    |                   |                       |              |
| White et al., 2010/ USA                | PPI    | 15  | - I: Completed a 16-week                                                             | -100% response rate | Social skills | Weak         |
|                                        |        |     | I: n = 15                                                                            |                   |                       |              |
| Study Authors | Intervention Type | N | I: n | C: n | Description | Outcomes | Level of Evidence |
|---------------|-------------------|---|-----|-----|-------------|-----------|------------------|
| Conner et al., 2018/ USA | PPI | N= 17 children | I: n = 17 | - 3 month follow-up by observation - Social learning theory | -100% response rate - Un-known follow-up by self-report - No theoretical and model | - Emotional awareness and skills enhancement | Weak |
| Pfeiffer et al., 2013/ USA | RCT | N= 37 parent and children | I: n = 20 | 100% response rate | - Social responsiveness, sensory processing, functional motor skills, and social-emotional factors | - Significant positive changes in goal attainment scaling scores - No other results were significant | Moderate |
| Bharathi et al., 2019/ India | cPPI | N= 52 children | I: n = 26 | -100% response rate | Social skills | - Significant increase in social skills’ scores | Moderate |
| Chiang et al., 2016/ Taiwan | cPPI | N= 34 parent and children | I: n = 18 | -100% response rate | Joint engagement | - Child-initiated supportive and coordinated joint engagement was greater for the intervention group | Weak |
| Study                          | Design | N= | Parent and Children | Intervention | Response Rate | Follow-up | Theoretical and Model | Conclusion |
|-------------------------------|--------|----|---------------------|--------------|---------------|-----------|-----------------------|------------|
| Whitehouse et al., 2017/ Australia | RCT    | 80 | 39/41               | Therapy Outcomes By You (TOBY) is an app-based learning curriculum designed for children and parents as a complement to early behavioral intervention. Therapy Outcomes By You (TOBY therapy) at least 20 min/day for a period of 6 months | -94% response rate | - 3 and 6 month follow-up by observation | - No theoretical and model | - There was no group difference in scores on the primary outcome - Significant improvements in the TOBY intervention group relative to the treatment-as-usual group on three secondary outcomes | Strong |
| Gengoux et al., 2019/ USA     | PPI    | 22 | 22                  | - I: Primary caregiver participated in 12 weekly sessions of developmental reciprocity treatment parent training, | -100% response rate | - Un-known follow-up by observation | - No theoretical and model | - Improvement in aspects of parent empowerment and social quality of life. - Improvement in core autism symptoms was observed on the social responsiveness - No differences in sensory sensitivity were observed on the Short Sensory Profile. | Weak |
| Wetherby et al., 2014/ USA    | RCT    | 82 | 42/40               | Training focused on teaching parents the importance of intensive intervention and how to support active engagement in | -100% response rate | - 9 month follow-up By observation | - No theoretical and model | - Differential efficacy on a parent report measure of communication, daily living, and social skills, as they showed | Moderate |
| Study | Design | Sample Size | Intervention Details | Outcome Measures | Conclusion |
|-------|--------|-------------|----------------------|-----------------|------------|
| Radley et al., 2014/ USA | PPI | N = 3 children
1: n = 3 | - I: Attended 10 social skills training sessions over five weeks, with social skills lessons targeting participation, conversation, perspective taking, and problem solving skills | -100% response rate
- Immediate follow-up by observation
- No theoretical and model | - Social skill improvement or stability | Weak |
| Sansosti and Powell-Smith, 2008/ USA | PPI | N = 3 children
1: n = 3 | - I: Using a multiple baseline across-participants design, computer-presented social stories and video models were implemented | -100% response rate
- 2 weeks follow-up by observation
- No theoretical and model | - Social Communication Skills | Weak |
| Begeer et al., 2015/ Netherlands | RCT | N = 101 children
1: n = 53
C: n = 48 | - Use of The "Mini ToM intervention" is an annualized, weekly intervention for groups of five to six children. It involves eight sessions of approximately 1 hr. | -96% response rate
- 6 month follow-up by self-report
- Theory of Mind | - Emotion understanding, social skills and social behavior | Moderate |
| Katagiri, 2002/ Japan | PPI | N = 12 children
1: n = 12 | - I: consisted of the teaching the selected emotion using verbal instructions alone, background music specially composed | -100% response rate
- Un-known follow-up by observation
- No theoretical and model | - Emotional understanding | Weak |
| Study                | Design   | N       | Intervention                                                                 | Outcome                                                                 | Effect Size |
|---------------------|----------|---------|------------------------------------------------------------------------------|--------------------------------------------------------------------------|-------------|
| Solomon et al., 2007/ USA | PPI      | N = 68 parent and children I: n = 68 | - Half-day (3-4 hour) visits to families’ homes to teach parents how to provide intensive, one-on-one, play-based services. | - 100% response rate - Functional emotional | Weak        |
| Baghdadli et al., 2013/ Franc | RCT      | N = 14 children I: n = 7 C: n = 7 | - I: met weekly for 1 h and 30 min for a total of 20 sessions (6 months). It proposed explicit training in social skills using techniques such as video modeling, social scenarios, problem-solving exercises and role-play | - 93% response rate - Social skill - Intervention group made fewer errors in labeling anger on adult faces | Strong      |
| Becker et al., 2017/ USA | RCT      | N = 31 children I: n = 17 C: n = 14 | - I: Provide 12 weeks of weekly treatment. In the experimental condition, participants’ interactions with the dogs varied based on the stage of the session and the sessions target skill. | - 96% response rate - Social skills - Significantly less symptomatic in intervention group - No significant differences were observed in the Social Language Development Test | Moderate    |
| Kasari et al., 2014/ Nigeria | RCT      | N = 51 children I: n = 30 C: n = 31 | - I: consisted of 2 stages. In stage 1, all children received 2 sessions per week for 3 | - 90.2% response rate - Communicative utterances - Improvements in spontaneous communicative utterances and novel words outcomes | Strong      |
| Study | Design | N = 62 parent and children | I: n = 30  
C: n = 32 | - I: Social ABCs coaching by one of five coaches. During coaching, parents are supported to learn the techniques in the context of play. Intervention included 12 weeks of 1.5-hr home visits with tapering intensity. Home visits.  
-90.2% response  
- 12 and 24 weeks follow-up by self-report rate  
- No theoretical and model | - Social orienting  
- Significant increases in child smiling and social orienting.  
- Significant gains in self-efficacy following the intervention | Strong |
| --- | --- | --- | --- | --- | --- | --- |
| Brian et al., 2017/ Canada | RCT | | | | | |
| Enav et al., 2019/ Switzerland | RCT | N = 68 parent and children  
I: n = 38  
C: n = 30 | - I: Workshops were conducted once per week for 90 min for 4 consecutive weeks.  
-100% response rate  
- 3 month follow-up by observation  
- No theoretical and model | - Emotion regulation  
- Reported decreased behavioral and emotional symptoms in their children, and greater parental self-efficacy. | Moderate |
| Drew et al., 2002/ UK | RCT | N = 12 parent and children  
I: n = 12  
C: n = 24 | - I: Parents were visited at home by a speech and language therapist every 6 weeks for a 3-hour session. Table games were gradually increased to 15–20 minutes daily. Activities were designed to take between 30 and 60 minutes "set aside" time.  
-100% response rate  
- 12 month follow-up by observation  
- No theoretical and model | - Development of joint attention skills and joint action routines  
- Progress in language development | Moderate |
| Study                                      | Design | n  | Group Description                                                                 | Outcome                                                                 | Effect Size |
|-------------------------------------------|--------|----|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------|
| Kasari et al., 2012/ USA                  | RCT    | N=60 | I: n = 30; C: n = 30                                                              | N= 60 children                                                          | Moderate    |
|                                           |        |     | - I: involved 12 sessions over 6 weeks                                             | -98% response rate - 3 month follow-up by observation - No theoretical and model |             |
|                                           |        |     | - Social skills                                                                    | - Significant improvements were found in social network salience, number of friendship nominations, teacher report of social skills in the classroom |             |
| Howlin et al., 2007/ UK                   | RCT    | N=88 | N= 88 children and teacher I1: n = 30; I2: n = 29; C: n = 29                      | N= 88 children and teacher                                           | Moderate    |
|                                           |        |     | - I: a 2-day workshop for teachers plus 6 half-day, school-based training sessions with expert consultants over 5 months | -94.3% response rate - 1 and 5 month follow-up by observation - No theoretical and model |             |
|                                           |        |     | - Social skills                                                                    | - Significant in reciprocal social interaction - No increases in frequency of speech, or improvements in language test scores. |             |
| Lorenzo et al., 2019/ Spain               | cPPI   | N=11 | N= 11 children I: n = 6; C: n = 5                                                  | N= 11 children                                                          | Weak        |
|                                           |        |     | - I: the experimental group worked with different augmented reality activities such as a player who had to score a goal; playing with a cow. The intervention lasted for 20 weeks, in 15 min sessions twice a week | -100% response rate - Un-known follow-up by observation - No theoretical and model |             |
|                                           |        |     | - Social skills                                                                    | - Significant in social skills                                         |             |
| Didehbani et al., 2016/ USA               | PPI    | N=30 | N= 30                                                                             | N= 30                                                                  | Weak        |
|                                           |        |     | - I: completed 10, 1-h sessions across 5 weeks. It provided realistic and dynamic opportunities to engage in, practice, and attain immediate feedback on relevant and | -100% response rate - Two weeks follow-up by self-report - No theoretical and model |             |
|                                           |        |     | - Social skills                                                                    | - Emotion recognition, social attribution, attention and executive function |             |
|                                           |        |     | - Significant improvements on measures of emotion recognition, social attribution, and executive function | - Improvements on measures of emotion recognition, social attribution, and executive function |             |
| Study                  | Design | N | I: C: | Intervention Details                                                                 | Follow-Up Details                                                   | Effect Size |
|-----------------------|--------|---|------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------|-------------|
| Weiss et al., 2018/ Canada | RCT    | 68 | 35:33 | I: including 10 sessions of manualized, individual tCBT. Employed a group-based spy-themed curriculum to address social skills and select computer games, use of the emotion education activities, use of code cards | -72% response rate  
- Ten weeks follow-up by self-report  
- No theoretical and model | Moderate |
| Corbett Et al., 2016/ USA | RCT    | 30 | 17:13 | I: received the treatment first. The intervention was delivered over 10 4-h sessions. | -96% response rate  
- 2 month follow-up by observation  
- Theory of Mind | Moderate |
| Bradshaw et al., 2017/ USA | PPI    | 6 | 6:6 | I: consisted of weekly 1-h parent coaching sessions with a primary caregiver over a period of 12 consecutive weeks | -100% response rate  
- Immediate follow-up by observation  
- No theoretical and model | Weak |
| Mitchell et al., 2015/ USA | PPI    | 20 | 20:20 | I: the 6-week program. Each week, the children participated in multiple activities, including social skills groups, group discussions, skills and drills sessions, recreational | -100% response rate  
- 6 weeks follow-up by observation  
- No theoretical and model | Weak |
| Study                        | Design | n= | Intervention Details                                                                 | Primary Outcomes                                                                                   | Effect Size |
|------------------------------|--------|-----|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------|
| Cotugno 2009/ USA            | PPI    | 18  | I: 30 week social competence and social skills group intervention program with children | Anxiety management, joint attention, and flexibility/transitions                                   | Weak        |
| DeRosier et al., 2011/ USA  | RCT    | 55  | I: in fifteen 60-minute group sessions during consecutive weeks. Parents attended and participated in four of the sessions with their child. | Social skills significant improvement in the areas of anxiety management, joint attention, and flexibility/transitions | Moderate    |
| Fteih 2017/ United Arab Emirates | RCT    | 12  | I1: n = 4 applied to each child separately using CompuThera Program. I2: n = 4 applied to each child separately using Language Master C: n = 4 subjected to the ordinary program applied in the center using the traditional linguistic training. | Language skills significant differences greater gains in language scores than those in the control group | Moderate    |
| Rollins et al., 2016/ USA   | PPI    | 4   | I: weekly home visits and worked with caregivers to establish and                        | Social interaction and eye contact                                                                | Weak        |
| Study                      | Intervention Type | Participants | Intervention Details | Follow-up | Main Findings | Overall Effectiveness |
|----------------------------|-------------------|--------------|----------------------|-----------|---------------|----------------------|
| Hutchins and Prelock 2013/ USA | PPI               | N= 20 children | I: n = 20            | -100% response rate | Problem behaviors and communication | Weak |
|                            |                   |              |                      |           |               |                      |                      |
| Hamdan et al., 2018/ Amman | cPPI              | N= 26 children | I: n = 13 C: n = 13  | -100% response rate | - Non-verbal communication skills and eye contact, imitation | Weak |
|                            |                   |              |                      |           |               |                      |                      |
| Drahota et al., 2011/ USA  | RCT               | N= 40 children | I: n = 17 C: n = 23  | -100% response rate | Daily living skills and related parental intrusiveness | Moderate |
|                            |                   |              |                      |           |               |                      |                      |
| Reitzel et al., 2013/ Canada | RCT              | N= 26 parent and children | I: n = 14 C: n = 12 | -57.7% response rate | Functional skills and communication | Moderate |
|                            |                   |              |                      |           |               |                      |                      |
| Scahill et al., 2016/ USA  | RCT               | N= 180 parent and children | I: training included | -96.6% response rate | Daily living skills | Moderate |
|                            |                   |              |                      |           |               |                      |                      |
| Study                      | Design | N= | I: n  | C: n  | Description                                                                 | Follow-up | Effect of Intervention                                                                 |
|---------------------------|--------|-----|-------|-------|------------------------------------------------------------------------------|-----------|---------------------------------------------------------------------------------------|
| Lopata et al., 2006/ USA  | PPI    | 21  | 21    | 21    | - I: conducted 5 days per week for 6 hours each day for 6 weeks. All participants received three identical core treatment components targeting social behaviors, including intensive social skills instruction, face-affect recognition, and interest expansion. | -100% response rate | - Social skills instruction and social behaviors - Significant improvement in social skills - Significant improvement in adaptability and reduction in unusual behavior |
| Kamps et al., 2015/ USA   | RCT    | 95  | 56    | 39    | - I: consisted of games and age-appropriate table-top play activities (e.g., card games, popular board games). | -89.5% response rate | - Social and communication skills - Significant more in social skills - Significant growth for total communication |
| Lim 2010/ USA             | RCT    | 50  | 18    | 14    | I1: music training watched a music video containing 6 songs and pictures of the 36 target words; I2: speech training watched a speech video | -89.5% response rate | - Language skills - Significant increase in verbal production and functional speech. |
| Study                            | Design | N | I: n | C: n | Intervention Details                                                                                                                                                                                                 | Follow-Up Details                                                                 | Model | Effect Size |
|---------------------------------|--------|---|------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|-------|-------------|
| Edgerton, 1994/ USA             | PPI    | 11 | 1: 11 |      | I: participated in individual improvisational music therapy sessions for a period of 10 weeks.                                                                                                                     | - 100% response rate - Un-known follow-up by observation - No theoretical and model | -     | Weak        |
| Schertz et al., 2018/ USA       | RCT    | 144| 1: 73 | 1: 71| I: in weekly 1-h home-based sessions for 32 weeks.                                                                                                                                                                      | - 100% response rate - 6 month follow-up by observation - No theoretical and model | -     | Weak        |
| Kaale et al., 2012/ USA         | RCT    | 61 | 1: 34 | 1: 27| I: 8 weeks of joint attention and intervention, in addition to their preschool programs C: 8 weeks of engagement and intervention, in addition to their preschool programs                                                                                   | - 100% response rate - 12 month follow-up by observation - No theoretical and model | -     | Moderate    |
| O’Haire et al., 2014/ Australia | cPPI   | 64 | 1: 37 | 1: 27| I: The Animal-Assisted Activities program consisted of 8 weeks of animal exposure in the school classroom in addition to 16 20-minute animal-interaction sessions                                                                 | - 100% response rate - 2 month follow-up by self-report - No theoretical and model | -     | Weak        |
| Frankel et al., 2010/ USA       | RCT    | 68 | 1: 35 | 1: 33| I: Targeted skills included conversational skills, peer entry skills,                                                                                                                                                 | - 100% response rate - 3 month follow-up by observation | -     | Moderate    |
| Study                        | Design | N     | I: n | C: n | Intervention                                                                 | Outcome                                                                                           | Effectiveness |
|------------------------------|--------|-------|------|------|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---------------|
| Sofronoff et al., 2015/ Australia | PPI    | 79    | 38   | 41   | Developing friendship networks, good sportsmanship, good host behavior during play dates, and handling teasing | No theoretical and model                                                                        | Weak          |
| Radley et al., 2016/ USA     | PPI    | 2     | 2    |      | Participants attended a 1-h social skills group each week over the course of approximately 11 weeks. | Social skills and emotion management, self-efficacy, child anxiety                                  | Weak          |
| Kim et al., 2008/ Korea      | RCT    | 15    | 8    | 7    | Music therapy and play sessions with Toys.                                    | Joint attention behaviors and non-verbal social communication skills                               | Moderate      |
| Schertz et al., 2013/ USA    | RCT    | 23    | 11   | 12   | Conducted weekly home-based intervention sessions with parents in their homes. | Joint attention                                                                                   | Moderate      |
| Study | Design | N= | I: | C: | Intervention | Outcome | Effect Size |
|-------|--------|----|----|----|-------------|---------|-------------|
| Sansosti and Powell-Smith 2006/ USA | PPI | 3 | n = 3 | - Social stories were implemented, and conducted three times per week | -100% response rate - Immediate follow-up by observation - No theoretical and model | Social behavior | Significant improvement in social behavior | Weak |
| Schreibman and Stahmer 2014/ USA | RCT | 39 | n = 19 | n = 20 | - I: Communication (e.g., communication temptations), require a response from the child, and use direct reinforcement | -100% response rate - 3 months follow-up by observation - No theoretical and model | Language skills | Increases in language skills | Moderate |
| Mpella et al., 2019/ USA | PPI | 6 | n = 6 | - I: A theatrical play programme with the physical education regular school programme alongside. 16 educational sessions for eight weeks. | -100% response rate - Immediate follow-up by observation - No theoretical and model | Social Skill | Improvement in cooperation, attention, obedience, and empathy | Weak |
| Jonsson et al., 2019/ Sweden | RCT | 39 | n = 19 | n = 20 | - I: an extended 24-week version of the social skills group training program KONTAKT with standard care. | -100% response rate - 3 month follow-up by observation - No theoretical and model | Social skills | Significant improvement in social skills | Moderate |
| Soorya et al., 2015/ USA | RCT | 69 | n = 35 | n = 34 | - I: 12-session cognitive-behavioral intervention (CBI) for verbal | -49.3% response rate - 3 month follow-up by observation - Theory of Mind | Social Cognitive Skills | Significant improvements were found on social behavior - No significant improvements were found on social cognitive outcomes | Strong |
| Koning et al., 2013/ Canada | RCT | 15 | n = 7 | - I: 15 week CBT-based | -100% response rate | Social perception, | Significant improvements | Moderate |
| Study                        | Design | N= 15 children | I: n = 15 | C: n = 8 | Intervention | Follow-up | Theoretical and Model | Skills | Response Rate | Skills | Differences |
|-----------------------------|--------|----------------|-----------|----------|--------------|-----------|------------------------|--------|---------------|--------|-------------|
| Kruck et al., 2017/ France  | PPI    | 15 children    | 10 sessions | - Social skills intervention. During intervention, boys attended weekly 2 h long group sessions | - 3 month follow-up by observation | - Cognitive behavior theory | peer interaction, and social knowledge | - Significant improve in social and emotional skills | -100% response rate | - No theoretical and model | - Social and emotional skills | Weak |
| Parsons et al., 2019/ Australia | RCT    | 60 children    | 30        | 30       | I: The Therapeutic Outcome By You (TOBY) application is delivered using a tablet device and can be accessed via the Apple iTunes® store and received a 1-h training session from the researchers | - Visual motor, imitation, receptive language and social skills | - No significant between-group differences were recorded for visual motor, imitation, receptive language and social skills | - 98.3% response rate | - No theoretical and model | - Communicating skill | Strong |
| Mohammadzaheri et al., 2014/ Iran | RCT    | 30 children    | 15        | 15       | I: Treatment sessions were conducted twice weekly for 60 min per session over a 3 month period. | - Significant more effective in improving communication skill | - No significant between-group differences for joint attention, response to | -100% response rate | - No theoretical and model | Joint attention and communication skill | Moderate |
| LaGasse 2015/ USA            | PPI    | 17 children    | 17        |          | I: Children participated in ten 50-minute group sessions over a period of 5 weeks. | - Significant between-group differences for joint attention, response to | - No significant between-group differences for initiation of communication | -100% response rate | - No theoretical and model | Joint attention and communication skill | Weak |
Locke et al., 2018/ USA

- I: School personnel were trained in during the child's lunch recess (approximately 30–45 min) for 12 sessions over 6 weeks
- 100% response rate
- 6 weeks follow-up by self-report
- No theoretical and model

- Social engagement
- Significantly higher social network inclusion and received more friendship nominations than children
- Children in both groups experienced reduced solitary engagement and increased joint engagement

N= 31 children
I: n = 14
C: n = 17

Note: cPPI = controlled pretest/post-test interventions, PPI= pretest/post-test interventions, N= number, I = intervention group, C = control group or comparison group

Table 2. Inter-rater agreement for component ratings

| Component ratings | Kappa value (SE) | P-value | Interpretation |
|-------------------|-----------------|---------|----------------|
| Selection bias    | 0.816 (0.87)    | <0.001  | Very good agreement |
| Study design      | 1.000 (0.00)    | <0.001  | Very good agreement |
| Confounders       | 0.821 (0.73)    | <0.001  | Very good agreement |
| Blinding          | 1.000 (0.00)    | <0.001  | Very good agreement |
| Data collection methods | 1.000 (0.00) | <0.001  | Very good agreement |
| Withdrawals and drop-outs | 0.636 (0.96) | <0.001  | Good agreement |

**Appendix A**

Pervasive Child Development Disorder* or Kanner* or Speech Disorder* or Communication Disorder* or Autis* or Asperger or PDD or PDD-NOS or Childhood Disintegrative Disorder* or Childhood Schizophrenia)

AND

Behavior Therapy or Social Skills Training or applied behavioral analy* or ABA or intensive behavioral intervent* or (IBI or IBT) or applied verbal behavior or verbal behavio* or (verbal NEAR (therap* or communicat*)) or lovaas or linwood or Douglass or CABAS or DTT or (Treatment NEAR Education NEAR Autistic NEAR communication NEAR Handicapped NEAR children) or teacch or floor time or "Social Communication Emotional Regulation Transactional Support" or scerts or (pivotal NEAR response) or discrete trial* or (((sensory or auditory) or (treat* or therap*)) or Sensory Motor Integration or facilitated communication or Family Therapy or ((parent or parents or caregiver* or care-giver* or family or families
or mother* or father* or maternal* or paternal*) NEAR (treat* or therap* or interven* or direct* or program* or train* or mediat* or rehabilit*)) or Picture Exchange or Sensory stimulation or Language Therapy or Speech Therapy or (Alternative NEAR Augmentative NEAR Communication) or occupational therapy or Computer-Assisted Instruction or (assist* NEAR tech*) or Dance Therapy or Music Therapy or Play Therapy or Socio environmental therapy or Early Intervention or (computer NEAR (teach* or instruct*)) or social stories or prompt* or ((augment* or social) NEAR communicat*) or (relationship NEAR develop*) or (cognitive( or (treat* or therap* or psychotherap*)) or cbt or (sound NEAR (treat* or therap*)) or (natural NEAR environment) or (activity NEAR schedule*) or (direct NEAR instruct*) or (giant NEAR step*) or developmental individual difference or option or (sonrise or kaufman) or precision or (social NEAR skill*) or hanen or miller or patterning* or philadelphia or (dolman or delaccato) or (exchange NEAR developpement) or bartelemy or (gentle NEAR teach*) or denver or leap or (learning experiences NEAR alternative program) or pcdi or “princeton child development institute” or rutgers or (natural NEAR teach*) or milieu or (neurodevelop* NEAR treat*) or ndt or walden or adlerian or theraplay or Eden or (social NEAR pragmatic) or "early bird" or (video NEAR model*) or (self NEAR (manage* or monitor*)) or yale or bancroft or horizon or “may institute”

Figures
Figure 1

Flow diagram for the identification, screening, eligibility and inclusion of studies