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and Elliot 1990). The number of items on the SSRS varies between 34- and 57-items based on the informant and their age. The SSRS gathers behavior ratings from parents, teacher, and student (for third grade students and above) on cooperation assertion, responsibility, empathy, and self-control (Gresham and Elliot 1990). The SSRS has been updated and replaced with the Social Skills Improvement System (SSIS; Gresham and Elliot 2008). The SSIS is a revision of the SSRS which includes updated manual and four additional subscales (communication, engagement, bullying, and autism spectrum) with high reliability (0.84). The SSIS produces an overall composite social skills score as well as subscale scores. While not used in the present study, the subscale scores' test-retest coefficients range between the .70s and .80s. In order to account for the varying reliability, researchers applied respective pre-post correlations. For both the SSRS and SSIS, researchers utilized only the parent-report composite scores from the studies. Fourteen of the identified studies utilized F2F-SST to teach social skills to youth with ASD (Choque Olsson et al. 2017; Dekker et al. 2019; Freitag et al. 2016; Jonsson et al. 2019; Laugeson et al. 2009; Lopata et al. 2010; Marshall et al. 2016; Matthews et al. 2018; Rabin et al. 2018; Schohl et al. 2014; Shum et al. 2019; Thomeer et al. 2019; Vernon et al. 2018; White et al. 2013). Specifically, Dekker et al. (2019) conducted an RCT of a manualized treatment that utilizes behavioral principles and social learning theory to teach social skills. They observed that children's SSRS scores significantly improved on the cooperation subscale. Freitag et al. (2016) examined the effects of Social Skills Training Autism-Frankfurt (SOSTA-FRA), which is a manualized, structured, cognitive-behavioral, group-based social skills training program for youth with high-functioning ASD. They found that both immediately after treatment and at 3 months of follow-up, there was a significant reduction in SRS scores compared to treatment as usual (Freitag et al. 2016). Laugeson et al. (2009) determined that Program for the Education and Enrichment of Relational Skills (PEERS; Laugeson and Frankel 2006), which is a manualized treatment that includes both separate and concurrent social skills groups for youth with ASD and their parents, demonstrated significant social improvement. Similarly, Matthews et al. (2018) utilized the PEERS curriculum to compare traditional PEERS to a peer-mediated PEERS curriculum (i.e., each participant with ASD has a typically developing peer mentor). Both groups experienced significant gains in social skills, and those in the peer-mediated group improved more than was maintained at a 4-month follow-up. Additionally, Rabin et al. (2018) examined a Hebrew version of PEERS and determined that there was a significant improvement in social skills, which was maintained 16 weeks post-treatment. Schohl et al. (2014) also found that PEERS significantly improved social skills in youth with higher-functioning ASD. A study conducted by Shum et al. (2019) in Hong Kong determined that a Chinese translation and adaptation of PEERS resulted in significant gains in social skills for adolescents with ASD. Thomeer and colleagues (2019) evaluated a comprehensive 5-week-long social skills group intervention called summerMAX. SummerMAX significantly improved social skills in children with ASD from pre- to post-treatment. Vernon et al. (2018) examined the effects of Social Tools And Rules for Teens (START), a manualized curriculum that includes free play, a learned social topic and practice, and a structured social activity. They found that there were significant post-treatment Group x Time differences between START and waitlist control. Lopata et al. (2010) also found that group social skills training resulted in statistically significant improvement in social skills for children with high-functioning ASD. Results from Marshall et al. (2016) suggested that individualized Social Stories are effective for improving social skills in youth with ASD. Choque Olsson et al. (2017) postulate that there are significant treatment effects for structured, manualized "KONTAKT" social skills group training for adolescents with ASD based on parent ratings both immediately following treatment and at 3-month follow-up; however, there were no significant group differences in child or teacher ratings. Jonsson and colleagues (2017) also used KONTAKT to improve communication skills, social awareness and navigation, and self-confidence. They reported a large effect size between pre- and post-treatment that continued through a 3-month follow-up. Lastly, White and colleagues determined that MASSI (White et al. 2009), a manual-based modular treatment that is delivered in individual therapy, group therapy, parent education, and coaching, significantly improves social skills in youth with ASD. F2F-SST studies included manualized treatment delivered in group settings and an individualized Social Stories intervention. All studies had significant treatment gains from pre- to post-treatment. Of the three manualized treatments that conducted follow-up measures post-treatment, results were maintained at 3- to 4-month post-treatment. Four studies utilizing BITS-SST were identified (Hopkins et al. 2011; Rice et al. 2015; Thomeer et al. 2015; Yun et al. 2017). Hopkins et al. (2011) conducted a study of Facesay, a computer program which utilizes human-like avatars and interactive games to teach facial processing, recognition, eye gaze, and joint attention. This intervention occurred entirely online and facilitators only served in a behavior monitoring capacity, such as giving praise or rewards to children who appropriately used their mouse or touch screen or who remained seated during the intervention (Hopkins et al. 2011). Children with both low- and high-functioning ASD who received BITS-SST had a significant positive change in their parent-reported social skills (Hopkins et al. 2011). Thomeer et al. (2015) found that a computerized program, Mind Reader, which uses facial video and vocal stimuli to teach simple and complex emotions, yielded a significant improvement in the social skills of children with high-functioning ASD from pre- to post-treatment. Social skills instruction and practice occurred online and were reinforced through in vivo practice with a staff clinician twice during each of the five treatment intervals (Thomeer et al. 2015). Rice and colleagues (2015) used the same computer program and found that, after controlling for pretest scores, there was a significant difference in reported social skills such that those in the experimental group showed significantly more improvement post-intervention than the control group. Yun et al.' (2017) studied the Robotic Intervention System (i.e., iRobiQ and CARO) which utilizes an interactive robot to teach facial emotion recognition and eye contact, with a human facilitator present but serving only to ensure the intervention was being performed correctly. However, no statistically significant improvement in social skills was found (Yun et al. 2017). Of the four studies, three reported statistically significant improvement in social skills and none included follow-up measures. Of the 18 studies (Table 1; 1266 participants) included in the analysis, 17 studies were entered as individual studies (F2F-SST = 14 studies, BITS-SST = 3 studies) and one study that provided independent samples (i.e., different control groups matched to condition) was entered independently. Specifically for BITS-SST, one study (Hopkins et al. 2011) provided two samples, high- and low-functioning ASD, with independent matched control groups. Where studies had multiple outcome measures, a grand mean effect size was derived in order to get an overall effect. Based on these criteria, the final analysis included 19 observations. The F2F-SST included a total of 1126 participants. Most F2F-SST studies utilized manualized protocols (e.g., KONTAKT, Skillstreaming, START, SOSTRA, PEERS, Social Stories). The interventions ranged in length from 2 weeks to one school year. The four BITS-SST studies included a total of 138 total participants. Treatment was provided in various formats, including utilization of computer-based software programs (e.g., CARO, FaceSay, iRobiQ, and Mind Reader), computer-based avatars, and a therapeutic robot. These interventions ranged in length from 8 to 12 weeks. Selected studies for social skills training for youth with ASD # Authors (date) Age range % male RCT conditions n Components Follow-up Primary outcome measures Cochrane Risk-of-Bias rating (low/some/high) F2F studies 1 Choque Olsson et al. (2017) 8-17 70.03% KONTAKT versus TAU 296 12 weekly 60- (children) or 90-min-long (adolescents) sessions implemented by "regular clinical staff" 3 months SRS Some 2 Dekker et al. (2019) 9-13 84.43% SST versus SST with PTI versus TAU 122 15 weekly 90-min-long sessions implemented by 2 psychologists 6 months VAB; SSRS Some 3 Freitag et al. (2016) 8-19 92.82% SOSTA-FRA versus TAU 209 12 weekly 90-min-long sessions implemented by 2 CBT-trained therapists 3 months SRS Some 4 Jonsson et al. (2018) 8-17 70.00% KONTAKT versus TAU 50 24 weekly 60- (children) or 90-min-long (adolescents) sessions implemented by 2 or three therapists 3 months SRS-2 Some 5 Laugeson et al. (2009) 13-17 84.85% PEERS versus WLC 33 12 weekly 90-min-long group sessions for teens and parents separately (held at the same time) implemented by clinicians - SSRS; QPQ; TASSK; FQS Some 6 Lopata et al. (2010) 7-12 94.4% Treatment versus WLC 36 5 daily 70-min-long treatment cycles, for 5 weeks, and 5 weekly 90-min-long parent training sessions implemented by trained graduate and undergraduate students Within 5 days ASC; SRS; BASC-2-PRS; DANVA2 Low/some 7 Marshall et al. (2016) 5-15 74% Treatment versus WLC 50 Stories were read to child by teacher 3 times each week for 2 weeks (total of 6 readings) 6 weeks SDQ; SRS-2 Some 8 Matthews et al. (2018) 13-17 82.22% PEERS versus peer-mediated PEERS versus WLC 34 14 weekly sessions implemented by 2 Bachelor's- or Master's-level clinicians ~ 4-5 months (end of school year) SRS-2; SSIS; OSQ-P; TASSK; SIAS Some 9 Rabin et al. (2018) 12-17 95.12% PEERS in Hebrew versus WLC 41 12 weekly 90-min-long manualized sessions of PEERS translated and adapted into Hebrew 16 weeks CASS; TASSK; OSQ; LSDQ; EQ; SRS-2; SSIS Some 10 Schohl et al. (2014) 11-16 81.03% PEERS versus WLC 58 14 weekly 90-min-long manualized group sessions of PEERS - VAB-II; TASSK; OSQ; FQS; SIAS; SRS; SSRS Some 11 Shum et al. (2019) 11-15 79.16% PEERS (Hong Kong Chinese Version) versus WLC 72 14 weekly 90-min-long manualized group sessions of PEERS translated and adapted to Hong Kong Chinese led by certified providers 14 weeks TASSK; QPQ; SRS-2; ABAS-II; ASBS Some 12 Thomeer et al. (2019) 7-12 84.21% summerMAX versus WLC 57 Comprehensive CBT-based psychosocial treatment implemented by a community agency; 5 70-min treatment cycles daily 5 days per week for 5 weeks 3 months CASL; ASC; SRS-2; BASC-2-PRS Some 13 Vernon et al. (2018) 12-17 69.30% START versus WLC 40 20 weekly 90-min sessions implemented by "college-aged social facilitators" - SSIS; SRS-2; SMCS; Some 14 White et al. (2013) 12-17 76.67% MASSI versus WLC 30 13 60-70-min-long individual sessions and 7 75-min-long group meetings implemented by clinicians 5 days SRS; CASI-Anx; PARS; CGI-I; DD-CGAS Some BITS studies 15 Hopkins et al. (2011) 6-15 89.79% FaceSay for HFASD versus FaceSay for LFASD versus control (used a different computer program for the same amount of time) 49 6 bi-weekly 30-min-long sessions implemented at school and supervised by the researchers; computer-based software which uses avatars to teach social skills 2 weeks KBIT; CARS; BFRT; SSRS; SSO Low 16 Rice et al. (2015) 5-11 90.32% FaceSay versus reading skills program (SuccessMaker) 31 10 weekly 25-min-long sessions implemented via computer-based software (overseen by teachers in the school's computer lab) - NEPSY-II; SRS-2 Low 17 Thomeer et al. (2015) 7-12 88.37% Mind reading versus WLC 43 2 90-min-long sessions per week for 12 weeks (24 total sessions) implemented via technology (in a college's computer lab) 5 weeks CAM-C; ERDS; SRS; BASC-2 PRS Some 18 Yun et al. (2017) 4-7 100% iRobiQ and CARO versus control group 15 8 weekly 40-min-long sessions implemented by a therapeutic robot (TC) or a human (CG) - ADOS; EWHA-VABS; SCQ; SRS; k-CBCL Some Based on Cochrane Risk-of-Bias methodological quality rating guidelines, almost all articles (15) were categorized as Some Risk-of-Bias (Choque Olsson et al. 2017; Dekker et al. 2019; Freitag et al. 2016; Jonsson et al. 2019; Marshall et al. 2016; Matthews et al. 2018; Rabin et al. 2018; Schohl et al. 2014; Shum et al. 2019; Thomeer et al. 2015, 2019; Vernon et al. 2018; White et al. 2013; Yun et al. 2017). Only two articles (Hopkins et al. 2011; Rice et al. 2015) were categorized as Low Risk-of-Bias. One article (Lopata et al. 2010) received a rating of Low Risk-of-Bias from one rater and Some Risk-of-Bias from the other rater. None meets criteria for High Risk-of-Bias, so all articles were able to be included in the analysis. Therefore, the scores ranged from 0 to 1, with an average rating of 0.84. Interrater rater reliability indicated acceptable agreement (kappa = 0.77). Generally, data synthesis was similar across the studies, using pre/posttest means and standard deviations for the control and treatment groups. A forest plot of studies, including the grand mean effect sizes, is presented in Fig. 2. Forest plot for BITS and F2F subgroups. BITS, Behavioral Intervention Technologies; F2F, face-to-face; HFA, high-functioning autism observed group; LFA, low-functioning autism observed group; SRS, Social Responsiveness Scale; SSRS, Social Skills Rating Scale; SSIS, Social Skills Improvement System; g, Hedges' g; p, p value for individual study and overall effect; diamond, overall effect sizeThe overall model indicated significant heterogeneity ( $\chi^2(19) = 59.14, p$