Psychosocial interventions targeting social functioning in adults on the autism spectrum: a literature review

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Abstract

Purpose of review: There is a perceived shortage of evidence-based treatment programs for adults on the autism spectrum. This article reviews the recent research literature on psychosocial / behavioral interventions targeting social functioning in autistic adults without intellectual disability.

Recent findings: We identified only 41 peer-reviewed studies published from 1980 through 2017 that tested intervention programs focused on one or more of the behavioral components of social functioning (i.e. social motivation, social anxiety, social cognition, and social skills) in more than one adult with autism spectrum disorder (ASD). The studies demonstrated substantial variability in treatment objectives, intervention procedures, assessment methods, and methodologic quality.

Summary: The results indicate a strong need for additional research to develop and rigorously test interventions for autistic adults that target the many behavioral components of social functioning and that include procedures to promote generalization of knowledge and skills to community settings.

Keywords

Introduction

Social functioning deficits – including difficulties with reciprocal social communication and with forming, maintaining, and understanding relationships – are core symptoms of autism spectrum disorder (ASD). These symptoms are particularly important and challenging to address for autistic adults, because adult relationships are more complex and subtler than

childhood interactions, and there is less community tolerance for social "mistakes" in adults (1–8). There is a need for both greater community understanding and acceptance of autistic adults, as well as the development and testing of programs to support autistic adults in social functioning (9–12).

Social functioning comprises a complex repertoire of behaviors that need to be tailored to the social context. Pallathra and colleagues (13) argue that there are at least four broad categories of behavior that underlie social functioning, each of which may be disrupted in adults with ASD to varying degrees: social motivation, social anxiety, social cognition, and social skills. We have argued that these four components of social functioning should be regarded as core treatment targets, as disruption of any one of these components could impair social functioning (13). Therefore, our present review uses these components as a framework for reviewing the published treatment literature.

The first component – reduced social motivation, i.e. reduced motivation to interact with others – is observed in many individuals with ASD (1, 14, 15). Social motivation is a complex construct that comprises five main subcomponents, any of which may be affected in ASD: prioritizing and attending to social stimuli (social orienting), endorsing an interest in interaction (social interest), seeking out social interaction (social approach), taking pleasure in interactions (social liking), and engaging in relationships with others over a sustained period of time (social maintaining) (14, 15). Second, many adults with ASD have debilitating social anxiety or social avoidance (16–18). Third, many adults with ASD have impairments in social cognition, which comprises the abilities to identify and interpret verbal and nonverbal social information (19–21). Finally, deficits in social skills are well documented in individuals with ASD both in childhood and adulthood (14, 22). Our data indicate that adults with ASD (13) show only modest correlations in measures across these categories (social motivation, anxiety, cognition, and skills), with a more consistent pattern of correlations between social motivation and most other categories. These data suggest that no single category determines functioning in all others; that interventions targeting social functioning may be most effective if they include modules targeting all 4 categories, including social motivation.

We sought to systematically review the research literature between 1980 and 2017, to determine the number of intervention studies targeting social functioning in autistic adults and the number that target more than one behavioral component of social functioning. We also sought to determine how many of these interventions included an opportunity for adults to generalize and apply knowledge and skills to their everyday lives in the community. Finally, we sought to determine the overall methodologic quality of these studies.

Methods

Search Procedure

A systematic literature search was executed to identify published treatment studies that include autistic adults, using three online databases (PsycINFO, PubMed, EMBASE on OVID). The search focused on terms related to adults with ASD but without intellectual disability. The search concentrated on psychosocial or behavioral interventions related to

social skills or social functioning. Search terms related to intellectual disability, biological studies, or animal models (e.g. gene, linked, drug, mouse, rat, pharmacology) were used to exclude studies (See Supplementary Material). Additional studies were identified through systematic analysis of the citations listed in review papers found in the standardized searches (Figure 1).

Inclusion and Exclusion Criteria

All articles reviewed were required to meet the following pre-determined criteria in order to be included: 1) they report peer-reviewed research published in English between January 1980 and December 2017; 2) they describe the execution and detailed methods of a psychosocial or behavioral intervention aimed at improving social functioning, rather than a descriptive study (studies evaluating supported employment methods or methods to teach tasks specifically related to employment were excluded); 3) they include at least one outcome measure that assessed skills, understanding, or affective state related to social functioning; 4) they have sample sizes of greater than one participant, with all participants being 16 years of age or older and at least 50% of participants being 18 years of age or older; 5) at least 50% of each study's sample must have been diagnosed with ASD without intellectual disability (i.e. full-scale IQ > 70) (Figure 1).

Rating of Methodological Quality

Methodology, participant demographics, and behavioral category target were determined for each article (Table 1). Regarding methodology, articles were classified as a randomized controlled trials (RCT), quasi-experimental studies (quasi), or non-controlled experiments (NCE). RCT studies were defined as those involving random assignment of participants to either an experimental group or a control group. Quasi studies assigned participants to experimental or control groups but did not use strictly-defined randomization to do so. NCE studies did not utilize a control group in their procedures.

The quality of all RCT and quasi articles was assessed using published methodological rating scales as described in Kasari et al. (23). The American Academy of Cerebral Palsy and Developmental Medicine scale was used to assess RCTs by examining participant inclusion criteria, intervention description, measurement, attrition, and analyses. The scale provides an overall rating of 'weak' (0–3 points), 'moderate', or 'strong' (23). Quasi articles were also rated using a scale by Gersten and colleagues (23, 24) that assesses 18 "essential" and "desirable" quality indicators (related to description of participants, implementation of intervention, validity of outcome measures, and data analysis), and provides an overall summary rating of "acceptable" or "high" quality (24). Our review refers to studies not meeting either acceptable or high ratings as "low" quality (Kasari et al., 2014). Finally, NCE articles were rated using a scale that Sackett and colleagues developed to determine the effectiveness of medical interventions (25) based on the quality of the evidence provided. The scale rates interventions at five different levels, the lowest of which is reserved for case series or studies with no controls (25).

All studies were rated by both the first and second authors. Inter-rater reliability (IRR) of these 2 authors, calculated by dividing total number of coded items by the number of

agreements (i.e. when each rater agreed within a score of one), was 0.89. Final ratings presented in Table 1 are the average of each rater's scores. Studies were also assessed to determine which component(s) of social functioning that each intervention targeted. Meta-analytical approaches were not conducted due to the methodological and clinical heterogeneity among all studies.

Results

Search Findings

Initial search terms (see Supplementary Material) yielded 1574 articles (Figure 1). Our process for screening and excluding articles based on our inclusion / exclusion criteria is illustrated in Figure 1. Forty-one studies met our inclusion criteria.

Summary of Methodological Quality

RCT—According to the AACPDM scale, five of the RCT studies were of weak quality (26–30), five were of moderate quality (31–35), and only one was of strong quality (36) (Table 1). Many of the weak quality RCT interventions lacked description of the reliability and validity of their outcome measures, indication of blind assessor, power calculations, and/or reported dropout rate. One study did not provide a well-described randomized assignment procedure (28).

Quasi—The majority of quasi-experimental interventions (37–42) were of low quality, as determined by the criteria of Gersten and colleagues (23, 24) (Table 1). One study was rated as acceptable quality (43) and the remaining two studies were deemed of high quality (44, 45). Many of the low-quality quasi interventions were lacking evidence of reliability and validity of each outcome measure, measures of inter-rater reliability, and/or description of how implementation fidelity was assessed.

Non-Controlled—The 21 non-controlled papers (12, 46–65) all received a very weak rating of 1 on the Sackett 1989 scale (Table 1), primarily because they did not have a control group.

Summary of Treatment Targets and Outcomes

The identified studies varied with regard to which domain(s) of social functioning was directly targeted by the intervention. The majority of the articles described programs targeting social cognition (n=12; (28, 34, 37–39, 42, 43, 47–49, 57, 63)) or social skills (n=17; (26, 27, 29, 30, 33, 35, 40, 46, 50–52, 54–56, 58, 60, 62)). Six studies targeted social anxiety, (31, 41, 44, 61, 64, 65) and only six studies specifically targeted more than one domain of social functioning (12, 32, 36, 45, 53, 59). No studies targeted social motivation as their primary treatment target, which is striking, given recent data on the importance of this component (13–15); however, some studies used assessments of motivation and anxiety as primary or secondary outcome measures (52, 56).

Interventions Targeting Social Cognition and Broader Cognitive Skills—Twelve interventions (28, 34, 37–39, 42, 43, 47–49, 57, 63) focused on improving social cognition.

The interventions targeted a variety of sub-domains within social cognition that are challenging for many adults with ASD (e.g. face recognition, emotion recognition, perspective taking).

Face recognition was targeted by two studies and used a combination of explicit rule-based instruction and practice labeling characteristics of faces vs. objects (42, 49). In both studies, the test group and control group significantly improved after training, while in one study, the test group showed significantly greater sensitivity to certain stimuli than the control group (42). Both studies suggest that face processing ability and strategies can be significantly improved through training. However, self-report measures of training experiences revealed that 64% of participants reported no change in social functioning (49), suggesting that participation in face processing training alone may not be sufficient to improve social functioning in the community.

Three studies addressed emotion recognition/inference as their primary treatment target (37, 38, 43). The interactive guide, *Mind Reading* (66) and a computer-based program (38) were used to teach emotion recognition and identification in faces and voices. Users of both programs demonstrated significant improvement on closely related tasks of complex emotion recognition as compared to the respective control group, but this improvement did not carry over to more distant generalization tasks of mental state recognition. Koehne and colleagues used a dramatically different approach to fostering emotion inference and empathic feelings by evaluating the efficacy of dance/movement intervention (SI-DMI), compared to a control movement intervention (CMI) (43). Participants treated with SI-DMI, which focused on interpersonal movement imitation and synchronization skills, showed significantly larger improvement in emotion inference, but not empathic feelings, than the control group.

Two studies evaluated the effect of interventions targeting the identification of social cues and the use of perspective taking skills (39, 57). Lovett and Rehfeldt implemented multiple exemplar instruction to effectively teach perspective taking skills (57). However, findings showed varying degrees of generalization of skills to more natural social interactions (57). In contrast, Turner-Brown et al. 2008 tested the utility of a group-based cognitive behavioral intervention to improve social cognition in adults with ASD, *Social Cognition and Interaction Training for Adults* (SCIT-A; (39)). SCIT-A included didactic sessions focusing on three aspects of social cognition: emotion recognition, directing attention in social interactions, and perspective taking. Intervention participants demonstrated significant improvements on primary outcomes measures of face emotion identification and theory of mind as compared to the treatment as usual control group of adults with ASD. Yet, the groups did not differ significantly on a more general measure of social communication skills.

Five studies targeted broader cognitive skills relevant to social functioning as their main treatment focus. Two studies (34, 48) used the same cognitive therapy intervention to treat general impairments in social and non-social information processing and problem solving, called *Cognitive Enhancement Therapy* (CET). CET combines computer-based neurocognitive training on improving cognition (e.g. processing speed, sustaining attention,

increasing cognitive flexibility, managing frustration, etc.) with a structured social-cognitive group curriculum focused on perspective taking, managing emotion, etc. Participants demonstrated significant levels of improvement in composite indices of all four cognitive and behavioral domains assessed (i.e. neurocognition, cognitive style, social cognition, and social adjustment) (48) and were more likely to gain competitive employment than their counterparts in the control group (34). Two similar group-format, manual-based interventions targeted social problem-solving skills in the workplace (47) and in the college setting (63). Both interventions demonstrated significant improvements on a task of social problem-solving skills for some participants (47, 63). Finally, Saban-Bezalel and colleagues tested the effectiveness of a short-term intervention in enhancing the comprehension of irony (28). This specialized intervention included video clips, short stories, and comic strips to teach the recognition of ironic expression and was effective in improving comprehension of irony as well as modifying the pattern of hemispheric processing of irony in the brain.

Interventions Targeting Social Skills—The category of behavior most commonly targeted in the identified studies (n=17) was social skills. The category of "social skills" in itself encompasses a host of different skills. While the majority of these social skills studies reported improvement post-intervention, many of the studies used qualitative data only.

Five studies focused on training specific aspects of *conversation*. These included skills related to forming and asking relevant and appropriately timed questions (58), reducing use of negative statements (56), forming and employing empathetic responses (55), and maintenance of reciprocal conversation (60, 62). Three out of the five studies employed an applied behavior analysis-style multiple-baseline approach, which included opportunities to practice discrete elements of conversation prior to training (baseline), during training, and during follow-up. Only one study employed a small group design (58) while the rest used a single subject design (55, 56, 60, 62). The majority of these interventions had moderate to substantial success in improving the targeted skills and showed varying degrees of successful maintenance of skills at follow-up. However, a lack of group-based statistical analysis of data from most of the studies limits our understanding of the significance of improvements at a group level. In addition, the lack of generalization data and considerably varied maintenance data provide only limited support for the notion that teaching discrete basics of conversation alone generalizes to the improvement of conversation in natural settings.

Five studies tested the efficacy of an intervention specifically focused on improving relational skills and engagement with peers. Three papers (26, 27, 29) evaluated the effectiveness of The Program for the Education and Enrichment of Relational Skills (PEERS), a caregiver-assisted social skills program for adolescents with ASD but adapted for young adults. Participants attended weekly group sessions while caregivers attended separate concurrent sessions. The primary goal of the intervention was to provide instruction and rehearsal of social skills specifically related to building and maintaining peer relationships. In the original randomized controlled pilot study (26), participants reported significantly less loneliness, improved social skills and social skills knowledge, and increased frequency of get-togethers as compared to the wait-list control group (26), the last three of which were replicated in the RCT study (27). Similar results were replicated in a

third study, which also indicated improvements in self-reported social anxiety (29). Koegel and colleagues used a multiple baseline design and individual weekly intervention sessions to focus on social planning related to each participant's interests. Participants worked on concrete organizational skills (e.g. using a planner, inviting peers to activities) that would enable them to engage socially (54). Participants reported attending more social events, as well as a higher quality of life and greater satisfaction with their college experience and peer interactions. Secondary improvements in grade point averages and successes with employment suggested generalization of skills to other areas of functioning. Finally, Cunningham and colleagues focused on improving social skills useful for navigating romantic relationships (33). Participants in the intervention, *Ready for Love,* demonstrated improvement on select social skills and empathy (33).

Five studies evaluated the effectiveness of training programs targeting social-vocational skills such as job interview skills (30, 35, 40, 51, 52). Two studies used computer-based training programs that included Theory of Mind (ToM)-based instructional training, video models, visual supports, and virtual reality practice job interviews (35, 40). The remaining three studies employed traditional group therapy sessions (30, 51, 52). Three studies utilized interventions that emphasized training on job interview-related social skills, such as answering interview questions, conveying oneself as dependable, closing the interview, and following-up with interviewers. (30, 35, 40). They implemented independently-coded mock interviews as primary outcomes measures, which revealed significant improvement in skills in the treatment group relative to the control group across all three studies. However, distal outcome measures, such as social adaptive behaviors and depressive symptoms, were not significantly different across groups in one study (30). The remaining two studies tested The Aspiration Program, a social and vocational skills support group (51, 52). Examples of program topics include employment goals, friendship development, skills for navigating social gatherings, and general problem solving (51). Out of the self-report measures evaluating appraisal of peer relations, ASD traits, and empathy, only a measure of empathy (67) was significantly improved post-intervention (51). The Aspiration Program also resulted in significantly reduced anxiety and depression in participants post-program (52). This intervention was noteworthy for its evaluation of multiple domains of social functioning across studies.

Interventions Targeting Social Anxiety—Six studies directly focused their intervention efforts on reducing social anxiety, depression, and/or avoidance behavior in adults with ASD (31, 41, 44, 61, 64, 65). Three studies used cognitive behavioral therapy (CBT) as their treatment strategy, in order to reduce symptoms of stress, social anxiety, depression, and/or avoidance behavior (44, 64, 65). Two studies used mindfulness-based therapy to target anxiety (31, 61), while the final study directly compared CBT and mindfulness-based stress reduction (MBSR) in reducing anxiety and depression (41).

Each CBT-based intervention demonstrated decreases in target symptoms, to varying degrees. The more traditional CBT intervention targeting depression and stress saw significantly reduced self-reported scores as compared to the waitlist control group (44). The second CBT-based intervention incorporated visualization as a technique to illustrate the "invisible code of social interaction and communication" (65), while the third intervention

used a combination of social skills training and CBT techniques in order to target concurrent social anxiety symptoms (64). Both mindfulness-based therapies used an intervention adapted for autistic adults, Mindfulness-Based Therapy-AS (MBT-AS) and demonstrated significant reductions in symptoms of anxiety and depression (31, 61). MBT-AS also led to an increase in positive affect and reduced rumination (31) as well as a reduction in symptoms of agoraphobia and somatization (61). Finally, results from Sizoo & Kuiper (2017) indicate that both MBSR and CBT were associated with reductions in anxiety and depressive symptoms, effects maintained at follow-up, but with no significant differences in efficacy of the two treatments (41).

Interventions Targeting Multiple Domains of Social Functioning—Of the 41 studies that we identified, only 6 directly targeted more than one component of social functioning in their intervention protocol (12, 32, 36, 45, 53, 59). A few studies were unique in their methodology, such as Kandalaft and colleagues who used virtual reality technology to provide an opportunity for participants to engage in realistic social scenarios and receive performance feedback, in addition to receiving training on social cognition concepts (53). White and colleagues also employed technological strategies via a novel computer-assisted intervention, which incorporates both CBT and mindfulness-acceptance based approaches to target social competence (i.e., social cognition and social skills) and self-regulation (including social anxiety/emotion regulation) (32). Finally, Koch and colleagues tested a dance movement therapy intervention targeting the improvement of attunement, which they hypothesized would lead to increased well-being, social cognition, and social skills (45). Hesselmark and colleagues tested the efficacy of CBT in targeting quality of life outcomes as well as measures of cognition and skills (36). The remaining two studies evaluated interventions based in community-settings, such as a vocational training program for software testing (12) and a college campus camp experience (59).

The CBT and dance movement therapy interventions demonstrated significant improvement in quality of life (36), well-being, and social skills (45) in participants post-intervention. White and colleagues' computer-assisted intervention resulted in inconsistent behavioral outcomes across their small sample size (32), while Retherford and collegues' college campus intervention showed the weakest findings by only reporting parent and student survey data describing their experience with the program. Baker-Ericzén and colleagues' *SUCCESS* intervention resulted in participant employment rates doubling post-intervention, however the authors were cautious to assert causal claims as the intervention was embedded within a vocational training program specifically targeting improved employment rates (12).

Conclusions

Intervention research on social functioning in adults with ASD has been starting to accelerate in recent years, due to emerging recognition of autistic adults and their needs. However, research on intervention programs targeting social functioning in autistic adults is still in early stages of development, with only 41 treatment studies identified that met our inclusion criteria over the past 37 years, of which only 11 were RCTs, including only 1 RCT with strong methodology by AACPDM scale criteria. There is a strong need for more RCTs,

which provide the best evidence of treatment effectiveness. Only then can we begin to carry out deeper analysis of the active ingredients of interventions (68).

While our review has been critical of the small number of treatment studies, and less-than-ideal methodological rigor of many studies, we also acknowledge the substantial challenges of carrying out high-quality studies in this field. A first challenge is that social functioning is inherently complex and multifaceted, and therefore not simple to measure. There is a striking lack of well-validated, reliable assessment instruments to measure the components of social functioning in adults with ASD. Many of the available instruments rely on self-report or informant report, rather than more objective measures; few have been developed for adults with ASD specifically; and few have been developed to measure change in response to treatment. Clearly, there is a strong need for development of better assessment instruments in an adult ASD population that have strong psychometric properties and can reliably detect quantitative changes in behaviors or symptoms over the course of treatment. It would be ideal for treatment studies to include measures of all components of social functioning, even for programs not directly targeting each domain, as this could provide better knowledge of how improvement in one component may affect change in other components. It is noteworthy that only 6 of the 41 studies that we identified specifically included primary measures of more than one component of social functioning.

A second major challenge of carrying out high quality treatment studies is the difficulty of promoting generalization of social functioning gains in a uniform way across studies. This is especially difficult given the heterogeneity of functioning among individuals with ASD, as well as the variability of community contexts. In many of the studies reviewed in this paper, participants improved on primary outcome measures that directly assessed knowledge and skills taught in the intervention curriculum. However, many studies did not assess or did not find generalization to social functioning in daily life. This raises an important question of whether, and to what degree, these interventions affect the lives of the participants. It will be important for the field to place greater attention and emphasis on generalization of skills, as well as measuring maintenance and generalization of skills post treatment, to ensure that our treatments are having a positive impact on participants daily lives.

A third challenge is designing studies with sufficient statistical power and relevance to the population. A priority of the field should be larger and more diverse sample sizes, as well as replication studies. Because the 41 studies that we identified had a divergence of treatment methods, modest sample sizes, and most lacked later replications, it is uncertain how many of the reported treatment effects are replicable. Moreover, future studies should include ethnically/socioeconomically diverse sample sizes that include representative groups of autistic adults. While this review has focused on treatments targeting adults without intellectual disability, additional reviews and treatment research are much-needed as well for intellectually disabled adults with ASD. It will be important for investigators to collaborate on treatment studies across sites in order to generate the needed sample size and diversity of participants.

By working together as a field to address these challenges – as well as promoting understanding and acceptance of ASD in the wider society – we can make faster progress

toward supporting autistic adults in navigating the social world and empowering these adults to achieve the quality of life that they desire.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding:

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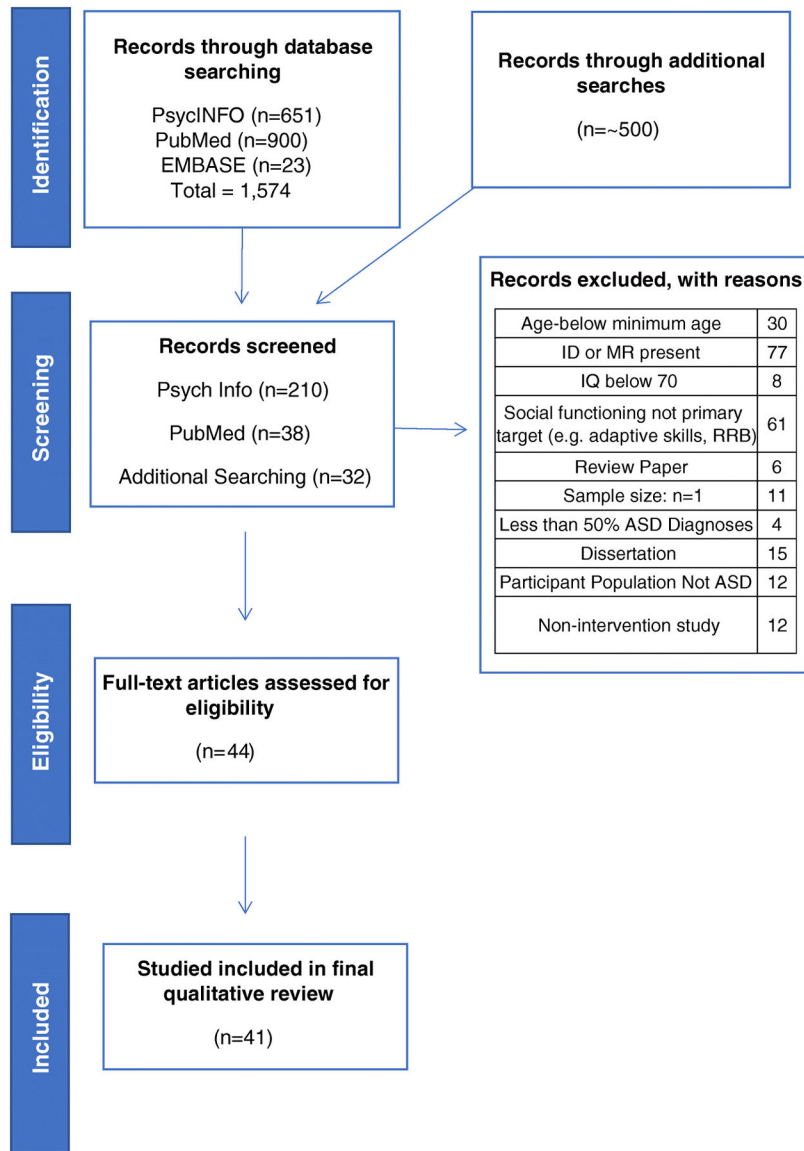* Papers of particular interest and importance, published recently

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Identification

Records through database searching

PsycINFO (n=651)
PubMed (n=900)
EMBASE (n=23)
Total = 1,574

Records through additional searches

(n=~500)

Screening

Records screened

Psych Info (n=210)

PubMed (n=38)

Additional Searching (n=32)

Records excluded, with reasons

Age-below minimum age	30
ID or MR present	77
IQ below 70	8
Social functioning not primary target (e.g. adaptive skills, RRB)	61
Review Paper	6
Sample size: n=1	11
Less than 50% ASD Diagnoses	4
Dissertation	15
Participant Population Not ASD	12
Non-intervention study	12

Eligibility

Full-text articles assessed for eligibility

(n=44)

Included

Studied included in final qualitative review

(n=41)

Fig. 1.
Manuscript identification process

Summary of studies included in review

Table 1

Study	Treatment (Tx) Name	Design	Total (n)	Tx (n)	Control (n)	Frequency	Duration	Delivery Format	Primary Social Domain Target(s)	Quality Rating
Baker-Ericzén (2017)	Supported Employment, Comprehensive Cognitive Enhancement, and Social Skills (SUCCESS)	NCE	8	8	-	1.5 hours per session	25 sessions	Group	Social Cognition; Social Skills	1
Bölte (2002)	-	Quasi	10	5	5	2 hours per week	5 weeks	Individual, Computer-Based	Social Cognition	5 (E:4; D:1), Low
Bonete (2014)	Interpersonal Problem Solving for Workplace Adaptation Programme	NCE	100	50	50 (TDC)	75 minutes per week	10 weeks	Group	Social Cognition	1
Cunningham (2016)	RelationshiP Enhancement	RCT	30	19	19	2 hours per week	8 weeks	Group	Social Skills	5, Moderate
Eack (2013)	Cognitive Enhancement Therapy	NCE	14	14	-	60–75 minutes per week	18 months	Individual, Computer-Based and Group	Social Cognition	1
Eack (2017)	Cognitive Enhancement Therapy	RCT	54	21	20	90 minutes per week	18 months	Individual, Computer-Based and Group	Social Cognition	5, Moderate
Eckman (2015)	Cognitive Behavioral Therapy with Visualization	NCE	18	18	-	45–60 minutes per session	15 sessions	Individual	Social Anxiety	1
Faja (2008)	-	Quasi	10	5	5	30–60 minutes per session	8 sessions	Individual, Computer-Based	Social Cognition	9 (E:8; D:1), Low
Faja (2012)	STAART	NCE	13	13	-	NR	5–8 sessions	Individual, Computer-Based	Social Cognition	1
Fullerton (1999)	Putting Feet on My Dreams	NCE	23	23	-	2–3 hours per session	10 sessions	Group	Social Skills	1
Gantman (2011)	PEERS® for Young Adults	RCT	17	9	8	90 minutes per week	14 weeks	Group	Social Skills	2.5, Weak
Golan (2006)	-	Quasi	31 (Exp 1); 26 (Exp 2)	19 (Exp 1); 13 (Exp 2)	22 (Exp 1); 13 (Exp 2)	2 hours per week	10 weeks	Individual, Computer-Based	Social Cognition	10.5 (E:8; D:2.5), Low
Hesselmark (2014)	Cognitive Behavioral Therapy (CBT)	RCT	68	34	34	3 hours per week	36 weeks	Group	Social Cognition; Social Skills	6, Strong
Hillier (2007)	Aspiration Program	NCE	49	49	-	60 minutes per week	8 weeks	Group	Social Skills	1
Hillier (2011)	Aspiration Program	NCE	13	13	-	60 minutes per week	8 weeks	Group	Social Skills	1
Howlin (1999)	-	NCE	10	10	-	2.5 hours per month	12 months	Group	Social Skills	1
Kandalaft (2012)	Virtual Reality Social Cognition Training	NCE	8	8	-	60 minutes twice a week	5 weeks	Individual, Computer-Based	Social Cognition; Social Skills	1
Kiep (2014)	Mindfulness-Based Therapy for Individuals on the Autism Spectrum	NCE	50	50	-	2.5 hours per week	9 weeks	Group	Social Anxiety	1
Koch (2014)	Dance Movement Therapy	Quasi	31	16	15	60 minutes per week	7 weeks	Group	Social Skills; Social Cognition	13 (E:9, D:4), High
Koegel (2013)	-	NCE	3	3	-	60 minutes per week	33 weeks	Individual	Social Skills	1

Study	Treatment (Tx) Name	Design	Total (n)	Tx (n)	Control (n)	Frequency	Duration	Delivery Format	Primary Social Domain Target (s)	Quality Rating
Koegel (2015)	-	NCE	5	5	-	10 minutes per week	4–8 weeks	Individual	Social Skills	1
Koegel (2016)	-	NCE	3	3	-	40 minutes per week	5–9 weeks	Individual	Social Skills	1
Koehne (2015)	Imitation and Synchroniz ation Based Dance / Movement	Quasi	51	27	24	90 minutes per session	10 sessions	Group	Social Cognition	12 (E:9; D:3.5), Acceptable
Laugeso n (2015)	PEERS® for Young Adults	RCT	22	12	10	90 minutes per week	16 weeks	Group	Social Skills	2.5, Weak
Lovett (2014)	-	NCE	3	3	-	30–45 minutes , 1–3 sessions per week	4–6 weeks	Group	Social Cognition	1
Mason (2012)	-	NCE	2	2	-	50 minutes , 2 sessions per week	weeks	Group, Video Modeling	Social Skills	1
McGillivray (2014)	Think Well, Feel Well, and Be Well	Quasi	32	26	16	2 hours per week	9 weeks	Group	Social Anxiety	14 (E:9, D:5), High
McVey (2016)	PEERS® for Young Adults	RCT	53	29	24	90 minutes per week	16 weeks	Group	Social Skills	3, Weak
Morgan (2014)	Interview Skills Curriculum	RCT	24	12	12	90 minutes per week	12 weeks	Group	Social Skills	3.5, Weak
Palmen (2008)	-	NCE	9	9	-	60 minutes per week	3 weeks	Group	Social Skills	1
Pugliese and White (2013)	Problem Solving Skills 101	NCE	5	5	-	1 session per week	9 weeks	Group	Social Cognition	1
Retherford (2015)	Camp Campus	NCE	NR	NR	-	15 hours/day	1 week	Group	Social Cognition; Social Skills	1
Saban-Bezalel (2015)	-	RCT	51	16	13 (ASD);22 (TDC)	30–45 minutes per week	5 weeks	Group	Social Cognition	2, Weak
Sizoo (2017)	CBT and Mindfulness Based Stress Reduction	Quasi	59	27 (CBT)	32 (MBSR)	90 minutes per week	13 weeks	Group	Social Anxiety	11, (E:7; D: 4), Low
Smith (2014)	Virtual Reality Job Interview Training (VR-JIT)	RCT	26	16	10	10 hours over 5 sessions	2 weeks	Individual, Computer-Based	Social Skills	4, Moderate
Spain (2017)	Group CBT	NCE	14	14	-	2 hours per week	11 weeks	Group MeetingS	Social Anxiety	1
Spek (2013)	-	RCT	41	20	21	2.5 hour weekly sessions	9 weeks	Group	Social Anxiety	4, Moderate
Strickland (2013)	Job TIPS	Quasi	22	11	11	Varied	10 days	Individual, Computer-Based	Social Skills	8.5 (E:7; D:1.5), Low
Trepagnier (2011)	-	NCE	16	16	-	2 sessions	2 weeks	Individual, Computer-Based	Social Skills	1
Turner-Brown (2008)	Social Cognition and Interaction Training for HFA Adults (SCIT-A)	Quasi	11	6	5	50 minutes per week	18 weeks	Group	Social Cognition	10 (E:7.5; D:2.5), Low'
White (2016)	Brain-Computer Interface for ASD (BCI-ASD)	RCT	8	4	4	40 minutes per week	10–14 sessions	Individual, Computer-Based	Social Cognition; Social Skills; Social Anxiety	4, Moderate

Design: RCT randomized controlled trial, Quasi quasi-experimental, NCE non-controlled experiment. NR indicates information was not reported, and "–" indicates the absence of a component described in the column header

All intervention studies were carried out in clinic / university settings, with the exception of the SUCCESS program