A meta-analysis of social skills training and related interventions for psychosis

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Abstract

Objective: Evidence suggests social skills training (SST) is an efficacious intervention for negative symptoms in psychosis, while evidence of efficacy in other psychosis symptom domains is limited. The current paper reports a comprehensive meta-analytic review of the evidence for SST across relevant outcome measures, control comparisons and follow up assessments. The secondary aim was to identify and investigate the efficacy of SST subtypes.

Methods: A systematic literature search identified 27 randomised controlled trials including N=1,437 participants. Trials assessing SST against active controls, treatment as usual (TAU) and waiting list control were included. Risk of bias was assessed using the Cochrane risk of bias assessment tool. A series of 70 meta-analytic comparisons provided effect sizes in Hedges' *g*. Heterogeneity and publication bias were assessed.

Results: SST demonstrated superiority over TAU (*g*=0.3), active controls (*g*=0.2-0.3) and comparators pooled (*g*=0.2-0.3) for negative symptoms; and over TAU (*g*=0.4) and comparators pooled (*g*=0.3) for general psychopathology. Superiority was indicated in a proportion of comparisons for all symptoms pooled and social outcome measures. SST subtype comparisons were underpowered, although social-cognitive approaches demonstrated superiority versus comparators pooled. SST treatment effects were not maintained at 6-month follow-up post-treatment.

Conclusions: SST demonstrates a magnitude of effect for negative symptoms similar to those commonly reported for CBT for positive symptoms, although unlike CBT, SST is not routinely recommended in treatment guidelines for psychological intervention. SST may have potential for wider implementation. Further stringent effectiveness research alongside wider pilot implementation of SST in in community mental health teams is warranted.

Keywords: Social skills training, psychosis, schizophrenia, meta-analysis

Introduction

Social Skills Training (SST) is a psychological intervention focused upon the development or improvement of social interaction, social performance or interpersonal skills, primarily offered to patients diagnosed with schizophrenia-spectrum disorders or psychosis. SST was initially developed in the context of the deinstitutionalisation of psychiatric patients returning to the community in the 1970s and utilised behavioural techniques such as role-play, modelling, coaching, instruction and feedback in an attempt to address interpersonal deficits. Literature from this period described SST as an effective means of reducing social anxiety although suggested that improved generalisability to real-life situations was desirable.[1]

Since an initial wave of development in the 1980s and 1990s, SST has diversified meaning that a range of related interventions may now be subsumed within the terminology. The term SST therefore represents a broader spectrum of related interventions within the contemporary literature. These include approaches focused primarily on social cognition that may also integrate technology. Such approaches differ from the similar cognitive remediation methodology by their focus primarily upon social cognitive process and social perception rather than upon improving neuropsychological variables such as memory, attention or executive function.[2,3] Similarly, a number of SST approaches assimilate cognitive-behavioural techniques such as cognitive restructuring although follow an SST-style group format as opposed to the typical formulation-based approach of cognitive-behavioural therapy (CBT).[4] Finally, a number of practically-focused approaches integrating SST with psycho-education, life management skills and relapse prevention strategies also exist.[5,6]

Negative symptoms refer to a specific pattern of commonly observed deficits in psychosis such as passive or apathetic social withdrawal, communication difficulties, blunting of affect and rigid or stereotypical thinking.[7] Comparatively less research has focused upon the treatment of negative symptoms than

positive symptoms while fewer targeted interventions have been developed. Only in recent years have negative symptoms been included as primary outcomes in SST-based interventions since early studies focused on social functioning outcomes.[1] Fusar-Poli *et al*[8] assessed the efficacy of pharmacological and psychological interventions for negative symptoms in a large meta-analysis and reported a medium effect size for second–generation anti-psychotics versus placebo (g=0.6, p=<0.05) while their comparison of 10 RCTs of first-generation anti-psychotics versus placebo was not significant (g=0.05, p=0.69). Both comparisons displayed a high degree of heterogeneity while for psychological interventions pooled they reported a small to medium effect size (g=0.4, p=<0.05) and moderate heterogeneity. The effect size for anti-depressants was smaller (g=0.3, p=<0.05). The question of whether medication is more efficacious than psychological interventions pooled is not straightforward since the majority of participants in RCTs for psychological interventions are already maintained on anti-psychotic medication. However, this meta-analytic evidence suggests that differences in efficacy between psychological and pharmacological interventions for negative symptoms are small.[8]

A recent meta-analysis, reported similar small to medium effect sizes (g=0.3-0.6) in favour of SST when compared to other psychological interventions for negative symptoms in psychosis.[9] Interestingly, the magnitude of the effect size increased with progressive sensitivity analyses to address risk of bias suggesting robustness. The UK NICE guidelines state that SST should not be offered as a specific intervention for psychosis following their conclusion in 2009 that SST did not show sufficient superiority over standard care alongside concerns regarding limited generalisabllity to everyday living[10] while the in the USA, guidelines have suggested SST is not an effective means to reduce symptoms.[11] SST is not routinely integrated within adult clinical psychology or community mental health settings in the UK National Health Service (NHS). Cognitive-behavioural therapy (CBT) is the most widely recommended and integrated psychological intervention for psychosis in the UK although many CBT manuals focus primarily on addressing positive rather than negative symptoms of psychosis.[12] Earlier meta-analytic evidence suggested that CBT

may be effective for negative symptoms (g=0.4, p<.05).[13] This effect was not however maintained when the authors excluded non-randomised studies and could not be replicated in a more recent meta-analysis when negative symptoms were primary (g=0.2, p>.05) or secondary (g=0.1,p>.05) outcomes.[14] The consideration that SST appears relatively more efficacious than CBT in reducing negative symptoms and has produced effect sizes comparable to pharmacological treatments suggests that further examination of its clinical utility is warranted.

The current review aimed to expand upon the promising meta-analytic evidence for SST from our previous comparative meta-analysis of psychological interventions for psychosis by applying a more comprehensive focus on SST and including all comparison conditions rather than only bona fide psychological interventions. To our knowledge it is 8 years since SST has been thoroughly examined via meta-analysis.[15] Given the accumulation of papers since this time means a renewed evaluation of its effectiveness is warranted. Since SST has further diversified into a range of related interventions we aimed to define and assess subtypes of SST as an adjunct to our primary comparisons. We also aimed to account for varying methodological rigour among SST trials since previous reviews did not address risk of bias within RCTs.[16,17] Our overall aim was therefore to provide a detailed meta-analytic review of the contemporary evidence-base for SST, with robust appraisal of risk of bias and methodological quality in RCTs. Our primary objective was to determine whether SST and SST subtypes demonstrate superiority in reducing negative symptoms against relevant comparison conditions. We hypothesised that SST would demonstrate superiority for negative symptoms across comparisons while superiority would not be demonstrated in other symptom domains.

Methods

A systematic literature search and meta-analysis was performed following PRISMA guidelines for the reporting of systematic reviews and meta-analyses.[18]

Protocol

The objectives and intended methodology of this project were registered via PROSPERO on 9th May 2016 and can be obtained at the following web location; http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42016038872.

Search strategy

A systematic literature search was completed in May 2016 (with no limits applied for year of publication) and included four databases: The Cochrane Central Register of Controlled Trials, Pubmed, PsychInfo and Embase. Abstracts were identified by entering text variations of three key terms dependent upon Boolean operators, MeSH terms, exploded terms and limit settings relevant to each database, namely; 1) social skills training and related interventions; 2) psychosis and related diagnoses and 3) randomised controlled trials. Further search strings have been included in supplementary materials. Articles included in published meta-analyses were also considered for inclusion.[9,16,17,19,20] Trial registrations, conference abstracts and dissertations were also considered via grey literature checks online.

Study selection

Studies were included if they were randomised controlled trials in which social skills training or related interventions were compared against a control condition and applied to a psychosis population. Studies also met the following inclusion criteria: a) the participants were diagnosed with psychotic disorders including schizophrenia, schizoaffective disorder, delusional disorder, brief psychotic disorder or psychosis NOS; b) the intervention was defined as SST or was primarily intended to improve social performance; c) the study was fully randomised and included comparison to an active control, treatment-as-usual

or a waiting list control and d) relevant outcome measures assessing psychotic symptoms and/or social performance were reported at post-treatment and/or follow up. Active controls include comparison of SST against other bona fide interventions such as cognitive-behavioural therapy and therefore provide the most stringent comparison.

Studies were excluded if: a) participants had alternative or comorbid diagnoses, such as substance abuse or ultra-high risk of psychosis; b) missing data could not be obtained by contacting authors or c) authors mixed elements of SST and other interventions into the intervention and/or control condition resulting in difficulty comparing the active SST element (for example, SST plus oxytocin). Only studies reported in the English language were included.

Risk of bias assessment

For consistency with the previous meta-analysis,[9] RCTs were assessed at the study level against the first four criteria of the Cochrane risk of bias tool; sequence generation, allocation concealment, blinding of assessors and incomplete outcome data. The final two items (selective outcome reporting and other sources of bias) were omitted as there is no evidence of their impact upon validity in meta-analysis.[21] The third item (blinding of assessors) was adapted to include only outcome assessors in blinding since, unlike medication trials, study therapists and participants cannot be blinded to the intervention being delivered. Two authors (D.T. and E.MG) calculated risk of bias scores via independent rating and resolution by discussion for 13 (48%) of the included studies while risk of bias assessments for 14 (52%) of studies were utilised from the previously published meta-analysis.[9] Risk of bias items were rated as high risk or low risk, while unclear items were categorised as high risk.

Data extraction

Symptom-related outcome data was extracted from 14 studies as part of the previous publication.[9] These data were checked for consistency and included in

the current analysis. One author (D.T.) extracted symptom-related outcome data from the remaining 13 studies and extracted social performance outcome data for all studies while another (E.MG) checked consistency. Spreadsheets piloted and utilised in the previous meta-analysis were employed for extraction. We contacted five authors[22–25] with requests for missing or unpublished outcome data, resulting in one successful further inclusion.[26]

Outcome measures

All continuous outcome measures relevant to psychotic symptoms, general psychopathology and social performance were extracted. We considered negative symptoms the primary outcome measure based on results of the previous meta-analysis.[9] In instances where multiple outcome measures were reported within one domain, all data was extracted and combined to form a pooled effect size for that domain. In a minority of studies, only dichotomous outcome data was available. These were converted into Hedges' g according to the methods integrated in CMA .[27] The *all symptoms* comparison therefore includes relapse, discharge and clinical exacerbation as proxy symptom measures.

Meta-analyses

The overall strategy for the meta-analyses was to progress gradually from a broad and inclusive sample of studies toward more methodologically robust comparisons. This meant that for each outcome measure category (all symptoms, positive symptoms, negative symptoms, general symptoms and social performance) or comparison category (all comparators, active controls, TAU and SC only), separate meta-analyses were performed for progressively decreasing risk of bias (0-4 where 4 indicates the highest risk of bias) when possible based on study availability. Meta-analyses were performed on outcome measures or comparator categories when at least 5 studies were available. Risk of bias sensitivity analyses were performed when at least 4

studies were available. It was acknowledged that comparisons meeting the minimum required number of studies would be considerably underpowered.

In order to investigate differences in efficacy between SST variations and related interventions, two authors (D.T. and A.M.) identified subtypes of SST independently and resolved disagreements by discussion before final categorisation. Separate meta-analyses were then performed using the same procedures as above. Similarly, meta-analyses for outcome measures assessed at follow-up were conducted when there were at least four studies available at any given follow-up time-point (e.g. 6 months).

For meta-analyses which did not require the combination of outcome measures at study level, the computer software R Studio version 1.0.136 was used to calculate pooled effect sizes using the packages *meta* and *metafor*[28,29] For comparisons that included studies where two outcome measures were reported in the same domain (e.g. two measures of negative symptoms), Comprehensive Meta-Analysis, version 3.0 was used due to its ability to provide a combined effect size at the study level. The programmes were checked for consistency of results on a proportion of comparisons. Both software packages provided an aggregated effect size indicating the pooled mean difference between groups at post-treatment or follow-up using Hedges' *g*. Hedges' g is an estimate of the standardised mean difference between groups and provides a more accurate estimate of effects in small samples than similar statistics for continuous outcome variables such as Cohen's *d.*[30] Alpha was set to 0.05 for all comparisons and 95% confidence intervals were obtained.

Heterogeneity

Both software packages calculated chi-square tests to assess the degree of heterogeneity for each comparison. The Q statistic and resultant alpha level were used to determine the presence of heterogeneity in each comparison. The I^2 statistic described the percentage of variance in each comparison that may

arise from heterogeneity between studies or outcome measures rather than by chance. For the purpose of assessment, heterogeneity was defined as absent (0%), low (25%), moderate (50%) and high (75%).[31] A 95% confidence interval was calculated for the I^2 statistic.

Publication bias

Publication bias for all meta-analyses was established by examining funnel plots.[32] Duval and Tweedie's[33] trim and fill procedure was used to estimate effect sizes after accounting for publication bias while Egger's[34] test of the intercept was applied to quantify bias and assess significance.

Power analysis

Due to progressive sensitivity analyses and our identification of SST subtypes, a number of comparisons were likely to be underpowered. We therefore utilised power analysis to determine the approximate number of studies required to identify relevant effects. Previous meta-analysis identified effect sizes ranging from roughly g = 0.2-0.6 for SST.[9] Based on Cuijpers'[35] table, for an average N of 30 per group in each study and conservatively assuming .80 power alongside alpha level 0.05, it was estimated that 18 studies would be required to detect an effect size of g = 0.2 for comparisons with low between study variance. Comparisons with medium and high variance would require 22 and 26 studies respectively.

Table 1. *SST subtype descriptions & comparison types*

	Definition	N_{st}	N_p
1.	1. *Cognitive-behavioural social skills training (CBSST):* CBSST defined interventions which utilised primarily a social-skills training approach similar to generic SST but also integrated cognitive-behavioural techniques such as cognitive restructuring, thought challenging or behavioural experiments. To limit heterogeneity we attempted to exclude interventions that were primarily structured as formulation-based CBT-based approaches that added aspects of SST since these interventions have less explicit skills training focus.[4,26]	4 [4,26,43,45,]	243
2.	2. *Generic social skills training*: Generic SST refers to approaches that remain close to the original model of SST emerging in the 1980s. Typically this consists of a behaviourally-oriented, group intervention based upon social learning traditions in which the therapist(s) engage participants in interpersonal training sessions. The focus is typically upon assertiveness, verbal and non-verbal communication, reduction of social distress and learning appropriate contextual responses in social situations. This may be achieved via modelling, role-play, rehearsal, group reflection and discussion or a variety of related methods.[1,36]	7 [40,42,46,47,52,57,59]	287
3.	3. *Social-cognitive skills training (SCST):* This category refers to a relatively broad range of interventions that focus primarily on refining social cognitive processes such as emotion perception, theory-of-mind abilities. In order to qualify, interventions were required to include a therapist-led, behavioural or reflective element in order to demonstration distinction from approaches further on a continuum toward cognitive remediation. SCST may integrate computer programmes or videos in order to facilitate improved training of social responses and may also follow a "drill and repeat" structure.[37,38]	8 [2,3,25,37,38,41,49,60]	295
4.	4. *UCLA-FAST based:* The acronym for this category refers firstly to those interventions explicitly based upon the University of California Los Angeles (UCLA) model of skills training, which integrates traditional SST alongside aspects of psycho-education, relapse prevention and skills in managing daily life tasks such as medication or independent travel. A similar approach is Functional Adaptive Skills Training (FAST) therefore these varieties of SST were combined to form a more practical-skills based category.[5,6,39]	8 [5,6,24,39,50,52,55,58]	612
5.	Treatment-as-usual (TAU) comparison: Refers to standard clinical care received by patients. TAU cannot be considered an active control in meta-analysis since intervention is non-standardised while both intervention and control groups in psychosis are likely to receive some form of TAU (e.g. medication).		
6.	Active controls: Includes bona-fide interventions such as cognitive-behavioural therapy alongside less recognised but standardised control interventions such as supportive counselling		
7.	Supportive counseling SC): Refers to non-directive supportive therapeutic contact which includes key common ingredients of therapy such as empathy and rapport without specific techniques of therapy models.[64]		

N_{st} = number of studies. N_p = number of participants who received each intervention.

Table 2. *Selected characteristics of included randomised controlled trials of social skills training and related interventions*

Study & publications	Country	Sample characteristics	Relevant comparisons & *N*	Symptom outcome measures	Format	Bias Risk (0-4)	Duration (weeks to PT approx)	Follow-up
Anzai *et al* [24]	Japan	DSM-IV & ICD-10 schizophrenia. Inpatients. Refractor. Poor insight.	SST (37) vs. OT (15)	Rehab scale, Discharge	Group	4	9	N/A
Bowie *et al* [39]	Canada & USA	Schizophrenia or schizoaffective disorder. Outpatients.	SST (38) vs. CR (38)	PANSS, SSPA	Group	1	12	12 weeks
Chien *et al* [40]	Taiwan	DSM-IV schizophrenia. Inpatients.	SST (35) vs. TAU (43)	PANSS, IAS	Group	3	4	N/A
Choi *et al* [41]	South Korea	DSM-IV schizophrenia and schizo-affective disorder. Outpatients	SST (17) vs. TAU (17)	SBST	Group	4	26	N/A
Dobson *et al* [42]	Canada	DSM-III Schizophrenia. Outpatients. Severe patients excluded.	SST (15) vs. BF 13)	PANSS	Group	3	11	N/A
Gohar *et al*[2]	Egypt	DSM-IV schizophrenia and schizo-affective disorder. Outpatients	SCST (22) vs. CST (20)	PANSS, MSCEIT	Group	3	8	N/A
Granholm *et al*[43,44]	USA	DSM-IV schizophrenia and schizo-affective disorder. Older outpatients 42+	CBSST (37) vs. TAU (39)	PANSS	Group	2	24	6, 12 months
Granholm *et al* [45]	USA	Older outpatients 45+, DSM-IV schizophrenia and schizoaffective disorder.	CBSST (41) vs. SC (38)	PANSS, SANS,	Group	1	36	4.5, 9 months
Granholm *et al*[4]	USA	DSM-IV schizophrenia and schizoaffective disorder. Outpatients.	CBSST (73) vs. SC (76)	PANSS, SANS, MASC	Group	1	36	6, 12 months
Hayes *et al* [46]	Australia	DSM-III-R schizophrenia. Non-current positive symptoms. Recruited from a range of services.	SST (23) vs. SC (22)	BPRS, SANS, SSIT	Group	4	18	6 months
Hogarty *et al* [47,48]	USA	RDC schizophrenia or schizoaffective disorder. High expressed emotion families. Inpatients.	SST (23) vs. FI (23)	Symptom relapse	Individual	4	104	N/A
Horan *et al* [3]	USA	DSM-IV schizophrenia or schizoaffective disorder. Clinically stable outpatients.	SST (17) vs. PE (17)	BPRS, SSPA	Group	2	6	N/A
Horan *et al* [49]	USA	DSM-IV schizophrenia, schizoaffective disorder, delusional disorder or psychosis. Clinically stable outpatients.	SST (19) vs. CR (24)	BPRS, SSPA, HAM-D	Group	2	12	N/A
Lecomte *et al* [50,51]	Canada	Early psychosis (< 2 years). Current psychotic symptoms. Stabilized outpatients.	CBT (48) vs. SST (54)	BPRS	Group	2	13	6, 12 months
Liberman et al [52–54]	USA	DSM-III schizophrenia. Inpatients.	SST (14) vs. PE (14)	PAS	Group	3	10	N/A

Table 2. *Continued*

Study & publications	Country	Sample characteristics	Relevant comparisons & *N*	Extracted outcome measures	Format	Bias Risk (0-4)	Duration (weeks to PT)	Follow-up
Liberman *et al* [55]	USA	Persistent & unremitting schizophrenia. Outpatients.	SST (42) vs. OT (42)	BSI, GAS, BPRS	Both	3	26	N/A
Marder *et al* [56]	USA	DSM-III schizophrenia. At least 2 acute episodes or 2 years psychotic symptoms. Male outpatients.	SST (13) vs. SC (14)	BPRS Exacerbations	Group	3	104	N/A
Ng *et al* [57]	Hong Kong	DSM-IV schizophrenia. Inpatients.	SST (18) vs. SC (18)	BPRS, SANS, SFS, SBS	Group	0	8	6 months
Patterson *et al* [58]	USA	DSM-IV schizophrenia or schizophreniform disorder. Older chronic Latino inpatients.	SST (21) vs. SC (8)	PANSS, SSPA	Group	3	26	12, 18 months
Patterson *et al* [5]	USA	DSM-IV schizophrenia or schizophreniform. Older chronic inpatients.	SST (124) vs. SC (116)	PANSS, SSPA, HAM-D	Group	2	26	N/A
Roberts *et al* [38]	USA	DSM-IV schizophrenia or schizoaffective disorder. Interaction difficulties. Outpatients	SCIT (33) vs. TAU (33)	PANSS, SSPA, GSFS	Group	2	13	3 months
Rus-Calafell *et al* [59]	Spain	DSM-IV-TR schizophrenia or schizoaffective disorder. Clinically stable outpatients.	SST (13) vs. TAU (18)	PANSS, SFS	Group	4	26	6 months
Gil Sanz *et al* [60]	Spain	CIE-10 Schizophrenia. Rehab patients.	SCT (7) vs. TAU (7)	PANSS, WHODAS-II	Group	3	10	N/A
Tas *et al* [37]	Turkey & Germany	DSM-IV schizophrenia. Clinically stable outpatients.	SST (22) vs. BF (27)	PANSS, SFS	Group	0	16	N/A
Velligan *et al* [26]	USA	DSM-IV Schizophrenia or schizoaffective disorder. Clinically stable outpatients.	CBSST (26) vs. TAU (25)	NSA-16, BNSS	Individual	1	39	N/A
Wang *et al* [25]	China	DMS-IV schizophrenia. Clinically stable outpatients.	SST (48) vs. SC (48)	PSP	Group	2	20	N/A
Xiang *et al* [6]	China	DSM-IV schizophrenia. Clinically stable inpatients & outpatients.	SST (50) vs. PE (53)	PANSS, SDSS	Group	1	4	6, 12 months

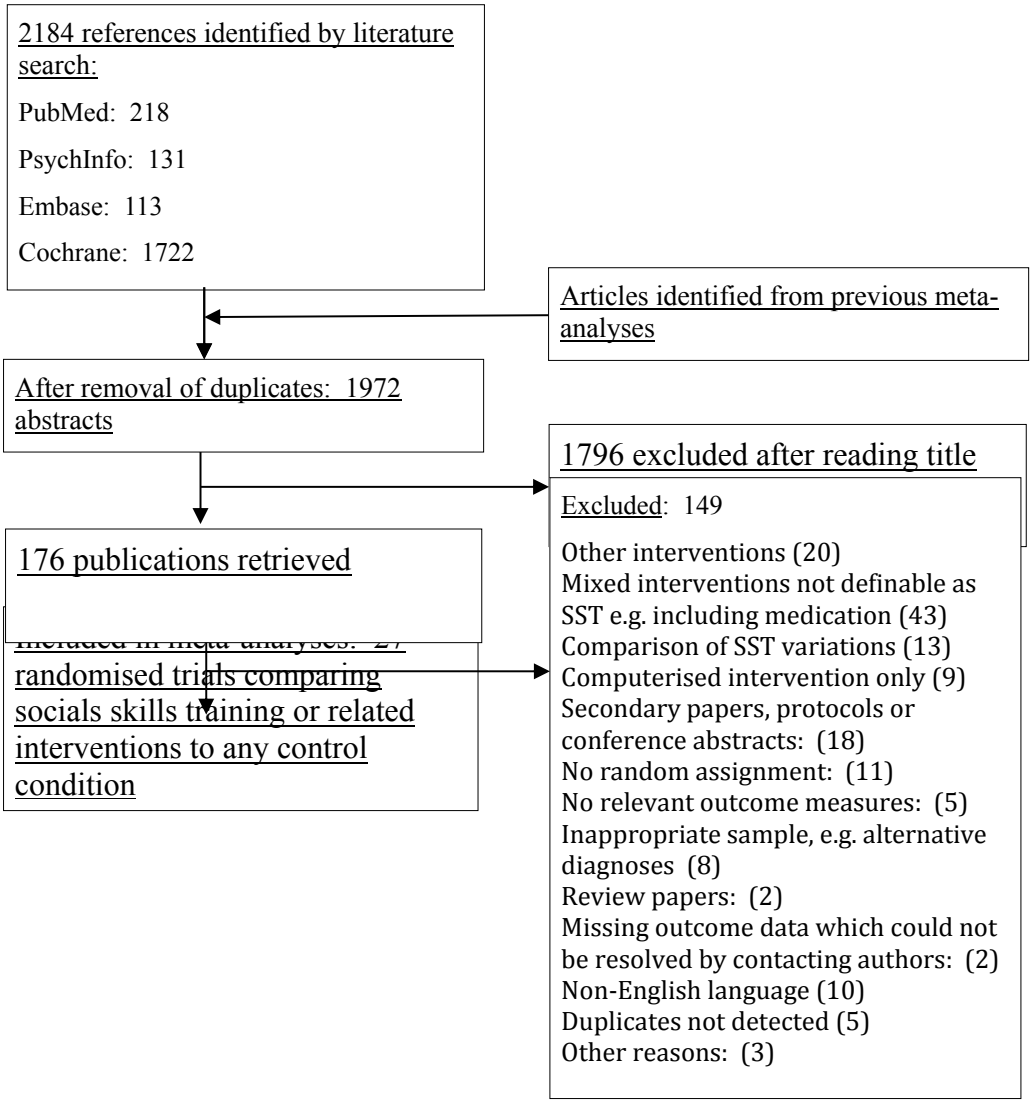
BF, Befriending; BPRS, Brief Psychiatric Rating Scale; BNSS, Brief Negative Symptom Scale; BSI, Brief Symptom Inventory CBT, Cognitive-Behavioural Therapy; CR, Cognitive Remediation; CST, Control Skills Training, FI, Family Intervention; GAS, Global Assessment Scale; GSFS, Global Social Functioning Scale; Ham-D, Hamilton Depression Rating Scale; IAS, Interaction Anxiety Scale; MASC, Maryland Assessment of Social Competence; MSCEIT, Mayer-Salovey Emotional Intelligence Test; *N*, Number of participants in each treatment group; NSA-16, Negative Symptoms Assessment; OT, Occupational Therapy; PANSS, Positive and Negative Syndromes Scale; PE, Psycho-education; PSP, Personal and Social Performance Scale; PT, Post-treatment; N/A, Not Applicable;,SANS, Scale for Assessment of Negative Symptoms; SBS, Social Behaviour Schedule; SBST, Social Behaviour Sequencing Task; SC, Supportive Counselling; SDSS, Social Disability Screening Schedule; SFS, Social Functioning Scale; SSPA, SSIT, Simulated Social Interaction Test; Social Skills Performance Assessment; SST, Social Skills Training; WHODAS-II, WHO Disability Scale

Results

Study selection

Figure 1 illustrates the selection process by which articles were screened for inclusion. Following removal of duplicates, 1972 titles abstracts were screened for relevant characteristics; a further 176 articles were retrieved for closer inspection of inclusion and exclusion criteria. 27 randomised controlled trials qualified for final inclusion resulting in data for N=1,437 participants being included across 70 meta-analyses and sensitivity analyses. All included RCTs reported outcome measures at post-treatment while 11 studies (40%) included follow up data ranging from 12 weeks to 18 months post-treatment.

Fig. 1. PRISMA Flowchart of inclusion of studies



Selected characteristics of included studies are available in Table 2. Twenty-Five studies (93%) applied group format only while only 2 applied individual format. Risk of bias scores within studies ranged from 1-4. This meant that no studies

achieved the lowest possible risk of bias score and therefore sensitivity analyses could not exclude all risk of bias. Details of risk of bias assessments at the study level are included in supplementary materials. Four broad subtypes of SST were identified as defined in Table1 and formed the basis of subtype comparisons.

Effect of SST on psychosis symptoms

Results for all comparisons of SST against active controls, TAU, SC and all comparators pooled are provided in Table 3. A summary forest plot of significant comparisons is provided in Figure 2. Separate meta-analyses were calculated for each symptom category and followed by risk of bias sensitivity analyses. SST was more efficacious than TAU for all symptoms (g=0.28, p=.02) but did not demonstrate superiority against comparators pooled, active controls or SC. The effect versus TAU was robust when removing studies with risk of bias scores of ≥4 (where 4 indicates the highest risk of bias score) although further sensitivity analyses were not possible due to limited study availability and the significant ≥4 comparison was underpowered. Heterogeneity was absent in the TAU comparison although other non-significant comparisons for all symptoms pooled showed moderate to high heterogeneity. SST did not demonstrate superiority in any comparisons for positive symptoms while heterogeneity was also moderate to high in this domain.

SST was more efficacious for negative symptoms when compared to all comparators pooled, active controls and TAU. SST was more efficacious compared to pooled comparators (g=0.19 p=.01) when all eligible studies were included in the analysis. When progressive removal of bias risk was implemented the effect size gradually increased to g=0.28 (p=.01). A similar trend was observed for comparison to active controls, where initial comparisons including all studies approached significance while gradual removal of bias resulted in an effect size of g=0.28 (p=.01). For comparison to TAU, SST was more efficacious when all studies were included (g=0.31, p=.01)

although studies only allowed for removal of studies with a bias risk score ≥4 (g=0.30, p=.02). The ≥4 bias comparison was underpowered. SST did not demonstrate superiority against SC for negative symptoms but this comparison was underpowered with only 4 studies available. There was no evidence of heterogeneity among negative symptom comparisons.

For PANSS general symptoms, SST demonstrated superiority against comparators pooled (g=0.32, p=0.02) and TAU (g =0.40, p=.01). The limited number of available studies in this symptom domain meant that sensitivity analyses for risk of bias were not possible while comparisons were underpowered. There was no evidence of significant heterogeneity.

Effect of SST for social performance

The results for social performance outcome measures are displayed in Table 3. SST was more efficacious when compared to all comparators pooled. This effect size gradually increased from g=0.33(p=.01) when all eligible studies were included to g=0.37, (p<.03) when studies scoring ≥3 on bias risk were excluded. The treatment effect was no longer significant on the final sensitivity analysis for studies scoring ≥2 on bias risk, although this comparison was underpowered with only 5 studies available. SST did not demonstrate significant superiority against active controls or TAU although the TAU comparison was particularly underpowered. The majority of comparisons in the social performance domain displayed moderate to high heterogeneity including significant effects.

Comparison of SST subtypes

Table 3 provides results of the comparison of the a priori specified SST subtypes. The majority of SST subtype comparisons were underpowered due to limited study availability. In order to assess trends in the data, effects that approached significance (p<0.1) were noted and the magnitude of non-significant effects were considered. The only subtype that demonstrated

significant superiority was SCST, which demonstrated a relatively robust effect size at ≥3 (g=0.39, p=.01) and ≥2 (g=0.41, p=.01) bias levels against any comparator pooled for all symptom measures pooled. Generic SST demonstrated an effect size that approached significance for all symptoms pooled (g=0.36, p=.057) while for negative symptoms a similar magnitude was observed despite the comparison being underpowered (g=0.27, p<.20). UCLA-FAST approaches showed a non-significant trend of inferiority for all symptoms pooled versus any comparator while CBSST comparisons were hampered by limited study availability. Comparisons of CBSST showed no evidence of heterogeneity while Generic SST and SCST symptom comparisons did not show significant heterogeneity. Heterogeneity was present for UCLA-FAST comparisons although decreased as bias risk was reduced. Moderate to high heterogeneity was observed across social performance comparisons.

Follow-up

Meta-analyses of follow-up data were only possible for the 6 months time-point, due to limited availability at other time points. Limited RCT availability also meant this section was restricted to all comparators pooled rather than allowing TAU or active control comparisons. SST did not demonstrate superiority against comparators pooled in any outcome domain. Follow-up comparisons were underpowered overall, whilst heterogeneity was consistently low.

Table 3. *Effect sizes of SST across outcome measures and comparison conditions*

	N	*g*	95% CI	*Z*	*p* of *Z*	Q-value	I^2 *(%)*	I^2 *95% CI*
SST for all symptom measures pooled								
Vs. any comparator								
all eligible studies	25	0.097	-0.074, 0.267	1.112	0.266	53.99*	55.48	30-72
excluding risk of bias score of 4	21	0.090	-0.091, 0.270	0.973	0.331	46.13*	56.64	29-73
excluding risk of bias score ≥3	13	0.106	-0.131, 0.343	0.879	0.379	34.59*	65.30	37-81
excluding risk of bias score ≥2	7	0.173†	-0.026, 0.373	1.704	0.088	6.42	6.49	0-73
Vs. active controls								
all eligible studies	18	0.067	-0.151, 0.286	0.605	0.545	45.23*	62.42	37-77
excluding risk of bias score of 4	15	0.051	-0.118, 0.281	0.440	0.660	37.30*	62.47	34-79
excluding risk of bias score ≥3	10	0.088	-0.209, 0.385	0.581	0.561	32.38*	72.20	47-85
excluding risk of bias score ≥2	6	0.165	-0.061, 0.392	1.431	0.152	6.19	19.15	0-64
Vs. TAU								
all eligible studies	6	0.282*	0.049, 0.515	2.373	0.018	2.80	0.00	0-75
excluding risk of bias score of 4	5	0.300*	0.054, 0.546	2.386	0.017	2.61	0.00	0-79
Vs. SC only								
all eligible studies	7	-0.104	-0.456, 0.247	-0.58	0.560	18.88*	68.23	30-86
excluding risk of bias score of 4	6	-0.090	-0.499, 0.318	-0.432	0.666	18.81*	73.42	39-88
excluding risk of bias score ≥3	4	-0.086	-0.669, 0.488	-0.294	0.769	17.99*	83.32	58-93
SST for positive symptoms								
Vs. any comparator								
all eligible studies	13	0.0895	-0.117, 0.296	0.85	0.397	23.88*	49.8	5-73
excluding risk of bias score of 4	12	0.984	-0.122, 0.318	0.88	0.381	23.72*	53.6	11-76
excluding risk of bias score ≥3	9	0.980	-0.150, 0.350	0.78	0.438	18.36*	56.4	8-79
excluding risk of bias score ≥2	5	0.050	-0.362, 0.460,	0.23	0.819	14.70*	72.8	32-89
Vs. active controls								
all eligible studies/ excluding risk of bias 4	8	0.080	-0.223, 0.380,	0.50	0.620	19.80*	64.6	25-83
excluding risk of bias score ≥3	7	0.127	-0.194, 0.450,	0.78	0.437	18.04*	66.7	26-85
excluding risk of bias score ≥2	5	0.050	-0.362, 0.460,	0.23	0.819	14.70*	72.8	32-89
Vs. TAU								
all eligible studies	5	0.151	-0.098, 0.400,	1.19	0.235	3.68	0.00	0-79
excluding risk of bias score of 4	4	0.176	-0.110, 0.460,	1.22	0.222	3.31	9.30	0-86

Table 3. *Continued*

	N	*g*	95% CI	*Z*	*p* of *Z*	Q-value	I^2 *(%)*	I^2 *95% CI*
SST for negative symptoms								
Vs. any comparator								
all eligible studies	17	0.191*	0.043, 0.338	2.53	0.011	19.67	18.65	0-54
excluding risk of bias score of 4	15	0.218*	0.077, 0.359	3.03	0.002	14.66	4.48	0-56
excluding risk of bias score ≥3	11	0.194*	0.041, 0.346	2.49	0.013	7.96	0.00	0-60
excluding risk of bias score ≥2	7	0.279*	0.087, 0.471	2.85	0.004	5.07	0.00	0-71
Vs. active controls								
all eligible studies	11	0.136	-0.070, 0.341	1.29	0.196	16.01	37.52	0-69
excluding risk of bias score of 4	10	0.185†	-0.009, 0.378	1.87	0.061	11.94	24.61	0-64
excluding risk of bias score ≥3	8	0.196*	0.010, 0.383	2.07	0.039	0.74	9.54	0-68
excluding risk of bias score ≥2	6	0.276*	0.073, 0.478	2.67	0.008	5.05	1.04	0-75
Vs. TAU								
all eligible studies	6	0.311*	0.078, 0.544	2.61	0.009	2.17	0.00	0-75
excluding risk of bias score of 4	5	0.300*	0.054, 0.546	2.39	0.017	2.09	0.00	0-79
Vs. SC only								
all eligible studies	4	0.013	-0.283, 0.257	0.09	0.927	2.77	0.00	0-85
SST for PANSS general symptoms								
Vs. any comparator, all eligible studies	6	0.318*	0.043, 0.594	2.26	0.023	7.33	31.70	0-72
Vs. TAU, all eligible studies	4	0.404*	0.111, 0.697	2.70	0.007	2.31	0.00	0-85
SST for social competency outcome measures								
Vs. any comparator								
all eligible studies	17	0.326*	0.079, 0.572	2.59	0.010	49.60*	67.79	47-81
excluding risk of bias score of 4	13	0.364*	0.100, 0.628	2.70	0.007	37.27*	67.80	43-82
excluding risk of bias score ≥3	9	0.372*	0.036, 0.709	2.17	0.030	33.20*	75.91	54-87
excluding risk of bias score ≥2	5	0.193	-0.065, 0.451	1.47	0.143	5.44	26.48	0-72
Vs. active controls								
all eligible studies	12	0.131	-0.234, 0496	0.70	0.482	59.59*	81.53	69-89
excluding risk of bias score of 4	10	0.227	-0.170, 0.624	1.12	0.262	51.16*	82.41	69-90
excluding risk of bias score ≥3	8	0.320	-0.098, 0.738	1.50	0.134	39.98	82.49	67-91
excluding risk of bias score ≥2	5	0.020	-0.312, 0.353	0.12	0.906	8.86	54.88	0-83
Vs. TAU								
all eligible studies	5	0.201	-0.140, 0.541	1.16	0.248	5.31	24.69	0-70

Table 3. *Continued*

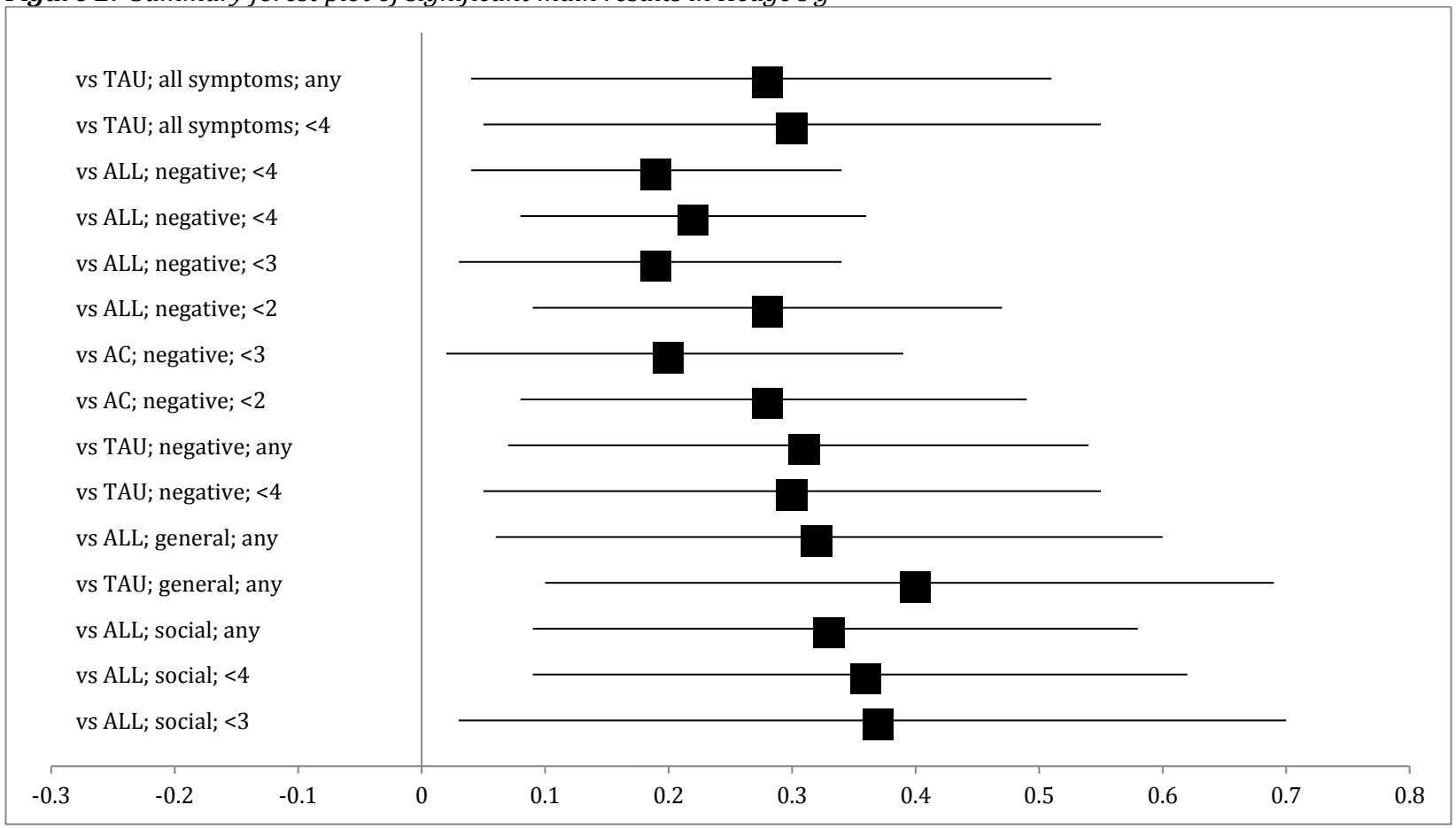
	N	*g*	95% CI	*Z*	*p* of Z	Q-value	I^2 (%)	I^2 95% CI
SST subtypes vs. any comparator								
All symptom measures pooled								
Generic SST, all eligible studies	7	0.171	-0.127, 0.468	1.13	0.260	8.70	31.77	0-71
Generic SST, excl. risk of bias ≥4	4	0.364†	-0.011, 0.739	1.90	0.057	4.21	28.71	0-74
Cognitive-behavioural SST, excl. risk of bias ≥3	4	0.147	-0.108, 0.403	1.13	0.258	0.59	0.00	0-85
Social-cognitive SST, excl. risk of bias ≥4	6	0.270	-0.027, 0.567	1.78	0.075	6.40	21.92	0-66
Social-cognitive SST, excl. risk of bias ≥3	5	0.392*	0.107, 0.678	2.70	0.007	2.48	0.00	0-79
Social-cognitive SST, excl. risk of bias ≥2	4	0.413*	0.116, 0.709	2.73	0.006	2.24	0.00	0-85
UCLA-FAST, all eligible studies	8	-0.058	-0.392, 0.276	-0.34	0.733	25.19*	72.21	43-86
UCLA-FAST, risk of bias ≥4	7	-0.176	-0.461, 0.109	-1.21	0.226	15.71*	61.81	13-83
UCLA-FAST, excl. risk of bias ≥3	4	-0.201	-0.649, 0.246	-0.88	0.378	14.65	79.52	46-92
Negative symptoms								
Generic SST, all eligible studies	5	0.268	-0.143, 0.678	1.28	0.201	8.66	53.83	0-83
Cognitive-behavioural SST, all eligible studies	4	0.146	-0.117, 0.402	1.11	0.266	0.46	0.00	0-85
Social-cognitive SST, all eligible studies	5	0.148	-0.213, 0.509	0.80	0.421	6.47	38.14	0-77
Social competency outcome measures								
Generic SST, all eligible studies	4	-0.031	-0.318, 0.256	0.21	0.832	1.31	0.00	0-85
Social-cognitive SST, all eligible studies	7	0.301	-0.211, 0.812	1.15	0.249	23.41*	74.37	45-88
Social-cognitive SST, excl. risk of bias ≥4	6	0.188	-0.340, 0.716	0.70	0.485	19.86*	74.82	43-89
Social-cognitive SST, excl. risk of bias ≥3	4	0.478†	-0.018, 0.975	1.89	0.059	8.38*	64.18	0-88
UCLA-FAST, all eligible studies	5	0.080	-0.587, 0.747	0.24	0.814	36.19*	88.95	77-95
UCLA-FAST, excl. risk of bias ≥4	4	0.267	-0.432, 0.966	0.75	0.454	27.9*	89.25	75-95
SST vs. any comparator at 6 month follow-up								
All symptoms, all eligible studies	8	0.035	-0.150, 0.220	0.37	0.712	1.94	0.00	0-68
All symptoms, excl. risk of bias ≥3	6	0.061	-0.139, 0.260	0.60	0.550	0.97	0.00	0-75
All symptoms, excl. risk of bias ≥2	4	0.116	-0.119, 0.352	0.97	0.333	0.09	0.00	0-85
Positive symptoms, all eligible studies	5	-0.084	-0.315, 0.147	-0.71	0.475	1.09	0.00	0-79
Positive symptoms, risk of bias ≥3	4	-0.078	-0.323, 0.166	-0.63	0.530	1.06	0.00	0-85
Negative symptoms, all eligible studies	7	0.001	-0.207, 0.209	0.03	0.995	4.22	0.00	0-71
Negative symptoms, excl. risk of bias ≥3	5	0.006	-0.223, 0.235	0.051	0.958	2.28	0.00	0-79
Social competency outcomes, all eligible studies	4	0.096	-0.186, 0.379	0.67	0.503	0.62	0.00	0-85

All comparisons were using random model. Risk of bias and subgroup analyses were only included in instances where at least 4 studies were available for that comparison. * $p<0.05$. † $p<0.1$. PANSS, Positive and Negative Syndromes Scale. CI, Confidence Interval. SC, Supportive Counselling. UCLA-FAST, University of California Los Angeles-Functional Adaptive Skills Training.

Publication bias

Examination of funnel plots and consideration of the trim and fill procedure for effects that demonstrated statistical significance indicated the presence of publication bias in only one comparison. The funnel plot for SST versus all comparators pooled for general symptoms suggested that one study with negative findings had not been published. The trim and fill procedure trimmed one study causing a marginal reduction in the magnitude of effect size in this comparison from *g*=0.32 (*p*=<.05) to *g*=0.26 (95% CI 0.01, 0.53). The classic fail-safe N procedure suggested that it would require 7 missing studies to bring significance below the 0.05 alpha level while Egger's[31] test of the intercept did not demonstrate significance.

***Figure 2**: Summary forest plot of significant main results in Hedge's g*



ALL, all comparators pooled; TAU, treatment-as-usual; AC, active controls; Social, social competency outcomes; General, PANSS general symptoms; Negative, negative symptoms; Any, all eligible studies included; <4, <3 and <2 denote sensitivity analyses progressively removing risk of bias.

Discussion

The current meta-analysis provided a systematic and comprehensive overview of the efficacy of SST for psychosis while also investigating SST subtypes. SST demonstrated superiority for negative symptoms against all comparators pooled, TAU and active controls with small but reliable differences. SST did not demonstrate superiority over SC for negative symptoms although this comparison was very low in power. SST also demonstrated superiority against any comparator and TAU for PANSS general symptoms with small to medium effects. SST was superior to TAU when pooling all symptom measures but did not demonstrate superiority against comparators pooled, active control or SC. There were no significant effects on positive symptoms. SST demonstrated superiority only against comparators pooled for social competency measures although this effect lost significance as bias risk and power decreased. Significant effects for social outcomes were overall marginally larger than those for negative symptoms although significant heterogeneity was present across significant findings in this category while effects were not maintained against active controls. In SST subtype comparisons, only SCST demonstrated superiority to pooled comparators.

As hypothesised, SST demonstrated superiority for negative symptoms including in comparison against active controls, which is the most stringent comparison category. SST also demonstrated beneficial effects on those comparisons possible for general symptoms. The overall trend in analyses for both negative and PANSS general symptoms showed that the magnitude of SST effect increased as risk of bias decreased, suggesting these effects may be robust. There was however still a minimal level of risk of bias present in the RCTs pooled to provide these conclusions since no RCT achieved the lowest possible risk of bias score. Sensitivity analyses for social outcomes did not follow this trend, with the effect size decreasing and findings losing significant when bias was minimised. Similarly, many comparisons allowed only the least stringent category of sensitivity analysis due to limited availability of methodologically strong RCTs. Comparisons in the social performance domain displayed moderate to high

heterogeneity. This heterogeneity may be a result of combining a high number of outcome measures that were not designed to measure a narrowly defined construct. Our combination of these measures may therefore indicate that a number of related but distinct outcomes were included while a lack of robust significant effects in this domain may also be related to the heterogeneity in the included outcomes.

While SCST demonstrated superiority to pooled comparators again with magnitude increasing as bias decreased, no other SST subtypes demonstrated superiority in the context of low power across comparisons. There were a two effects approaching significance; generic SST at the ≥4 risk of bias sensitivity analysis and SCST at the ≥3 risk of bias sensitivity analysis, while UCLA-FAST performed poorly despite having the highest statistical power. This may therefore suggest that 'practical' life skills approaches have less beneficial impact upon symptoms than other subtypes. It is difficult to draw any conclusion regarding CBSST due to limited study availability. The identification of SST subtypes in meta-analysis may therefore become more relevant as the literature develops and future meta-analyses may benefit from increased study availability to bolster categories. Further research in this area which can more intricately compare the effectiveness of SST subtypes may help influence the development of effective SST interventions.

The beneficial effects of SST were not maintained at 6 months follow-up. Comparisons did not approach significance and generally had a low magnitude of effect, therefore low power is unlikely to be the primary reason for null findings. SST has faced criticism that learning does not generalise well to real-life situations.[16] This finding also has implications for SST developers as it is important that generalisability and longevity are considered closely in SST manuals.

The effect sizes reported for SST for negative symptoms (g=0.2-.03) are marginally greater than those reported for CBT for positive symptoms and marginally smaller than those reported for anti-psychotics,[8,9] while current

evidence does not support CBT for negative symptoms.[14] If we consider CBT as an intervention addressing positive symptoms and SST for negative symptoms, each intervention has effects of roughly equivalent magnitude for its target area.[61] As discussed, SST is not recommended as a stand-alone intervention by NICE and therefore is not routinely implemented in the NHS.[10] Furthermore, no UK RCTs met inclusion criteria for this meta-analysis while many meet criteria for CBT meta-analyses.[9,15,62,63] It is possible that a culture towards cognitive-behavioural, formulation-based interventions is limiting the consideration of alternative approaches that demonstrate similar efficacy. The group-based style of SST may lend itself well to application within a CMHT environment and has the potential to act as a cost-effective means of addressing negative symptoms while improved care matching protocols may develop to help identify which patients may benefit most from the range of available interventions and depending on their capacity to engage.[64]

The positive findings for SST on general psychopathology are also of interest. The PANSS general psychopathology subscale may be conceptualised as a measure of general distress including depression and anxiety, which have been identified as factorial dimensions within psychosis symptomatology.[65] Understanding of depression as an integral part of psychosis is limited as are targeted interventions. The small to medium effect sizes shown for SST in this domain suggest that targeting general psychopathology is worthy of consideration for the broader recovery agenda[66] while contemporary research challenges the traditionally prevalent assumption that psychosis and depression are aetiologically distinct.[65] Considered broadly these findings suggest the importance of developing interventions for psychosis populations that carefully consider the symptom and functioning domains measured by negative and general symptom scales.

It should also be recognised that negative symptoms represent heterogeneous sequelae within psychosis. Recent research supports a two-factor structure within negative symptoms in which expressive or neurocognitive deficits are associated primarily with limited life functioning while a second factor

representing limited social motivation is associated with depressive symptomatology.[66,67] Research on intervention targeting specific subgroups within negative symptoms is in its infancy.[68] While simultaneously considering our findings on general symptoms, the potential crossover between negative symptoms and depressive symptomatology has implications for the development of effective interventions.

On a macro level, this review also provides support that small but reliable differences exist between psychological interventions, particularly in on the outcomes targeted specifically by the intervention. This contradicts the Dodo verdict that all psychological interventions are equivalent since SST retained superiority for negative symptoms observed elsewhere.[9,69] Small effect sizes and a number of non-significant comparisons versus active controls may also be interpreted as supportive of the premise that interventions are roughly equivalent although the difficulty of low power in these comparisons should not be dismissed. Wampold[70,71] highlights the tendency of meta-analyses of psychological interventions to establish targeted, symptom-specific improvement as opposed to improved general functioning. The observed effect on PANSS general symptoms suggests improvement may occur on outcomes capturing comorbidity although our methodology does not have the sophistication to specify the mechanism of such improvements.

There were a number of limitations including those inherent to meta-analyses and those specific to this review. With regard to the literature, although, 27 RCTs were included participant numbers in many trials were low.[60] Many comparisons were therefore hampered by low power and there were not enough high quality studies minimising bias risk to allow comparison at the lowest risk of bias level. This meant that any significant finding is still susceptible to some degree of potential bias.

Based to our comparison strategy, another limitation was that many RCTs had to be excluded due to the mixed nature of interventions; for example integrating medication, exercise or other psychological therapies alongside SST. It was

beyond the scope of this review to consider these interventions although a narrative systematic review may help provide clarity on this burgeoning literature. Similarly, although we attempted to address the issue via joint decision-making, our categorisation of SST subtypes retains a degree of subjectivity while subtypes may contain heterogeneity. Nevertheless, the first meta-analytic consideration of SST subtypes provides guidance for future reviewers as this literature develops

The lack of translation capability should also be considered a limitation in this review since we were unable to fully assess ten potential papers for inclusion. A final limitation is that a wider range of outcomes are relevant to recovery from psychosis than those included in this review; for example quality of life, neurocognitive function, relapse or employment. Considering all such outcomes was beyond the scope of our project therefore, depending on study availability, future research may consider them.

Taken in the context of wider research findings, the magnitude of effects demonstrated by SST for negative and general symptoms are relatively comparable to other interventions including the extent of benefit shown by anti-psychotic and anti-depressant medication.[8] As aforementioned, we recognise that since the majority of participants in included RCTs would have been maintained on medication, the beneficial effects of SST are over and above any existing pharmacological effect on symptoms whereas the efficacy of SST for unmedicated participants remains unknown.

The results of this meta-analysis suggest that SST has the potential for wider clinical application while the level of evidence demonstrated for SST contradicts its exclusion by NICE in the UK.[10] The effect sizes reported are impressive for a group-based psychological intervention suggesting that SST may have potential as a cost-effective alternative to individual therapies addressing negative and general symptoms in healthcare systems struggling to provide routine psychological intervention while SST may also provide a beneficial adjunct to CBTp focused on appraisal and positive symptoms.

Further high-quality outcome research may help clarify doubts regarding the applicability and durability of SST in practice. At the very least, an RCT with stringent methodology applying SST for negative symptoms in a routine mental healthcare setting is warranted. Any future research may also benefit from integrating a cost-effectiveness analysis. Future SST research must focus upon further reducing risk of bias among RCTs and therefore allowing equivalence to CBT methodology alongside addressing the concerns regarding generalisability and longevity. It is therefore important that methodologically stringent RCTs integrate follow-up assessments on primary outcome measures while the integration of booster sessions or any similar attempt to prolong beneficial effects, trouble-shoot and increase applicability to real-life settings may help address existing concerns.

Declaration of interest

None.

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