# Disorganisation and thought disorder and socio-cognitive functioning in schizophrenia-spectrum disorders: A meta-analysis.

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Title: **Disorganisation and thought disorder and socio-cognitive functioning in schizophrenia-spectrum disorders: A meta-analysis.**

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**Key words:** schizophrenia; social cognition; theory-of-mind; emotion recognition; social perception; emotion processing.

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## ABSTRACT

Background: Poor social cognition is prevalent in schizophrenia-spectrum disorders. Some authors argue that these effects are symptom-specific and that socio-cognitive difficulties (e.g. Theory-of-Mind) are strongly associated with thought disorder (TD) and symptoms of disorganisation. Aims: The current review tests the strength of this association. Method: We meta-analysed studies published between 1980 and 2016 that tested the association between social cognition and these symptoms in schizophrenia-spectrum disorders. Results: Our search (PsycINFO, MEDLINE and Web of Science) identified 123 studies (N= 9107). Overall effect-size (ES) was r= -0.313, indicating a moderate association between symptoms and social cognition. Sub-analyses yielded a moderate association between symptoms and ToM (r= -0.349), emotion recognition (r= -0.334) but smaller ES for social perception (r= -0.188), emotion regulation (r= -0.169) and attributional biases (r= -0.143). Conclusions: The association is interpreted within models of communication that highlight the importance of mentalisation and processing of partner-specific cues in conversational alignment and grounding.

"No matter how one may try, one cannot not communicate"

Watzlawick, Bavelas, and Jackson [1(p48)]

## 1. Background

Researchers in the field of psychosis have long been interested in the role of social cognition in psychotic experiences. [2,3] Consequently, there is now a wealth of meta-analytical evidence showing that deficits in theory-of-mind (ToM; the ability to infer mental states in others), social perception, and emotion recognition are highly prevalent in individuals with schizophrenia-spectrum diagnoses. [4,5] Some researchers have suggested that impairments in social cognition play a specific role in disorganised symptoms in schizophrenia-spectrum disorders, especially thought disorder (TD). [3,6] Here we report a statistical synthesis of the evidence on the association between domains of social cognition and TD and other symptoms of disorganisation in participants diagnosed with schizophrenia-spectrum disorders.

### 1.1 Socio-cognitive domains

An NIMH workshop defined social cognition as a set of:

"(The) mental operations that underlie social interactions, including perceiving, interpreting, and generating responses to the intentions, dispositions, and behaviors of others".

Green et al. [7 (p1211)]

Hence, social cognition is a multi-faceted construct, referring to a broad range of higher-level inferential, attributional and regulatory processes, as well as lower-level social cue perception and processing. The consensus is that these processes comprise four core domains, namely: ToM and mental state attribution, social perception, attributional style or biases, and emotion processing. [8] Some have distinguished a fifth domain referred to as emotion recognition. This encompasses lower-level emotional cue perception and identification (see supplementary materials for definition of domains and examples of tasks).

### 1.1.1. ToM and mental state attribution

ToM (or mental state attribution) refers to the ability of the individual to infer intentions, dispositions and beliefs in others from their speech, actions and/or non-verbal behaviour. [3,9] Relevant assessment tasks may involve reading short passages, describing social interactions, where intentions of the characters are inferred from hints or indirect speech acts (e.g. Hinting task). [2] Alternatively, participants may be asked to sequence picture-card stories that require the correct inference of false beliefs in order to understand the story plot (e.g. Picture-Sequencing Task). [10]

### 1.1.2. Social perception

Social perception refers to the ability to decode and interpret social cues (verbal and non-verbal) in an interpersonal situation. This involves both the correct interpretation of cues in a social context but also the processing of social knowledge (i.e. the ability to utilise roles, rules and goals in a social situation and the knowledge of how they

affect other people's behaviours). In some tasks, participants are presented with social situations followed by multiple-choice questions that test their ability to interpret cues about social roles and rules (e.g. Interpersonal Perception Task). [11] Alternatively, tasks may involve the presentation of short audio and video clips that test the accurate interpretation of body postures, gestures, facial expressions or voice cues (e.g. Profile of Non-verbal Sensitivity). [12]

### 1.1.3. Emotion recognition

Emotion recognition refers to the ability to identify human emotion from a range of stimuli and cues such as facial expressions or tone of voice. Emotion recognition tasks may involve the ability to correctly identify different emotional states from video clips of an actor performing facial, vocal-tonal and upper-body movement cues (e.g. Bell-Lysaker Emotion Recognition Task) [13] or the identification of different emotional states from the tone of voice of audio-taped speakers reading out loud sentences of neutral content (e.g. Voice Emotion Identification Test). [14]

### 1.1.4. Attributional bias/style

Attributional bias refers to quick causal inferences that individuals make about positive and negative social events. These inferences (or attributions) are typically classified as external (i.e. the cause is attributed to others) or internal (i.e. cause is attributed to self). Sometimes, external attributions may be classified as personal (i.e. cause is the actions of another person) or situational (i.e. cause is attributed to situational factors). Tasks involve asking the participants to imagine themselves in a

positive or negative social situation and to report the most likely causal explanation for an event. Example measures include the Attributional Style Questionnaire [15] and the Internal, Personal, and Situational Attributions Questionnaire. [16]

### 1.1.5. Emotion processing and regulation

Emotion processing refers to skills that range from the perception of emotion to the understanding and management (regulation) of emotions. Although, some of these skills overlap with the competencies involved in emotion recognition the construct is broader and encompasses affective regulatory strategies. The assessment of emotional processing can involve questionnaire measures (e.g. Emotion Regulation Questionnaire) [17] or tasks where the participant is asked to rate brief vignettes that tap into the management, regulation or facilitation of emotions (e.g. Mayer-Salovey-Caruso Emotional Intelligence Test). [18]

## 1.2. Thought disorder and cognitive disorganisation

TD refers to range of thinking, linguistic and communication atypicalities that render the speech and communication of some individuals difficult to follow and apparently unintelligible. [19] These symptoms are a relatively enduring feature in psychotic patients [20] and have been associated with poorer quality of life, [21] higher rates of readmissions, [22] and poorer occupational and social functioning. [23,24] Perhaps more importantly, TD in psychotic patients has been associated with poor therapeutic alliance, [25] a core process in cognitive behavioural therapy for psychosis. [26] Despite a considerable amount of research in the field, the processes and mechanisms involved

in TD are still unclear. [27,28] However, such knowledge may be important for the development of effective psychological treatments for TD.

Some authors have argued that no single mechanism will ever be able to explain the full range of symptoms of TD because it is highly heterogeneous cluster of experiences and behaviours. [27] Although, there is no final word regarding the number of factors involved in TD, [29] it is clear that a distinction can be made between an impoverished speech factor, that includes symptoms such as alogia (or poverty of speech), and a disorganisation factor, which includes symptoms such as derailment, tangentiality, or incoherence. [30] This dichotomy has also been referred to as negative and positive TD. TD assessment scales such as the Scale for the Assessment of Thought, Language and Communication Disorders (TLC), [31] or the Thought Language Index (TLI), [32] distinguish between poverty of speech and disorganisation items and such differentiation has been further supported by factor analytical studies [33] and studies on the psychological mechanisms of both positive and negative TD. [34,35]

Many studies have used measurements using general psychopathology scales (e.g. Positive and Negative Syndrome Scale [36] or the Brief Psychiatric Rating Scale [37]) to test hypotheses about the mechanisms involved in TD. These include single ratings of conceptual disorganisation or symptom factors. The single ratings are highly correlated with more extensive measures of TD [38] and they capture symptoms of disorganisation such as derailment, incoherence, or illogicality (i.e. positive TD) but not symptoms of cognitive impoverishment such as alogia or poverty of speech. The symptom factors, which are derived from factor analysis and are typically labelled in the literature as 'disorganisation' or 'cognitive' factors, seem to form an orthogonal cluster of experiences distinct from positive and negative symptoms in schizophrenia-spectrum disorders. [39] They are highly associated with positive TD but

not alogia or poverty of speech. [40] A further problem is that they tend to encompass variance from PANSS items such as tension, inappropriate affect, or mannerisms and posturing, experiences that would not normally fall under the category of TD. [41]

For the conceptual and methodological reasons outlined above we felt that it was important that our analytical strategy distinguished between nuanced constructs, which code different and at times distinct phenomena.

### 1.3. Social cognition, TD and cognitive disorganisation

One study has suggested that TD patients might be aware of their communication difficulties. [42] However, some studies have reported some inconsistency between patient-reported TD and clinician-rated TD [43,44] and others have reported that patients seem to be unaware that their verbalisations are idiosyncratic and difficult to follow, despite being able to successfully judge other TD patients' verbalisations as bizarre and atypical. [45] This apparent inability to shift perspective, repair communication, and cooperatively adjust the message to the needs (and level of knowledge) of the listener is crucial when communication goes awry [46] and has been highlighted by several authors as a crucial feature in TD. For example, Frith [3] suggested that difficulties inferring the state of knowledge, intentions, and beliefs of an interlocutor, together with difficulties in interpreting the interlocutor's social signals, could prevent repair when communication fails, thereby leading to speech being perceived by the interlocutor as tangential or derailed. Similarly, Hardy-Baylé and colleagues [6] suggested that symptoms of disorganisation in patients diagnosed with schizophrenia-spectrum disorders could be explained by difficulties in representing other peoples' mental states and integrating contextual information during

conversations. These hypotheses have been partially supported in a review [47] and a meta-analysis[5] of the literature on ToM in patients diagnosed with schizophrenia-spectrum disorders but difficulties with ToM do not occur in isolation from other kinds of deficits [48] and it is therefore likely that other domains of social cognition may also be important in TD.

For example, Toomey and colleague found significant associations between poor social perception and symptoms of disorganisation in patients [49] and Kee and colleagues found significant associations between disorganization and poor emotion recognition. [50] It is not difficult to offer interpretations of these findings. For example, *stilted speech* (pedantic speech that is excessively formal and inappropriate for the context of the conversation) [31] could be partially explained by poor social perception (speaking with excessive formality when the social context requires a more informal style). Although hypotheses such as this are speculative at the present time, they highlight the value of exploring a wide range of domains of social cognition in relation to TD and disorganisation.

### 1.4. Study aim

The aim of the current review was to quantify the strength of the association between different domains of social cognition and TD, disorganisation and alogia in schizophrenia-spectrum disorders.

## 2. Method

The present review was carried out in adherence to the Meta-Analysis of Observational Studies in Epidemiology (MOOSE) guidelines [51] and the general principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for reporting systematic reviews and meta-analyses. [52]

## 2.1. Literature search

After initial scoping searches, three electronic databases (PsycINFO, MEDLINE and Web of Science) were searched for papers published between 1980 and 2016 using the following search terms: social cognition OR theory of mind OR theory-of-mind OR mentali$ation OR mental state attribution OR affect* OR emotion* (recognition or identification or regulation or management or processing or perception) social perception OR social knowledge OR attribution* (bias* or style) AND schizophreni* OR psychos* AND formal thought disorder OR thought dis* OR thinking dis* OR disorgani* OR conceptual dis* OR cognitive dis* OR communication dis*. The three searches yielded a total of 3,077 records (Figure 1).

***INSERT FIGURE 1 HERE***

## 2.2. Study selection

The inclusion criteria were: (1) the study was published in English language; (2) the paper was fully accessible; (3) the study was published in a peer-reviewed journal; (4) the sample was composed of patients diagnosed with schizophrenia-spectrum

disorders; (5) a clear TD or disorganisation measure could be identified; (6) a socio-cognitive measure could be identified; and (6) statistical data were available for extraction.

Although TD is a transdiagnostic phenomenon that can be observed in different mental health conditions, [27] we have opted to exclude studies with patients with other diagnoses (e.g. Bipolar Affective Disorder) as there is significant differences across diagnoses on course, quality, and temporal stability of these experiences. [53–55]



### 2.3. Symptom grouping strategy

In order to test the impact of different symptoms on social cognition, we organised the effect-sizes (ES) in three different symptom groups: disorganisation (factor), alogia (poverty of speech) and thought disorder (TD). The first group included ES from studies where researchers calculated the association between social cognition and a symptom factor (e.g. 'disorganisation factor' or 'cognitive factor') derived from clinical symptom scale (e.g. PANSS or BPRS). These factors were likely to include variance from symptoms that despite being statistically associated with TD, do not represent what would normally be assumed to fall under remit of the construct (e.g. tension, mannerisms and posturing). [56] The second group (alogia) included ES from studies where extractable data for the association between social cognition and a single item for alogia or poverty of speech was provided. These were almost always clinical symptom scales such as the SANS. [57] Finally, our third group (thought disorder) included data from studies where ES was calculated from a TD-specific scale score (e.g. TLC [58] or Bizarre Idiosyncratic Thinking Scale [59]) or from a single-

item (other than alogia or poverty of speech) from a clinical rating scale (e.g. PANSS stereotyped thinking or conceptual disorganisation [60,61]). In these cases, we opted to maintain the original designation used by the authors in Table 2. Included in this symptom group were also ES that had been estimated from clinical symptom scales that have specific TD subscales (e.g. SAPS [62]). The analyses of this group will include a ES for the group as whole and then a second estimate for studies that have used only TD-specific measures (without the scores from single-item clinical rating scales). The reason for this is to understand the strength of the estimate when TD is measure with robust (multi-item) and purposely designed measures.

### 2.4. Statistical analysis

Statistical analysis was carried out with CMA© (Comprehensive Meta-Analysis). Overall ES was estimated using Pearson's correlation coefficient (r) and random effects analysis given the likelihood that our analysis would carry a substantial amount of variation across studies. In studies with multiple socio-cognitive scores within the same domain, ES was computed from the average across tasks so that overall ES could be computed from a single estimate by study.

Heterogeneity was measured with $\tau^2$, Q and with $I^2$ and sensitivity analysis was carried out with group comparisons and meta-regression. Publication bias was tested by the visual inspection of the funnel plot, Begg and Mazumdar's rank order correlation, Egger's regression intercept, and Duval and Tweedie's "trim and fill" procedure.

***INSERT TABLE 1 HERE***

## 3. Results

### 3.1. Study and sample characteristics

Our search identified 123 studies with extractable data. The demographic and clinical characteristics of the studies can be found in Table 1 and the methodological characteristics can be found in Table 2.

***INSERT TABLE 2 HERE***

### 3.2. Overall effect size (ES)

The pooled ES for all the studies combined was r= -0.313 (k= 123; 95%CI [-0.346; -0.279]; z= -17.226; p< 0.001) which indicates a negative correlation of moderate strength. Not surprisingly, there was a significant amount of heterogeneity (Q[122]= 306.702; p< 0.001; $I^2$= 60.222; $\tau^2$= 0.022; SE= 0.006; var= 0.000; $\tau$= 0.147) likely due to both the clinical and methodological diversity across studies.

***INSERT FIGURE 2 HERE***

#### 3.2.1. Covariates

In order to test the stability of ES across time we ran a meta-regression using year of publication as the predicting variable and individual ES as the outcome variable. Overall, year of publication was found to be a significant predictor of the relationship between symptoms and socio-cognitive performance (β= 0.010; SE = 0.003; 95% CI [0.004; 0.016]; z= 3.34; p= 0.0008) suggesting that ES increased over time.

In order to test if the association between symptoms and social cognition was specific to phase of illness (i.e. state-dependent), we compared the strength of the ES across different patient groups. The analysis of studies that have tested inpatients yielded a correlation of -0.359 (k= 31; 95%CI [-0.419; -0.297]; z= -10.514; p< 0.001) with a significant level of heterogeneity (Q[30]= 44.344; p= 0.044; $I^2$= 32.347; $\tau^2$= 0.012; SE= 0.010; var= 0.000; τ= 0.109). The analysis for studies that tested outpatients yielded a smaller but nevertheless significant correlation, -0.260 (k= 55; 95%CI [-0.307; -0.213]; z= -10.350; p< 0.001) with a significant level of heterogeneity (Q[54]= 120.950; p< 0.001; $I^2$= 55.354; $\tau^2$= 0.017; SE= 0.007; var= 0.000; τ= 0.132). Finally, the analysis of studies that have tested mixed samples yielded a correlation of -0.353 (k= 37; 95%CI [-0.414; -0.289]; z= -10.121; p< 0.001) with again a significant level of heterogeneity (Q[36]= 122.079; p< 0.001; $I^2$= 70.511; $\tau^2$= 0.028; SE= 0.014; var= 0.000; τ= 0.168). Comparison between ES revealed that differences were statistically significant (Q[2] = 8.563; p= 0.014) with the ES for studies with both inpatients and mixed samples being significantly higher than ES for studies with outpatients.

Finally, we ran a meta-regression to test the impact of patient's age on the size of the ES between socio-cognitive performance and TD. Overall, age was not found to be a significant predictor of the ES (β= 0.005; SE = 0.003; 95% CI [−0.001; 0.011]; z= 1.80; p= 0.072).

### 3.2.2. Subgroup analyses by symptom

In order to calculate the ES for different symptom groups, we ran a subgroup analysis using a mixed effects model. The analysis of studies that used disorganisation or cognitive factors derived from scales such as the PANSS and the BPRS yielded a correlation of -0.323 (k= 76; 95%CI [-0.362; -0.282]; z= -14.638; p< 0.001) again with a significant level of heterogeneity (Q[75]= 205.002; p< 0.001; $I^2$= 63.415; $\tau^2$= 0.021; SE= 0.008; var= 0.000; $\tau$= 0.143).

A subsample of studies considered alogia (or poverty of speech). For these studies the calculation yielded a significant correlation of -0.300 (k= 26; 95% CI [-0.395; -0.198]; z= -5.584; p< 0.001) but again with a significant level of heterogeneity (Q[25]= 72.995; p< 0.001; $I^2$= 65.751; $\tau^2$= 0.048; SE= 0.023; var= 0.001; $\tau$ = 0.219).

Studies that calculated the ES for TD (including single items such as stereotyped thinking, difficulties with abstract thinking or incoherence of speech) yielded a correlation of -0.292 (k= 33; 95% CI [-0.350; -0.232]; z= -9.115; p< 0.001), also with a significant level of statistical heterogeneity (Q[32]= 47.530; p= 0.038; $I^2$= 32.675; $\tau^2$= 0.011; SE= 0.009; var= 0.000; $\tau$= 0.105).

In order to compare the ES for the different symptom groups (i.e. disorganisation factor, alogia, and TD), we ran a mixed effect analysis which revealed that differences between groups were not statistically significant (Q[2] = 0.758; p= 0.684).

Finally, we calculated the ES just for studies that had used TD-specific measures (e.g. TLC). These studies yielded a correlation of -0.351 (k=9; 95% CI [-0.479; -0.208]; z= -4.623; p< 0.001), this analysis revealed a non-significant level of statistical heterogeneity (Q[8]= 21.924; p= 0.005; $I^2$= 63.511; $\tau^2$= 0.033; SE= 0.028; var= 0.001; $\tau$= 0.183).

### 3.2.3. ToM

The pooled ES for the association between ToM and all symptoms combined was of moderate strength, -0.349 (k= 59; 95% CI [-0.396; -0.301]; z= -13.269; p< 0.001). This association revealed a considerable amount of statistical heterogeneity (Q[58]= 174.594; p< 0.001; $I^2$= 66.780; $\tau^2$= 0.025; SE= 0.010; var= 0.000; $\tau$= 0.158). We also analysed the data across symptom groups (online supplementary materials). ES for disorganisation, TD and alogia were all significant and of moderate strength with no significant difference across symptom-group. The analysis for studies that used TD-specific measures revealed a larger ES with a non-significant level of heterogeneity (online supplementary materials).

### 3.2.4. Social perception

The pooled ES for the association between social perception and symptoms was weaker, -0.188 (k= 17; 95%CI [-0.256; -0.117]; z= -5.158; p< 0.001). However, the analysis carried a non-significant amount of heterogeneity (Q[16]= 18.219 ; p= 0.311; $I^2$= 12.178; $\tau^2$= 0.003; SE= 0.008; var= 0.000; $\tau$ = 0.052). The analyses across symptom groups revealed a significant association between social perception and TD

(*r*= -0.259), a marginally significant and weak association with alogia, and non-significant ES for the association between social perception and disorganisation (online supplementary materials).

### 3.2.5. Emotion recognition

The relationship between emotion recognition and symptoms was of moderate strength, -0.334 (k= 53; 95%CI [-0.380; -0.286]; z= -12.842; p< 0.001). Again, this analysis revealed that there was a significant amount of statistical heterogeneity across studies (Q[52]= 112.138 ; p< 0.001; $I^2$= 53.629; $\tau^2$= 0.018; SE= 0.008; var= 0.000; $\tau$= 0.132). The analyses by symptom-group revealed significant and sizable ES for the individual association between emotion recognition and disorganisation, TD and alogia, especially with the latter (*r*= -0.397), although differences across the three ES were not significant (online supplementary materials).

### 3.2.6. Attributional biases

Only a small number of studies looked at attributional biases and the pooled ES was non-significant, -0.143 (k= 4; 95%CI [-0.347; 0.073]; z= -1.298; p= 0.194). Not surprisingly, this analysis revealed a very low amount of heterogeneity (Q[3]= 5.890; p= 0.117; $I^2$= 49.067; $\tau^2$= 0.024; SE= 0.040; var= 0.002; $\tau$= 0.154). The analyses by symptom group revealed a significant association only between attributional biases and disorganisation but there were no significant associations for TD or alogia (online supplementary materials).

### 3.2.7. Emotion processing and regulation

The analysis of the strength of association between emotion processing and regulation and symptoms was significant but weak, -0.169 (k= 14; 95%CI [-0.243; -0.092]; z= -4.287; p< 0.001) with a non-significant level of heterogeneity (Q[13]= 14.532; p= 0.337; $I^2$= 10.540; $\tau^2$= 0.002; SE= 0.009; var= 0.000; $\tau$= 0.048). The analyses by symptom-group revealed significant associations between emotion processing difficulties and both TD and disorganisation but not alogia (online supplementary materials).

### 3.3. Publication bias

Visual inspection of the scatterplot for the analysis including all of the studies (online supplementary materials) revealed some degree of asymmetry suggestive of publication bias. In order to test the dataset, we used the following tests: (1) Begg and Mazumdar's rank order correlation; (2) Egger's regression intercept; and, (3) Duval and Tweedie's "trim and fill" procedure.

Begg and Mazumdar's rank correlation [63] yielded a significant Kendall's $\tau$ of -0.235 (z= 3.854; p< 0.001) suggestive of publication bias. Consistent with this, the Egger's test [64] also yielded a significant intercept of -1.498 (SE= 0.275; 95% CI [−2.042; -0.955]; t[121]= 5.458; p< 0.001) supporting the existence of bias. Finally, Duval and Tweedie's (2000) "trim and fill" procedure identified 35 potential missing studies (to the right of the mean). The recomputed point estimate, using random effects model, was -0.228 (95% CI [-0.265; -0.191]) suggesting that even after adjustment the estimate was significant and sizable.

## 4. Discussion

The overall pooled ES suggests a significant and moderate association between poor performance on socio-cognitive tasks and severity of disorganised symptoms in patients diagnosed with schizophrenia-spectrum disorders. More importantly, sub-analyses by symptom groups showed that correlations were sizable and significant for TD, alogia and disorganised symptoms, with no significant differences between the three symptom groups. However, it is important to point out that we found a considerable amount of statistical heterogeneity. In part, this is not unexpected given the methodological diversity in the assessments of both social cognition (e.g. emotion recognition tasks that tap into different sensory modalities or ToM tasks with different levels of complexity) and symptoms (some studies measured disorganisation with an assessment of general psychopathology, e.g. PANSS and others measured TD with specific scales, e.g. TLC). Moreover, there are considerable discrepancies across the conceptual frameworks that underlie the different TD measures. [66–68] Different measures rely on different ratings, scoring systems, or methodologies to elicit speech samples (e.g. proverb interpretation, clinical interview, etc.), [31,69] and have different clinical, cognitive, and neuroanatomical correlates. [59,70–73] Hence, caution is required when interpreting these findings.

One of the few analyses that did not reveal significant heterogeneity was the relationship between TD and social cognition, especially in the case of the ES calculated for studies that used TD-specific measures. A possible explanation is that these studies used specific symptom measures instead of general psychopathology scales, which often only have limited items to measure cognitive disorganisation or

TD (e.g. PANSS or the SAPS) and which may also include non-TD related items. Given that TD is a heterogeneous construct, [29] it is not surprising that heterogeneity was greater when more general psychopathology measures were used. In other words, the more robust the TD measure, the stronger and clearer the overall effect.

Another finding that might speak to the issue of statistical heterogeneity is the association between year of publication and ES. Our meta-regression suggested a linear and significant relationship between these two variables, with ES increasing with time. It is possible that the emergence of dominant theories about the role of social cognition in schizophrenia-spectrum disorders has inadvertently led to a publication bias towards "positive" findings in the field. This explanation is consistent with the results of our Begg and Mazumdar's rank correlation and the Egger's test which were consistent with the presence of publication bias, and with the "trim and fill" procedure which identified 35 potentially missing studies. However, recalculation of the point estimate after adjustment for missing studies, revealed an ES that was sizable and significant, so it seems unlikely that missing data would be sufficient to nullify the main findings.

Interestingly, the analysis by age of participants turned out to be non-significant, suggesting that the relationship between social cognition and TD is relatively stable across different age groups. In contrast, the sub-group analyses by patient status revealed that ES were significantly greater in studies that have tested inpatient samples. Although, there is evidence suggesting that both social cognitive difficulties, [74] and TD [20] are not specifically characteristic of patients diagnosed with schizophrenia-spectrum disorders (they can be found in other diagnostic groups), it is likely that both TD and poor social cognition become more salient during periods of psychotic crisis when patients are highly distressed. For example, it is a well-

established finding that TD worsens when patients are asked to talk about personally and emotionally salient topics, a phenomenon known as the affective reactivity of speech effect. [75,76] It follows that if social cognition is important in TD, then the relationship may well be more evident during an acute inpatient admission.

A second set of analyses concerned the ES across the different socio-cognitive domains. As expected on the basis of socio-cognitive theories of TD and disorganisation, [3,6] a strong association was found between poorer performance on ToM tasks and all symptom groups. We also found an equally sizable and significant association between poor emotion recognition and symptoms. This is not unexpected given that some ToM tasks (e.g. "Reading the mind in the eyes" test) are based on emotion recognition. However, it is interesting to note that most robust association was with alogia. In the case of social perception and emotion processing tasks, although effects were evident, they were much weaker with former being particularly associated with positive forms of TD as opposed to alogia. Regarding the weak associations with emotion processing, this is somehow unexpected given the well reported finding that TD worsens with negative affect. [75] Finally, the moderate association between attributional biases and disorganisation should be interpreted with caution given that there were only two studies included in the analysis. We are aware of no theoretical model that predicts these patterns of association but it is worth noting that some of these domains do not necessarily have absolute and categorical boundaries and may overlap greatly.

There are good theoretical reasons for expecting a relationship between TD and poor social cognition. As mentioned earlier, Frith [3] suggested that communication difficulties in patients (i.e. TD) could be partly explained by their inability to infer the state of knowledge of the listener. This is consistent with studies that have found that,

when patients with TD are provided with the opportunity to explain their perspective and contextualise their communications, their verbalisations no longer sound bizarre or 'disordered'. [77] Hence, it seems reasonable to propose that difficulties at the level of social cognition (e.g. delayed activation of the fronto-temporal-parietal areas that support mentalisation), [78] may render the patient unable to repair or readjust communication when unprompted, because of difficulties in timely detecting subtle and dynamic emotional and social cues from the interlocutor.

The establishment of conversational alignment, [79] or grounding [80] in communication or dialog is dependent on the early, automatic, and timely processing and monitoring of partner-specific information (e.g. verbal and non-verbal paralinguistic cues and signals). This process helps the addressee disambiguate language and the speaker adjust communication to the needs of the addressee, enabling the incremental shared understanding between interlocutors (as dialog unfolds) and leading to more effective and efficient communication over time. According to Brennan and colleagues:

> "(…) dialog can be viewed as a highly coordinated hypothesis-testing activity that individuals engage in together, where one partner's presentation (their hypothesis of what their partner will understand) plays a dual role by providing the other person with evidence of how the previous utterance has been understood." [80 (p316)]

A person who cannot disambiguate the question of the interviewer, or cannot infer the state of knowledge of the listener, is more likely to answer questions in an egocentric or tangential way, by *intermingling*, interweaving or blending in decontextualised concerns and worries into the context of the conversation, [81] thereby making communications sound idiosyncratic or even bizarre. This account is consistent with findings from studies that have reported that patients who display TD have significant difficulties disambiguating and processing linguistic and conversational context. [82]

One important point to acknowledge at this stage is that the ability to infer other peoples' mental and emotional states may not be independent from the ability to reflect and understand one's own mental state (i.e. self-reflection or meta-awareness). For example, one study showed that gains in self-reflection predicted improvements in social cognition and, more specifically, the patient's ability to infer the mental or emotional states of others. [83] Some authors have hypothesised that TD patients have difficulties synthesising and making sense of their own cognitive experiences (resulting in "cacophonous selves") [84] and, consistent with this idea, two studies have reported that patients with disorganised symptoms are significantly impaired in both self-reflexivity and social cognition. [85,86] There is also evidence that patients diagnosed with schizophrenia-spectrum disorders have difficulties recalling autobiographical memories [87] (which may be necessary when making sense of others through analogical reasoning). [88,89] So it is plausible that difficulties with self-reflection or meta-awareness may underlie both poor mentalising and TD. However, the relationship between poor self-reflection and other domains of social cognition also associated with TD would be more difficult to explain.

Another possible interpretation is that symptoms of disorganisation may have a detrimental impact on both the patient's ability to reason about their own and other peoples' mental states. For example, Minor and colleagues reported that symptoms of disorganisation moderated the relationship between neurocognition and both social cognition and self-reflexivity in patients diagnosed with schizophrenia-spectrum disorders. [90,91] However, such interpretation does not explain why TD patients fail to see their verbalisation as bizarre and idiosyncratic while at the same time they are able to successfully judge the verbalisation of other TD patients as anomalous. [45]

One of the limitations of the present meta-analysis is that the calculated strength of the associations between domains of social cognition and symptoms did not account for symptom comorbidity. This is important because difficulties with ToM have been reported to be significantly associated with negative symptoms and persecutory delusions.[5] In future studies, it will be important to establish the strength of the association between domains of social cognition and TD after accounting for other psychotic experiences especially negative symptoms, given its association with both poor mentalisation and dysfunctional mirror neuron activity. [92] Moreover, it might be suggested that the strength of the ES could just reflect general "severity of illness" or more general cognitive difficulties. However, if this was case, then one would expect the correlations with social perception, emotion regulation and attributional biases to be equally sizable, which they were not. Another limitation of the review is the overrepresentation of men in the study samples. Few studies have attempted to control or account for sex-differences, so it is possible that some of these difficulties are to some extent sex-specific.

Finally, social cognition is only one piece in the puzzle of TD other psychological mechanisms have been shown to be involved in these cluster of

experiences. For example, we have reported previously that difficulties in *internal* source monitoring (ability to correctly discriminate whether self-generated cognitions were verbalised or just thought) [93] coupled with negative affect are important to explain exacerbation of TD during emotional challenge, [75] and that poverty of speech seems to be specifically associated with impoverished inner speech (especially dialogical inner speech). [35] Finally, how these mechanisms relate to important social predictors of TD remains a matter of speculation. Some authors have suggested that difficulties recognising and reasoning about mental states in patients diagnosed with schizophrenia-spectrum disorders could be a consequence of early experiences such as poor early attachments relationship, childhood trauma, or isolation, [94] factors that have been found to be associated with TD. [38,95–97] For example, a recent study showed that poor ToM mediated the relationship between insecure attachment and emerging psychotic symptoms. [98] In future studies, it will be important to examine the relationships between social predictors and socio-cognitive processes in TD using more complex psychosocial models.

It may also be fruitful to test if existent social cognitive training packages have an impact on TD (e.g. social cognition enhancement training). [99] A published meta-analysis of social cognitive training in schizophrenia-spectrum disorders reported significant and sizable ES on both ToM and facial affect recognition and identification. [100] The ES for psychotic symptoms for this kind of intervention have been modest, but given the findings of the current meta-analysis, it would be pertinent to trial social cognitive packages that focus on both emotion recognition and perspective taking in communication on patients with persistent TD. This is important given the known association between TD and poorer quality of life, relapse, and poorer occupational and social functioning.

## Declaration of interests

None.

## Contributors

P. Sousa, W. Sellwood, and R. Bentall were responsible for study concept and design. P. Sousa carried out the systematic search, statistical analyses and the interpretation of the findings (under the supervision of W. Sellwood and R. Bentall). P. Sousa was responsible for drafting the manuscript and W. Sellwood, M. Griffiths, and R. Bentall for the critical revision. All authors accepted the final version.

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Title: **Disorganisation and thought disorder and socio-cognitive functioning in schizophrenia-spectrum disorders: A meta-analysis.**

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**Key words:** schizophrenia; social cognition; theory-of-mind; emotion recognition; social perception; emotion processing.

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**ABSTRACT**

Background: Poor social cognition is prevalent in schizophrenia-spectrum disorders. Some authors argue that these effects are symptom-specific and that socio-cognitive difficulties (e.g. Theory-of-Mind) are strongly associated with thought disorder (TD) and symptoms of disorganisation. Aims: The current review tests the strength of this association. Method: We meta-analysed studies published between 1980 and 2016 that tested the association between social cognition and these symptoms in schizophrenia-spectrum disorders. Results: Our search (PsycINFO, MEDLINE and Web of Science) identified 123 studies (N= 9107). Overall effect-size (ES) was r= -0.313, indicating a moderate association between symptoms and social cognition. Sub-analyses yielded a moderate association between symptoms and ToM (r= -0.349), emotion recognition (r= -0.334) but smaller ES for social perception (r= -0.188), emotion regulation (r= -0.169) and attributional biases (r= -0.143). Conclusions: The association is interpreted within models of communication that highlight the importance of mentalisation and processing of partner-specific cues in conversational alignment and grounding.

> "No matter how one may try, one cannot not communicate"
>
> Watzlawick, Bavelas, and Jackson [1(p48)]

## 1. Background

Researchers in the field of psychosis have long been interested in the role of social cognition in psychotic experiences. [2,3] Consequently, there is now a wealth of meta-analytical evidence showing that deficits in theory-of-mind (ToM; the ability to infer mental states in others), social perception, and emotion recognition are highly prevalent in individuals with schizophrenia-spectrum diagnoses. [4,5] Some researchers have suggested that impairments in social cognition play a specific role in disorganised symptoms in schizophrenia-spectrum disorders, especially thought disorder (TD). [3,6] Here we report a statistical synthesis of the evidence on the association between domains of social cognition and TD and other symptoms of disorganisation in participants diagnosed with schizophrenia-spectrum disorders.

### 1.1 Socio-cognitive domains

An NIMH workshop defined social cognition as a set of:

> "(The) mental operations that underlie social interactions, including perceiving, interpreting, and generating responses to the intentions, dispositions, and behaviors of others".
>
> Green et al. [7 (p1211)]

Hence, social cognition is a multi-faceted construct, referring to a broad range of higher-level inferential, attributional and regulatory processes, as well as lower-level social cue perception and processing. The consensus is that these processes comprise four core domains, namely: ToM and mental state attribution, social perception, attributional style or biases, and emotion processing. [8] Some have distinguished a fifth domain referred to as emotion recognition. This encompasses lower-level emotional cue perception and identification (see supplementary materials for definition of domains and examples of tasks).

### 1.1.1. ToM and mental state attribution

ToM (or mental state attribution) refers to the ability of the individual to infer intentions, dispositions and beliefs in others from their speech, actions and/or non-verbal behaviour. [3,9] Relevant assessment tasks may involve reading short passages, describing social interactions, where intentions of the characters are inferred from hints or indirect speech acts (e.g. Hinting task). [2] Alternatively, participants may be asked to sequence picture-card stories that require the correct inference of false beliefs in order to understand the story plot (e.g. Picture-Sequencing Task). [10]

### 1.1.2. Social perception

Social perception refers to the ability to decode and interpret social cues (verbal and non-verbal) in an interpersonal situation. This involves both the correct interpretation of cues in a social context but also the processing of social knowledge (i.e. the ability to utilise roles, rules and goals in a social situation and the knowledge of how they

affect other people's behaviours). In some tasks, participants are presented with social situations followed by multiple-choice questions that test their ability to interpret cues about social roles and rules (e.g. Interpersonal Perception Task). [11] Alternatively, tasks may involve the presentation of short audio and video clips that test the accurate interpretation of body postures, gestures, facial expressions or voice cues (e.g. Profile of Non-verbal Sensitivity). [12]

### 1.1.3. Emotion recognition

Emotion recognition refers to the ability to identify human emotion from a range of stimuli and cues such as facial expressions or tone of voice. Emotion recognition tasks may involve the ability to correctly identify different emotional states from video clips of an actor performing facial, vocal-tonal and upper-body movement cues (e.g. Bell-Lysaker Emotion Recognition Task) [13] or the identification of different emotional states from the tone of voice of audio-taped speakers reading out loud sentences of neutral content (e.g. Voice Emotion Identification Test). [14]

### 1.1.4. Attributional bias/style

Attributional bias refers to quick causal inferences that individuals make about positive and negative social events. These inferences (or attributions) are typically classified as external (i.e. the cause is attributed to others) or internal (i.e. cause is attributed to self). Sometimes, external attributions may be classified as personal (i.e. cause is the actions of another person) or situational (i.e. cause is attributed to situational factors). Tasks involve asking the participants to imagine themselves in a

positive or negative social situation and to report the most likely causal explanation for an event. Example measures include the Attributional Style Questionnaire [15] and the Internal, Personal, and Situational Attributions Questionnaire. [16]

### 1.1.5. Emotion processing and regulation

Emotion processing refers to skills that range from the perception of emotion to the understanding and management (regulation) of emotions. Although, some of these skills overlap with the competencies involved in emotion recognition the construct is broader and encompasses affective regulatory strategies. The assessment of emotional processing can involve questionnaire measures (e.g. Emotion Regulation Questionnaire) [17] or tasks where the participant is asked to rate brief vignettes that tap into the management, regulation or facilitation of emotions (e.g. Mayer-Salovey-Caruso Emotional Intelligence Test). [18]

## 1.2. Thought disorder and cognitive disorganisation

TD refers to range of thinking, linguistic and communication atypicalities that render the speech and communication of some individuals difficult to follow and apparently unintelligible. [19] These symptoms are a relatively enduring feature in psychotic patients [20] and have been associated with poorer quality of life, [21] higher rates of readmissions, [22] and poorer occupational and social functioning. [23,24] Perhaps more importantly, TD in psychotic patients has been associated with poor therapeutic alliance, [25] a core process in cognitive behavioural therapy for psychosis. [26] Despite a considerable amount of research in the field, the processes and mechanisms involved

in TD are still unclear. [27,28] However, such knowledge may be important for the development of effective psychological treatments for TD.

Some authors have argued that no single mechanism will ever be able to explain the full range of symptoms of TD because it is highly heterogeneous cluster of experiences and behaviours. [27] Although, there is no final word regarding the number of factors involved in TD, [29] it is clear that a distinction can be made between an impoverished speech factor, that includes symptoms such as alogia (or poverty of speech), and a disorganisation factor, which includes symptoms such as derailment, tangentiality, or incoherence. [30] This dichotomy has also been referred to as negative and positive TD. TD assessment scales such as the Scale for the Assessment of Thought, Language and Communication Disorders (TLC), [31] or the Thought Language Index (TLI), [32] distinguish between poverty of speech and disorganisation items and such differentiation has been further supported by factor analytical studies [33] and studies on the psychological mechanisms of both positive and negative TD. [34,35]

Many studies have used measurements using general psychopathology scales (e.g. Positive and Negative Syndrome Scale [36] or the Brief Psychiatric Rating Scale [37]) to test hypotheses about the mechanisms involved in TD. These include single ratings of conceptual disorganisation or symptom factors. The single ratings are highly correlated with more extensive measures of TD [38] and they capture symptoms of disorganisation such as derailment, incoherence, or illogicality (i.e. positive TD) but not symptoms of cognitive impoverishment such as alogia or poverty of speech. The symptom factors, which are derived from factor analysis and are typically labelled in the literature as ‘disorganisation’ or ‘cognitive’ factors, seem to form an orthogonal cluster of experiences distinct from positive and negative symptoms in schizophrenia-spectrum disorders. [39] They are highly associated with positive TD but

not alogia or poverty of speech. [40] A further problem is that they tend to encompass variance from PANSS items such as tension, inappropriate affect, or mannerisms and posturing, experiences that would not normally fall under the category of TD. [41]

For the conceptual and methodological reasons outlined above we felt that it was important that our analytical strategy distinguished between nuanced constructs, which code different and at times distinct phenomena.

### 1.3. Social cognition, TD and cognitive disorganisation

One study has suggested that TD patients might be aware of their communication difficulties. [42] However, some studies have reported some inconsistency between patient-reported TD and clinician-rated TD [43,44] and others have reported that patients seem to be unaware that their verbalisations are idiosyncratic and difficult to follow, despite being able to successfully judge other TD patients' verbalisations as bizarre and atypical. [45] This apparent inability to shift perspective, repair communication, and cooperatively adjust the message to the needs (and level of knowledge) of the listener is crucial when communication goes awry [46] and has been highlighted by several authors as a crucial feature in TD. For example, Frith [3] suggested that difficulties inferring the state of knowledge, intentions, and beliefs of an interlocutor, together with difficulties in interpreting the interlocutor's social signals, could prevent repair when communication fails, thereby leading to speech being perceived by the interlocutor as tangential or derailed. Similarly, Hardy-Baylé and colleagues [6] suggested that symptoms of disorganisation in patients diagnosed with schizophrenia-spectrum disorders could be explained by difficulties in representing other peoples' mental states and integrating contextual information during

conversations. These hypotheses have been partially supported in a review [47] and a meta-analysis[5] of the literature on ToM in patients diagnosed with schizophrenia-spectrum disorders but difficulties with ToM do not occur in isolation from other kinds of deficits [48] and it is therefore likely that other domains of social cognition may also be important in TD.

For example, Toomey and colleague found significant associations between poor social perception and symptoms of disorganisation in patients [49] and Kee and colleagues found significant associations between disorganization and poor emotion recognition. [50] It is not difficult to offer interpretations of these findings. For example, *stilted speech* (pedantic speech that is excessively formal and inappropriate for the context of the conversation) [31] could be partially explained by poor social perception (speaking with excessive formality when the social context requires a more informal style). Although hypotheses such as this are speculative at the present time, they highlight the value of exploring a wide range of domains of social cognition in relation to TD and disorganisation.

### 1.4. Study aim

The aim of the current review was to quantify the strength of the association between different domains of social cognition and TD, disorganisation and alogia in schizophrenia-spectrum disorders.

## 2. Method

The present review was carried out in adherence to the Meta-Analysis of Observational Studies in Epidemiology (MOOSE) guidelines [51] and the general principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for reporting systematic reviews and meta-analyses. [52]

## 2.1. Literature search

After initial scoping searches, three electronic databases (PsycINFO, MEDLINE and Web of Science) were searched for papers published between 1980 and 2016 using the following search terms: social cognition OR theory of mind OR theory-of-mind OR mentali$ation OR mental state attribution OR affect* OR emotion* (recognition or identification or regulation or management or processing or perception) social perception OR social knowledge OR attribution* (bias* or style) AND schizophreni* OR psychos* AND formal thought disorder OR thought dis* OR thinking dis* OR disorgani* OR conceptual dis* OR cognitive dis* OR communication dis*. The three searches yielded a total of 3,077 records (Figure 1).

***INSERT FIGURE 1 HERE***

## 2.2. Study selection

The inclusion criteria were: (1) the study was published in English language; (2) the paper was fully accessible; (3) the study was published in a peer-reviewed journal; (4) the sample was composed of patients diagnosed with schizophrenia-spectrum

disorders; (5) a clear TD or disorganisation measure could be identified; (6) a socio-cognitive measure could be identified; and (6) statistical data were available for extraction.

Although TD is a transdiagnostic phenomenon that can be observed in different mental health conditions, [27] we have opted to exclude studies with patients with other diagnoses (e.g. Bipolar Affective Disorder) as there is significant differences across diagnoses on course, quality, and temporal stability of these experiences. [53–55]

### 2.3. Symptom grouping strategy

In order to test the impact of different symptoms on social cognition, we organised the effect-sizes (ES) in three different symptom groups: disorganisation (factor), alogia (poverty of speech) and thought disorder (TD). The first group included ES from studies where researchers calculated the association between social cognition and a symptom factor (e.g. 'disorganisation factor' or 'cognitive factor') derived from clinical symptom scale (e.g. PANSS or BPRS). These factors were likely to include variance from symptoms that despite being statistically associated with TD, do not represent what would normally be assumed to fall under remit of the construct (e.g. tension, mannerisms and posturing). [56] The second group (alogia) included ES from studies where extractable data for the association between social cognition and a single item for alogia or poverty of speech was provided. These were almost always clinical symptom scales such as the SANS. [57] Finally, our third group (thought disorder) included data from studies where ES was calculated from a TD-specific scale score (e.g. TLC [58] or Bizarre Idiosyncratic Thinking Scale [59]) or from a single-

item (other than alogia or poverty of speech) from a clinical rating scale (e.g. PANSS stereotyped thinking or conceptual disorganisation [60,61]). In these cases, we opted to maintain the original designation used by the authors in Table 2. Included in this symptom group were also ES that had been estimated from clinical symptom scales that have specific TD subscales (e.g. SAPS [62]). The analyses of this group will include a ES for the group as whole and then a second estimate for studies that have used only TD-specific measures (without the scores from single-item clinical rating scales). The reason for this is to understand the strength of the estimate when TD is measure with robust (multi-item) and purposely designed measures.

### 2.4. Statistical analysis

Statistical analysis was carried out with CMA© (Comprehensive Meta-Analysis). Overall ES was estimated using Pearson's correlation coefficient (r) and random effects analysis given the likelihood that our analysis would carry a substantial amount of variation across studies. In studies with multiple socio-cognitive scores within the same domain, ES was computed from the average across tasks so that overall ES could be computed from a single estimate by study.

Heterogeneity was measured with $\tau^2$, Q and with $I^2$ and sensitivity analysis was carried out with group comparisons and meta-regression. Publication bias was tested by the visual inspection of the funnel plot, Begg and Mazumdar's rank order correlation, Egger's regression intercept, and Duval and Tweedie's "trim and fill" procedure.

***INSERT TABLE 1 HERE***

## 3. Results

### 3.1. Study and sample characteristics

Our search identified 123 studies with extractable data. The demographic and clinical characteristics of the studies can be found in Table 1 and the methodological characteristics can be found in Table 2.

***INSERT TABLE 2 HERE***

### 3.2. Overall effect size (ES)

The pooled ES for all the studies combined was r= -0.313 (k= 123; 95%CI [-0.346; -0.279]; z= -17.226; p< 0.001) which indicates a negative correlation of moderate strength. Not surprisingly, there was a significant amount of heterogeneity (Q[122]= 306.702; p< 0.001; $I^2$= 60.222; $\tau^2$= 0.022; SE= 0.006; var= 0.000; $\tau$= 0.147) likely due to both the clinical and methodological diversity across studies.

***INSERT FIGURE 2 HERE***

#### 3.2.1. Covariates

In order to test the stability of ES across time we ran a meta-regression using year of publication as the predicting variable and individual ES as the outcome variable. Overall, year of publication was found to be a significant predictor of the relationship between symptoms and socio-cognitive performance (β= 0.010; SE = 0.003; 95% CI [0.004; 0.016]; z= 3.34; p= 0.0008) suggesting that ES increased over time.

In order to test if the association between symptoms and social cognition was specific to phase of illness (i.e. state-dependent), we compared the strength of the ES across different patient groups. The analysis of studies that have tested inpatients yielded a correlation of -0.359 (k= 31; 95%CI [-0.419; -0.297]; z= -10.514; p< 0.001) with a significant level of heterogeneity (Q[30]= 44.344; p= 0.044; $I^2$= 32.347; $\tau^2$= 0.012; SE= 0.010; var= 0.000; τ= 0.109). The analysis for studies that tested outpatients yielded a smaller but nevertheless significant correlation, -0.260 (k= 55; 95%CI [-0.307; -0.213]; z= -10.350; p< 0.001) with a significant level of heterogeneity (Q[54]= 120.950; p< 0.001; $I^2$= 55.354; $\tau^2$= 0.017; SE= 0.007; var= 0.000; τ= 0.132). Finally, the analysis of studies that have tested mixed samples yielded a correlation of -0.353 (k= 37; 95%CI [-0.414; -0.289]; z= -10.121; p< 0.001) with again a significant level of heterogeneity (Q[36]= 122.079; p< 0.001; $I^2$= 70.511; $\tau^2$= 0.028; SE= 0.014; var= 0.000; τ= 0.168). Comparison between ES revealed that differences were statistically significant (Q[2] = 8.563; p= 0.014) with the ES for studies with both inpatients and mixed samples being significantly higher than ES for studies with outpatients.

Finally, we ran a meta-regression to test the impact of patient's age on the size of the ES between socio-cognitive performance and TD. Overall, age was not found to be a significant predictor of the ES (β= 0.005; SE = 0.003; 95% CI [−0.001; 0.011]; z= 1.80; p= 0.072).

### 3.2.2. Subgroup analyses by symptom

In order to calculate the ES for different symptom groups, we ran a subgroup analysis using a mixed effects model. The analysis of studies that used disorganisation or cognitive factors derived from scales such as the PANSS and the BPRS yielded a correlation of -0.323 (k= 76; 95%CI [-0.362; -0.282]; z= -14.638; p< 0.001) again with a significant level of heterogeneity (Q[75]= 205.002; p< 0.001; $I^2$= 63.415; $\tau^2$= 0.021; SE= 0.008; var= 0.000; $\tau$= 0.143).

A subsample of studies considered alogia (or poverty of speech). For these studies the calculation yielded a significant correlation of -0.300 (k= 26; 95% CI [-0.395; -0.198]; z= -5.584; p< 0.001) but again with a significant level of heterogeneity (Q[25]= 72.995; p< 0.001; $I^2$= 65.751; $\tau^2$= 0.048; SE= 0.023; var= 0.001; $\tau$ = 0.219).

Studies that calculated the ES for TD (including single items such as stereotyped thinking, difficulties with abstract thinking or incoherence of speech) yielded a correlation of -0.292 (k= 33; 95% CI [-0.350; -0.232]; z= -9.115; p< 0.001), also with a significant level of statistical heterogeneity (Q[32]= 47.530; p= 0.038; $I^2$= 32.675; $\tau^2$= 0.011; SE= 0.009; var= 0.000; $\tau$= 0.105).

In order to compare the ES for the different symptom groups (i.e. disorganisation factor, alogia, and TD), we ran a mixed effect analysis which revealed that differences between groups were not statistically significant (Q[2] = 0.758; p= 0.684).

Finally, we calculated the ES just for studies that had used TD-specific measures (e.g. TLC). These studies yielded a correlation of -0.351 (k=9; 95% CI [-0.479; -0.208]; z= -4.623; p< 0.001), this analysis revealed a non-significant level of statistical heterogeneity (Q[8]= 21.924; p= 0.005; $I^2$= 63.511; $\tau^2$= 0.033; SE= 0.028; var= 0.001; $\tau$= 0.183).

### 3.2.3. ToM

The pooled ES for the association between ToM and all symptoms combined was of moderate strength, -0.349 (k= 59; 95% CI [-0.396; -0.301]; z= -13.269; p< 0.001). This association revealed a considerable amount of statistical heterogeneity (Q[58]= 174.594; p< 0.001; $I^2$= 66.780; $\tau^2$= 0.025; SE= 0.010; var= 0.000; $\tau$= 0.158). We also analysed the data across symptom groups (online supplementary materials). ES for disorganisation, TD and alogia were all significant and of moderate strength with no significant difference across symptom-group. The analysis for studies that used TD-specific measures revealed a larger ES with a non-significant level of heterogeneity (online supplementary materials).

### 3.2.4. Social perception

The pooled ES for the association between social perception and symptoms was weaker, -0.188 (k= 17; 95%CI [-0.256; -0.117]; z= -5.158; p< 0.001). However, the analysis carried a non-significant amount of heterogeneity (Q[16]= 18.219 ; p= 0.311; $I^2$= 12.178; $\tau^2$= 0.003; SE= 0.008; var= 0.000; $\tau$ = 0.052). The analyses across symptom groups revealed a significant association between social perception and TD

(*r*= -0.259), a marginally significant and weak association with alogia, and non-significant ES for the association between social perception and disorganisation (online supplementary materials).

### 3.2.5. Emotion recognition

The relationship between emotion recognition and symptoms was of moderate strength, -0.334 (k= 53; 95%CI [-0.380; -0.286]; z= -12.842; p< 0.001). Again, this analysis revealed that there was a significant amount of statistical heterogeneity across studies (Q[52]= 112.138 ; p< 0.001; $I^2$= 53.629; $\tau^2$= 0.018; SE= 0.008; var= 0.000; $\tau$= 0.132). The analyses by symptom-group revealed significant and sizable ES for the individual association between emotion recognition and disorganisation, TD and alogia, especially with the latter (*r*= -0.397), although differences across the three ES were not significant (online supplementary materials).

### 3.2.6. Attributional biases

Only a small number of studies looked at attributional biases and the pooled ES was non-significant, -0.143 (k= 4; 95%CI [-0.347; 0.073]; z= -1.298; p= 0.194). Not surprisingly, this analysis revealed a very low amount of heterogeneity (Q[3]= 5.890; p= 0.117; $I^2$= 49.067; $\tau^2$= 0.024; SE= 0.040; var= 0.002; $\tau$= 0.154). The analyses by symptom group revealed a significant association only between attributional biases and disorganisation but there were no significant associations for TD or alogia (online supplementary materials).

### 3.2.7. Emotion processing and regulation

The analysis of the strength of association between emotion processing and regulation and symptoms was significant but weak, -0.169 (k= 14; 95%CI [-0.243; -0.092]; z= -4.287; p< 0.001) with a non-significant level of heterogeneity (Q[13]= 14.532; p= 0.337; $I^2$= 10.540; $\tau^2$= 0.002; SE= 0.009; var= 0.000; $\tau$= 0.048). The analyses by symptom-group revealed significant associations between emotion processing difficulties and both TD and disorganisation but not alogia (online supplementary materials).

### 3.3. Publication bias

Visual inspection of the scatterplot for the analysis including all of the studies (online supplementary materials) revealed some degree of asymmetry suggestive of publication bias. In order to test the dataset, we used the following tests: (1) Begg and Mazumdar's rank order correlation; (2) Egger's regression intercept; and, (3) Duval and Tweedie's "trim and fill" procedure.

Begg and Mazumdar's rank correlation [63] yielded a significant Kendall's $\tau$ of -0.235 (z= 3.854; p< 0.001) suggestive of publication bias. Consistent with this, the Egger's test [64] also yielded a significant intercept of -1.498 (SE= 0.275; 95% CI [−2.042; -0.955]; t[121]= 5.458; p< 0.001) supporting the existence of bias. Finally, Duval and Tweedie's (2000) "trim and fill" procedure identified 35 potential missing studies (to the right of the mean). The recomputed point estimate, using random effects model, was -0.228 (95% CI [-0.265; -0.191]) suggesting that even after adjustment the estimate was significant and sizable.

## 4. Discussion

The overall pooled ES suggests a significant and moderate association between poor performance on socio-cognitive tasks and severity of disorganised symptoms in patients diagnosed with schizophrenia-spectrum disorders. More importantly, sub-analyses by symptom groups showed that correlations were sizable and significant for TD, alogia and disorganised symptoms, with no significant differences between the three symptom groups. However, it is important to point out that we found a considerable amount of statistical heterogeneity. In part, this is not unexpected given the methodological diversity in the assessments of both social cognition (e.g. emotion recognition tasks that tap into different sensory modalities or ToM tasks with different levels of complexity) and symptoms (some studies measured disorganisation with an assessment of general psychopathology, e.g. PANSS and others measured TD with specific scales, e.g. TLC). Moreover, there are considerable discrepancies across the conceptual frameworks that underlie the different TD measures. [66–68] Different measures rely on different ratings, scoring systems, or methodologies to elicit speech samples (e.g. proverb interpretation, clinical interview, etc.), [31,69] and have different clinical, cognitive, and neuroanatomical correlates. [59,70–73] Hence, caution is required when interpreting these findings.

One of the few analyses that did not reveal significant heterogeneity was the relationship between TD and social cognition, especially in the case of the ES calculated for studies that used TD-specific measures. A possible explanation is that these studies used specific symptom measures instead of general psychopathology scales, which often only have limited items to measure cognitive disorganisation or

TD (e.g. PANSS or the SAPS) and which may also include non-TD related items. Given that TD is a heterogeneous construct, [29] it is not surprising that heterogeneity was greater when more general psychopathology measures were used. In other words, the more robust the TD measure, the stronger and clearer the overall effect.

Another finding that might speak to the issue of statistical heterogeneity is the association between year of publication and ES. Our meta-regression suggested a linear and significant relationship between these two variables, with ES increasing with time. It is possible that the emergence of dominant theories about the role of social cognition in schizophrenia-spectrum disorders has inadvertently led to a publication bias towards "positive" findings in the field. This explanation is consistent with the results of our Begg and Mazumdar's rank correlation and the Egger's test which were consistent with the presence of publication bias, and with the "trim and fill" procedure which identified 35 potentially missing studies. However, recalculation of the point estimate after adjustment for missing studies, revealed an ES that was sizable and significant, so it seems unlikely that missing data would be sufficient to nullify the main findings.

Interestingly, the analysis by age of participants turned out to be non-significant, suggesting that the relationship between social cognition and TD is relatively stable across different age groups. In contrast, the sub-group analyses by patient status revealed that ES were significantly greater in studies that have tested inpatient samples. Although, there is evidence suggesting that both social cognitive difficulties, [74] and TD [20] are not specifically characteristic of patients diagnosed with schizophrenia-spectrum disorders (they can be found in other diagnostic groups), it is likely that both TD and poor social cognition become more salient during periods of psychotic crisis when patients are highly distressed. For example, it is a well-

established finding that TD worsens when patients are asked to talk about personally and emotionally salient topics, a phenomenon known as the affective reactivity of speech effect. [75,76] It follows that if social cognition is important in TD, then the relationship may well be more evident during an acute inpatient admission.

A second set of analyses concerned the ES across the different socio-cognitive domains. As expected on the basis of socio-cognitive theories of TD and disorganisation, [3,6] a strong association was found between poorer performance on ToM tasks and all symptom groups. We also found an equally sizable and significant association between poor emotion recognition and symptoms. This is not unexpected given that some ToM tasks (e.g. "Reading the mind in the eyes" test) are based on emotion recognition. However, it is interesting to note that most robust association was with alogia. In the case of social perception and emotion processing tasks, although effects were evident, they were much weaker with former being particularly associated with positive forms of TD as opposed to alogia. Regarding the weak associations with emotion processing, this is somehow unexpected given the well reported finding that TD worsens with negative affect. [75] Finally, the moderate association between attributional biases and disorganisation should be interpreted with caution given that there were only two studies included in the analysis. We are aware of no theoretical model that predicts these patterns of association but it is worth noting that some of these domains do not necessarily have absolute and categorical boundaries and may overlap greatly.

There are good theoretical reasons for expecting a relationship between TD and poor social cognition. As mentioned earlier, Frith [3] suggested that communication difficulties in patients (i.e. TD) could be partly explained by their inability to infer the state of knowledge of the listener. This is consistent with studies that have found that,

when patients with TD are provided with the opportunity to explain their perspective and contextualise their communications, their verbalisations no longer sound bizarre or 'disordered'. [77] Hence, it seems reasonable to propose that difficulties at the level of social cognition (e.g. delayed activation of the fronto-temporal-parietal areas that support mentalisation), [78] may render the patient unable to repair or readjust communication when unprompted, because of difficulties in timely detecting subtle and dynamic emotional and social cues from the interlocutor.

The establishment of conversational alignment, [79] or grounding [80] in communication or dialog is dependent on the early, automatic, and timely processing and monitoring of partner-specific information (e.g. verbal and non-verbal paralinguistic cues and signals). This process helps the addressee disambiguate language and the speaker adjust communication to the needs of the addressee, enabling the incremental shared understanding between interlocutors (as dialog unfolds) and leading to more effective and efficient communication over time. According to Brennan and colleagues:

> "(…) dialog can be viewed as a highly coordinated hypothesis-testing activity that individuals engage in together, where one partner's presentation (their hypothesis of what their partner will understand) plays a dual role by providing the other person with evidence of how the previous utterance has been understood." [80 (p316)]

A person who cannot disambiguate the question of the interviewer, or cannot infer the state of knowledge of the listener, is more likely to answer questions in an egocentric or tangential way, by *intermingling*, interweaving or blending in decontextualised concerns and worries into the context of the conversation, [81] thereby making communications sound idiosyncratic or even bizarre. This account is consistent with findings from studies that have reported that patients who display TD have significant difficulties disambiguating and processing linguistic and conversational context. [82]

One important point to acknowledge at this stage is that the ability to infer other peoples' mental and emotional states may not be independent from the ability to reflect and understand one's own mental state (i.e. self-reflection or meta-awareness). For example, one study showed that gains in self-reflection predicted improvements in social cognition and, more specifically, the patient's ability to infer the mental or emotional states of others. [83] Some authors have hypothesised that TD patients have difficulties synthesising and making sense of their own cognitive experiences (resulting in "cacophonous selves") [84] and, consistent with this idea, two studies have reported that patients with disorganised symptoms are significantly impaired in both self-reflexivity and social cognition. [85,86] There is also evidence that patients diagnosed with schizophrenia-spectrum disorders have difficulties recalling autobiographical memories [87] (which may be necessary when making sense of others through analogical reasoning). [88,89] So it is plausible that difficulties with self-reflection or meta-awareness may underlie both poor mentalising and TD. However, the relationship between poor self-reflection and other domains of social cognition also associated with TD would be more difficult to explain.

Another possible interpretation is that symptoms of disorganisation may have a detrimental impact on both the patient's ability to reason about their own and other peoples' mental states. For example, Minor and colleagues reported that symptoms of disorganisation moderated the relationship between neurocognition and both social cognition and self-reflexivity in patients diagnosed with schizophrenia-spectrum disorders. [90,91] However, such interpretation does not explain why TD patients fail to see their verbalisation as bizarre and idiosyncratic while at the same time they are able to successfully judge the verbalisation of other TD patients as anomalous. [45]

One of the limitations of the present meta-analysis is that the calculated strength of the associations between domains of social cognition and symptoms did not account for symptom comorbidity. This is important because difficulties with ToM have been reported to be significantly associated with negative symptoms and persecutory delusions.[5] In future studies, it will be important to establish the strength of the association between domains of social cognition and TD after accounting for other psychotic experiences especially negative symptoms, given its association with both poor mentalisation and dysfunctional mirror neuron activity. [92] Moreover, it might be suggested that the strength of the ES could just reflect general "severity of illness" or more general cognitive difficulties. However, if this was case, then one would expect the correlations with social perception, emotion regulation and attributional biases to be equally sizable, which they were not. Another limitation of the review is the overrepresentation of men in the study samples. Few studies have attempted to control or account for sex-differences, so it is possible that some of these difficulties are to some extent sex-specific.

Finally, social cognition is only one piece in the puzzle of TD other psychological mechanisms have been shown to be involved in these cluster of

experiences. For example, we have reported previously that difficulties in *internal* source monitoring (ability to correctly discriminate whether self-generated cognitions were verbalised or just thought) [93] coupled with negative affect are important to explain exacerbation of TD during emotional challenge, [75] and that poverty of speech seems to be specifically associated with impoverished inner speech (especially dialogical inner speech). [35] Finally, how these mechanisms relate to important social predictors of TD remains a matter of speculation. Some authors have suggested that difficulties recognising and reasoning about mental states in patients diagnosed with schizophrenia-spectrum disorders could be a consequence of early experiences such as poor early attachments relationship, childhood trauma, or isolation, [94] factors that have been found to be associated with TD. [38,95–97] For example, a recent study showed that poor ToM mediated the relationship between insecure attachment and emerging psychotic symptoms. [98] In future studies, it will be important to examine the relationships between social predictors and socio-cognitive processes in TD using more complex psychosocial models.

It may also be fruitful to test if existent social cognitive training packages have an impact on TD (e.g. social cognition enhancement training). [99] A published meta-analysis of social cognitive training in schizophrenia-spectrum disorders reported significant and sizable ES on both ToM and facial affect recognition and identification. [100] The ES for psychotic symptoms for this kind of intervention have been modest, but given the findings of the current meta-analysis, it would be pertinent to trial social cognitive packages that focus on both emotion recognition and perspective taking in communication on patients with persistent TD. This is important given the known association between TD and poorer quality of life, relapse, and poorer occupational and social functioning.

## Declaration of interests

None.

## Contributors

P. Sousa, W. Sellwood, and R. Bentall were responsible for study concept and design. P. Sousa carried out the systematic search, statistical analyses and the interpretation of the findings (under the supervision of W. Sellwood and R. Bentall). P. Sousa was responsible for drafting the manuscript and W. Sellwood, M. Griffiths, and R. Bentall for the critical revision. All authors accepted the final version.

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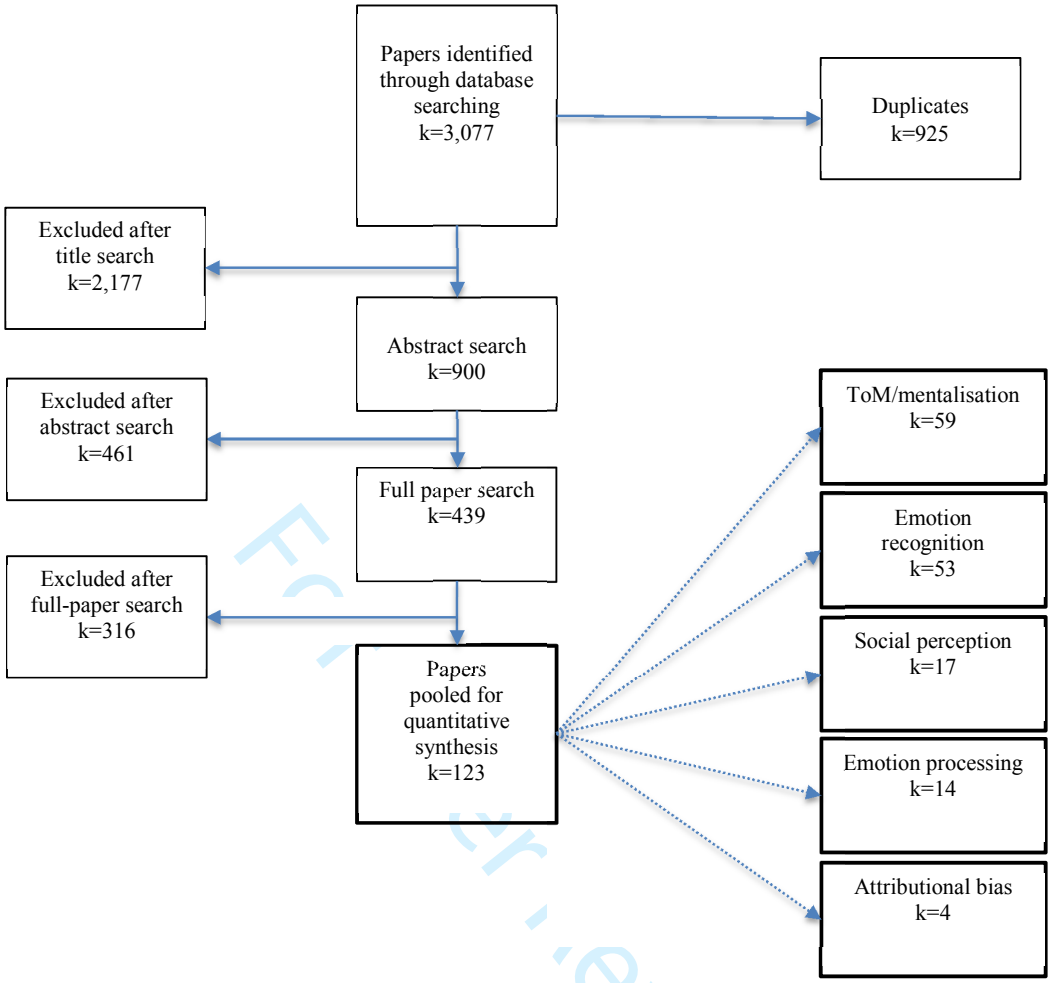


**Figure 1 –** Flowchart of the different stages of the systematic search.

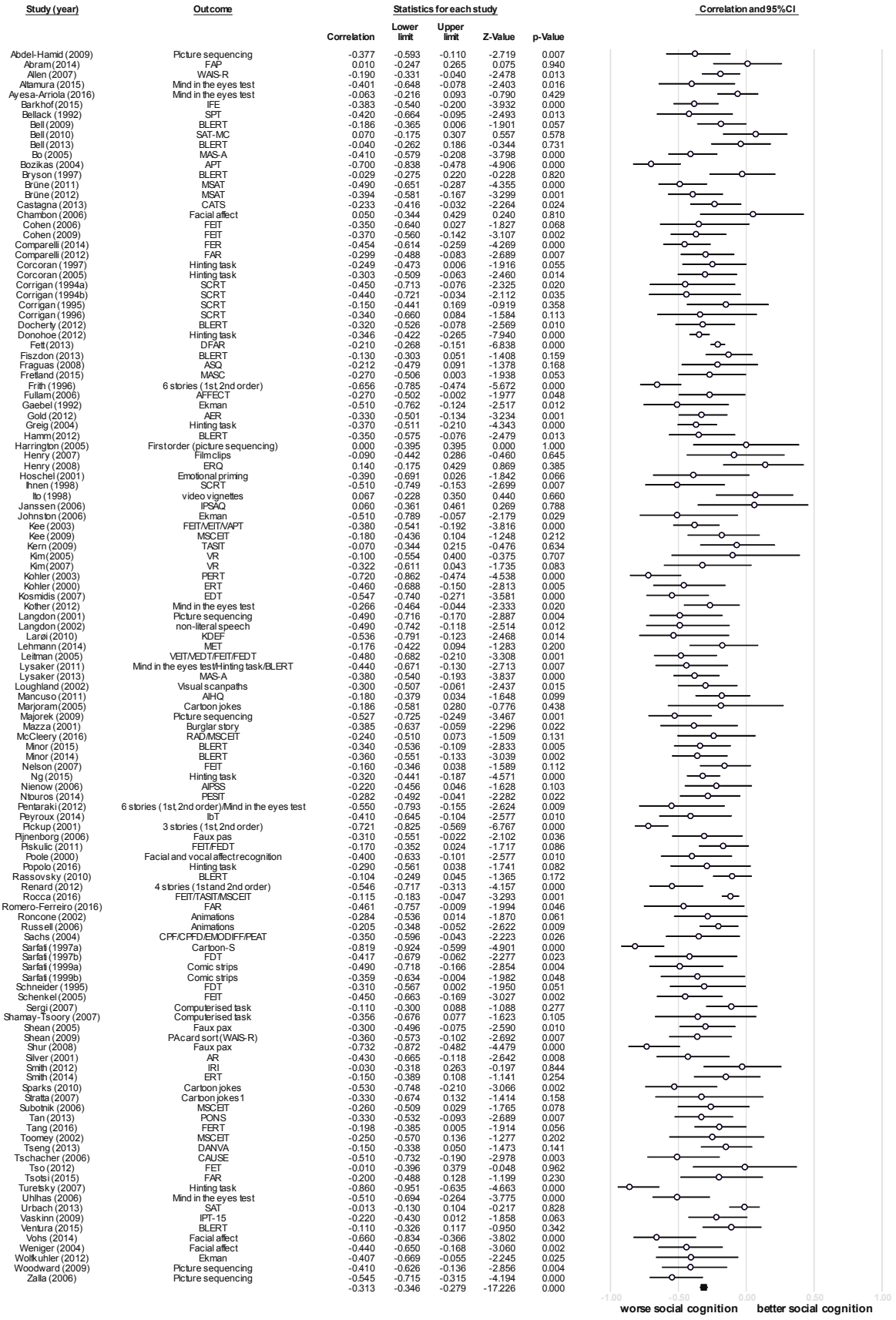


**Figure 2** – Forest plot.

| **Study characteristics** | | **k=123** |
|---|---|---|
| Design | Cross-sectional (%) | 114 (92.68%) |
| | Longitudinal (%) | 9 (7.32%) |
| Sample size | Total | 9107 |
| Sex | Male (%) | 6338 (69.59%) |
| | Female (%) | 2573 (28.25%) |
| Age | Mean (sd) | 36.61 (6.27) |
| Status | Outpatient (%) | 56 (45.16%) |
| | Inpatient (%) | 31 (25.00%) |
| | Mixed (%) | 37 (29.84%) |
| Diagnostic label | Schizophrenia (%) | 63 (51.22%) |
| | Spectrum (%) | 60 (48.78%) |
| Diagnostic criteria | DSM-III-R or above (%) | 118 (95.93%) |
| Socio-cognitive domain | ToM (%) | 59 (40.14%) |
| | Social perception (%) | 17 (11.56%) |
| | Emotion recognition (%) | 53 (36.05%) |
| | Attributional biases (%) | 4 (2.72%) |
| | Emotion processing (%) | 14 (9.52%) |
| Symptom | Disorganisation factor (%) | 76 (53.15%) |
| | Alogia (%) | 26 (18.18%) |
| | Thought disorder (%) | 23 (16.08%) |
| | Other (%) | 18 (12.59%) |
| Scale | PANSS/SANS/SAPS/BPRS (%) | 106 (86.18%) |
| | Other (%) | 17 (13.82%) |

**Table 1 –** Demographic and clinical variables.

| Author (1st) | Year | Design | Country | Domain | Task | Symptom | Measure | Sample | Size (n) | Males | Females | Age (±) | Diagnoses | Criteria |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abdel-Hamid | 2009 | CS | Germany | TOM | PictSeq | Disorg (F) | PANSS | Mixed | 50 | 24 | 26 | 37.08 (12.3) | Spectrum | DSM-4 |
| Abram | 2014 | CS | US | ER | FAP | Disorg (F) | SAPS<br>SANS | Outpatient | 59 | 37 | 22 | 35.51 (9.39) | Scz | DSM-4 |
| Allen | 2007 | CS | US | TOM | PictArrang | Disorg (F) | BPRS | Inpatient | 169 | 169 | 0 | 36.2 (7.9) | Scz | DSM-4 |
| Altamura | 2015 | CS | Italy | TOM | Eyes test | Disorg (F) | PANSS | Outpatient | 35 | 6 | 24 | 42.47 (10.4) | Scz | DSM-4-TR |
| Ayesa-Arriola | 2016 | LONG | Spain | TOM | Eyes test | Disorg (F) | SAPS<br>SANS | Outpatient | 160 | 86 | 74 | 32.17 (10.78) | Spectrum | DSM-4 |
| Barkhof | 2015 | CS | Netherlands | ER | IFE | Disorg (F) | PANSS | Mixed | 98 | 82 | 16 | 35.1 (9.7) | Spectrum | DSM-4 |
| Bellack | 1992 | CS | US | SP | SPT | Disorg (I) | BPRS | Inpatient | 34 | 25 | 9 | 30.3 (7.3) | Scz | DSM-3-R |
| Bell | 2013 | CS | US | ER<br>TOM<br><br>PROC | BLERT<br>Hint<br>SAT-MC<br>MSCEIT | Alogia | SANS | Outpatient | 77 | 43 | 34 | 43.4 (10.4) | Spectrum | DSM-4 |
| Bell | 2010 | CS | US | TOM | SAT-MC | Disorg (F) | PANSS | Outpatient | 66 | 40 | 26 | 42.73 (10.4) | Spectrum | DSM-4 |
| Bell | 2009 | CS | US | ER<br>TOM | BLERT<br>Hint<br>BORI | TD | BIZ | Outpatient | 105 | 61 | 44 | 42.8 (8.9) | Spectrum | DSM-4 |
| Bo | 2015 | CS | Denmark | TOM | MAS-A | Disorg (I) | PANSS | Mixed | 79 | 64 | 15 | 36.9 (10.4) | Scz | DSM-4-TR |
| Bozikas | 2004 | CS | Greece | ER | APT<br>Cartoon-F<br>KAMT | Disorg (F) | PANSS | Outpatient | 35 | 21 | 14 | 36.51 (10.16) | Scz | DSM-4 |
| Bryson | 1997 | CS | US | ER | BLERT | TD | BIZ | Outpatient | 63 | 61 | 2 | 43.56 (8.18) | Spectrum | DSM-3-R |
| Brüne | 2012 | CS | Germany | TOM | MSAT | Disorg (F) | PANSS | Mixed | 58 | 41 | 17 | 35.45 (10.3) | Scz | DSM-4 |
| Brüne | 2011 | CS | Germany | TOM | MSAT<br>PictSeq | Disorg (F) | PANSS | Mixed | 69 | 45 | 24 | 36.3 (10.3) | Spectrum | DSM-4 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Castagna | 2013 | CS | Italy | ER | CATS | Disorg (F) | PANSS | Outpatient | 94 | 66 | 28 | 41.8 (10.2) | Scz | DSM-4-TR |
| Chambon | 2006 | CS | France | ER | FERT | TD<br>Alogia | SAPS<br>SANS | Inpatient | 26 | 20 | 6 | 32.1 (7.8) | Scz | DSM-4 |
| Cohen | 2009 | CS | US | ER | FEIT | Disorg (F) | SAPS | Inpatient | 67 | 27 | 40 | 41.29 (8.55) | Spectrum | DSM-4 |
| Cohen | 2006 | CS | US | ER | FEIT | Disorg (F) | BPRS | Inpatient | 28 | 24 | 4 | 33.36 (1.26) | Scz | DSM-4 |
| Comparelli | 2014 | CS | Italy | ER | FER | Disorg (F) | PANSS | Mixed | 79 | 46 | 33 | 30.59 (5.45) | Spectrum | DSM-4-TR |
| Comparelli | 2012 | CS | Italy | ER | FAR | Disorg (F) | PANSS | Mixed | 79 | 46 | 33 | 30.05 (1.4) | Spectrum | DSM-4 |
| Corcoran | 2005 | CS | UK | TOM | Hint | TD | PSE | Outpatient | 59 | 51 | 8 | 40.5 (10.1) | Scz | DSM-4 |
| Corcoran | 1995 | CS | UK | TOM | Hint | TD | PSE | Mixed | 55 | 38 | 17 | 31.8 (8.9) | Scz | DSM-3-R |
| Corrigan | 1996 | CS | US | SP | SFRT<br>SCRT | Disorg (F) | BPRS | Inpatient | 23 | 17 | 6 | 34.5 (6.9) | Spectrum | DSM-3-R |
| Corrigan | 1995 | LONG | US | SP | SCRT | Disorg (F) | BPRS | Mixed | 40 | 18 | 22 | 35.3 (10.1) | Spectrum | DSM-3-R |
| Corrigan | 1994a | CS | US | SP | SCRT | Disorg (F) | BPRS | Inpatient | 26 | 19 | 7 | 34.5 (6.9) | Scz | DSM-3-R |
| Corrigan | 1994b | CS | US | SP | SCRT | Disorg (F) | BPRS | Inpatient<br>Outpatient | 23<br>20 | 18<br>9 | 5<br>11 | 33.9 (7.5)<br>37.4 (8.2) | Scz | DSM-3-R |
| Docherty | 2013 | CS | US | SP<br>TOM<br>ER | PONS<br>Cartoon-S<br>Hint<br>Ekman<br>BLERT | CD | CDI | Outpatient | 63 | 42 | 21 | 40 (8) | Spectrum | DSM-4 |
| Donohoe | 2012 | CS | Ireland | TOM | Hint | Disorg (F) | SAPS<br>SANS | Mixed | 487 | 352 | 135 | 41.1 (12.31) | Scz | DSM-4 |
| Fett | 2013 | CS | Netherlands | ER | DFAR | Disorg (F) | PANSS | Mixed | 1032 | 795 | 237 | 27.3 (7.2) | Scz | DSM-4-TR |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TOM | Hint | | | | | | | | |
| Fiszdon | 2013 | CS | US | ER<br>PROC<br>TOM | BLERT<br>MSCEIT<br>Hint | Disorg (F) | PANSS | Outpatient | 119 | 77 | 42 | 44.95 (11.04) | Spectrum | DSM-4 |
| Fraguas | 2008 | CS | Spain | ATT | ASQ | Disorg (F) | PANSS | Outpatient | 56 | 31 | 13 | 38.1 (9.7) | Spectrum | ICD-10 |
| Fretland | 2015 | CS | Norway | TOM | MASC | Disorg (F) | PANSS | Mixed | 52 | 33 | 19 | 28.8 (NK) | Spectrum | DSM-4 |
| Frith | 1996 | CS | UK | TOM | Story | Disorg (F) | PSE | Inpatient | 55 | 36 | 19 | 32.3 (9.9) | Scz | DSM-3-R |
| Fullam | 2006 | CS | UK | ER | AFFECT | Disorg (F) | PANSS | Inpatient | 54 | 54 | 0 | 36.11 (8.94) | Scz | DSM-4 |
| Gaebel | 1992 | LONG | Germany | ER | Ekman | Alogia | SANS | Inpatient | 23 | 17 | 6 | 31.3 | Scz | DSM-3-R |
| Gold | 2012 | CS | US | ER | AER | Disorg (F) | PANSS | Mixed | 92 | 79 | 13 | 37.8 (10.4) | Spectrum | DSM-4 |
| Greig | 2004 | CS | US | TOM | Hint | TD<br>Disorg (F) | PANSS<br>SAPS<br>BIZ | Outpatient | 128 | 102 | 26 | NK | Spectrum | DSM-3-R |
| Hamm | 2012 | LONG | US | TOM<br>ER | MAS-A<br>BLERT | Disorg (F) | PANSS | Outpatient | 49 | 44 | 5 | 50.37 (7.54) | Spectrum | DSM-4 |
| Harrington | 2005 | CS | New Zealand | TOM | Story<br>PictSeq | Alogia<br>TD | SAPS<br>SANS | Mixed | 25 | NK | NK | 33.5 (7.9) | Spectrum | DSM-4 |
| Henry | 2008 | CS | Australia | PROC | ERQ | Alogia<br>TD | SAPS<br>SANS | Mixed | 41 | 19 | 22 | 37.5 (10.67) | Spectrum | DSM-4 |
| Henry | 2007 | CS | Australia | PROC | Video | Alogia<br>TD | SAPS<br>SANS | Outpatient | 29 | 13 | 16 | 34.65 (9.37) | Spectrum | DSM-4 |
| Hoschel | 2001 | CS | Germany | ER | Priming | Disorg (F) | SAPS<br>SANS | Inpatient | 23 | 13 | 10 | 37 (13) | Scz | DSM-4 |
| Ihnen | 1998 | CS | US | SP | SCRT | Disorg (F) | BPRS | Outpatient | 26 | 15 | 11 | 33.4 (9.7) | Scz | DSM-4 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ito | 1998 | CS | Japan | SP | RPT | Disorg (F) | BPRS | Mixed | 46 | 28 | 18 | 40.5 (8.7) | Scz | DSM-3-R |
| Janssen | 2006 | CS | Netherlands | ATT | IPSAQ | Disorg (I)<br>TD | PSE<br>SAPS | Outpatient | 23 | 17 | 6 | 31.8 (9.3) | Scz | DSM-3-R |
| Johnston | 2006 | CS | Australia | ER | Ekman | Alogia | SANS | Outpatient | 18 | 9 | 9 | 38.8 (10.0) | Scz | ICD-10 |
| Kee | 2009 | CS | US | PROC | MSCEIT | Alogia<br>TD | SAPS<br>SANS | Outpatient | 50 | 31 | 19 | 34.37 (7.69) | Scz | DSM-4 |
| Kee | 2003 | LONG | US | ER | FEIT<br>VEIT<br>VAPT | Disorg (I) | BPRS | Outpatient | 94 | 63 | 31 | 38.7 (9.8) | Spectrum | DSM-4 |
| Kern | 2008 | CS | US | TOM | TASIT | Alogia<br>TD | SAPS<br>SANS | Outpatient | 49 | 31 | 28 | 34.5 (7.8) | Spectrum | DSM-4 |
| Kim | 2007 | CS | South Korea | ER<br>SP | VirtualReal | Stereotyped<br>Abstract<br>Disorg (I) | PANSS | Inpatient | 30 | 16 | 14 | 29.63 (4.98) | Scz | DSM-4 |
| Kim | 2005 | CS | South Korea | ER<br>SP | VirtualReal | Stereotyped<br>Disorg (I) | PANSS | Inpatient | 17 | 12 | 5 | 30.41 (5.36) | Scz | DSM-4 |
| Kohler | 2003 | CS | US | ER | PERT | Alogia | SAPS<br>SANS | Outpatient | 28 | 19 | 9 | 30.3 | Spectrum | DSM-4 |
| Kohler | 2000 | CS | US | ER | ERT | TD<br>Alogia | SAPS<br>SANS | Outpatient | 28 | 20 | 15 | 30.6 (9.5) | Scz | DSM-4 |
| Kosmidis | 2007 | CS | Greece | ER | KAMT<br>EDT | Disorg (F) | PANSS | Mixed | 37 | 23 | 14 | 34.06 (7.92) | Scz | DSM-4 |
| Köther | 2012 | CS | Germany | TOM | Eyes test | TD | PANADSS | Mixed | 76 | 50 | 26 | 34.26 (11.41) | Spectrum | DSM-4-TR |
| Langdon | 2002 | CS | Australia | TOM | SCT<br>PictSeq | Alogia<br>TD | SAPS<br>SANS | Mixed | 25 | NK | NK | NK | Spectrum | DSM-4 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Langdon | 2001 | CS | Australia | TOM | PictSeq | TD<br>Alogia | SAPS<br>SANS | Mixed | 32 | 18 | 14 | 37.31 (10.74) | Spectrum | DSM-4 |
| Larøi | 2010 | CS | Belgium | ER | KDEF | Disorg (F) | PANSS | Inpatient | 20 | 11 | 9 | 32.9 (10.36) | Scz | DSM-4 |
| Lehmann | 2014 | CS | Germany | PROC | MET | Disorg (F) | PANSS | Mixed | 55 | 32 | 23 | 39.8 (11.9) | Spectrum | DSM-4-TR |
| Leitman | 2005 | CS | US | ER | VEIT<br>VEDT<br>FEIT<br>FEDT | Disorg (F) | BPRS | Inpatient | 43 | 33 | 10 | 39 (12) | Spectrum | DSM-4 |
| Lysaker | 2013 | CS | US | TOM<br>ER | MAS-A<br>Eyes test<br>Hint<br>BLERT | Disorg (F) | PANSS | Outpatient | 95 | 82 | 13 | 49.36 (8.7) | Spectrum | DSM-4 |
| Lysaker | 2011 | LONG | US | TOM<br>ER | Eyes test<br>Hint<br>BLERT | Disorg (F) | PANSS | Outpatient | 36 | 33 | 3 | 50.39 (8.29) | Spectrum | DSM-4 |
| Loughland | 2002 | CS | Australia | ER | VScan | Disorg (F) | PANSS | Outpatient | 65 | 43 | 22 | 33.6 (8) | Scz | DSM-3-R |
| Mancuso[1] | 2011 | CS | US | TOM<br>SP<br>ATT | MSCEIT<br>TASIT<br>FEIT<br>PONS<br>AIHQ | Alogia | SANS | Outpatient | 85 | 76 | 9 | 48.5 (8.6) | Spectrum | DSM-4 |
| Marjoram | 2005 | CS | UK | TOM | Cartoon | Incoherence<br>Poverty | KSS | Mixed | 20 | 12 | 8 | 39.8 (11.6) | Scz | DSM-4 |
| Majorek | 2009 | CS | Germany | TOM | PictSeq | Disorg (F) | PANSS | Mixed | 71 | 50 | 21 | 33.6 (9.5) | Scz | DSM-4 |
| Mazza | 2001 | CS | Italy | TOM | Story | Disorg (F) | SAPS<br>SANS | Outpatient | 35 | 30 | 5 | 33.9 (5.8) | Scz | DSM-4 |
| McCleery | 2016 | LONG | US | PROC<br>SP | MSCEIT<br>RAD | Disorg (F) | BPRS | Outpatient | 41 | 26 | 15 | 31.06 (7.43) | Spectrum | DSM-4 |

[1] The data from the socio-cognitive tasks was subjected to an exploratory factor analysis and the resulting factors were interpreted as shown on the table.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Minor | 2015 | CS | US | TOM<br>ER<br>PROC | SAT-MC<br>Hint<br>BLERT<br>MSCEIT | Disorg (I) | PANSS | Outpatient | 67 | 63 | 4 | 50.49 (10.46) | Spectrum | DSM-4-TR |
| Minor | 2014 | CS | US | TOM<br>ER<br>PROC | SAT-MC<br>Hint<br>BLERT<br>MSCEIT | Disorg (F) | PANSS | Outpatient | 68 | 44 | 24 | 50.50 (10.38) | Spectrum | DSM-4-TR |
| Nelson | 2007 | CS | US | ER | FEIT | Disorg (F) | BPRS | Inpatient | 100 | 72 | 28 | 38.38 (9.37) | Scz | DSM-4-TR |
| Ng | 2015 | CS | US | TOM | Hint | Disorg (F) | PANSS | Outpatient | 193 | 124 | 69 | 46.19 (10.81) | Spectrum | DSM-4 |
| Nienow | 2006 | CS | US | SP<br>ER | AIPSS<br>BLERT | Disorg (F) | SAPS | Inpatient | 56 | 42 | 14 | 41.54 (7.84) | Spectrum | DSM-4 |
| Ntouros | 2014 | CS | Greece | TOM<br>ER | PESIT[2] | Disorg (F) | PANSS | Outpatient | 65 | 52 | 13 | 26.38 (5.42) | Spectrum | DSM-4 |
| Pentaraki | 2012 | CS | Greece | TOM | Story<br>Eyes test | Disorg (I) | PANSS | Mixed | 21 | 21 | 0 | 24.37 (3.82) | Scz | DSM-4-TR |
| Peyroux | 2014 | CS | France | ATT | IbT | Disorg (F) | PANSS | Inpatient | 38 | 26 | 12 | 37.0 (7.10) | Scz | DSM-4-TR |
| Pickup | 2001 | CS | UK | TOM | Story | Disorg (F) | PSE | Mixed | 41 | 29 | 12 | 38.2 (12.4) | Scz | DSM-4 |
| Pijnenborg | 2009 | CS | Netherlands | ER<br>TOM | FEEST<br>PT<br>Fauxpas | Disorg (F) | PANSS | Mixed | 46 | 34 | 12 | 27.4 (7.7) | Scz | DSM-4 |
| Piskulic | 2011 | LONG | Canada | SP<br>ER | SFRT<br>SCRT<br>FEIT<br>FEDT | Stereotyped Abstract | PANSS | Outpatient | 103 | 68 | 35 | 30.3 (7.6) | Spectrum | DSM-4 |
| Poole | 2000 | CS | US | ER | FAR<br>VAR | Disorg (F) | PANSS | Outpatient | 40 | 31 | 9 | 41 (9) | Spectrum | DSM-4 |
| Popolo | 2016 | CS | Italy | TOM | PictSeq | Disorg (F) | PANSS | Outpatient | 37 | 33 | 4 | 27.19 (6.57) | Scz | DSM-4-TR |

[2] PESIT data on Emotion Recognition and TOM was analyzed separately.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Hint | | | | | | | | | |
| Rassovsky | 2011 | CS | US | SP | PONS | Alogia | BPRS | Outpatient | 174 | 144 | 30 | 44.5 (9.89) | Scz | DSM-4 |
| Renard | 2012 | CS | US | ER | BLERT | Disorg (F) | PANSS | Outpatient | 49 | 45 | 4 | 51.82 (9.75) | Spectrum | DSM-4 |
| Rocca | 2016 | CS | Italy | PROC<br>ER<br>TOM | MSCEIT<br>FEIT<br>TASIT | Disorg (F) | PANSS | Outpatient | 809 | 568 | 241 | 40.1 (10.8) | Scz | DSM-4 |
| Romero-Ferreiro | 2016 | CS | Spain | ER | FAR | Disorg (F) | PANSS | Outpatient | 19 | 13 | 6 | 43.89 (9.5) | Scz | ICD-10 |
| Roncone | 2002 | CS | Italy | TOM | Story | Disorg (F) | BPRS | Outpatient | 44 | 34 | 10 | 33.4 (6.09) | Spectrum | DSM-4 |
| Russell | 2006 | CS | UK | TOM | Anim | Disorg (F) | PANSS | Mixed | 61 | 59 | 2 | 33.89 (9.49) | Spectrum | DSM-4 |
| Sachs | 2004 | CS | Austria | ER | CPF<br>CPFD<br>EMODIFF<br>PEAT | Alogia | SANS | Inpatient | 40 | 25 | 15 | 30.4 (8.1) | Scz | DSM-4 |
| Sarfati | 1999a | CS | France | TOM | Cartoon-S | TD | TLC | Inpatient | 25 | 7 | 18 | 32.45 (10) | Scz | DSM-4 |
| Sarfati | 1999b | CS | France | TOM | Cartoon-S | TD | TLC | Inpatient | 26 | 21 | 5 | 32.7 (11.4) | Scz | DSM-3-R |
| Sarfati | 1997a | CS | France | TOM | Cartoon-S | TD | TLC | Inpatient | 12 | 5 | 7 | 27.2 (7.5) | Scz | DSM-3-R |
| Sarfati | 1997b | CS | France | TOM | Cartoon-S | TD | TLC | Inpatient | 24 | 19 | 5 | 31.9 (11.8) | Scz | DSM-3-R |
| Schneider | 1995 | CS | Germany | ER | FDT | Disorg (F)<br>Alogia | SAPS<br>SANS | Mixed | 40 | 21 | 19 | 30.4 (7.7) | Scz | DSM-3-R |
| Schenkel | 2005 | CS | US | TOM | Hint | Disorg (F) | BPRS | Inpatient | 42 | 15 | 17 | 41.71 (10.5) | Spectrum | DSM-4 |
| Sergi | 2007 | CS | US | SP<br>ER | IPT<br>PONS<br>VEIT | Alogia | SANS | Outpatient | 100 | 91 | 9 | 49 (7.1) | Spectrum | DSM-4 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | FEIT | | | | | | | | | |
| Shamay-Tsoory | 2007 | CS | Israel | PROC<br>TOM | IRI<br>CogAffect | Alogia | SANS | Mixed | 22 | 13 | 9 | 32.56 (10.83) | Scz | DSM-4 |
| Shean | 2009 | CS | US | TOM | PictArrang | Disorg (F) | SAPS<br>SANS | Inpatient | 54 | 25 | 29 | 35.6 (4.32) | Spectrum | DSM-4 |
| Shean | 2005 | CS | US | TOM | PictArrang | Disorg (F) | BPRS | Inpatient | 73 | 34 | 39 | 39.9 (5.42) | Spectrum | DSM-4 |
| Shur | 2008 | CS | Israel | TOM | Fauxpas | Alogia | SANS | Mixed | 26 | 17 | 9 | 32.58 (10.24) | Scz | DSM-4 |
| Silver | 2001 | CS | Israel | ER | FEIT<br>FEDT | Alogia | SANS | Inpatient | 36 | 25 | 11 | 40.61 (10.72) | Scz | DSM-4 |
| Smith | 2014 | CS | US | PROC<br>ER | EPT<br>AR<br>FAP | Disorg (F) | SAPS<br>SANS | Outpatient | 60 | 38 | 22 | 35.36 (9.07) | Scz | DSM-4 |
| Smith | 2012 | CS | US | PROC | IRI | Disorg (F) | SAPS<br>SANS | Outpatient | 46 | 30 | 16 | 35.2 (8.2) | Scz | DSM-4 |
| Sparks | 2010 | CS | Australia | TOM | TASIT | Alogia | SANS | Outpatient | 30 | 17 | 13 | 45.9 (8.7) | Spectrum | DSM-4 |
| Stratta | 2007 | CS | Italy | TOM | Cartoon | Disorg (F) | PANSS | Outpatient | 20 | 17 | 3 | 38.5 (10.9) | Scz | DSM-3-R |
| Subotnik | 2006 | CS | US | SP | SFRT | TD | BIZ | Outpatient | 47 | 35 | 12 | 28.6 (6.4) | Spectrum | DSM-4 |
| Tan | 2014 | CS | Australia | PROC | MSCEIT | TD | TLC | Mixed | 58 | 31 | 27 | 43.64 (9.36) | Spectrum | DSM-4 |
| Tang | 2016 | CS | China | ER | FERT | Disorg (F) | BPRS | Inpatient | 94 | 94 | 0 | 47.85 (6.35) | Scz | DSM-4 |
| Toomey | 2002 | CS | US | SP | PONS | Disorg (F)<br>Disorg (I) | BPRS | Inpatient | 28 | 19 | 9 | 34.14 (8.42) | Spectrum | DSM-3-R |
| Tschacher | 2006 | CS | Switzerland | TOM | CAUSE | Disorg (F) | PANSS | Mixed | 31 | 24 | 7 | 27.7 (7.3) | Spectrum | ICD-10 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tseng | 2013 | CS | Taiwan | ER | DANVA2 | Disorg (F) | PANSS | Outpatient | 111 | 51 | 60 | 38.23 (10.13) | Scz | DSM-4 |
| Tso | 2012 | CS | US | PROC | MSCEIT | TD<br>Alogia | SAPS<br>SANS | Outpatient | 26 | 19 | 7 | 43.9 (12.5) | Spectrum | DSM-4 |
| Tsotsi | 2015 | CS | Greece | ER | FAR | Disorg (F) | PANSS | Outpatient | 38 | 19 | 19 | 33.9 (6.7) | Scz | DSM-4 |
| Turetsky | 2007 | CS | US | ER | Penn | Alogia | SAPS<br>SANS | Mixed | 16 | 12 | 4 | 30.5 (6) | Scz | DSM-4 |
| Uhlhas | 2006 | CS | UK | TOM | Hint<br>Eyes test<br>Story | Disorg (F) | PANSS | Mixed | 48 | 34 | 6 | 38.4 (7.6) | Spectrum | DSM-4 |
| Urbach | 2013 | CS | France | TOM | SCD<br>V-SIR | Disorg (F) | PANSS | Mixed | 281 | 149 | 57 | 42.7 (10.15) | Scz | DSM-4 |
| Vaskinn | 2009 | CS | US | SP | IPT-15 | Alogia | SANS | Outpatient | 72 | 61 | 11 | 46.7 (9.6) | Spectrum | DSM-4 |
| Ventura | 2015 | LONG | US | TOM | Anim | Disorg (F) | SAPS<br>SANS | Outpatient | 77 | 60 | 17 | 21.47 (3.76) | Spectrum | DSM-4 |
| Vohs | 2014 | CS | US | TOM<br><br>ER | MAS-A<br>Eyes test<br>Hint<br>BLERT | Disorg (F) | PANSS | Outpatient | 26 | 21 | 5 | 23.81 (3.63) | Spectrum | DSM-4 |
| Weniger | 2004 | CS | Netherlands | ER | Ekman | Disorg (F) | SAPS<br>SANS | Mixed | 45 | 28 | 17 | 34.7 (12) | Scz | DSM-4 |
| Wolfkühler | 2012 | CS | Germany | ER | Ekman | Disorg (F) | PANSS | Inpatient | 60 | 47 | 13 | 32.3 (8.3) | Scz | ICD-10 |
| Woodward | 2009 | CS | Canada | TOM | Hint | Abstract | PANSS | Mixed | 46 | NK | NK | 33.35 (10.36) | Spectrum | DSM-4 |
| Zalla | 2006 | CS | France | TOM | PictSeq | Disorg (F) | SAPS | Outpatient | 40 | 21 | 19 | 40.7 (9.05) | Scz | DSM-4-TR |

**Table 2 –** Methodological characteristics of the pooled studies.

**CS**: Cross-sectional; **LONG**: Longitudinal; **TOM**: Theory-of-mind; **ER**: Emotion Recognition; **SP**: Social Perception; **PROC**: Emotion Processing; **ATT**: Attributional Style; **PictSeq**: Picture Sequencing Task; **PictArrang**: Picture Arrangement subtest and/or Picture Completion subtest (WAIS-R); **Eyes test**: "Reading the mind in the eyes" test; **IFE**: The identification of Facial Emotions Task; **SPT**: Social Perception Test; **BLERT**: Bell-Lysaker Emotion Recognition Task; **Hint**: Hinting Task; **SAT-MC**: Social Attribution Test - Multiple Choice; **MSCEIT**: Mayer-Salovey-Caruso Emotional Intelligence Test; **BORI**: Bell Object Relations Inventory; **APT**: Affective Prosody Test; **Cartoon-F**: Fantie's Cartoon Test; **KAMT**: Kinney's Affect Matching Test; **MSAT**: Mental State Attribution Task; **CATS**: Comprehensive Affect Testing System; **FERT**: Facial Emotion Recognition Task; **FEIT**: Facial Emotion Identification Task; **SFRT**: Situational Feature Recognition Test; **SCRT**: Social Cue Recognition Test; **Cartoon-S**: Sarfati ToM Cartoon Stories Test; **PONS**: Profile of Nonverbal Sensitivity Test; **Ekman**: Ekman stimuli/test; **DFAR**: The Degraded Facial Affect Recognition Task; **ASQ**: Attributional Style Questionnaire; **MASC**: Movie for the Assessment of Social Cognition; **Story**: ToM Stories Task (1st and 2nd order); **IbT:** Intentionality bias Test; **RAD:** Relationships Across Domains test; **AFFECT**: Animated Full Facial Comprehension Test; **AER**: Auditory Emotion Recognition Task; **MAS-A**: Metacognitive Assessment Scale-Abbreviated; **ERQ**: Emotion Regulation Questionnaire; **Video**: Emotion Elicitation using Video Clips; **Priming**: Emotional Priming Task; **RPT**: Role Play Test; **IPSAQ:** Internal, Personal, Situational Attributions Questionnaire; **VEIT**: Voice Emotion Identification Test; **VAPT**: Videotape Affect Perception Test; **TASIT**: The Awareness of Social Inference Test; **VirtualReal**: Virtual Reality Social Perception Tool; **PERT:** Penn Emotion Recognition Test; **ERT**: Emotion Recognition Task; **EDT**: Emotion Discrimination Test; **SCT**: Story Comprehension Task; **KDEF**: Karolinska Directed Emotional Faces; **MET:** Multifaceted Empathy Test; **VEDT**: Voice Emotion Discrimination Test; **FEDT**: Face Emotion Discrimination Test; **VScan**: Visual Scanpaths; **AIHQ**: Ambiguous Intentions Hostility Questionnaire; **Cartoon**: ToM Cartoon Jokes Task; **AIPSS**: Assessment of Interpersonal Problem-Solving Skills; **PESIT**: Perception of Social Inference Test; **FEEST**: The Facial Expression of Emotions: Stimuli and Test; **Fauxpas**: Faux Pas Task; **PT**: Prosody Task; **FAR**: Facial Affect Recognition; **VAR**: Vocal Affect Recognition; **Anim**: Animations Task; **CPF:** Computerised Penn Facial Memory Test; **CPFD:** Computerised Penn Facial Test Delayed; **EMODIFF:** Emotion Differentiation Test; **PEAT:** Penn's Emotion Acuity Test; **FDT**: Facial Discrimination Task; **CAUSE:** Perception of causality paradigm; **DANVA2:** Diagnostic Analysis of Nonverbal Accuracy; **IPT**: Interpersonal Perception Task; **IRI**: Interpersonal Reactivity Index; **CogAffect**: Cognitive and Affective Mental Inference Task adapted from 'The Seeing Leads To Knowing' Test; **EPT**: Emotional Perspective-Taking Task; **AR**: Affective Responsiveness Task; **FAP**: Facial Affect Perception Task; **Penn**: Penn Facial Emotion Stimuli; **SCD**: Scale for the Evaluation of Communication Disorders; **V-SIR**: Versailles-Situational Intention Reading; **Disorg (F): Disorganised factor; Disorg (I)**: Conceptual disorganisation (item); **TD**: Thought Disorder; **Alogia**: Alogia; **CD**: Communication Disturbances; **Stereotyped**: Stereotyped Thinking; **Abstract**: Abstract Thinking; **Incoherence**: Incoherence of Speech; **Poverty**: Poverty of Speech; **PANSS**: Positive and Negative Syndrome Scale; **PANADSS: Positive and Negative and Disorganized Syndrome Scale; BPRS**: Brief Psychiatric Rating Scale; **SANS**: Scale for the Assessment of Negative Symptoms: Scale for the Assessment of Positive Symptoms; **PSE**: Present State Examination; **CDI**: Communication Disturbances Index; **KSS**: Krawiecka Standardized Scale for Rating Chronic Psychotic Patients; **TLC**: Scale for the Assessment of Thought, Language and Communication Disorders; **BIZ**: Bizarre-Idiosyncratic Thinking Scale; **Mixed**: Inpatients and Outpatients; **NK**: Not known; **Spectrum**: Psychosis-Spectrum Disorders; **Scz**: Schizophrenia; **DSM**: Diagnostic and Statistical Manual of Mental Disorders (**R**: Revised; **TR**: Text Revision); **ICD**: International Classification of Diseases.