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Deficits in Domains of Social Cognition in Schizophrenia: A Meta-Analysis of the Empirical Evidence

Gauri N. Savla*[,1], Lea Vella[2], Casey C. Armstrong[1], David L. Penn[3], and Elizabeth W. Twamley[1,4]

[1]Department of Psychiatry, University of California, San Diego, La Jolla, CA; [2]Joint Doctoral Program in Clinical Psychology, San Diego State University/University of California, San Diego, San Diego, CA; [3]Department of Psychology, University of North Carolina, Chapel Hill, Chapel Hill, NC; [4]Center of Excellence for Stress and Mental Health, VA San Diego Healthcare System, San Diego, CA

*To whom correspondence should be addressed; tel: 858-822-6449, fax: 858-822-7514, e-mail: gsavla@ucsd.edu

Objective: **Social cognition is strongly associated with functional outcome in schizophrenia, making it an important target for treatment. Our goal was to examine the average magnitude of differences between schizophrenia patients (SCs) and normal comparison (NCs) patients across multiple domains of social cognition recognized by the recent NIMH consensus statement: theory of mind (ToM), social perception, social knowledge, attributional bias, emotion perception, and emotion processing.** ***Method:*** **We conducted a meta-analysis of peer-reviewed studies of social cognition in schizophrenia, published between 1980 and November, 2011.** ***Results:*** **112 studies reporting results from 3908 SCs and 3570 NCs met our inclusion criteria. SCs performed worse than NCs across all domains, with large effects for social perception (g = 1.04), ToM (g = 0.96), emotion perception (g = 0.89), and emotion processing (g = 0.88). Regression analyses showed that statistically significant heterogeneity in effects within domains was not explained by age, education, or gender. Greater deficits in social and emotion perception were associated with inpatient status, and greater deficits in emotion processing were associated with longer illness duration.** ***Conclusions:*** **Despite the limitations of existing studies, including lack of standardization or psychometric validation of measures, the evidence for deficits across multiple social cognitive domains in schizophrenia is clear. Future research should examine the role of neurobiological and psychosocial factors in models linking various aspects of deficit in schizophrenia, including social cognition, in order to identify targets for intervention.**

Introduction

Schizophrenia is associated with markedly impoverished social dexterity and functioning.[1] The ability to navigate social cues and behaviors is inherently dependent on a knowledge base and set of skills, commonly known as "social cognition,"[2] defined by schizophrenia researchers as the "(the processes by which) we draw inferences about other people's beliefs and intentions and how we weigh social situational factors in making these inferences."[3] Allusions to deficits in aspects of social cognition and functioning among people with schizophrenia can be found as early as the writings of Kraepelin (eg, "*Loss of sympathy* is shown in indifference and want of understanding for the misfortunes of others …" [p. 33]).[4] Efforts to identify characteristics of schizophrenia that may explain poor functional outcome have been ongoing since the earliest conceptualizations of the condition. The focus on Schneiderian first-rank symptoms as potential predictors of functioning shifted to neurocognitive deficits about three decades ago, with hundreds of studies demonstrating that cognitive functioning is more relevant to real-world functioning than are positive symptoms of schizophrenia.[5]

Social cognition research has been part of the broader research in general social psychology for decades, and applications to schizophrenia can be found in published studies through the 1980s and 1990s. Penn and colleagues,[6] in 1 of the first reviews of social cognition in schizophrenia, emphasized the importance of studying cognitive processes underlying how people with schizophrenia think about themselves, others, social situations, and social interactions in further understanding the etiology of the disorder. Pivotal publications by Green and colleagues[7,8] further spurred this area of research.

Indeed, the critical role of social cognition in functional disability has now been well established in the current literature.[9] In a recent meta-analysis, Fett and colleagues[10] investigated the associations between neurocognition, social cognition, and domains of functional outcome in schizophrenia, concluding that social cognition was most strongly related to functioning. Social cognition appears to be moderately related to domains

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of neurocognition, negative symptoms, and disorganization, as demonstrated in another recent meta-analysis by Ventura and colleagues.[11] The study of social cognition in schizophrenia not only has clinical/functional implications but also potentially significant research implications. Socioemotional and higher neurocognitive processes, such as abstract thinking, working memory, and online monitoring, appear to mature late in ontogeny,[12] coinciding with the period of life associated with typical onset of schizophrenia. Therefore, examining these processes in conjunction with each other can further our understanding of the disrupted neurobiological systems in schizophrenia.

Social cognition, like other aspects of cognition, is a multifaceted concept, comprising several sub-domains and processes. The NIMH consensus statement on social cognition in schizophrenia identified five relevant domains: ToM, social perception, social knowledge, attributional bias, and emotion processing.[3] Although the consensus statement included emotion perception within the domain of emotion processing, we chose to examine it separately, to investigate whether simply identifying and labeling emotions was less impaired in schizophrenia than understanding one's own emotions and facilitating or managing them. Table 1 gives a brief description of each of these constructs and their prototypical measures.

There are 2 meta-analyses of ToM in schizophrenia[13,14] and 1 of facial emotion perception,[15] each demonstrating robust deficits in those respective domains. These, at least in part, reflect the disproportionately large numbers of studies of these domains compared with the other four domains, ie, social perception, social knowledge, attributional bias, and emotion processing. Fett and colleagues[10] reported that ToM had the strongest relationship with community functioning (combined correlation = 0.48), followed by social perception and social knowledge (combined) was a close second (combined correlation = 0.41); indeed, deficits in social perception (the ability to understand social roles, rules, and context) and social knowledge (the representational templates of social situations, or awareness of the roles, rules, expectations, and goals that govern social situations) may be critical to functional outcomes among people with the illness, yet have been little studied. Furthermore, finer distinctions between the various community functioning outcomes, such as social and relational functioning and their relationships with the various social cognitive domains are warranted from an interventions perspective. Given the different processes potentially underlying the social cognition domains, it is not possible to make conclusions about social cognition deficits in schizophrenia based on reviews and meta-analyses of a subset of the social cognitive domains. Examining the existing literature in these additional domains, along with up-to-date research on the more widely studied domains of social cognition is, therefore, warranted. The goal of the current meta-analysis was to examine whether social cognitive assessments provide reliable evidence of impairment in schizophrenia. Specifically, we aimed to investigate (1) the magnitude of differences between SC and NC participants across all six domains of social cognition (and consequently, whether the focus on ToM and facial emotion perception has overshadowed the potential relevance of other domains), (2) whether SC participants are equally impaired across domains, and (3) to what extent, if any, could demographic or disease burden variables explain variability within domains.

Methods

The methods of this study met criteria specified by the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) statement.[16]

Literature Search

We conducted a literature search of the PsycINFO database using the following keywords: social cognition, theory of mind, emotion perception, social perception, attributional bias, and schizophrenia. In PubMed, we used the following search string: "([social cognition {tiab} OR theory of mind {tesh} OR social perception {mesh} OR attributional style OR emotion perception OR emotion processing] AND schizophrenia [major]) OR (schizophrenia [major] AND [social behavior {major} AND {cognition <major> OR cognition disorders <major>}])." The abbreviations in the string refer to title or abstract (tiab), medical subject heading (mesh), and major subject heading (major). The 2 searches combined yielded 888 unique articles, all published between 1980 and November 2011. We limited our search to articles written in English and those describing studies with human subjects. We also conducted an additional search in PubMed to capture articles that may have escaped processing by the National Library of Medicine. This was accomplished using the same search in a "keyword" format (ie, no Boolean indicators and limiting the search to "NOT MEDLINE" articles), therefore leaving us with only the most recent, non-indexed references (unique number of studies, ie, "k" = 224).

Study and Data Selection

We included studies that met the following criteria: (1) article written in English; (2) peer-reviewed publication; (3) psychosis sample with at least 90% of participants diagnosed with schizophrenia or schizoaffective disorder; (4) NC sample; (5) results reported as means and standard deviations, or F or *t* values so that effect sizes could be calculated. In cases where these data were not reported, we contacted the authors and included those studies if we received usable data.

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Table 1. Social Cognition Domains and their Descriptions

Domain	Description	Example of a Prototypical Task
Theory of mind (ToM)	*Definition:* The ability to interpret an individual's speech and actions in terms of his or her intentions, knowledge, and beliefs Tasks involve inferring mental states from facial expressions or perspective-taking "First-order" ToM: the ability infer what another person is thinking "Second-order" ToM: the ability to infer what one person believes another person is thinking (ie, a "belief about a belief")	**Reading the Mind in the Eyes task**[32]: requires that one infer the mental state of a person only by looking at a photograph of the person's eyes
Social perception	*Definition:* The ability to understand and appraise social roles, rules, and context Involves using verbal and nonverbal cues in order to make inferences about a social situation May be central to functioning in a social context, ie, facilitating interactions with people in social settings or establishing relationships Can involve making critical appraisals, such as judgments of trustworthiness in other people	**Profile of Nonverbal Sensitivity (PONS)**[33]: video-taped scenes containing facial expressions, voice intonations, and bodily gestures. After watching each scene, participants were asked to select from two situations (eg, saying a prayer or talking to a lost child) that would prompt the social cues observed
Social knowledge	*Definition:* Refers to representational templates of social situations or awareness of the roles, rules, expectations, and goals that govern social situations[34] Can be declarative, comprising facts and abstract concepts (eg, social scripts) or procedural (eg, rules, skills, and strategies) processes[35]	**Situational Feature Recognition Test (SFRT)**[36]: requires subjects to select appropriate actions from a list of actions associated with a particular social situation (eg, going to a movie), followed by a list of goals
Attributional bias	*Definition:* Attributional bias/style reflects whether one typically makes inferences about the causes of positive and negative events to internal (personal), external (other person), or situational factors Referred to in terms of externalizing bias (EB) vs personalizing bias (PB) EB is the tendency to overattribute positive rather than negative events to oneself, and PB is the tendency to attribute negative events to others rather than to situational factors	**The Internal, Personal, and Situational Attributions Questionnaire (IPSAQ)**[18]: consists of statements describing an incident; the subject is asked to select one of three causes of the incident. Items reflect internal, external, and situational causes
Emotion perception	*Definition:* Refers to the ability to accurately identify and name emotions of others, primarily by means of facial expressions Emotions may also be perceived through vocal prosody	**The Face Emotion Identification Test (FEIT)**[37]: uses the Izard/Ekman emotion photographs and asks subjects to circle one of six "basic" emotions displayed (happiness, sadness, anger, fear, surprise, and shame)
Emotion processing	*Definition:* Refers to the ability to understand emotions, discriminate between different emotions, and manage emotions and emotional reactions	**Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT)**[38] is part of the MATRICS battery[39]: is self-administered, performance-based measure, comprising eight tasks. In the widely used **Managing Emotions** subscale (designed to measure the cognition of emotion regulation) participants must judge actions that are most effective in obtaining a specified emotional outcome for an individual in a story (eg, what a character may do to reduce his or her anger)

We excluded studies with samples that overlapped with other published reports. In articles reporting results from overlapping samples, we chose the study with either the largest sample or the one with the most relevant/usable data. When multiple tasks were used to assess 1 single social cognition domain, we selected scores on 1 task (that we determined as most psychometrically sound or that was most commonly used across studies) per domain. We did not include results from any studies with overlapping samples within domains, however, we did include the same studies across domains (eg, the study by Addington et al[17] included measures for social perception, social knowledge, and emotion perception, therefore, Addington et al contributed 1 data point to each domain).

A total of 112 studies, yielding 154 effect sizes, met our selection criteria (table 2). We excluded articles from the total number (k = 1112) yielded by our search strategies for the following reasons: reviews or letters to the editor

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Table 2. Studies Included in the Meta-analysis: Description of Samples and Domain-wise Social Cognition Tasks

	First Author	Location of Research	N (SCs)	N (NCs)	Years Ill (SCs)	Sample Description (SCs)	Social Cognition Task	Domain
1	Addington[a]	Canada	53	55	>3	O	FEIT	EP
							Social Cue Discrimination Test	SP
							Situational Features Recognition Test (action)	SK
2	Baas[a]	the Netherlands	18	28	9.9	O	Trustworthiness Social Judgment Task	SP
3	Badan Bâ	Switzerland	16	16	9.5	O	ToM: First-order false belief stories	ToM
4	Bediou	France	30	30	8.82	"clinically stable"	Facial affect recognition	EP
5	Benedetti	Italy	24	20	12.7	O	Comic-strip stories (ToM condition; errors)	ToM
							Comic-strip stories (Affective empathy condition; errors)	EP
6	Bigelow	United States	20	14	2.7	B; recent-onset	Movie stills—Unmasked Faces Test (accuracy)	EP
7	Bora[a]	Australia, Turkey	91	55	10.7	O	Eyes Test	ToM
8	Borod	United States	20	21	13.58	"chronic"	FEIT	EP
9	Bozikas	Greece	36	30	10.92	I	Cartoon stories (developed for Greek population; first-order false belief)	ToM
10	Brüne[a]	Germany	23	18	12.3	Both	Facial affect recognition task (total score)	EP
							Cartoon picture stories (first-order false belief)	ToM
11	Brüne[a]	Germany	38	29	8.8	NR	Cartoon picture stories-Mental states total (a + b)	ToM
12	Brunet	France	25	25	21.6	NR	Attribution of Intention Task	ToM
13	Chambon	France	26	26	9.6	I	Facial emotion recognition task (discriminability for upright faces)	EP
14	Champagne-Lavau	Canada	31	29	16.2	O	Comic-strip stories	ToM
15	Chen	United States	19	30	18.1	NR	NimStim Face Stimulus Test ("happy" condition)	EP
							Eyes task	ToM
16	Chung	United States	35	32	NR	O	Emotional Context Processing Task (valence ratings across conditions)	EPr
17	Corcoran	United Kingdom	59	44	13.9	O	Hinting Task	ToM
18	Corcoran[a]	United Kingdom	55	30	NR	I	Hinting Task	ToM
19	Corrigan	United States	26	14	NR	O	Schema Component Sequencing Task-Revised (Combined Juxtaposition score)	SK
20	Corrigan	United States	24	15	15.2	I	Social Cue Perception Task (sensitivity to social cues)	SP
21	Couture[a]	United States	44	41	5.5	"mild psychopathology"	Movie stills—with face (total)	EP
							The Abbreviated Trustworthiness task—Untrustworthy faces	SP
							Eyes task	ToM

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Table 2. (Continued)

	First Author	Location of Research	N (SCs)	N (NCs)	Years Ill (SCs)	Sample Description (SCs)	Social Cognition Task	Domain
22	Csukly	Hungary	58	29	10.8	O	The Emotion Hexagon Task (total across conditions)	EP
23	Das	Australia	23	22	9.4	NR	Online implicit mentalizing task (Intentionality condition)	ToM
24	de Achával	Argentina	20	20	NR	O	Faces Test (emotion recognition)	EP
							Reading the Mind in the Eyes Test	ToM
25	Diaz	United States	11	17	13.7	NR	Working memory based on IAPS photographs (accuracy)	EPr
26	Donohoe	Ireland	73	78	18.2	O	IPSAQ EB	EB
							IPSAQ PB	PB
27	Edwards	Australia	29	24	NR	O; first-episode	Facial Affect Computer Tasks (FACT) #4, Emotion labeling task	EP
28	Feinberg	United States	20	20	NR	I	Faces with standardized emotions (Emotions labeling task)	EP
29	Fisher	United States	91	30	NR	O	Facial Affect Recognition	EP
30	Fujiwara	Japan	26	20	10.1	O	Perception of Affect Tasks (PAT)—Matching the social situation with emotional labels	ToM
							PAT—Matching emotional faces with emotional labels	EP
							PAT—Matching emotional faces with nonverbal social situations	EPr
31	Green	United States	81	46	FE	O; first-episode	MSCEIT (Identifying Emotions)	EP
							MSCEIT (Managing Emotions)	EPr
							TASIT (Perception of Social Inference—Enriched)	ToM
							Relationships Across Domains	SP
31a	Green	United States	53	47	>5	O; chronic	MSCEIT (Identifying Emotions)	EP
							MSCEIT (Managing Emotions)	EPr
							TASIT (Perception of Social Inference—Enriched)	ToM
							Relationships Across Domains	SP
32	Green	Australia	20	22	NR	O	Vignette-Face Task (accuracy)	EPr
							Facial emotion processing task (accuracy)	EP
33	Gur	United States	14	14	NR	O	Emotional valence discrimination task	EP

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Table 2. (Continued)

	First Author	Location of Research	N (SCs)	N (NCs)	Years Ill (SCs)	Sample Description (SCs)	Social Cognition Task	Domain
34	Hall	United Kingdom	20	20	NR	NR	Hexagon task (face emotion recognition)	EP
							Social Cognition Test (complex social judgments)	SP
35	Haralanova	Bulgaria	30	30	14.23	I	Task based on IAPS and Munich Affective Picture System (neutral stimuli, subjective emotional arousal)	EPr
36	Harrington[a]	New Zealand	25	38	10.9	B	Position sequencing position scores (social script and mechanical stories)	SK
							False Belief stories (first-order ToM)	ToM
37	Heimberg	United States	20	20	NR	I; first hospitalization, neuroleptic naïve	Facial emotion discrimination	EP
38	Hirao	Japan	20	20	10.6	NR	Reading the Mind in the Eyes	ToM
39	Hooker	United States	20	27	18.8	O	Facial affect recognition (based on Benton Test of Facial Recognition)	EP
40	Hooker	United States	21	17	24.47	O	The Recognition of Faux Pas test % correct, Faux Pas total score	ToM
41	Horan	United States	45	41	14.6	I	FEIT	EP
42	Ibanez	Argentina	13	13	12.46	NR	Valence categorization task	EP
43	Irani	United States	10	10	NR	O	Reading the Mind in the Eyes Task (accuracy)	ToM
44	Johnston	Australia	18	18	>2	O	Facial emotion recognition (accuracy)	EP
45	Kantrowitz	United States	41	41	NR	I	Voice emotion recognition	EP
46	Kelemen	Hungary	52	30	NR	O	Eyes Test	ToM
47	Kern	United States	50	44	NR	O	TASIT (Perception of Social Inference—Enriched)	ToM
48	Kern	United States	176	300	19.5	O	MSCEIT (Managing Emotions)	EPr
49	Kerr	United States	29	23	NR	I	FEIT	EP
50	Kinderman & Bentall	United Kingdom	20	20	NR	I	IPSAQ EB	EB
							IPSAQ PB	PB
51	Kington	United Kingdom	16	16	11.96	B	Expression Recognition Test—Basic Emotions, Faces	EP
							Expression Recognition Test—Complex Mental States, Eyes	ToM
52	Kline	United States	27	15	NR	O	Facial affect labeling	EP
53	Kohler	United States	35	45	5.6	O	Emotion valence task	EP
54	Kosmidis	Greece	28	26	11.4	NR	TASIT (modified for Greek sample, Perception of Social Inference)	ToM
55	Kosmidis	Greece	37	32	10.9	Both	Emotion discrimination task	EP
56	Kubota	France	25	10	12.5	Both; hearing-impaired	Facial affect labeling task	EP
57	Kucharska-Pietura	Poland	100	50	7.6	I	Facial emotion recognition task	EP

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Table 2. (Continued)

	First Author	Location of Research	N (SCs)	N (NCs)	Years Ill (SCs)	Sample Description (SCs)	Social Cognition Task	Domain
58	Kuperberg	United States	18	18	16.9	O	Two-sentence scenarios to assess perception of emotional valence	EP
59	Langdon[a]	Australia	35	34	12.6	O	IPSAQ EB	EB
							IPSAQ PB	PB
							Picture Sequencing Task—False Belief	ToM
							Picture Sequencing Task—Social Script	SK
60	Lee	United States	12	13	NR	O	Belief Attribution Task: False Belief	ToM
61	Leentjens	Netherlands	26	24	18	O	Facial affect discrimination task	EP
62	Leitman	United States	43	34		NR	FEIT	EP
63	Lepage	Canada	30	28	8.5	O	Facial emotion valence perception	EP
64	Leppanen	South Africa	44	40	13.7	O	Mac-Brain Face Stimulus Set (% hits across "happy" conditions)	EP
65	Lewis	United States	18	10	NR	I	Facial affect recognition (errors)	EP
66	Lincoln	Germany	75	75	10	B	Theory of mind movie task of social situations ("intentions" condition)	ToM
							IPSAQ EB	EB
							IPSAQ PB	PB
67	Marjoram	United Kingdom	15	15	11.3	B	Hinting Task	ToM
68	Martin	France	20	20	12.6	I	Facial affect matching task (accuracy)	EPr
69	Martino	Argentina	21	15	8.57	O	Faux-pas task	ToM
70	Mathews[a]	United States	40	40	NR	O	Facial emotion recognition (discrimination)	EP
							TASIT (Perception of Social Inference subtests)	ToM
71, 72	Matsui / Sumiyoshi[b]	Japan	25	32	NR	O	Frequency judgment task	SP
73	Mier	Germany	16	16	NR	O	Affective ToM task	ToM
							Facial recognition of emotion	EP
74	Mo	China	29	22	19.34	I	Sally-Ann stories (first-order false belief)	ToM
75	Montag	Germany	80	80	9.8	B	Movie for Assessment of Social Cognition (mental state decoding)	ToM
76	Mueser	United States	28	15	NR	I	FEIT	EP
77	Novic	United States	17	17	10.6	I	Facial affect recognition	EP
78	Park	United States	20	16	NR	O	Emotional identification	EP
79	Pijnenborg	Netherlands	46	53	7	O	Facial expression identification task	EP
80	Pinkham[a]	United States	49	44	10.4	O	FEIT	EP
							Schema Component Sequencing Task (accuracy)	SK
							Hinting Task	ToM
81	Pinkham[a]	United States	24	12	NR	O	Trustworthiness/approachability task (% rated trustworthy)	SP

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Table 2. (Continued)

	First Author	Location of Research	N (SCs)	N (NCs)	Years Ill (SCs)	Sample Description (SCs)	Social Cognition Task	Domain
82	Pousa	Spain	61	51	10.69	O	Picture Sequencing Task (Social Script)	SK
							Picture Sequencing Task (False Belief)	ToM
83	Randall[a]	United Kingdom	32	18	NR	O	ToM: first-order false belief stories	ToM
							IPSAQ EB	EB
							IPSAQ PB	PB
84	Reske	Germany	12	15	NR	First-episode	Facial Emotion Discrimination Task (% correct)	EP
85	Rubin	United States	22	31	13.23	NR; all women	Penn Emotion Acuity Test	EP
85a	Rubin	United States	26	26	11.58	NR; all men	Penn Emotion Acuity Test	EP
86	Russell	United Kingdom	5	7	13	NR	Reading the Mind in the Eyes Test (errors)	ToM
87	Sachs	Austria	40	43	3.7	I	Emotion differentiation test	EP
							Penn Emotion Acuity Test	EPr
88	Sarfati[a]	France	25	15	NR	I	Comic-strip stories (ToM)	ToM
89	Sasson	United States	10	10	4.2	O	Movie Stills Task (Face-present condition)	EP
90	Schimansky	Switzerland	40	39	12.5	B	Reading the Mind in the Eyes Test	ToM
91	Schneider	Germany/ United States	20	20	NR	I	Facial Emotions for Brain Activation Test-Emotion Discrimination (accuracy)	EP
92	Scholten	The Netherlands	53	42	5.9	Both	Facial affect recognition task	EP
93	Shamay-Tsoory[a]	Israel	24	28	NR	O	Ekman Faces Test	EP
							Cognitive ToM task	ToM
94	Stewart	United Kingdom	59	38	13.95	B	Request/Response Task (Knowledge Attribution)	ToM
95	Streit	Germany, Japan	15	12	NR	I	Pictures of Facial Affect (first affect recognition run)	EP
96	Suslow	Germany	49	28	NR	Both	Emotion priming/Facial emotion discrimination task (decision latencies)	EPr
97	Tenyi	Hungary	26	26	NR	NR	Violations of the Maxim of Relevance (ToM vignettes)	ToM
98	Tomlinson	United Kingdom	16	24	NR	NR	Point-light images	EP
99	Toomey[a]	United States	28	28	NR	I; institutionalized	Profile of Nonverbal Sensitivity Test (total)	SP
100	Tse	Hong Kong	40	46	15.15		Facial Affect Perception Test (FAP) (total error)	EP
101	Tso	United States	33	33	17.9	O	Reading the Mind in the Eyes Task	ToM
							MSCEIT (Managing Emotions)	EPr
102	Tsoi	United Kingdom	30	30	17.5	B	Six sets of cartoon picture stories	ToM
103	Turetsky	United States	16	16	9	O	Penn Facial Emotion Stimuli	EP
104	Van't Wout	the Netherlands	37	41	9.62	Both	Facial affect recognition (degraded faces) errors across emotion conditions	EP

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Table 2. (Continued)

	First Author	Location of Research	N (SCs)	N (NCs)	Years Ill (SCs)	Sample Description (SCs)	Social Cognition Task	Domain
105	Vaskinn	United States	72	58	NR	O	The Interpersonal Perception Task-15	SP
106	Vistoli[a]	France	19	21	NR	NR	Comic-strips stories (ToM; errors)	ToM
107	Weniger	Germany	45	30	6.7	NR	Facial affect recognition (errors)	EP
108	Williams[a]	Australia	28	72	0.95	O; first-episode	Facial Emotions for Brain Activation Test (Emotion Discrimination accuracy)	EP
109	Wolwer	Germany	32	21	NR	I	Facial affect recognition	EP
110	Wynn[a]	United States	33	42	NR	O	Half-PONS	SP
111	Yamashita	Japan	49	28	14	O	Means-Ends Problem Solving Procedure	SK
112	Zhu	China	40	31	9.2	I	Faux pas Test (Faux pas recognition questions)	ToM
113	Ziv	Israel	30	30	13.2	O	ToM stories (first-order false belief)	ToM
							Emotion Inference Questionnaire	SP

Notes: All references in this table are listed in the supplemental material. Tasks used in multiple studies: FEIT, Face Emotion Identification Test; IAPS, International Affective Picture System; TASIT, The Awareness of Social Inference Test; IPSAQ, Internal, Personal, Situational Attribution Questionnaire; PONS, Profile of Nonverbal Sensitivity; MSCEIT, Mayer–Salovey–Caruso Emotional Intelligence Test (In all cases, we used the names of the task as specified in the report.) Social cognition domains: ToM, Theory of Mind; EP, Emotion Perception; EPr, Emotion Processing; SP, Social Perception; SK, Social Knowledge; EB, Externalizing Bias; PB, Personalizing Bias; SC, schizophrenia sample; NC, normal comparison sample; NR, not reported; O, outpatients; I, inpatients; B, mixed inpatient and outpatient sample; Unless indicated, NOT specified as first-episode.

[a]Indicate studies chosen among several with overlapping samples.

[b]Study authors indicated (via e-mail correspondence) that the 2 articles reported data collected at the same time from the SC and NC samples.

(k = 213), no NC sample (k = 393), no social cognition measures (k = 129), no schizophrenia sample/atypical schizophrenia sample, eg, prodrome, ultra-high-risk, or child sample (k = 198), <90% of sample with schizophrenia or schizoaffective disorder (k = 46), unusable data/no responses from authors to e-mails requesting data (k = 51), overlapping samples (k = 48). (Some articles met multiple exclusion criteria, but we only counted them once.) Among the non-indexed articles we found in PubMed (wherein we could not specify limits), we excluded 26 articles describing animal studies and 10 articles written in a language other than English.

Data Extraction and Coding

Prior to conducting our analyses, we coded the following variables from the studies we reviewed: (1) first author, publication year, and country of origin; (2) number of participants, gender distribution, years of education in both groups; (3) duration of illness, inpatient vs outpatient status, first-episode vs not, type of antipsychotic medication, additional sample descriptors for the schizophrenia sample; (4) means and SDs, (or when unavailable), *t* values, F values, or chi-squared values for one measure per domain for each study. We classified emotion labeling tasks under the emotion perception domain, tasks requiring discrimination between emotion valences, and managing emotions under the emotion-processing domain. For attributional bias, we coded externalizing bias (EB) and personalizing bias (PB) separately; all studies included in our meta-analysis measured attributional bias with the Internal, Personal, and Situational Attributions Questionnaire (IPSAQ)[18] (there are other measures of attributional bias that have been used in people with schizophrenia, but they were not among those used in the studies that met our selection criteria). The IPSAQ yields an EB score (calculated by subtracting the number of internal attributions for negative events from the number of internal attributions for positive events) and a PB score (calculated by

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dividing the number of personal attributions for negative events by the sum of both personal and situational attributions for negative events).

Statistical Analysis

In all domains except attributional bias, scores reflected social cognitive abilities (with lower scores indicating poorer social cognition). We examined PB and EB separately; the scores in this case reflected the direction of bias, rather than impaired vs intact performance. All analyses were conducted in STATA/IC, version 10 (StataCorp. 2007. Stata Statistical Software: Release 10. College Station, TX: StataCorp LP). We used standardized mean difference effect sizes with Hedges correction for small sample size bias, ie, "g" to compare the schizophrenia and NC samples.[19] We calculated the mean effect sizes for each of the social cognition categories using the *meta* program. Forest plots and funnel graphs were created using the *metagraph* and *metafunnel* programs, respectively. We calculated a fail-safe *n* using Orwin's formula,[20] using a criterion effect size of 0.2. The fail-safe *n* is the number of studies with effect sizes of zero that would reduce the mean effect size to 0.2, a small effect.[21] We examined publication bias with Egger's regression intercept test, a statistical test of funnel plot asymmetry, using the *metabias* program.

When the homogeneity analysis (Q-test[22]) was significant and the I^2 index was greater than 50 (ie, more than 50% [a medium level] of total variability is due to true heterogeneity[23]), we used a random effects model in the mean effect size analysis and followed up with meta-regressions to examine heterogeneity between studies (*metan* program).

The independent variables to be examined in the meta-regressions, determined a priori, included the following: age, years of education, percent male, illness duration, first-episode (vs chronic/multiepisode), inpatient status (vs outpatient), and English speaking (vs not). Age, education, and percent male were all entered as 2 variables each (eg, age of schizophrenia sample and age of normal controls) as all studies reported these variables as 2 separate categories. Due to the large amount of missing data from each of the categories, separate univariate regressions were conducted for each pre-determined variable, to ensure that all available data would be utilized. (If all independent variables were included in a single regression, the k would decrease by more than 50% for many of the analyses, thus severely limiting interpretation of results.)

Results

Study Characteristics

Forty-two of the 112 studies included in our final analysis were conducted in the United States. Assessments in 48 of the 112 studies were conducted in a language other than English (we assumed that assessments in the United States and the United Kingdom were conducted in English unless otherwise noted [k = 2]).

Sample Characteristics

The 112 articles (comprising 114 unique samples) reported on 3908 SCs and 3570 NCs. Not all studies reported demographic data, although most reported age of participants (k = 110). The average age of SCs and NCs was 35.1 years (mean SD = 9.1) and 34.5 years (mean SD = 9.4), respectively. SCs had fewer years of education than did NC participants (mean years = 12.3 and 13.9 years, respectively; k = 76). Most of the study participants were men (mean = 67.0% in SCs, k = 109 and mean = 60.5% in NCs, k = 106).

Mean duration of illness of the SCs was 11.9 years (mean SD = 8.1; k = 69), which included four studies of first-episode patients (37 studies did not describe their sample in terms of chronicity). Twenty-four studies were conducted with inpatients with schizophrenia, 52 with community-dwelling outpatients, and 15 with both (21 studies did not report type of treatment setting). Seventy-one-point-three percent of the SCs across the studies were prescribed at least one atypical antipsychotic medication. Studies widely differed in the assessments they used to measure presence and severity of psychopathology among their SC participants; however, from our examination of the symptom scores, it appeared that participants generally had a mild to moderate level of symptoms.

Effect Size Calculations

SCs performed more poorly on all domains of social cognition compared with NCs. Effects sizes are reported in table 3 and are described below. Please see supplementary material for forest plots and funnel graphs for studies under each domain.

ToM (k = 50, n[NC] = 1536, n[SC] = 1760)

The mean effect for ToM was large (g = 0.96, with 95% confidence interval [CI] = 0.83 – 1.09, $P < .001$). We examined the potential role of age, education, gender, illness duration, inpatient status, and English-speaking status in the statistically significant heterogeneity across ToM studies (Q = 146.19, $P < .001$; $I^2 = 66.5$). There were no studies of ToM that included only first-episode patients. None of the variables examined significantly explained variability in the effect sizes ($P \geq .063$). The fail-safe *n* was 191. Egger's bias coefficient was significant (bias = 3.20, se = 0.80, $P < .001$) indicating possible publication bias.

Social Perception (k = 13, n[NC] = 450, n[SC] = 503)

The mean effect for social perception was large (g = 1.04, 95% CI = 0.79 – 1.29, $P < .001$). We examined the potential role of age, education, gender, illness duration,

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Table 3. Effect Sizes, Heterogeneity across Studies, and Publication Bias

Domain	k	ES (g)	CI	*P*	Q	*df*	*P*	*n* (NC)	*n* (SC)	Fail-safe *n*[a]	Bias Coefficient	Bias SE	*P*
Theory of mind	50	0.96	±13	<0.001	146.19	49	<0.001	1536	1760	191	3.2	0.80	<0.001
Social perception	13	1.04	±25	<0.001	37.91	12	<0.001	450	503	54	3.72	1.77	0.06
Social knowledge	7	0.54	±17	<0.001	10.48	6	0.106	263	298	12	3.62	2.69	0.237
Externalizing bias	5	−0.02	±38	0.918	14.56	4	0.006	225	221	−6	−0.71	3.26	0.841
Personalizing bias	5	−0.17	±55	0.532	29.33	4	<0.001	225	221	−9	−6.61	2.52	0.079
Emotion perception	62	0.89	±17	<0.001	324.63	61	<0.001	1715	1935	214	4.17	1.11	<0.001
Emotion processing	12	0.88	±30	<0.001	54.56	11	<0.001	638	574	41	−1.09	1.67	0.528

Note: k, number of studies; ES, effect size (Hedge's g); CI, confidence interval; Q, homogeneity analysis.
[a]Number of studies with effect size of 0 needed to reduce the mean effect size to a criterion level (ie, *d* = medium effect size of 0.5 or small effect size of 0.2).

first-episode status, inpatient status, and English-speaking status to explain the heterogeneity among the effect sizes (Q = 37.91, $P < .001$; $I^2 = 68.3$).

Only inpatient status significantly accounted for variability in the social perception effect sizes (estimate = 1.07, SE = 0.29, $P = .005$), with inpatients having greater deficits than outpatients. The remaining variables were not significant ($P \geq .189$). The fail-safe *n* was 54. Egger's bias coefficient was not significant ($P = .060$).

Social Knowledge (k = 7, n[NC] = 263, n[SC] = 298)

The mean effect for social knowledge was medium (g = 0.54, 95% CI = 0.37 – 0.72, $P < .001$), and there was no statistically significant evidence of heterogeneity across these studies (Q = 10.48, $P = .106$; $I^2 = 42.8$). The fail-safe *n* was 12. Egger's bias coefficient was not significant ($P = .237$).

Attributional Bias (k = 5, n[NC] = 225, n[SC] = 221)

The mean effect for both EB and PB was negligible (g = −0.02, 95% CI = −0.40 to 0.36, $P = .918$ and g = −0.17, 95% CI = −0.72 to 0.37, $P = .532$, respectively). Because both effect size estimates were nonsignificant, we did not conduct further analyses on these constructs. (We also conducted separate analyses on three of the four studies that included only SCs with persecutory delusions and found no difference in the results.)

Emotion Perception (k = 62, n[NC] = 1715, n[SC] = 1935)

The mean effect for emotion perception (k = 62) was large (g = 0.89, 95% CI = 0.72 − 1.05, $P < .001$). We examined the potential role of age, years of education, percent male, illness duration, first-episode status, inpatient status, and English-speaking status to explain the statistically significant heterogeneity across studies (Q = 324.63, $P < 0.001$; $I^2 = 81.2$).

Inpatient status was the only variable that significantly accounted for variability in the emotion perception effect sizes (estimate = 0.56, SE = 0.18, $P = .002$), with inpatients having greater deficits than outpatients. The remaining variables were not significant ($P \geq .140$). The fail-safe *n* was 214. Egger's bias coefficient was significant (bias = 4.17, se = 1.11, $P < .001$), indicating possible publication bias.

Emotion Processing (k = 12, n[NC] = 638, n[SC] = 574)

The mean effect for emotion processing (k = 12) was large (g = 0.88, 95% CI = 0.58 − 1.17, $P < .001$). We examined the potential role of age, education, gender, illness duration, first-episode status, inpatient status, and English-speaking status to explain the statistically significant heterogeneity across studies (Q = 54.56, $P < .001$; $I^2 = 79.8$).

Illness duration was the only variable that significantly accounted for variability in the emotion processing effect sizes (estimate = 0.08, SE = 0.03, $P = .04$); longer illness duration accounted for more pronounced deficits. The remaining variables were not significant ($P \geq .118$). The fail-safe *n* was 41. Egger's bias coefficient was not significant ($P = .528$).

Discussion

The goal of this study was to review and examine the quantitative evidence of deficits in domains of social cognition in schizophrenia, including those that have not been extensively studied but deemed important by the NIMH consensus statement on social cognition in schizophrenia.[3] SCs performed more poorly than did the NC participants across all domains. Each of the social cognition domains had high levels of heterogeneity among the effect sizes within the domains, except attributional bias. The direction of all effects, however, was the same, and we examined this heterogeneity with regression analyses.

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There were no significant differences in the direction of attributional bias between the NCs and SCs, including the subset of patients with persecutory delusions. There was no heterogeneity in the effect sizes for PB or EB, and notably, unlike the other domains, the same measure of attributional bias was used across all the studies we included in our analysis. There was some evidence from the studies included in this meta-analysis that PB was associated with paranoid traits in people across both samples, but not specifically with a schizophrenia diagnosis. There is evidence from other studies comparing SCs with paranoia to those without, suggesting that the former tend to have an EB for negative events.[24]

The large effect seen for ToM (Hedge's g = 0.96 in 50 studies) was consistent with previous meta-analyses with fewer studies (Sprong et al[14]: k = 29, Cohen's d = −1.26; Bora et al[13] k = 36, d [range across individual tasks] = 0.90 − 1.08). The large effect for emotion perception (g = 0.89 in 62 studies) was also as expected, based on reviews and a recent meta-analysis of emotion identification in schizophrenia (Kohler et al[15]: k = 86, d = −0.91).[25] (Unlike Kohler et al,[15] we selected 1 emotion identification task per study and excluded studies with overlapping samples.) Our results also call attention to the importance of social perception, which had the largest effect size (g = 1.04 in 13 studies), and emotion processing, which had a large effect size (g = 0.88 in 12 studies). These 2 domains have not been studied nearly as extensively as ToM and emotion perception, but the strength of their effects warrants future research on these domains. Social knowledge, too, is a lesser studied domain in schizophrenia; however, like crystallized "cold" cognition abilities, one might expect that declarative social knowledge, such as scripts for common social situations, may be relatively less impaired than other social cognitive abilities in schizophrenia (g = 0.54 in seven studies).

Heterogeneity in effect sizes between studies within the domains was not accounted for by age, gender, education, or language in the schizophrenia samples. Patients with longer duration of illness had greater deficits in emotion processing, and greater deficits in social perception and emotion perception were associated with inpatient status. Studies have demonstrated that fluctuations in social cognition impairments do not seem to be related to symptoms of reality distortion (ie, delusions and hallucinations), but have fairly strong relationships with disorganization and negative symptoms.[16] We could not examine in detail the mechanisms underlying inpatient status and worse social and emotion perception deficits due to the lack of available data. However, given that hospitalization is typically associated with elevated positive symptoms (rather than negative symptoms),[26] our results suggest that acute psychosis may disrupt some aspects of social cognition. A recent factor analysis also showed that positive symptoms and agitation are also associated with a "hostile attributional style" among SCs[27] (we did not conduct any regression analyses for attributional style because of lack of heterogeneity in the effect sizes).

We were restricted in our ability to conduct multivariate regression analyses by missing data; furthermore, we were unable to use data on symptom severity, type and length of antipsychotic treatment, or similar disease burden variables, given the varied manner in which sample characteristics were assessed. However, the majority of the unexplained variance appears to stem from several factors related to the social cognition measures (table 2 demonstrates the heterogeneity in how a given construct was measured): (1) except for established and widely used tasks such as the Reading the Mind in the Eyes task, few measures were standardized; (2) tasks were modified, culturally adapted, and/or translated, such that equivalence of task versions was unknown. Social cognition tasks also face the problems that underlie neuropsychological tests; when tasks are not matched on relevant psychometric variables (such as task difficulty) and differ in their ability to discriminate between high and low performances, we cannot make inferences about differential deficits in a patient population with certainty.[28] Thus, apparent performance differences may be confounded by the differing discriminatory power of the tests.

Despite the limitations of the studies we reviewed, the results are important in that they suggest that social cognition deficits clearly exist in schizophrenia across domains and may reflect some overlapping deficits among people with the illness. Some domains of social cognition have smaller effects than others, and most have substantially smaller effects than certain nonsocial cognitive domains, notably, processing speed as measured by Digit Symbol tasks (g = 1.57).[29] However, a large effect size may not necessarily be indicative of a central or core deficit, whereas small effects can have a considerable impact on outcomes, depending on their position within a longer causal sequence. This point is also underscored in reviews and meta-analyses demonstrating that social cognition deficits are more strongly related to functioning than are neurocognitive deficits.[9,10] The meta-analysis by Fett and colleagues[10] separated out the effects of social perception and emotion processing and perception on community functioning, and the results from the current meta-analysis place those findings in a broader context by quantifying the degree of deficit in those domains in a way that has not been done before. There is also evidence from evolutionary biology and cognitive neuroscience research that social and nonsocial higher-order cognitive processes are intricately related constructs and are associated with overlapping neurobiological systems (eg, medial prefrontal cortex) that are implicated in schizophrenia.[30,31] To that end, this meta-analysis does not allow for an estimation of the independence of social cognitive impairments from more general cognitive impairments, or the specific processes underlying social cognitive deficits. Indeed, the

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clinical study of social cognition may have far outpaced the development of conceptual models and finer measures of social cognition in schizophrenia.

Conclusions

In conclusion, previously published meta-analyses of social cognition in schizophrenia have focused on 2 domains (ToM and emotion perception) without comparing them to other domains. Given the multifaceted nature of social cognition in schizophrenia, comparing results across all six NIMH consensus domains is warranted in order to examine differential deficits across domains and predictors of impairment. Our meta-analysis replicated the results of existing meta-analyses of ToM and emotion perception, but we also examined the other four domains of social cognition in schizophrenia, with an emphasis on the magnitude of and potential variables associated with heterogeneity. Furthermore, our study highlights the importance of further research on social perception and emotion processing, which showed some of the largest effect sizes, yet have been less studied than some of the other domains. Additionally, deficits in both of these domains were related to disease-burden variables (inpatient status and chronicity, respectively) and may have implications for functional intervention. Our study also found no significant differences in attributional style between the schizophrenia and healthy comparison groups, with no heterogeneity in effect sizes within the PB and EB sub-domains. Heterogeneity of results within the other domains was largely unexplained, which underscores the need for development and use of psychometrically sound assessments that can reliably measure social cognition in schizophrenia. Future models of functional impairment in schizophrenia that incorporate social cognition will be needed, along with a better understanding of the biological and environmental underpinnings of such impairments, to inform more effective treatment.

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Supplementary Material

Supplementary material is available at http://schizophreniabulletin.oxfordjournals.org.

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