Review Article

Advances in the ecological validity of research on social cognition in schizophrenia: A systematic review of the literature

Alvaro Cavieres [*], Vanessa Acuña, Marcelo Arancibia, Camila Escobar

Valparaiso University, Valparaíso, Chile

ABSTRACT

Introduction: Ecologically valid assessments need to require tasks representative of real, everyday interactions between people in a social environment (i.e., verisimilitude) and to predict aspects of real-life performance in those same interactions (i.e., veridicality). To determine how researchers interested in social cognition among people with schizophrenia currently understand and apply ecological validity in their work, we conducted a systematic review of studies that had the ecological validity of their results as an explicit objective.
Methods: We performed the described systematic review following PRISMA guidelines.
Results: Of the 18 studies reviewed, only two defined *ecological validity*, 15 incorporated modifications to improve their verisimilitude, eight proposed analyses to examine their veridicality, and seven aimed to achieve both objectives.
Conclusions: Our systematic review suggests that very few published studies on social cognition among people with schizophrenia have explicitly defined *ecological validity*, and most have focused only on the verisimilitude of the tasks required while neglecting the veridicality of the results.

1. Introduction

People with schizophrenia face numerous challenges in their daily lives, including a reduced capacity for close relationships (Budziszewska et al., 2020), difficulties with obtaining and keeping jobs (Hakkaart-van Roijen et al., 2015), decreased engagement in social activities (Bellack et al., 2007), and less adequate social functioning overall (Gorostiaga et al., 2017). Although those difficulties partly stem from a general deficit in cognitive performance, most have been attributed to poor functioning in *social cognition* (Halverson et al., 2019; Schmidt et al., 2011), defined as the ability to perceive, interpret, and process social information in real-world settings and to construct representations of relationships between oneself and others and flexibly use those representations to guide social behavior (Green et al., 2008).

Although social cognition, considered to be a core feature of schizophrenia, has received considerable attention from researchers, its specific role in appropriate social functioning among people with schizophrenia remains somewhat disputed. Brown et al. (2014) found that theory of mind (ToM) had the most widespread relationship with social functioning across multiple subdomains, whereas other domains of social cognition correlated only with specific areas of social

functioning. Those results, in implying that different domains of social cognition may serve different aspects of social functioning, are consistent with the findings of a previous review showing that relationships between social cognition and aspects of functional outcomes depend on the specific domains of each construct examined (Couture et al., 2006). They also corroborate the results of a meta-analysis showing that only a fraction of the variance in social functioning can be explained by variations in social cognitive performance (Fett et al., 2011).

More recent studies, however, have demonstrated a correlation between social cognition, work skills, and interpersonal functioning (Mucci et al., 2021). Moreover, individuals with higher baseline social cognition have often been shown to exhibit more significant improvement in work skills and interpersonal functioning. A systematic review and meta-analysis of cross-sectional and longitudinal studies examining cognitive predictors of psychosocial function in individuals with early psychosis has also revealed that social cognition is significantly associated with both concurrent and long-term function (Cowman et al., 2021).

Social functioning can be understood as the sum of two distinct functional constructs: real-world behavior (i.e., observed real-world functioning, or what the patient actually does) and functional capacity

(i.e., the patient's performance under neutral and optimal conditions on tasks related to the real world; Bechi et al., 2017). Discrepancies may exist between functional capacity and functional performance, with the former being influenced by factors affecting everyday behavior (Bowie et al., 2012). Moreover, several noncognitive factors may influence differences in performance on tests versus in everyday life, including in terms of emotional problems, premorbid functioning, psychomotor functioning, health problems, and varying environmental demands (Chaytor and Schmitter-Edgecombe, 2003). Those distinctions may be important when examining social cognition's contribution to social functioning, for they may lead to different conclusions.

Most research on social cognition has explored the five domains defined by the National Institute of Mental Health workshop (Green and Leitman, 2008)—ToM, emotional processing, attributional bias, social knowledge, and social perception—with social perception and social knowledge being far less studied than the other three domains (Cavieres and López-Silva, 2022). Most tests used in research require participants to recognize or discriminate facial expressions (Gorrino et al., 2024), complete questionnaires or describe interactions (De Rossi and Georgiades, 2022), or view pictures and/or movies or read stories to identify double bluffs, mistakes, or white lies. (Yeh et al., 2021).

In the Social Cognition Psychometric Evaluation (SCOPE) study, Pinkham et al. (2018) employed a systematic approach to assess the psychometric properties of the most widely utilized measures in four core domains of social cognition—emotion processing, social perception, ToM/mental state attribution, and attributional bias—with the objective of identifying the most appropriate measures for use in clinical trials. According to the results the Hinting Task (Corcoran et al., 1995), Bell Lysaker Emotion Recognition Task, and the Penn Emotion Recognition Task (Kohler et al., 2003) demonstrated the most robust psychometric properties and were therefore recommended for use in future trials. By contrast, the Reading the Mind in the Eyes Test (Baron-Cohen et al., 2001), the Awareness of Social Inference Test (McDonald et al., 2003), and Intentionality Bias Task (Rosset, 2008) exhibited somewhat weaker psychometric properties and thus require further study (Pinkham et al., 2018).

Beyond that, much of the mentioned research on social cognition has been criticized for the methodologies employed. According to Teufel et al. (2013), simple pictorial representations of other people are "social" in the restricted sense that they reproduce their physical features, not their spatiotemporal properties. Even watching videos can be considered to be "non-social," because observers know that they are not watching real people and will not attribute mental states to the stimuli, or else they may do so in a qualitatively different way from real social interaction. On that count, Pönkänen et al. (2011) have identified different information-processing mechanisms depending on whether observers believe that they are watching a real person present at the time of viewing. Teufel et al. (2010), meanwhile, have argued that another person's actual or assumed presence increases observers' tendency to attribute mental states to the stimuli observed, which affects their perceptual processing of specific socially relevant information. At the same time, Fuchs (2015) has criticized current paradigms that conceive people with schizophrenia as being enclosed individuals with clearly defined brain dysfunction. Instead, Fuchs has countered that most mental disorders imply more or less profound disturbances of intersubjectivity, meaning a restricted capacity to flexibly respond to the social environment and reach a shared understanding by interacting with others. Nevertheless, social cognition is commonly studied in contexts without any real interactions.

Those issues all relate to social cognitive assessments' *ecological validity*, defined as the degree to which results obtained in controlled experimental conditions relate to performance observed in natural environments (Tupper and Cicerone, 1991). Two complementary characteristics of studies are generally considered to be necessary to meet that criterion: *verisimilitude*, or the degree to which a test's cognitive demands resemble demands encountered in the everyday environment, and

veridicality, or the degree to which tests empirically relate to measures of daily functioning (Franzen and Wilhelm, 1996). On the one hand, verisimilitude requires tests that ideally consist of everyday cognitive tasks so that inferences about the individual's probability of performing the tasks in everyday life can easily be drawn from their results. To determine veridicality, on the other hand, the relationship between performance on social cognitive tests and measures of everyday functioning (e.g., employment status, clinician's ratings, and behavioral observations) is assessed using statistical methods (Spooner and Pachana, 2006). Whereas some authors have focused on new methodologies to improve the reliability and generalizability of the results of such investigations (Benito-Ruiz et al., 2022; Hermans et al., 2019), others have advocated shifting from a construct-driven to a function-driven approach in order to improve the ecological validity of their findings (Burgess et al., 2006).

To be sure, ecological validity is a critical aspect to consider when recommending methods of evaluation to advance the study of social cognition among people with schizophrenia. Establishing the ecological validity of the measures is important for at least two reasons. First, to clarify the relationship between people's social cognition and real-life performance, the tasks required should be similar to ones encountered in their daily lives and not represent additional difficulties resulting from greater cognitive demands. Second, to ensure the construct validity of social cognition, it is necessary to assess the ability to perceive, interpret, and process social information in real-life settings.

Against that background, we determined that it was important to identify new methodologies developed by researchers to improve the ecological validity of their work. Instead of examining the ecological validity of the work itself, we opted for the mentioned approach because, despite the long development of research on social cognition among people with schizophrenia, many aspects remain that are not fully established, including what is meant by *ecological validity* and how to best achieve it. To that end, we conducted a systematic review of studies that have examined social cognition among people with schizophrenia and that explicitly included the ecological validity of their results as a primary objective. We sought to answer three questions regarding the studies examined: (1) Was ecological validity explicitly defined? (2) How was the verisimilitude of the study ensured? (3) How was the veridicality of the results determined?

2. Methods

We performed a systematic review following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (Page et al., 2021). The completed checklist is included as supplementary material.

2.1. Data sources and search strategy

To select literature for the review, we searched three databases from their inception until the date of the search without restrictions on date or language: Medline (Ovid MEDLINE(R) ALL, 1946–April 1, 2024), Embase (Ovid, 1974–April 1, 2024), and Scopus (Elsevier, XXXX–April 1, 2024). Details about our search strategy are made available as supplementary material.

We included studies that evaluated the ecological validity of measurements of social cognition among people more than 18 years old with the *Diagnostic and Statistical Manual of Mental Disorders* or the International Classification of Diseases diagnosis of schizophrenia of all races and both sexes in any setting (i.e., inpatient and outpatient). Only studies that measured ecological validity on a continuous scale were included. We excluded secondary studies (i.e., systematic reviews with meta-analyses and narrative reviews) and non-English literature. The quality of studies was assessed using the Appraisal Tool for Cross-Sectional Studies (Downes et al., 2016), the results of which are available as supplementary material.

2.2. Study selection

Two reviewers (AC and MA) independently selected studies for inclusion in the systematic review, while a third reviewer (VA) resolved any disagreement between them. The software Covidence was used to record decisions and resolve disagreements between individual judgments.

2.3. Data extraction

AC and MA independently extracted data from the included studies (i.e., sample, methods, interventions, outcomes, results, and major conclusions), while VA independently extracted data from a random sample of those studies (i.e., 10 % of the total) to ensure reliability (Table 1).

3. Results

We recovered a total of 2357 studies, 636 of which were duplicates. After primary screening, we were left with 57 articles that we retrieved and assessed for eligibility. Of them, 39 were excluded due to being posters, non-English literature, or non-available articles or because the design or the outcomes measured did not correspond with the objectives of our review. Ultimately, 18 studies were included in the review (see Fig. 1).

Only two of the selected studies included an explicit definition of *ecological validity* (Bromley et al., 2012; Vaskinn et al., 2009) that referred to both verisimilitude and veridicality. Regarding the design of the studies, 15 incorporated modifications to improve their verisimilitude (Behere et al., 2011; Bekele et al., 2017; Briend et al., 2019; Buck et al., 2014; Cavieres et al., 2022; Chaturvedi et al., 2020; Faith and Rempfer, 2018; Granholm et al., 2013; Huang et al., 2023; Penn et al., 2002; Poole et al., 2000; Serra-Mayoral et al., 2021; Shi et al., 2013; Souto et al., 2020; Vaskinn et al., 2009), eight proposed analyses to examine their veridicality (Bromley et al., 2012; Buck et al., 2014; Chen et al., 2017; Faith and Rempfer, 2018; Granholm et al., 2013; Penn et al., 2002; Poole et al., 2000; Vaskinn et al., 2009), and only seven aimed to achieve both objectives (Bromley et al., 2012; Buck et al., 2014; Canty et al., 2021; Faith and Rempfer, 2018; Granholm et al., 2013; Penn et al., 2002; Poole et al., 2000).

Concerning the social cognitive functions assessed, five studies examined ToM, five studied emotion recognition, two studied social perception, and one examined the jumping-to-conclusions bias. The remaining five studies reported methods based on directly observing patients' performance in real-life situations to improve the veridicality of such investigations.

Concerning the findings, the three investigations that employed virtual reality (VR) technology to enhance the realism of stimuli and the environments in which they were presented revealed different results. First, Bekele et al. (2017) presented emotional expressions with increasing levels of intensity preceded by a narrative for context. The participants were asked what emotion they thought the avatar displayed and how confident they were in their response. Although they performed similarly, patients with schizophrenia differed from control participants in the manner that they processed and responded to the emotional faces. Second, Souto et al. (2020) employed validated stimuli in experimental conditions that closely approximated reality in order to compare the performance of patients and controls in a facial emotion recognition task. The findings indicated that patients exhibited a lower number of correct responses than controls and with more significant challenges in recognizing fear and disgust. Third and last, Canty et al. (2021) used a virtual interface to simulate real-life demands, and ToM was found to have added value in predicting both community functioning and functional capacity beyond what was accounted for by cognitive empathy, clinical symptoms, and neurocognition among people with schizophrenia.

Meanwhile, other researchers employed videos of actors or real people. For one, Behere et al. (2011) found that a sample of patients exhibited a significantly higher incidence of errors in recognizing emotions than healthy controls did. Moreover, they concluded that patients with more pronounced symptoms tended to misidentify "non-threatening" emotions as "threatening." For another, Briend et al. (2019) requested participants to listen to film excerpts and infer the mental states of the characters. Among the results, patients demonstrated significantly poorer performance than controls on a comprehension questionnaire and decreased recruitment of the right temporoparietal junction. Beyond that, Huang et al. (2023) instructed participants to infer the thoughts, feelings, or intentions of characters in a video depicting individuals having dinner. The scores on the task were significantly correlated with a ToM task and the recognition of facial and prosodic emotions. In other work, Serra-Mayoral et al. (2021) presented short clips of everyday social interactions to participants, who subsequently responded to one ToM-based question. Patients demonstrated a significant deficit in complex ToM-based tasks that require the comprehension of language pragmatics and others' intentions, whereas the recognition of basic emotions remained relatively intact. Last, Vaskinn et al. (2009) presented videotaped scenarios of individuals in natural settings to both patient and control groups. After each scene, participants were presented with a series of multiple-choice questions about the status of the characters, the veracity of the statements made by individuals in the scenes, and the level of intimacy between the individuals depicted. Although the test discriminated between groups, it did not reveal any correlations with community functioning among individuals diagnosed with schizophrenia.

Other researchers have proposed new measures such as the Narrative of Emotions Task (NET); (Buck et al., 2014), an interview that prompts participants to define a range of emotions, give narrative accounts involving the emotions, and explain why the described events elicit those emotions. Total NET scores were significantly correlated with overall performance on a role-play task, but only one significant association with global measures of social and community functioning was found. Convergent validity analysis indicated that NET taps into aspects of emotional perception and ToM, whereas no association with attributional bias emerged. More recently, Chaturvedi et al. (2020) used auditory clips in which emotional content was expressed only in the auditory properties of the speech, not in the semantic content. Patients exhibited significant impairment in recognizing emotions compared with controls. The authors concluded that the newly developed test, referred to as the INTONATION Test, is more sensitive to deficits in recognizing emotions among patients with schizophrenia than measures previously used.

Other authors have modified existing measures to improve their ecological validity. Poole et al. (2000), for example, presented photographs of faces from the series by Ekman and Friesen along with recorded sentences containing emotionally neutral content and prosodic intonation depicting five emotions. Participants had to choose the label that best described the emotion portrayed by each face or audio clip. Among the results, errors in recognizing affect correlated with more severe psychotic symptoms and lower quality of life. Later, Cavieres et al. (2022) attempted to assess the tendency to jump to conclusions by modifying an existing task, in which different elements of information (e.g., faces and objects) remained hidden. Participants could choose between giving their interpretation of the ambiguous situation or requesting to see the hidden information. The authors found that patients with schizophrenia showed a statistically significant tendency to jump to conclusions, including in the proposed novel social task.

In other studies, researchers have focused on recording participants' daily activities to better assess their psychosocial functioning. For instance, Bromley et al. (2012) developed a video ethnography method that measures and codifies naturalistic behaviors, and in a limited sample of people with schizophrenia, social functioning was associated with neurocognition. Meanwhile, Faith and Rempfer (2018) presented

Table 1

Characteristics of included studies and main results SZ = schizophrenia HC = healthy controls ToM = Theory of Mind.

	Methodology	Task design	Sample	Main results	Defined ecological validity	Ensured verosimilitude	Determined veridicality
Behere RV, 2011	Comparison of facial emotion recognition deficits in symptomatic and asymptomatic antipsychotic naïve schizophrenia patients	Still photographs and videos of actors emoting the six basic emotions. Subjects had to recognize the emotion from several alternatives on a response sheet. There was no time limit.	SZ; symptomatic = 26 Asymptomatic = 37 HC = 45	The patient group made significantly greater errors in emotion recognition as compared to healthy controls	No	Dynamic emotional expression stimuli	No
Bekele E, 2017	A usability study of a virtual reality system for Affect Analysis in Facial Expressions (VR-SAAFE)	The VR-based system presented 5 emotional expressions with 4 levels of intensity, preceded by a context story. Subjects were asked what emotion they thought the avatar displayed and how confident they were in their choice.	SZ = 12 HC = 12	There were significant differences in the way patients with schizophrenia processed and responded to the emotional faces	No	VR allows for increased precision in the temporal dynamics of the emotional expression, and accompanying stories provide context	No
Briend F, 2019	Development and validation of an integrative fMRI task to explore the neural basis of social cognition	The task comprised listening to film extracts and inferring characters' mental states.	SZ = 20 HC = 28	Patients performed significantly worse on the comprehension questionnaire and showed decreased recruitment of the right temporo-parietal junction	No	The novel ecological task included movie excerpts showing verbal social interactions in a familiar daily context	No
Bromley E, 2012	Developed video ethnography methodology that measures naturalistic behaviors with Community Performance Indicators (CPIs).	Video ethnography to capture subjects' everyday behaviors in their usual environments	SZ = 9 selected for high or low composite scores on the MATRICS Consensus Cognitive Battery (MCCB).	High and low MCCB subjects showed statistically significant differences on all 4 CPIs.	Ecological validity concerns the predictive relationship between performance on a set of tests and behavior in real-world settings	Documentation of subjects' behavior while accompanying them in everyday settings	Results from the sample suggest that CPIs capture skills associated with cognition
Buck B, 2014	Evaluation of the psychometric properties of the Narrative of Emotions Task (NET)	An interview prompts participants to define a range of emotions, give a narrative account involving the emotion, and explain why the described event elicited the emotion.	SZ = 45	Total NET scores were significantly correlated with overall performance on the SSPA (role-play task)	No	No	Results showed a significant relationship between the NET and a social skills role-play, but only one significant association with more global measures of social and community functioning
Canty AL, 2021	Explored the contributions of cognitive empathy, ToM, neurocognition, and clinical symptoms in predicting the social functioning of individuals with schizophrenia.	Participants were administered the Virtual Assessment of Mentalising Ability (VAMA) and the Empathy Quotient (EQ) as part of a larger neuropsychological and social functioning assessment battery.	Early sz = 26, Chronic sz = 32	ToM was found to have added value in predicting both community functioning and functional capacity	No	The Virtual Assessment of Mentalising Ability (VAMA) uses a virtual interface to simulate the demands of real-life social interactions	Results were correlated with two measures of social functioning
Cavieres A, 2022	To compare the tendency of people with SZ and HC to jump to conclusions in a non-probabilistic task of interpreting an everyday social situation.	Volunteers interpret images in which different information elements (faces, objects) remain hidden. People can choose to give their interpretation of the ambiguous situation or request to see the hidden information.	SZ = 48 HC = 44	Patients with schizophrenia showed a statistically significant tendency to jump to conclusions, including in the proposed novel social task	No	The authors attempted to assess the tendency to jump to conclusions using everyday stimuli and stimuli referring to social situations.	None

Table 1 (*continued*)

	Methodology	Task design	Sample	Main results	Defined ecological validity	Ensured verosimilitude	Determined veridicality
Chaturvedi R, 2020	Comparison of emotion recognition in people with SZ and HC using speech clips in which the emotional content is conveyed only by its auditory properties.	Following the presentation of each stimulus, subjects are required to select one of five emotions that they believe the clip exhibited.	SZ = 28 HC = 16	Patients exhibited significant impairment in emotion recognition	No	This study utilized a newly developed auditory emotion recognition test that contained natural stimuli from spontaneous displays of emotions	None
Chen KW, 2017	Validation of the psychometric properties of 3 ToM measures in patients with schizophrenia,	The "Reading the Mind in the Eyes" test (RMET), the Faux Pas Task, and the Strange Stories	53 patients with schizophrenia	All 3 advanced ToM measures had large random measurement errors, poor concurrent validity, and low ecological validity	No	None	Low correlations exist between all ToM measures and The Revised Social Functioning Scale-Taiwan short version.
Faith LA, 2018	Analysis of the performance of individuals with serious mental illness on the Test of Grocery Shopping Skills (TOGSS)	Participants must shop for common grocery items from a list provided to them in an unfamiliar grocery store. The study examined accuracy and time.	SZ/ schizoaffective disorder =21; bipolar disorder =15 depressive and/ or anxiety disorders =23	TOGSS was significantly associated with real life grocery shopping, in terms of both shopping accuracy and time	No	The TOGSS was developed as a naturalistic task to assess functional skill performance in a grocery store environment.	To assess real-world functioning regarding grocery shopping skills, participants were directly observed during one of their own grocery shopping trips.
Granholm E, 2013	Computerized Ecological Momentary Assessment (EMAc) was used to record daily social interactions and their subjective appraisals by individuals with SZ or schizoaffective disorder.	Participants completed electronic questionnaires on a personal digital assistant (PDA) four times per day for one week	145 individuals with SZ or schizoaffective disorder	More positive interaction appraisals at any point in a day were associated with more significant positive affect, which, in turn, was a strong predictor of more social interactions over subsequent hours.	No	EMAc was used to record real social interactions, social interaction appraisals, and momentary affect four times daily for one week.	No
Huang YL, 2023	Psychometric analysis of the Movie for the Assessment of Social Cognition- taiwanese version (MASC-TW)	A video-based test depicting people having dinner. Participants are asked to infer the characters' thoughts, feelings, or intentions.	SZ = 41 HC = 167	The scores on the MASC-TW were significantly correlated with scores on a ToM task and the recognition of facial and prosodic emotions	No	The Movie for the Assessment of Social Cognition (MASC) enables the assessment of social cognition through a video that displays social interactions, including visual, auditory, and verbal information.	No
Penn DL, 2002	Performance of persons with SZ was compared to HC on a battery of social perceptual tasks that require social context processing	A battery of social perceptual tasks that require social context processing	SZ = 35 HC = 46	The group with SZ was impaired on all tasks relative to HC and showed little evidence of utilizing available contextual information.	none	A battery of social perceptual tasks that require social context processing. Adding contextual information to a social sequencing task	The relationship between social context processing and ward behavior (as measured with the Nurse's Observation Scale for Inpatient Evaluation) was examined for the clinical sample
Poole JH, 2000	Analysis of the relationship between emotion recognition and quality of life in a sample of people with schizophrenia	Photographs of faces and audio-recorded sentences of emotionally neutral content and prosodic intonation depicting five emotions. Participants had to choose the label that best described the emotion on each face, or audio	SZ = 40	Affect recognition errors correlated with more severe psychotic symptoms and with lower quality of life	None	A combination of facial and prosodic perceptual tasks to evaluate hetero-modal affect recognition in schizophrenia	The quality of life of community-dwelling schizophrenia patients was evaluated in relation to affect recognition abilities

Table 1 (*continued*)

	Methodology	Task design	Sample	Main results	Defined ecological validity	Ensured verosimilitude	Determined veridicality
Serra-Mayoral A, 2021	Performance on the Battery to Assess Theory of mind (BAT) and three other tests of social cognition was compared in a sample of SZ patients with an HC group	Short clips of everyday social interactions were shown to the participants, who then answered one ToM question and one control question for basic cognition	SZ = 30 HC = 30	The BAT was sensitive to detect the ToM impairments in schizophrenia, showed good internal consistency and concurrent validity	No	The scenes depicted everyday social interactions	No
Shi C, 2013	validation of the Beijing Performance-based Functional Ecological Test (BJ-PERFECT)	A role-play task in three areas of functioning: transportation, financial management and work ability	SZ = 50 HC = 37	The schizophrenia group scored significantly lower than HC on the BJ-PERFECT	No	No	Social cognition performance, measured by the Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT), was correlated with the BJ_PERFECT
Souto T, 2020	Comparison of patients and controls in a facial emotion recognition task using the Virtual Reality program for Facial Emotion Recognition (VR-FER).	A 3D stimuli in a virtual environment It involved a recognition task of neutral facial emotion stimuli and six basic emotions	SZ = 12 HC = 12	Patients presented a lower number of correct answers	No	The program uses validated stimuli in experimental conditions that are as close to reality as possible and occur in real-time.	No
Vaskinn A, 2009	Results from the Interpersonal Perception Task-15 were compared in persons with SZ and HC	Videotaped scenes of real persons in real situations. Each scene is followed by 1 multiple-choice question about either the status of the persons, the veracity of a person making 2 separate statements, or the intimacy level between persons	SZ = 72 HC = 58	The test discriminated well between groups, but failed to show associations with community functioning in participants with schizophrenia.	Ecological validity may be substantiated by verisimilitude and/or veridicality	The Interpersonal Perception Task uses real-life social behavior as stimuli involving real persons in real situations.	No associations with community functioning were found

the Test of Grocery Shopping Skills (TOGSS), which requires participants to shop for common grocery items on a list provided to them at an unfamiliar grocery store. Their results indicated that the TOGSS was significantly associated with real-life grocery shopping in terms of both accuracy and time. Added to that, Granholm et al. (2013) described the use of the Computerized Ecological Momentary Assessment to record daily social interactions and the subjective appraisals of the interactions by individuals with schizophrenia. They found that more positive appraisals were associated with more positive affect, which, in turn, was a strong predictor of more social interactions. That pattern of results suggests that subjective affective experiences motivate real-world social functioning in individuals with schizophrenia more than cognitive appraisals do. Furthermore, when Shi et al. (2013) sought to validate the Beijing Performance-Based Functional Ecological Test, a role-play task in three areas of functioning—transportation, financial management, and work ability—they found that individuals with schizophrenia scored significantly lower than controls.

Last, two of the studies reviewed involved examining the veridicality of existing instruments. In one, Chen et al. (2017) aimed to validate the psychometric properties of three ToM measures among patients with schizophrenia and found low correlations between the measures and the Revised Social Functioning Scale-Taiwan short version. In their article, they recommend interpreting the scores of those three advanced ToM measures cautiously because they may not provide reliable or valid results. In the other, Penn et al. (2002) correlated a battery of social perceptual tasks requiring social context processing with the Nurse's Observation Scale for Inpatient Evaluation scores. Among their results,

participants with schizophrenia or schizoaffective disorder demonstrated impaired performance on all tasks relative to controls. In processing social context, the participants with schizophrenia showed little evidence of utilizing available contextual information.

4. Discussion

Only two studies in our review included explicit definitions of *ecological validity* (Bromley et al., 2012; Vaskinn et al., 2009). That trend may reflect the need for a wider dissemination of a precise definition of the term, along with the practical consequences of its adoption. More precise definitions of some domains of social cognition are also lacking, which has resulted in a lack of consensus on recommendations for studying them. As a consequence, research has concentrated on emotion recognition and ToM, whereas social knowledge and social perception have been mostlyignored. In fact, a significant number of the studies reviewed were designed to improve their verisimilitude by using representations of social interactions via VR devices or movie clips; however, the assessments continued to prioritize ToM-based tasks or tasks involving emotion recognition while neglecting other domains of social cognition.

In approximately half of the studies that we reviewed, the veridicality of results was examined by correlating performance on tasks targeting social cognition and measures of psychosocial functioning. However, only a few revealed significant associations, and the evidence can corroborate neither a general correlation between two homogeneous categories nor specific relationships between multidomain
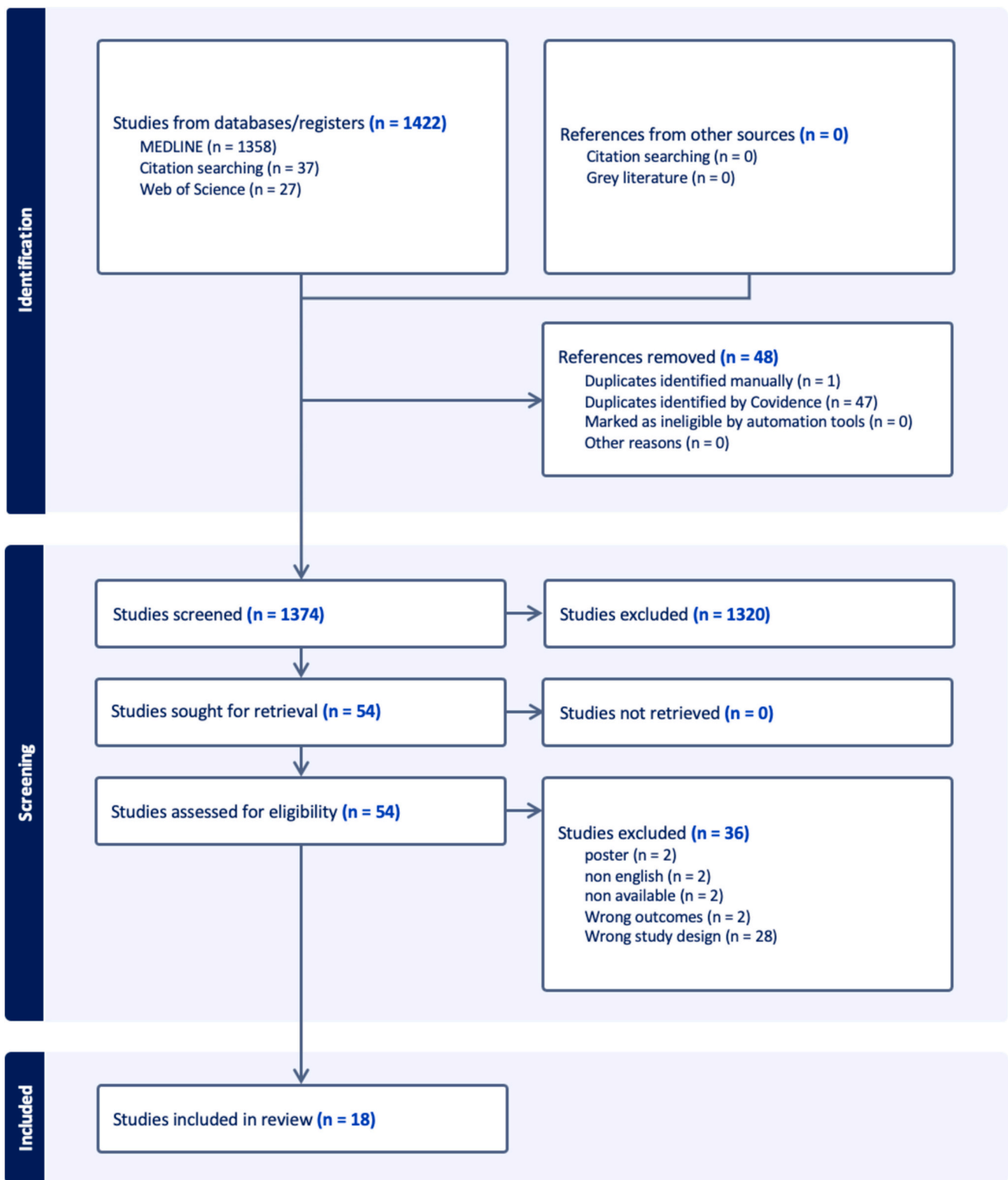
Fig. 1. Flow chart of the selection of literature to review.

categories with multiple intermediate variables.

Another critical aspect to consider is the origin of instruments for assessment and the extent to which they have been developed for use among people with schizophrenia. For example, because ToM and emotion recognition derive from working with people with autism, it is disputed whether alterations in interpersonal performance observed in both pathologies correspond to the same alteration or are merely similar behaviors (Le Gall and Iakimova, 2018). It is also essential to consider

the cultural flexibility of the instruments, including the language used, the environment, the clothing worn, and people's faces and voices, all of which may have different meanings in settings other than where they originated (Hajdúk et al., 2020).

In the future, to reverse the direction of research, it may be important to consider Burgess et al.'s (2006) argument about executive functioning—that is, to begin examining behavioral difficulties and, only later, try to understand which cognitive mechanisms might be

involved—which could increase the representativeness and generalizability of research in the process.

4.1. New methodologies and lessons from phenomenology

In everyday situations, individuals have to perceive and understand other people's emotions and intentions and decide on appropriate behaviors given the social context. Therefore, ecologically valid assessments of social cognition need to require tasks that represent real, everyday interactions between people in the social environment and predict aspects of real-life performance in those situations. However, the tasks most used in studies with people with schizophrenia, including in the SCOPE study (Pinkham et al., 2018), involve viewing and responding to static stimuli (e.g., labeling emotions in faces or eyes) or interpreting written social vignettes (e.g., making inferences about people's true intentions). However, such tasks have been criticized for their limited ability to capture social cognitive processes as they typically unfold in everyday life (Vaskinn and Horan, 2020). For that reason, it may be worthwhile to consider some methodological innovations and the measurement of new constructs that could enrich the understanding of the difficulties faced by people with schizophrenia in social situations.

The integrative model of metacognition (Lysaker et al., 2021) proposes that people become aware and make sense of their thoughts, emotions, and corporal experiences in an integrative metacognitive process in which their experiences are understood in the context of their intersubjective relationships with others. Whereas a social cognitive deficit is more or less a discrete failure in a specific function (e.g., emotion recognition), a metacognitive deficit is a failure in integrating, evaluating, and responding to the social context. The metacognitive capacity to think about oneself, others, one's place in the community, and one's ability to develop and enact plans based on that information can be measured using a quantitative scale (Semerari et al., 2003).

Ecological momentary assessment is a research method that requires participants to report symptoms, affects, and behaviors close to the time of their occurrence and at multiple times based on agreed-upon events or periods, which can overcome recall-related problems typical of self-report (Moskowitz and Young, 2006). Although the method cannot provide insights into the causes of social impairment, it could be especially valuable in determining the veridicality of studies by allowing the recording of various aspects of patients' psychosocial functioning, including where they are, with whom, what kind of tasks they are doing, and/or the difficulties that they may be facing.

Another methodological innovation is the use of Virtual Reality can be defined as the presentation of a computer-generated 3D environment in which the user receives visual, auditory, or tactile stimuli. In more advanced VR technology, the movements of users influence the stimuli in ways that provide an experience felt to be both authentic and immersive (Gigante, 1993). Using VR relates directly to verisimilitude by offering testing environments that are similar to real life. Rus-Calafell et al. (2018) have demonstrated that the research modality is safe for and accepted by participants and can be used to require them to perform everyday life behaviors and, in turn, offer insights into difficulties present in real-world social interactions.

Interpersonal distance (IPD) is the area that individuals maintain around themselves and into which others cannot intrude without arousing discomfort (Hayduk, 1983). IPD is dynamic in that it reflects changes in one's disposition toward social interactions and varying perceptions of the intentions of the people that one interacts with. When preferred IPD has been measured among patients with schizophrenia in both real and virtual interactions, they have maintained greater IPD than controls, a condition linked to more severe symptoms of schizophrenia (Kraus et al., 2024). Likewise, the inner representation of the peripersonal space (i.e., the space surrounding the body wherein physical interactions with elements of the environment occur) depends on the physical proximity between the people interacting and their familiarity, their social proximity, and the interactions between them

(Bogdanova et al., 2021). Indeed, when VR has been used to explore perceived IPD among people with schizophrenia (Park et al., 2009), they have indicated a smaller perceived peripersonal space than controls have (Lee et al., 2021).

A long tradition in phenomenology links schizophrenia to interpersonal difficulties. Stanghellini (2001) has defined the *loss of common sense* as the lack of both practical knowledge about social situations and a basic intuitive attunement with the social world, meaning the affective–conative capacity to become involved in others' lives and use context-relevant cues to make sense of others in social situations. Somewhat similarly, Fuchs (2015) has distinguished the faulty functioning of the ToM module "inside" the person from an immediate, prereflective disturbance in the relationship between them and others in an emergent bipersonal field called "intersubjectivity." That disconnection leaves patients without an understanding of others' expressions and actions in shared situations, and the fundamental alienation that results creates a sense of detachment that replaces the basic sense of being with others. If such is indeed the case, then researchers might also need to identify an ecologically valid way to study an intrasubjective phenomenon beyond and even prior to the cognitive processes present in social interactions.

5. Conclusions

In our review, we found evidence of modifying existing tasks on tests examining social cognition among people with schizophrenia to make the tasks more similar to situations encountered in real life. Even more interesting is the use of new technology, including VR, as a means of increasing the verisimilitude of such tasks. Veridicality, however, was a far less-considered aspect in the studies that we reviewed. Consequently, the specific relationships between particular aspects of social cognition and social functioning in people with schizophrenia continue to be unclear. Improving that trend requires more precise definitions and better measurement instruments, including ones involving the direct observation of people's real-life performance, as suggested by some of the publications reviewed. Last, establishing the ecological validity of the results of research is crucial for confirming the validity of constructs and advancing their clinical applications.

CRediT authorship contribution statement

Alvaro Cavieres: Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Vanessa Acuña:** Writing – review & editing, Formal analysis. **Marcelo Arancibia:** Writing – review & editing, Methodology. **Camila Escobar:** Methodology.

Declaration of competing interest

None to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scog.2024.100333.

References

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., Plumb, I., 2001. The "Reading the Mind in the Eyes" Test revised version: a study with normal adults, and adults with Asperger syndrome or high-functioning autism. J. Child Psychol. Psychiatry 42 (2), 241–251 (PMID: 11280420).

Bechi, M., Bosia, M., Spangaro, M., Buonocore, M., Cavedoni, S., Agostoni, G., Bianchi, L., Cocchi, F., Guglielmino, C., Smeraldi, E., Cavallaro, R., 2017. Exploring functioning in schizophrenia: predictors of functional capacity and real-world behaviour. Psychiatry Res. 251, 118–124. https://doi.org/10.1016/j.psychres.2017.02.019 (Epub 2017 Feb 9. PMID: 28199909).

Behere, R.V., Venkatasubramanian, G., Arasappa, R., Reddy, N.N., Gangadhar, B.N., 2011. First rank symptoms & facial emotion recognition deficits in antipsychotic

naïve schizophrenia: implications for social threat perception model. Prog. Neuro-Psychopharmacol. Biol. Psychiatry 35, 1653–1658. https://doi.org/10.1016/J.PNPBP.2011.05.019.

Bekele, E., Bian, D., Peterman, J., Park, S., Sarkar, N., 2017. Design of a Virtual Reality System for Affect Analysis in Facial Expressions (VR-SAAFE): application to schizophrenia. IEEE Trans. Neural Syst. Rehabil. Eng. 25, 739–749. https://doi.org/10.1109/TNSRE.2016.2591556.

Bellack, A.S., Green, M.F., Cook, J.A., Fenton, W., Harvey, P.D., Heaton, R.K., Laughren, T., Leon, A.C., Mayo, D.J., Patrick, D.L., Patterson, T.L., Rose, A., Stover, E., Wykes, T., 2007. Assessment of community functioning in people with schizophrenia and other severe mental illnesses: a white paper based on an NIMH-sponsored workshop. Schizophr. Bull. 33, 805–822. https://doi.org/10.1093/SCHBUL/SBL035.

Benito-Ruiz, G., Luzón-Collado, C., Arrillaga-González, J., Lahera, G., 2022. Development of an ecologically valid assessment for social cognition based on real interaction: preliminary results. Behav. Sci. (Basel) 12 (2), 54. https://doi.org/10.3390/bs12020054 (PMID: 35200305; PMCID: PMC8869373).

Bogdanova, O.V., Bogdanov, V.B., Dureux, A., Farnè, A., Hadj-Bouziane, F., 2021. The peripersonal space in a social world. Cortex 142, 28–46. https://doi.org/10.1016/J.CORTEX.2021.05.005.

Bowie, C.R., McGurk, S.R., Mausbach, B., Patterson, T.L., Harvey, P.D., 2012. Combined cognitive remediation and functional skills training for schizophrenia: effects on cognition, functional competence, and real-world behavior. Am. J. Psychiatry 169 (7), 710–718. https://doi.org/10.1176/appi.ajp.2012.11091337 (PMID: 22581070).

Briend, F., Marzloff, V., Brazo, P., Lecardeur, L., Leroux, E., Razafimandimby, A., Dollfus, S., 2019. Social cognition in schizophrenia: validation of an ecological fMRI task. Psychiatry Res. Neuroimaging 286, 60–68. https://doi.org/10.1016/J.PSCYCHRESNS.2019.03.004.

Bromley, E., Mikesell, L., Mates, A., Smith, M., Brekke, J.S., 2012. A video ethnography approach to assessing the ecological validity of neurocognitive and functional measures in severe mental illness: results from a feasibility study. Schizophr. Bull. 38, 981–991. https://doi.org/10.1093/SCHBUL/SBR002.

Brown, E.C., Tas, C., Can, H., Esen-Danaci, A., Brüne, M., 2014. A closer look at the relationship between the subdomains of social functioning, social cognition and symptomatology in clinically stable patients with schizophrenia. Compr. Psychiatry 55 (1), 25–32. https://doi.org/10.1016/j.comppsych.2013.10.001 (Epub 2013 Oct 10. PMID: 24210952, Jan).

Buck, B., Ludwig, K., Meyer, P.S., Penn, D.L., 2014. The use of narrative sampling in the assessment of social cognition: the Narrative of Emotions Task (NET). Psychiatry Res. 217, 233–239. https://doi.org/10.1016/J.PSYCHRES.2014.03.014.

Budziszewska, M.D., Babiuch-Hall, M., Wielebska, K., 2020. Love and romantic relationships in the voices of patients who experience psychosis: an interpretive phenomenological analysis. Front. Psychol. 11. https://doi.org/10.3389/FPSYG.2020.570928.

Burgess, P.W., Alderman, N., Forbes, C., Costello, A., Coates, L.M.A., Dawson, D.R., Anderson, N.D., Gilbert, S.J., Dumontheil, I., Channon, S., 2006. The case for the development and use of "ecologically valid" measures of executive function in experimental and clinical neuropsychology. J. Int. Neuropsychol. Soc. 12, 194–209. https://doi.org/10.1017/S1355617706060310.

Canty, A.L., Cao, Y., Neumann, D., Shum, D.H.K., 2021. The functional significance of cognitive empathy and theory of mind in early and chronic schizophrenia. Psychiatry Res. 299, 113852. https://doi.org/10.1016/J.PSYCHRES.2021.113852.

Cavieres, A., López-Silva, P., 2022. Social perception deficit as a factor of vulnerability to psychosis: a brief proposal for a definition. Front. Psychol. 13, 805795. https://doi.org/10.3389/FPSYG.2022.805795/BIBTEX.

Cavieres, A., Acuña, V., Wachtendorff, C., Maldonado, R., 2022. People with schizophrenia use less information to interpret ambiguous social situations. J. Behav. Ther. Exp. Psychiatry 74. https://doi.org/10.1016/J.JBTEP.2021.101690.

Chaturvedi, R., Kraus, M., Keefe, R.S.E., 2020. A new measure of authentic auditory emotion recognition: application to patients with schizophrenia. Schizophr. Res. 222, 450–454. https://doi.org/10.1016/J.SCHRES.2019.11.043.

Chaytor, N., Schmitter-Edgecombe, M., 2003. The ecological validity of neuropsychological tests: a review of the literature on everyday cognitive skills. Neuropsychol. Rev. 13, 181–197. https://doi.org/10.1023/B:NERV.0000009483.91468.FB.

Chen, K.W., Lee, S.C., Chiang, H.Y., Syu, Y.C., Yu, X.X., Hsieh, C.L., 2017. Psychometric properties of three measures assessing advanced theory of mind: evidence from people with schizophrenia. Psychiatry Res. 257, 490–496. https://doi.org/10.1016/J.PSYCHRES.2017.08.026.

Corcoran, R., Mercer, G., Frith, C.D., 1995. Schizophrenia, symptomatology and social inference: investigating "theory of mind" in people with schizophrenia. Schizophr. Res. (1), 5–13. https://doi.org/10.1016/0920-9964(95)00024-g (PMID: 8541250).

Couture, S.M., Penn, D.L., Roberts, D.L., 2006. The functional significance of social cognition in schizophrenia: a review. Schizophr. Bull. 32 (Suppl. 1), S44–S63. https://doi.org/10.1093/schbul/sbl029 (Epub 2006 Aug 17. PMID: 16916889; PMCID: PMC2632537).

Cowman, M., Holleran, L., Lonergan, E., O'Connor, K., Birchwood, M., Donohoe, G., 2021. Cognitive predictors of social and occupational functioning in early psychosis: a systematic review and meta-analysis of cross-sectional and longitudinal data. Schizophr. Bull. 47 (5), 1243–1253. https://doi.org/10.1093/schbul/sbab033 (PMID: 33761534; PMCID: PMC8379554).

De Rossi, G., Georgiades, A., 2022. Thinking biases and their role in persecutory delusions: a systematic review. Early Interv. Psychiatry 16, 1278–1296. https://doi.org/10.1111/EIP.13292.

Downes, M.J., Brennan, M.L., Williams, H.C., Dean, R.S., 2016. Development of a critical appraisal tool to assess the quality of cross-sectional studies (AXIS). BMJ Open 6

(12), e011458. https://doi.org/10.1136/bmjopen-2016-011458 (PMID: 27932337; PMCID: PMC5168618).

Faith, L.A., Rempfer, M.V., 2018. Comparison of performance-based assessment and real world skill in people with serious mental illness: ecological validity of the test of grocery shopping skills. Psychiatry Res. 266, 11–17. https://doi.org/10.1016/J.PSYCHRES.2018.04.060.

Fett, A.K.J., Viechtbauer, W., Dominguez, M. de G., Penn, D.L., van Os, J., Krabbendam, L., 2011. The relationship between neurocognition and social cognition with functional outcomes in schizophrenia: a meta-analysis. Neurosci. Biobehav. Rev. 35, 573–588. https://doi.org/10.1016/J.NEUBIOREV.2010.07.001.

Franzen, M.D., Wilhelm, K.L., 1996. Conceptual foundations of ecological validity in neuropsychological assessment. In: Sbordone, R.J., Long, C.J. (Eds.), Ecological Validity of Neuropsychological Testing. Gr Press/St Lucie Press, Inc., pp. 91–112

Fuchs, T., 2015. Pathologies of intersubjectivity in autism and schizophrenia. J. Conscious. Stud. 22 (1–2), 191–214.

Gigante, M.A., 1993. Virtual reality: definitions, history and applications. Virtual Real. Syst. 3–14. https://doi.org/10.1016/B978-0-12-227748-1.50009-3.

Gorostiaga, A., Balluerka, N., Guilera, G., Aliri, J., Barrios, M., 2017. Functioning in patients with schizophrenia: a systematic review of the literature using the International Classification of Functioning, Disability and Health (ICF) as a reference. Qual. Life Res. 26, 531–543. https://doi.org/10.1007/S11136-016-1488-Y.

Gorrino, I., Rossetti, M.G., Girelli, F., Bellani, M., Perlini, C., Mattavelli, G., 2024. A critical overview of emotion processing assessment in non-affective and affective psychoses. Epidemiol. Psychiatr. Sci. 33, e8. https://doi.org/10.1017/S.204579602400009X (PMID: 38356360; PMCID: PMC10894699).

Granholm, E., Ben-Zeev, D., Fulford, D., Swendsen, J., 2013. Ecological Momentary Assessment of social functioning in schizophrenia: impact of performance appraisals and affect on social interactions. Schizophr. Res. 145, 120–124. https://doi.org/10.1016/J.SCHRES.2013.01.005.

Green, M.F., Leitman, D.I., 2008. Social cognition in schizophrenia. Schizophr. Bull. 34, 670–672. https://doi.org/10.1093/schbul/sbn045.

Green, M.F., Penn, D.L., Bentall, R., Carpenter, W.T., Gaebel, W., Gur, R.C., Kring, A.M., Park, S., Silverstein, S.M., Heinssen, R., 2008. Social cognition in schizophrenia: an NIMH workshop on definitions, assessment, and research opportunities. Schizophr. Bull. 34, 1211. https://doi.org/10.1093/SCHBUL/SBM145.

Hajdúk, M., Achim, A.M., Brunet-Gouet, E., Mehta, U.M., Pinkham, A.E., 2020. How to move forward in social cognition research? Put it into an international perspective. Schizophr. Res. 215, 463–464. https://doi.org/10.1016/J.SCHRES.2019.10.001.

Hakkaart-van Roijen, L., Bouwmans, C., de Sonneville, C., Mulder, C., 2015. Employment and the associated impact on quality of life in people diagnosed with schizophrenia. Neuropsychiatr. Dis. Treat. 11, 2125. https://doi.org/10.2147/NDT.S83546.

Halverson, T.F., Orleans-Pobee, M., Merritt, C., Sheeran, P., Fett, A.K., Penn, D.L., 2019. Pathways to functional outcomes in schizophrenia spectrum disorders: meta-analysis of social cognitive and neurocognitive predictors. Neurosci. Biobehav. Rev. 105, 212–219. https://doi.org/10.1016/j.neubiorev.2019.07.020.

Hayduk, L.A., 1983. Personal space: where we now stand. Psychol. Bull. 94, 293–335. https://doi.org/10.1037/0033-2909.94.2.293.

Hermans, K., Achterhof, R., Myin-Germeys, I., Kasanova, Z., Kirtley, O., Schneider, M., 2019. Improving ecological validity in research on social cognition. Soc. Cogn. Psychosis 249–268. https://doi.org/10.1016/B978-0-12-815315-4.00010-0.

Huang, Y.L., Chen, T.T., Dziobek, I., Tseng, H.H., 2023. Mentalizing in a movie for the assessment of social cognition (MASC): the validation in a Taiwanese sample. BMC Psychol. 11. https://doi.org/10.1186/S40359-023-01321-0.

Kohler, C.G., Turner, T.H., Bilker, W.B., Brensinger, C.M., Siegel, S.J., Kanes, S.J., Gur, R. E., Gur, R.C., 2003. Facial emotion recognition in schizophrenia: intensity effects and error pattern. Am. J. Psychiatry 160 (10), 1768–1774. https://doi.org/10.1176/appi.ajp.160.10.1768 (PMID: 14514489).

Kraus, J., Čavojská, N., Harvanová, S., Hajdúk, M., 2024. Interpersonal distance in schizophrenia: a systematic review. Schizophr. Res. 266, 1–11. https://doi.org/10.1016/J.SCHRES.2024.02.006.

Le Gall, E., Iakimova, G., 2018. Social cognition in schizophrenia and autism spectrum disorder: points of convergence and functional differences. Encephale 44, 523–537. https://doi.org/10.1016/j.encep.2018.03.004.

Lee, H.S., Hong, S.J.J., Baxter, T., Scott, J., Shenoy, S., Buck, L., Bodenheimer, B., Park, S., 2021. Altered peripersonal space and the bodily self in schizophrenia: a virtual reality study. Schizophr. Bull. 47, 927–937. https://doi.org/10.1093/SCHBUL/SBAB024.

Lysaker, P.H., Cheli, S., Dimaggio, G., Buck, B., Bonfils, K.A., Huling, K., Wiesepape, C., Lysaker, J.T., 2021. Metacognition, social cognition, and mentalizing in psychosis: are these distinct constructs when it comes to subjective experience or are we just splitting hairs? BMC Psychiatry 21 (1), 329. https://doi.org/10.1186/s12888-021-03338-4 (PMID: 34215225; PMCID: PMC8254212).

McDonald, S., Flanagan, S., Rollins, J., Kinch, J., 2003. TASIT: a new clinical tool for assessing social perception after traumatic brain injury. J. Head Trauma Rehabil. 18 (3), 219–238. https://doi.org/10.1097/00001199-200305000-00001 (PMID: 12802165).

Moskowitz, D.S., Young, S.N., 2006. Ecological momentary assessment: what it is and why it is a method of the future in clinical psychopharmacology. J. Psychiatry Neurosci. 31, 13.

Mucci, A., Galderisi, S., Gibertoni, D., Rossi, A., Rocca, P., Bertolino, A., Aguglia, E., Amore, M., Bellomo, A., Biondi, M., Blasi, G., Brasso, C., Bucci, P., Carpiniello, B., Cuomo, A., Dell'Osso, L., Giordano, G.M., Marchesi, C., Monteleone, P., Niolu, C., Oldani, L., Pettorruso, M., Pompili, M., Roncone, R., Rossi, R., Tenconi, E., Vita, A., Zeppegno, P., Maj, M., Italian Network for Research on Psychoses, 2021. Factors associated with real-life functioning in persons with schizophrenia in a 4-year

follow-up study of the Italian Network for Research on Psychoses. JAMA Psychiatry 78 (5), 550–559. https://doi.org/10.1001/jamapsychiatry.2020.4614 (PMID: 33566071; PMCID: PMC7876615, May 1).

Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., McDonald, S., McGuinness, L.A., Stewart, L.A., Thomas, J., Tricco, A.C., Welch, V.A., Whiting, P., Moher, D., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 372, n71. https://doi.org/10.1136/bmj.n71 (PMID: 33782057; PMCID: PMC8005924).

Park, S.H., Ku, J., Kim, J.J., Jang, H.J., Kim, S.Y., Kim, S.H., Kim, C.H., Lee, H., Kim, I.Y., Kim, S.I., 2009. Increased personal space of patients with schizophrenia in a virtual social environment. Psychiatry Res. 169, 197–202. https://doi.org/10.1016/J.PSYCHRES.2008.06.039.

Penn, D.L., Ritchie, M., Francis, J., Combs, D., Martin, J., 2002. Social perception in schizophrenia: the role of context. Psychiatry Res. 109, 149–159. https://doi.org/10.1016/S0165-1781(02)00004-5.

Pinkham, A.E., Harvey, P.D., Penn, D.L., 2018. Social cognition psychometric evaluation: results of the final validation study. Schizophr. Bull. 44, 737–748. https://doi.org/10.1093/SCHBUL/SBX117.

Pönkänen, L.M., Alhoniemi, A., Leppänen, J.M., Hietanen, J.K., 2011. Does it make a difference if I have an eye contact with you or with your picture? An ERP study. Soc. Cogn. Affect. Neurosci. 6, 486–494. https://doi.org/10.1093/scan/nsq068.

Poole, J.H., Tobias, F.C., Vinogradov, S., 2000. The functional relevance of affect recognition errors in schizophrenia. J. Int. Neuropsychol. Soc. 6, 649–658. https://doi.org/10.1017/S135561770066602X.

Rosset, E., 2008. It's no accident: our bias for intentional explanations. Cognition 108 (3), 771–780. https://doi.org/10.1016/j.cognition.2008.07.001 (Epub 2008 Aug 9. PMID: 18692779).

Rus-Calafell, M., Garety, P., Sason, E., Craig, T.J.K., Valmaggia, L.R., 2018. Virtual Reality in the assessment and treatment of psychosis: a systematic review of its utility, acceptability and effectiveness. Psychol. Med. 48, 362–391. https://doi.org/10.1017/S0033291717001945.

Schmidt, S.J., Mueller, D.R., Roder, V., 2011. Social cognition as a mediator variable between neurocognition and functional outcome in schizophrenia: empirical review and new results by structural equation modeling. Schizophr. Bull. 37 (Suppl. 2), S41–S54. https://doi.org/10.1093/schbul/sbr079 (PMID: 21860046; PMCID: PMC3160114, Sep).

Semerari, A., Carcione, A., Dimaggio, G., Falcone, M., Nicolò, G., Procacci, M., Alleva, G., 2003. How to evaluate metacognitive functioning in psychotherapy? The metacognition assessment scale and its applications. Clin. Psychol. Psychother. 10, 238–261. https://doi.org/10.1002/CPP.362.

Serra-Mayoral, A., Mareca, C., Cano, R., Romaguera, A., Alsina, M., Gutiérrez, L., Valls, È., Sarró, S., McKenna, P.J., Pomarol-Clotet, E., Calderón, C., 2021. The BAT: a videotaped battery to assess theory of mind in schizophrenia. Psychiatry Res. 297, 113709. https://doi.org/10.1016/J.PSYCHRES.2021.113709.

Shi, C., He, Y., Cheung, E.F.C., Yu, X., Chan, R.C.K., 2013. An ecologically valid performance-based social functioning assessment battery for schizophrenia. Psychiatry Res. 210, 787–793. https://doi.org/10.1016/J.PSYCHRES.2013.09.023.

Souto, T., Silva, H., Leite, A., Baptista, A., Queirós, C., Marques, A., 2020. Facial emotion recognition: virtual reality program for facial emotion recognition—a trial program targeted at individuals with schizophrenia. Rehabil. Couns. Bull. 63, 79–90. https://doi.org/10.1177/0034355219847284.

Spooner, D.M., Pachana, N.A., 2006. Ecological validity in neuropsychological assessment: a case for greater consideration in research with neurologically intact populations. Arch. Clin. Neuropsychol. 21, 327–337. https://doi.org/10.1016/J.ACN.2006.04.004.

Stanghellini, G., 2001. Psychopathology of common sense. Philos. Psychiatry Psychol. 8, 201–218. https://doi.org/10.1353/PPP.2001.0018.

Teufel, C., Fletcher, P.C., Davis, G., 2010. Seeing other minds: attributed mental states influence perception. Trends Cogn. Sci. 14, 376–382. https://doi.org/10.1016/j.tics.2010.05.005.

Teufel, C., von dem Hagen, E., Plaisted-Grant, K.C., Edmonds, J.J., Ayorinde, J.O., Fletcher, P.C., Davis, G., 2013. What is social about social perception research? Front. Integr. Neurosci. 6, 128. https://doi.org/10.3389/fnint.2012.00128.

Tupper, D.E., Cicerone, K.D., 1991. Introduction: developmental and rehabilitative issues in the neuropsychology of everyday life. In: The Neuropsychology of Everyday Life: Issues in Development and Rehabilitation. Springer US, Boston, MA, pp. 1–14.

Vaskinn, A., Horan, W.P., 2020. Social cognition and schizophrenia: unresolved issues and new challenges in a maturing field of research. Schizophr. Bull. 46, 464–470. https://doi.org/10.1093/SCHBUL/SBAA034.

Vaskinn, A., Sergi, M.J., Green, M.F., 2009. The challenges of ecological validity in the measurement of social perception in schizophrenia. J. Nerv. Ment. Dis. 197, 700–702. https://doi.org/10.1097/NMD.0B013E3181B3AE62.

Yeh, Y.C., Lin, C.Y., Li, P.C., Hung, C.F., Cheng, C.H., Kuo, M.H., Chen, K.L., 2021. A systematic review of the current measures of theory of mind in adults with schizophrenia. Int. J. Environ. Res. Public Health 18 (13), 7172. https://doi.org/10.3390/ijerph18137172 (PMID: 34281109; PMCID: PMC8297277).