

## SOCIAL COGNITION IN SCHIZOPHRENIA

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### Abstract

Social cognition is considered as a valuable construct to understand the nature and disability of schizophrenia. Deficits in social cognition have been documented in schizophrenic patients throughout the course of illness, and have been associated to social functioning. Theoretical paradigms exploring social cognition (emotion processing, theory of mind, attributional bias, social perception, social knowledge), its clinical and cognitive correlates, and its neural substrates will be presented. Finally, implications for psychopharmacological and rehabilitation programs will be discussed.

**Key Words:** Schizophrenia – Social Cognition – Theory of Mind – Emotion Perception – Attributional Style – Social Perception – Social Functioning

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**Declaration of interest:** None

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### Introduction

Different definitions have been proposed to describe “social cognition”. For some authors social cognition involves perception, interpretation and processing of information related to the self, to others, and to interpersonal interactions (Penn et al. 1997). Social cognition can be defined as mental operations underlying social interactions, which include the human ability to perceive the intentions and dispositions of others (Brothers 1990), or as the ability to construct representations of the relations between oneself and others, and to use those representations flexibly to guide social behavior (Adolphs 2001).

Deficits in social cognition have been documented in schizophrenic patients throughout the course of illness compared to healthy subjects (Penn et al. 1997). These impairments are present at first episode (Bertrand et al. 2007, Edwards et al. 2001), and tend to be stable in subsequent phases of illness, even if they can be amplified by symptoms duration and severity. Moreover they result relatively independent of a general cognitive deficit, and have a functional significance disturbing social adaptation of patients (Brüne et al. 2005, Edwards 2002, Trémeau 2006).

The importance of this domain has been recognized through the inclusion of social cognition in the Consensus Cognitive Battery for Clinical Trials in

Schizophrenia of the National Institute Mental Health (NIMH) - MATRICS Conference (Green et al. 2004). The discussion group at the NIMH established consensus on cognitive domains and test criteria in schizophrenia (working memory, attention/vigilance, verbal learning and memory, visual learning and memory, reasoning and problem solving, speed of processing) and included social cognition in recommendations for future research.

There is a general agreement that social cognition is a valuable construct to understand the nature and disability of schizophrenia. Several theoretical paradigms were proposed to study social cognition: emotion processing, theory of mind, attributional bias, social perception, social knowledge (Penn et al. 1996). The relationships between these domains and fundamental features of schizophrenia, such as symptomatology and cognition, have been explored with contrasting results.

Emotion processing have been analyzed along three dimensions of recognition, expression, and experience of emotions (Trémeau 2006). Among these three dimensions, emotion recognition (facial expression and prosody) has been the most investigated over the past 15 years. In schizophrenic patients a greater impairment in facial emotion recognition is evident regarding the perception of negative emotional stimuli compared to positive ones. These deficits are

present at onset of illness, have been observed in both medicated and unmedicated subjects with schizophrenia, and seem to be stable during the course of illness, although there are some evidences that patients in remission perform better than in acute phase. Possible factors influencing this ability have been largely explored. Most studies failed to find correlations between facial emotion recognition, global measures of psychopathology, and positive symptoms (Addington and Addington 1998, Borod et al. 1993, Edwards et al. 2001, Kee et al. 1998, Salem et al. 1996, Silver and Shlomo 2001), with the exception of negative symptoms (Baudouin et al. 2002, Gaebel and Wolwer 1992, Lewis and Garver 1995, Gur et al. 2006, Martin et al. 2005, Mueser et al. 1996, Kohler et al. 2000, 2003, Philips et al. 2003, Putnam and Kring 2007, Schneider et al. 1995, Turetsky et al. 2007). Besides, patients with paranoid symptoms are more accurate, relative to non paranoid, in emotional tasks (An et al. 2006, Combs and Penn 2004, Young and Bentall 1997, Mujica-Parodi 2000, Nelson et al. 2007, Peer et al. 2004, Pinkham et al. 2003, Turetsky et al. 2007). The highest correlation between cognitive abilities and emotion perception was found for attention and vigilance (Trémeau 2006). Finally, it is still unclear whether emotion perception deficit is part of generalized facial performance deficit or is specific to facial emotion processing (Kosmidis et al. 2007).

The relationship between prosody and symptomatology is less explored in comparison to facial channel. Preliminary results are mixed: in schizophrenic patients, deficits in recognition of emotional prosody resulted associated with positive, and disorganized symptoms (Poole et al. 2000), but also with negative (Addington and Addington 1998, Borod et al. 1993, Hoekert et al. 2007, Salem et al. 1996, Wölwer et al. 1996).

Concerning expression and experience of emotion in patients with schizophrenia, deficit in facial and acoustic expressions are reported, whereas the emotion reactivity seems to be not reduced, even if it can increase in specific conditions. Moreover, most studies show that patients do not seem to experience less negative emotion than controls, but they tend to undervalue the pleasure they have or would have from these circumstances (Kring and Germans 2004).

The term theory of mind refers to the ability to represent the mental state of others and/or to make inferences about another's intentions (Premack and Woodruff 1978). Impairment of theory of mind is most profound among individuals with prominent negative, or disorganized (behavioral), and paranoid symptoms, during acute psychotic episodes, and improves during remission (Pinkham et al. 2003). There is a substantial body of evidence that theory of mind deficits in schizophrenia are likely to be specific rather than to be the result of general cognitive impairments (Brüne et al. 2005). Attributional bias represents the individual tendency in explaining the cause of events, characterized by particular cognitive biases such as the attribution of internal perceptual events to an external source (hostile attributional bias, jump to conclusions) (Colbert and Peters 2002, Waldheter et al. 2005).

Social perception describes the person's comprehension of social rules and conventions, whereas

social knowledge refers to the ability to ascertain social cues from behavior provided in a social context, such as social schema. Usually social perception and social knowledge are grouped together.

### *Social cognition and social functioning in schizophrenia*

Two main theoretical models have been proposed to explain social functioning in schizophrenia. The first model underlines the role of basic cognitive processes on social functioning. In several studies it has been demonstrated that cognition is significantly associated with social functioning (Addington and Addington 1999, Brenner et al. 1992, Neuchterlein et al. 1992, Penn et al. 1997, Pinkham et al. 2003, Sharma and Antonova 2003, Silverstein et al. 1997, Spaulding et al. 1994), however the amount of variance explained by neurocognition on functional outcome resulted to vary widely (10% to 50%) (Addington and Addington 1999, Addington et al. 2005, Green et al. 2000, Penn et al. 1997). As cognitive impairments partially explain outcome, they need to be explored for potential implications on rehabilitation program.

Recent research has developed a further theoretical model on social functioning in schizophrenia, that associates cognitive deficits of information processing and social abilities. Social cognition may reflect a higher order cognitive function that is dependent on more basic non-social cognitive processes, serving as a mediator between basic cognitive processes and social functioning (Green and Neuchterlein 1999, Penn et al. 1999). This hypothesis has been taken into account in a second model that consider a combination of neurocognition, social cognition and psychological variables as predictors of social functioning (Addington et al. 2005; Brekke et al. 2005; Couture et al. 2006; Green et al. 2000, 2004, 2005; Vauth et al. 2004).

Social cognition deficits result key determinants of functional outcome in schizophrenia. A recent review by Couture (2006) presented principal results on functional significance of social cognition in schizophrenia. Measures of functional outcome have been divided into 4 main areas: social behaviour in the milieu, community functioning, social skills, and social problem solving. The social cognitive domains have been distinguished in social perception, theory of mind, attributional style and emotion perception.

There is a general support for a significant association between social perception and social behaviour in the milieu (Appelo et al. 1992, Penn et al. 2002, Vauth et al. 2004), except for one study (Penn et al. 1996). Social perception has also shown a consistent relationship with community functioning (Kim et al. 2005, Penn et al. 1996, Revheim and Medalia 2004, Sergi et al. 2006), and social problem solving (Addington et al. 2006, Corrigan et al. 1995, Toomey et al. 1997). In contrast the link between social perception and social skill has not been established (Pinkham and Penn 2006).

Inconclusive findings emerged regarding theory of mind and outcome, due to critical methodological issues (Brüne 2005, Pinkham and Penn 2006, Roncone et al. 2002, Schenkel et al. 2005). However theory of

mind seems to be related to social functioning in schizophrenic patients. Also attributional style has been object of less studies on social functioning, because it has been studied more in the context of persecutory delusions rather than functional outcome (Lysaker et al. 2005, Waldheter et al. 2005).

Moderate to large effect sizes are documented for the relationship between emotion perception and social behavior in the milieu (Brüne 2005, Corrigan et al. 1995, Cohen et al. 2006, Hooker and Park 2002, Mueser et al. 1996), social skill (Cohen et al. 2006, Ihnen et al. 1998, Mueser et al. 1996, Pinkman and Penn 2006, Pinkham et al. 2007), community functioning (Brekke et al. 2005, Kee et al. 2003, Poole et al. 2000). No study has yet examined the relationship between emotion perception and social problem solving. Evidence showed that emotion perception may mediate the relationship between neurocognition and functional outcome (Brekke et al. 2005, Couture et al. 2006). In conclusion, despite a lot of works suggesting a functional significance of social cognition, more long-term studies are needed to provide support for a causal relationship.

### *The neural basis of social cognition*

Evolutionary psychology, developmental science, neuropsychology, neuroimaging, and psychopathology provided some empirical evidences on restricted group of neural circuits, specialized to process social information. A lot of research has explored the neural basis of social cognition in both nonclinical and clinical groups (Abdi and Sharma 2004; Brunet-Gouet and Decety 2006; Lee et al. 2004, 2006; Pinkham et al. 2003). Brunet-Gouet and Decety (2006) observed differences between schizophrenic patients and healthy subjects during social cognitive tasks in hemodynamic response in the medial prefrontal cortex, the prefrontal cortex, the amygdala, the inferior parietal lobe. The above mentioned regions seem to be critically involved in social cognition abilities.

In healthy subjects, specific brain patterns are associated with theory of mind, emotion perception and self-agency. For instance, activations in the paracingulate gyrus are almost systematically associated with theory of mind tasks, while the amygdala is mainly involved in emotion perception tasks. During these tasks it has been observed also an activation of superior temporal sulcus, and inferior frontal area. Moreover, the inferior parietal lobe seem to be crucial in the agency judgments (Brunet-Gouet and Decety 2006).

In schizophrenia, medial prefrontal cortex seems to be critical for theory of mind abilities (Brunet et al. 2003, Russel et al. 2000), whereas deficit in emotion perception seems to be more associated with temporal/amygdala and orbitofrontal abnormal activity (Aleman et al. 2005, Shayegan and Stahl 2005, Vuilleumier and Pourtois 2007). In particular, the ventral system (ventrolateral prefrontal cortex, orbitofrontal, ventral anterior cingulate gyrus, amygdala, insula, thalamus, ventral striatum, and brainstem nuclei) seems to be involved in the identification of the emotional significance of a stimulus, in the production of an affective state, and in autonomic response regulation.

In the effortful regulation of affective states is predominant the dorsal system (dorsolateral prefrontal cortex, dorsomedial prefrontal cortex, dorsal anterior cingulate gyrus, and hippocampus structures) (Phillips et al. 2003), but a reciprocal functional relationship may exist between these two neural systems. Brain abnormalities in these areas and neurochemical dysfunctions observed in schizophrenic patients are considered to be linked with information processing impairment, caused by dopamine dysregulation (Brunet-Gouet and Decety 2006).

### *Therapeutic implications for social cognition deficits*

Based on neural substrates and theoretical issues, several studies attempted to define the psychopharmacological implications to remedy social cognitive abilities in schizophrenia. The contributions mainly concerned emotion perception domain. Investigations into the neurobiology of affective dysfunction showed abnormal amygdala activation in schizophrenia during affect recognition task. Serotonergic and anxiolytic GABAergic agents are implied in modulation of activation of the limbic system, suggesting interesting indications for remediation efforts (Pinkham et al. 2007). Contrary, no relations between improvements in emotion perception and antipsychotic treatment are reported (Gaebel and Wolwer 1992, Herbener et al. 2005, Hogarty et al. 2004, Mueser et al. 1997, Poole et al. 2000), except for one study that show a major efficacy of risperidone than haloperidol (Kee et al. 1998).

In order to improve social cognitive abilities in schizophrenia, also some specific cognitive trainings have been developed, opening new future directions of research. The possibility to reinforce or remediate social cognition abilities may improve outcome, in particular this has been demonstrated for the emotion recognition domain. The first applications to remedy impairment in social cognition concerning facial affect recognition consist in active interventions based on monetary reinforcement and facial mimicry with repeated practice (Penn and Combs 2000). Based on cognitive theories, other interventions utilized attentional prompts to direct attention to the face as a tool to improve emotion perception (Combs et al. 2006) because patients with schizophrenia tend to focus on non-essential areas of the face or even peripheral stimuli (Phillips and David 1997, Streit et al. 1997) and they show evidence of abnormal visual scan paths. The use of attentional prompts seem to compensate for problems in visual scanning found in schizophrenia and ameliorate emotion recognition abilities. Besides, the "Training of Affect Recognition, TAR" (Fromm et al. 2003) has been designed specifically for remediation of impairment in facial affect perception in schizophrenic patients, resulting more efficacy, compared to non specific social cognitive programs (cognitive remediation training and treatment as usual) (Wölver et al. 2005). These tasks, which are arranged as computer tasks and desk work, become progressively more complex and difficult. The strategies use the principles of errorless learning, direct positive reinforcement,

feature abstraction, verbalization and self-instruction. The most important compensatory strategy is verbalization of the characteristic features of facial affect in terms of facial action units. Thus, remediation of deficit of emotion processing is possible in schizophrenia patients, but not achievable with a traditional cognitive rehabilitation program such the cognitive remediation training.

These social cognitive programs have focused on a single ability, nevertheless there are some preliminary social cognitive interventions “broad based”. Combs et al. (2007) tested, for example, the efficacy of the Social Cognition and Interaction Training (SCIT) (Penn et al. 2007), a program designed to remedy emotion perception, theory of mind and attributional style for persons with schizophrenia. This training permitted to improve all social cognitive measures, independently of change in clinical symptoms over the time, suggesting that the rehabilitation program plays a specific role in successful treatment.

## Conclusions

This paper aimed to provide an overview of current research attempting to explain the social cognitive deficits observed in schizophrenic patients. Social cognition has been evaluated in several domains, such as perception of social cues, expression and recognition of emotions, and mental state attribution to others. The assessment of social cognitive abilities, and its correlates, could contribute to a better understanding of the nature and disability of schizophrenia.

Moreover, the functional significance of social cognition permitted to developed specific remediation programs and suggested psychopharmacological implications for schizophrenic patients, as shown by preliminary promising interventions.

## References

- Abdi Z, Sharma T (2004). Social cognition and its neural correlates in schizophrenia and autism. *CNS Spectrum* 9, 5, 335-43.
- Addington J, Addington D (1998). Facial affect recognition and information processing in schizophrenia and bipolar disorder. *Schizophrenia Research* 32, 3, 171-181.
- Addington J, Addington D (1999). Neurocognitive and social functioning in schizophrenia. *Schizophrenia Bulletin* 25, 1, 173-82.
- Addington J, Saeedi H, Addington D (2006). Facial affect recognition: a mediator between cognitive and social functioning in psychosis? *Schizophrenia Research* 85, 1-3, 142-50.
- Addington J, Saeedi H, Addington D (2005). The course of cognitive functioning in first episode psychosis: changes over time and impact on outcome. *Schizophrenia Research* 78, 1, 35-43.
- Adolphs R. (2001). The neurobiology of social cognition. *Current Opinion Neurobiology* 11, 2, 231-9.
- Aleman A, de Haan EH, Kahn RS (2005). Object versus spatial visual mental imagery in patients with schizophrenia. *Journal of Psychiatry Neuroscience* 30, 1, 53-6.
- An SK, Lee E, Kim JJ, Namkoong K, Kang JI, Jeon JH, Seok JH, Choi SH (2006). Greater impairment in negative emotion evaluation ability in patients with paranoid schizophrenia. *Yonsei Medical Journal* 47, 3, 343-53.
- Appelo MT, Woonings FM, van Nieuwenhuizen CJ, Emmelkamp PM, Slooff CJ, Louwerens JW (1992). Specific skills and social competence in schizophrenia. *Acta Psychiatrica Scandinavica* 85, 6, 419-22.
- Baudouin JY, Martin F, Tiberghien G, Verlut I, Franck N (2002). Selective attention to facial emotion and identity in schizophrenia. *Neuropsychologia* 40, 5, 503-511.
- Bertrand MC, Sutton H, Achim AM, Malla AK, Lepage M (2007). Social cognitive impairments in first episode psychosis. *Schizophrenia Research* 95, 1-3, 124-33.
- Borod JC, Martin CC, Alpert M, Brozgold A, Welkowitz J (1993). Perception of facial emotion in schizophrenic and right brain-damaged patients. *Journal of Nervous and Mental Disease*, 181, 8, 494-502.
- Brekke J, Kay DD, Lee KS, Green MF (2005). Biosocial pathways to functional outcome in schizophrenia. *Schizophrenia Research* 80, 2-3, 213-225.
- Brenner HD, Hodel B, Genner R, Roder V, Corrigan PW (1992). Biological and cognitive vulnerability factors in schizophrenia: implications for treatment. *British Journal of Psychiatry*, Suppl 18, 154-63.
- Brothers L (1990). The neural basis of primate social communication. *Motivation and Emotion* 14, 81-91.
- Brüne M (2005). “Theory of mind” in schizophrenia: a review of the literature. *Schizophrenia Bulletin* 31, 1, 21-42.
- Brunet E, Sarfati Y, Hardy-Baylé MC, Decety J (2003). Abnormalities of brain function during a nonverbal theory of mind task in schizophrenia. *Neuropsychologia* 41, 12, 1574-82.
- Cohen AS, Forbes CB, Mann MC, Blanchard JJ (2006). Specific cognitive deficits and differential domains of social functioning impairment in schizophrenia. *Schizophrenia Research* 81, 2-3, 227-38.
- Colbert SM, Peters ER (2002). Need for closure and jumping-to-conclusions in delusion-prone individuals. *The Journal of Nervous and Mental Disease* 190, 1, 27-31.
- Combs DR, Adams SD, Penn DL, Roberts D, Tiegreen J, Sten P (2007). Social Cognition and Interaction Training (SCIT) for inpatients with schizophrenia spectrum disorders: preliminary findings. *Schizophrenia Research* 91, 1-3, 112-6.
- Combs DR, Penn DL. The role of subclinical paranoia on social perception and behavior (2004). *Schizophrenia Research* 69, 1, 93-104.
- Combs DR, Tosheva A, Wanner J, Basso MR (2006). Remediation of emotion perception deficits in schizophrenia: the use of attentional prompts. *Schizophrenia Research* 87, 1-3, 340-1.
- Corrigan PW, Toomey R (1995). Interpersonal problem solving and information processing in schizophrenia. *Schizophrenia Bulletin* 21, 3, 395-403.
- Couture SM, Penn DL, Roberts DL (2006). The functional significance of social cognition in schizophrenia: a review. *Schizophrenia Bulletin* 32, Suppl 1, S44-63.
- Edwards J, Jackson HJ, Pattison PE (2002). Emotion recognition via facial expression and affective prosody in schizophrenia: a methodological review. *Clinical Psychology Review* 22, 6, 789-832.
- Edwards J, Pattison PE, Jackson HJ, Wales RJ (2001). Facial affect and affective prosody recognition in first-episode schizophrenia. *Schizophrenia Research* 48, 2-3, 235-53.
- Frommann N, Streit M, Wölwer W (2003). Remediation of facial affect recognition impairments in patients with schizophrenia: a new training program. *Psychiatry Research* 117, 3, 281-4.
- Gaebel W, Wölwer W (1992). Facial expression and emotional face recognition in schizophrenia and depression. *European Archives of Psychiatry and Clinical Neuroscience* 242, 1, 46-52.
- Green MF, Kern RS, Braff DL, Mintz J (2000). Neurocognitive deficits and functional outcome in schizophrenia: are we measuring the “right stuff”? *Schizophrenia Bulletin* 26, 1, 119-36.

- Green MF, Nuechterlein KH, Gold JM, Barch DM, Cohen J, Essock S, Fenton WS, Frese F, Goldberg TE, Heaton RK, Keefe RS, Kern RS, Kraemer H, Stover E, Weinberger DR, Zalcman S, Marder SR (2004). Approaching a consensus cognitive battery for clinical trials in schizophrenia: the NIMH-MATRICES conference to select cognitive domains and test criteria. *Biological Psychiatry* 56, 5, 301-7.
- Green MF, Nuechterlein KH (1999). Should schizophrenia be treated as a neurocognitive disorder? *Schizophrenia Bulletin* 25, 2, 309-19.
- Green MF, Olivier B, Crawley JN, Penn DL, Silverstein S (2005). Social cognition in schizophrenia: recommendations from the measurement and treatment research to improve cognition in schizophrenia new approaches conference. *Schizophrenia Bulletin* 31, 4, 882-7.
- Gur RE, Kohler CG, Ragland JD, Siegel SJ, Lesko K, Bilker WB, Gur RC (2006). Flat affect in schizophrenia: relation to emotion processing and neurocognitive measures. *Schizophrenia Bulletin* 32, 2, 279-287.
- Herbener ES, Hill SK, Marvin RW, Sweeney JA (2005). Effects of antipsychotic treatment on emotion perception deficits in first-episode schizophrenia. *American Journal of Psychiatry* 162, 9, 1746-8.
- Hoekert M, Kahn RS, Pijnenborg M, Aleman A (2007). Impaired recognition and expression of emotional prosody in schizophrenia: review and meta-analysis. *Schizophrenia Research* 96, 1-3, 135-45.
- Hogarty GE, Flesher S, Ulrich R, Carter M, Greenwald D, Pogue-Geile M, Kechavan M, Cooley S, DiBarry AL, Garrett A, Parepally H, Zoretich R. Cognitive enhancement therapy for schizophrenia: effects of a 2-year randomized trial on cognition and behavior (2004). *Archives of General Psychiatry* 61, 9, 866-76.
- Hooker C, Park S (2002). Emotion processing and its relationship to social functioning in schizophrenia patients. *Psychiatry Research* 112, 1, 41-50.
- Ihnen GH, Penn DL, Corrigan PW, Martin J (1998). Social perception and social skill in schizophrenia. *Psychiatry Research* 80, 3, 275-86.
- Lee KH, Farrow TF, Spence SA, Woodruff PW (2004). Social cognition, brain networks and schizophrenia. *Psychological Medicine* 34, 3, 391-400.
- Lee KH, Brown WH, Egleston PN, Green RD, Farrow TF, Hunter MD, Parks RW, Wilkinson ID, Spence SA, Woodruff PW (2006). A functional magnetic resonance imaging study of social cognition in schizophrenia during an acute episode and after recovery. *American Journal of Psychiatry* 163, 11, 1926-33.
- Kaysner N, Sarfati Y, Besche C, Hardy-Baylé MC (2006). Elaboration of a rehabilitation method based on a pathogenetic hypothesis of "theory of mind" impairment in schizophrenia. *Neuropsychological Rehabilitation* 16, 1, 83-95.
- Kee KS, Green MF, Mintz J, Brekke JS (2003). Is emotion processing a predictor of functional outcome in schizophrenia? *Schizophrenia Bulletin* 29, 3, 487-97.
- Kee KS, Kern RS, Green MF (1998). Perception of emotion and neurocognitive functioning in schizophrenia: what's the link? *Psychiatry Research* 81, 1, 57-65.
- Kim JW, Kim JJ, Jeong BS, Ki SW, Im DM, Lee SJ, Lee HS (2005). Neural mechanism for judging the appropriateness of facial affect. *Brain Research: Cognitive Brain Research* 25, 3, 659-67.
- Kohler CG, Bilker W, Hagendoorn M, Gur RE, Gur RC (2000). Emotion recognition deficit in schizophrenia: association with symptomatology and cognition. *Biological Psychiatry* 48, 2, 127-36.
- Kohler CG, Martin EA (2006). Emotional processing in schizophrenia. *Cognitive Neuropsychiatry* 11, 3, 250-271.
- Kohler CG, Turner TH, Bilker WB, Brensinger CM, Siegel SJ, Kanes SJ, Gur RE, Gur RC (2003). Facial emotion recognition in schizophrenia: intensity effects and error pattern. *American Journal of Psychiatry* 160, 10, 1768-74.
- Kosmidis MH, Bozikas VP, Giannakou M, Anezoulaki D, Fantie BD, Karavatos A (2007). Impaired emotion perception in schizophrenia: a differential deficit. *Psychiatry Research* 149, 1-3, 279-284.
- Kring AM, Germans MK (2004). *Subjective experience of emotion in schizophrenia*. In: Jenkins JH, Barrett RJ, eds. *The Edge of Experience: schizophrenia, culture, and subjectivity*. Cambridge University Press, New York, NY, pp. 329-348.
- Lewis SF, Garver DL (1995). Treatment and diagnostic subtype in facial affect recognition in schizophrenia. *Journal of Psychiatric Research* 29, 1, 5-11.
- Lysaker PH, Lancaster RS, Nees MA, Davis LW (2005). Attributional style and symptoms as predictors of social functioning in schizophrenia. *Journal of Rehabilitation Research and Development* 41, 225-232.
- Martin F, Baudouin JY, Tiberghien G, Franck N (2005). Processing emotional expression and facial identity in schizophrenia. *Psychiatry Research* 134, 1, 43-53.
- Mueser KT, Doonan R, Penn DL, Blanchard JJ, Bellack AS, Nishith P, DeLeon J (1996). Emotion recognition and social competence in chronic schizophrenia. *Journal of Abnormal Psychology* 105, 2, 271-275.
- Mueser KT, Penn DL, Blanchard JJ, Bellack AS (1997). Affect recognition in schizophrenia: a synthesis of findings across three studies. *Psychiatry* 60, 4, 301-8.
- Mujica-Parodi LR, Malaspina D, Sackeim HA (2000). Logical processing, affect, and delusional thought in schizophrenia. *Harvard Review of Psychiatry* 8, 2, 73-83.
- Nelson AL, Combs DR, Penn DL, Basso MR (2007). Subtypes of social perception deficits in schizophrenia. *Schizophrenia Research* 94, 1-3, 139-47.
- Nuechterlein KH, Snyder K, Mintz J (1992). Paths to relapse: possible transactional processes connecting patient illness onset, expressed emotion, and psychotic relapse. *British Journal of Psychiatry* 161, 88-96.
- Peer JE, Rothmann TL, Penrod RD, Penn DL, Spaulding WD (2004). Social cognitive bias and neurocognitive deficit in paranoid symptoms: evidence for an interaction effect and changes during treatment. *Schizophrenia Research* 71, 2-3, 463-71.
- Penn DL, Combs D (2000). Modification of affect perception deficits in schizophrenia. *Schizophrenia Research* 46, 2-3, 217-29.
- Penn DL, Corrigan PW, Martin J, Ihnen G, Racenstein JM, Nelson D, Cassisi J, Hope DA (1999). Social cognition and social skills in schizophrenia: the role of self-monitoring. *The Journal of Nervous and Mental Disorder* 187, 3, 188-90.
- Penn DL, Ritchie M, Francis J, Combs D, Martin J (2002). Social perception in schizophrenia: the role of context. *Psychiatry Research* 109, 2, 149-59.
- Penn DL, Roberts DL, Combs D, Sterne A (2007). Best practices: The development of the Social Cognition and Interaction Training program for schizophrenia spectrum disorders. *Psychiatric Services* 58, 4, 449-51.
- Penn DL, Spaulding W, Reed D, Sullivan M, Mueser KT, Hope DA (1997). Cognition and social functioning in schizophrenia. *Psychiatry* 60, 4, 281-91.
- Penn DL, Spaulding W, Reed D, Sullivan M (1996). The relationship of social cognition to ward behavior in chronic schizophrenia. *Schizophrenia Research* 20, 3, 327-35.
- Phillips ML, David AS (1997). Visual scan paths are abnormal in deluded schizophrenics. *Neuropsychologia* 35, 1, 99-105.
- Phillips ML, Drevets WC, Rauch SL, Lane R (2003). Neurobiology of emotion perception II: Implications for major psychiatric disorders. *Biological Psychiatry* 54, 5, 515-28.
- Pinkham AE, Gur RE, Gur RC (2007). Affect recognition deficits in schizophrenia: neural substrates and psychopharmacological implications. *Expert Review of Neurotherapeutics* 7, 7, 807-16.

- Pinkham AE, Penn DL, Perkins DO, Lieberman J (2003). Implications for the neural basis of social cognition for the study of schizophrenia. *American Journal of Psychiatry* 160, 5, 815-24.
- Pinkham AE, Penn DL (2006). Neurocognitive and social cognitive predictors of interpersonal skill in schizophrenia. *Psychiatry Research* 143, 2-3, 167-78.
- Poole JH, Tobias FC, Vinogradov S (2000). The functional relevance of affect recognition errors in schizophrenia. *Journal of International Neuropsychological Society* 6, 6, 649-58.
- Premack D, Woodruff G (1978). Does the chimpanzee have a theory of mind? *Behavioural and Brain Sciences* 4, 515-526.
- Putnam KM, Kring AM (2007). Accuracy and intensity of posed emotional expressions in unmedicated schizophrenia patients: vocal and facial channels. *Psychiatry Research* 151, 1-2, 67-76.
- Revheim N, Medalia A (2004). Verbal memory, problem-solving skills and community status in schizophrenia. *Schizophrenia Research* 68, 2-3, 149-58.
- Roncone R, Falloon IR, Mazza M, De Risio A, Pollice R, Necozone S, Morosini P, Casacchia M (2002). Is theory of mind in schizophrenia more strongly associated with clinical and social functioning than with neurocognitive deficits? *Psychopathology* 35, 5, 280-8.
- Russell TA, Chu E, Phillips ML (2006). A pilot study to investigate the effectiveness of emotion recognition remediation in schizophrenia using the micro-expression training tool. *British Journal of Clinical Psychology* 45, (Pt 4), 579-83.
- Salem JE, Kring AM, Kerr SL (1996). More evidence for generalized poor performance in facial emotion perception in schizophrenia. *Journal of Abnormal Psychology* 105, 3, 480-483.
- Schenkel LS, Spaulding WD, Silverstein SM (2005). Poor premonitory social functioning and theory of mind deficit in schizophrenia: evidence of reduced context processing? *Journal of Psychiatric Research* 39, 5, 499-508.
- Schneider F, Gur RC, Gur RE, Shtasel DL (1995). Emotional processing in schizophrenia: neurobehavioral probes in relation to psychopathology. *Schizophrenia Research* 17, 1, 67-75.
- Sergi MJ, Rassovsky Y, Nuechterlein KH, Green MF (2006). Social perception as a mediator of the influence of early visual processing on functional status in schizophrenia. *American Journal of Psychiatry* 163, 3, 448-54.
- Sergi MJ, Rassovsky Y, Widmark C, Reist C, Erhart S, Braff DL, Marder SR & Green MF (2007). Social cognition in schizophrenia: relationships with neurocognition and negative symptoms. *Schizophrenia Research* 90, 1-3, 316-324.
- Sharma T, Antonova L (2003). Cognitive function in schizophrenia. Deficits, functional consequences, and future treatment. *Psychiatric Clinic in North American* 26, 1, 25-40.
- Shayegan DK, Stahl SM (2005). Emotion processing, the amygdala, and outcome in schizophrenia. *Progress in Neuropsychopharmacology Biological Psychiatry* 29, 5, 840-5.
- Silver H, Goodman C, Knoll G, Isakov V (2004). Brief emotion training improves recognition of facial emotions in chronic schizophrenia. A pilot study. *Psychiatry Research* 128, 2, 147-54.
- Silver H, Shlomo N (2001). Perception of facial emotions in chronic schizophrenia does not correlate with negative symptoms but correlates with cognitive and motor dysfunction. *Schizophrenia Research* 52, 3, 265-273.
- Silverstein SM (1997). Information processing, social cognition, and psychiatric rehabilitation in schizophrenia. *Psychiatry* 60, 4, 327-40.
- Spaulding WD, Sullivan M, Weiler M, Reed D, Richardson C, Storzabch D (1994). Changing cognitive functioning in rehabilitation of schizophrenia. *Acta Psychiatrica Scandinavica* 90, suppl 384, 116-124.
- Streit M, Wölwer W, Gaebel W (1997). Facial-affect recognition and visual scanning behaviour in the course of schizophrenia. *Schizophrenia Research* 24, 3, 311-7.
- Toomey R, Wallace CJ, Corrigan PW, Schuldberg D, Green MF (1997). Social processing correlates of nonverbal social perception in schizophrenia. *Psychiatry* 60, 4, 292-300.
- Trémeau F (2006). A review of emotion deficits in schizophrenia. *Dialogues in Clinical Neuroscience* 8, 1, 59-70.
- Turetsky BI, Kohler CG, Indersmitten T, Bhati MT, Charbonnier D, Gur RC (2007). Facial emotion recognition in schizophrenia: When and why does it go awry? *Schizophrenia Research* 94, 1-3, 253-263.
- Vauth R, Rüscher N, Wirtz M, Corrigan PW (2004). Does social cognition influence the relation between neurocognitive deficits and vocational functioning in schizophrenia? *Psychiatry Research* 128, 2, 155-65.
- Vuilleumier P, Pourtois G (2007). Distributed and interactive brain mechanisms during emotion face perception: evidence from functional neuroimaging. *Neuropsychologia* 45, 1, 174-94.
- Waldheter EJ, Jones NT, Johnson ER, Penn DL (2005). Utility of social cognition and insight in the prediction of inpatient violence among individuals with a severe mental illness. *The Journal of Nervous and Mental Disease* 193, 9, 609-18.
- Wölwer W, Frommann N, Halfmann S, Piaszek A, Streit M, Gaebel W (2005). Remediation of impairments in facial affect recognition in schizophrenia: efficacy and specificity of a new training program. *Schizophrenia Research* 80, 2-3, 295-303.
- Wölwer W, Streit M, Polzer U, Gaebel W (1996). Facial affect recognition in the course of schizophrenia. *European Archives of Psychiatry and Clinical Neuroscience* 246, 3, 165-70.
- Young HF, Bentall RP (1997). Social reasoning in individuals with persecutory delusions: the effects of additional information on attributions for the observed behaviour of others. *British Journal of Clinical Psychology* 36, (Pt 4), 569-73.