Working memory dysfunctions predict social problem solving skills in schizophrenia

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Working memory dysfunctions predict social problem solving skills in schizophrenia

Jia Huang, Shu-ping Tan, Sarah C. Walsh, Lauren K. Spriggens, David L. Neumann, David H.K. Shum, Raymond C.K. Chan

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A B S T R A C T

The current study aimed to examine the contribution of neurocognition and social cognition to components of social problem solving. Sixty-seven inpatients with schizophrenia and 31 healthy controls were administrated batteries of neurocognitive tests, emotion perception tests, and the Chinese Assessment of Interpersonal Problem Solving Skills (CAIPSS). MANOVAs were conducted to investigate the domains in which patients with schizophrenia showed impairments. Correlations were used to determine which impaired domains were associated with social problem solving, and multiple regression analyses were conducted to compare the relative contribution of neurocognitive and social cognitive functioning to components of social problem solving. Compared with healthy controls, patients with schizophrenia performed significantly worse in sustained attention, working memory, negative emotion, intention identification and all components of the CAIPSS. Specifically, sustained attention, working memory and negative emotion identification were found to correlate with social problem solving and 1-back accuracy significantly predicted the poor performance in social problem solving. Among the dysfunctions in schizophrenia, working memory contributed most to deficits in social problem solving in patients with schizophrenia. This finding provides support for targeting working memory in the development of future social problem solving rehabilitation interventions.

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1. Introduction

Impaired social function is one of the key diagnostic features of schizophrenia (APA, 2000). Social function can be defined by specific functional outcomes which fit into three categories: (1) psychosocial function, (2) social problem solving ability and (3) broader aspects of behavior in community outcome or activities of daily living (Green et al., 2000). Empirical findings suggest that the poor social problem solving ability observed in patients with schizophrenia are associated with their clinical symptoms (Bjerke et al., 2014), their elevated levels of emotional distress (Ponizovsky et al., 2013) and negatively impact their quality of life (Hsiao et al., 2012).

The Assessment of Interpersonal Problem Solving Skills (AIPSS) is a widely-used tool to assess specific types of social problem solving ability deficits (Donahoe et al., 1990). It has been shown to be an effective assessment tool in schizophrenia populations (Vaskinn et al., 2009; Leshner et al., 2013). According to the social skills model (Wallace et al., 1980; Bellack, 2004), social problem solving ability is made up of three types of skills: receiving, processing, and sending. Receiving skills are the ability to understand or decode social stimuli. These skills include detection of expressions or appropriate social cues, such as tone of voice, gesture, and content of conversations. Processing skills involve the critical analysis and ability to reflect on social situations, as well as the integration of real time information with long term memory and response planning. Sending skills refer to the ability to generate behavior, paralinguistic skills and verbal content suitable as a response to the demands of social situations. Since the AIPSS was developed, it has been widely used in many countries (Favrod et al., 1998; Kern et al., 2005; Goulding et al., 2010). The Chinese Assessment of Interpersonal Problem Solving Skills (CAIPSS) has...
been validated in Hong Kong, China (Leung and Tsang, 2006). However, the Chinese version has not been used in mainland China. Given the difference between Cantonese (which is adopted in Hong Kong) and Pu-tong-hua (the official language spoken across the country in mainland China), and the sub-cultural differences between Hong Kong residents and mainlanders, the validated Hong Kong version may not be directly applicable to mainland Chinese settings. The first aim of the current study was to investigate the specific social problem solving deficits of schizophrenia in mainland China by comparing CAIPSS performance of mainland patients to that of healthy controls.

When exploring the aspects of social skills in which patients with schizophrenia have deficits, one avenue researchers have focused on is to identify the underlying mechanisms that contribute to this area in terms of symptoms (Bjerke et al., 2014), neurocognition (Cochet et al., 2006; Ucok et al., 2006; Zanello et al., 2006) and social cognition (Vaskinn et al., 2008; Addington et al., 2010). For psychiatric symptoms, while positive symptoms such as hostility and paranoid ideation were found to be positively correlated with the occurrence of the social problem solving ability in psychiatric samples (Bjerke et al., 2014), the severity of negative symptoms were found to inversely determine the performance of sending skills that underlay the social problem solving ability in schizophrenia by using a regression statistical model (Ventura et al., 2013). For neurocognitive elements, a longitudinal study (Addington and Addington, 2000) showed that neurocognitive measures positively predicted the level of social problem solving in schizophrenia patients at a two and a half year follow-up. Specifically, social problem solving scores were found to be significantly positively associated with psychomotor speed, vigilance, early information processing, verbal ability, verbal and visual memory, cognitive flexibility and executive functioning (Addington and Addington, 1999; Addington et al., 2001; Vaskinn et al., 2009). Most of these neurocognitive functions can be measured by a verbal fluency test (Backes et al., 2014). In addition to the above neurocognitive functions, working memory and sustained attention have been identified as specific impairments in schizophrenia (Chan et al., 2004; Chan et al., 2010; Kumar et al., 2010). However, few studies provided evidence of the contribution of working memory and sustained attention to social problem solving deficits in schizophrenia. Therefore, we adopted a test of verbal fluency, together with tests of sustained attention, working memory, visual reproduction, and logical memory to assess executive processes, attention, verbal and visual memory, and working memory function of the subjects. The second aim of the current research was to explore which of these neurocognitive functions were related to the three components of social problem solving ability and their size of contribution to the social problem solving, with the goal of promoting understanding of social problem solving deficits in schizophrenia.

The system of underlying mechanisms of social problem solving is complex. In addition to the contribution of neurocognition, it is also interesting to investigate the possible contribution of social cognition to social problem solving ability. Social cognition, such as emotion perception, has been found to mediate the influence of neurocognition on social problem solving (Addington et al., 2010). Furthermore, a previous study (Pinkham and Penn, 2006) has found that social cognition significantly contributed unique variance to the social problem solving ability beyond that of neurocognition in schizophrenia. These findings suggest that for those patients who do not have deficits in neurocognitive functions, alterations in social problem-solving skills may reflect impairments in social cognitive function domains such as emotion perception. Emotion perception is an important aspect of social cognition which contributes to the social functioning. For example, it has been found to predict vocational functioning (Hooker and Park, 2002), and impairments in this domain have been found to correlate with poor work performance (Hofer et al., 2009). Moreover, previous researchers have found that in social perception and emotion categorization perception tasks, patients with schizophrenia utilized less available contextual information than healthy controls (Penn et al., 2002; Huang et al., 2009b). When processing ambiguous facial expression, outpatients with schizophrenia did not show negative bias (Kee et al., 2006) while actively paranoid patients with schizophrenia would attribute anger to neutral faces (Pinkham et al., 2011). Given the aforementioned findings showing deficits of social perception observed in patients with schizophrenia, we examined whether the cognitive bias in emotion perception, if present, and the accuracy of emotion/intention perception in social context was related to the deficits in the three components of social problem solving in schizophrenia. Among those social perception deficits found to be related to the social problem solving, we further aimed to investigate which one(s) contribute(s) most to explaining social problem solving deficits.

Taken together, the present study aimed: (1) to investigate the specific social problem solving deficits in schizophrenia patients in mainland China through a comparison with healthy controls. Specifically, we examined whether patients with schizophrenia have impairments in social problem solving, neurocognition, and social cognition; (2) to explore which of the neurocognition or social perception dysfunctions are related to the three components of social problem solving as measured by the CAIPSS within the schizophrenia group; (3) to answer the research question that among the neurocognitive and social cognitive dysfunctions found to be related to the social problem solving, which one(s) would contribute most or predict the levels of social problem solving in schizophrenia taking into account symptomatology. Based on these aims, we formulated three hypotheses. The first hypothesis was that the schizophrenia group would show a lower level of performance than the control group in social problem solving and neuropsychological functions such as attention and memory, and the schizophrenia group would also use less contextual information and show cognitive bias towards ambiguous facial expressions. The second hypothesis was that both the neuropsychological and social cognitive dysfunctions in schizophrenia would be positively associated with poor performance in social problem solving. The third hypothesis was that among the dysfunctions associated with social problem solving, the combination of neuro- and social-cognition components would best predict levels of social problem solving.

2. Method

2.1. Subjects

Sixty seven patients with schizophrenia were recruited from the Beijing Huilongguan Hospital. All of them were in-patients who had a diagnosis of schizophrenia. Diagnoses were based on a DSM-IV structured clinical interview (APA, 2000) conducted by an experienced psychiatrist who was blind to the purpose of this study. All of the patients had no comorbidities Axis I or axis II disorder, and no history of medical or neurological disorders. All patients were being treated with antipsychotic drugs. Thirty-one healthy subjects were also recruited from the community as controls for the current study. The two groups did not differ in age, years of education, gender (all of the subjects were male) or estimated IQ. Table 1 shows the demographic information of the subjects.

2.2. Measures

2.2.1. Background cognition

Estimated IQ was obtained using four subtests (viz., information, digit span, arithmetic, similarities) of the Chinese revision of the Wechsler Adult Intelligence Scale – Revised (WAIS- RC; Gong, 1992)).
Table 1

Comparison of demographic characteristics between patients with schizophrenia and healthy control participants.

<table>
<thead>
<tr>
<th></th>
<th>Schizophrenia Mean (S.D.)</th>
<th>Control Mean (S.D.)</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>36.30(9.80)</td>
<td>32.97(12.03)</td>
<td>2.185</td>
</tr>
<tr>
<td>Education</td>
<td>11.39(2.95)</td>
<td>10.68(2.95)</td>
<td>1.225</td>
</tr>
<tr>
<td>Estimated IQ</td>
<td>97.05(6.93)</td>
<td>101.87(20.69)</td>
<td>1.464</td>
</tr>
<tr>
<td>Medication dose (CPZ mg/day)</td>
<td>321.78(194.47)</td>
<td></td>
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<tr>
<td>Illness duration (year)</td>
<td>13.43(8.41)</td>
<td></td>
<td></td>
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<tr>
<td>PANSS</td>
<td></td>
<td></td>
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<tr>
<td>Positive symptoms</td>
<td>11.69(3.67)</td>
<td></td>
<td></td>
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<tr>
<td>Negative symptoms</td>
<td>17.38(5.17)</td>
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<tr>
<td>General psychopathology</td>
<td>25.74(5.49)</td>
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CPZ: chlorpromazine; PANSS: Positive and Negative Syndrome Scale; n.s.: p > 0.05

2.2.2. Neurocognitive assessments

The Logical Memory (LM) and the Visual Reproduction (VR) subtests of the Wechsler Memory Test (Gong et al., 1989) were administered to all subjects to assess verbal and visual memory. Verbal fluency (VF) was assessed by the number of words verbally produced in response to animal names within 1 min (Squire and Strauss, 1998).

The Sustained Attention to Response Task (SART) was used to assess sustained attention in a brain damaged sample (Robertson et al., 1997) but since has been shown to be sensitive to attention deficits in patients with schizophrenia (Chan et al., 2004). The SART is a computer test where 225 single digits are presented to the test taker over 43 min. Each digit is presented for 250 ms followed by a 900 ms mask. The test taker is required to press a key in response to the digit except on 25 occasions when the digit 3 would appear. On these occasions the test taker is required to withhold his/her response. The digit 3 appeared randomly throughout the trials. The performance index was 'efficiency' (hit rate-symptomatology when identifying levels of social problem solving.

An N-back task (Callcott et al., 1998) was used to assess the working memory of each subject. The numbers 2, 4, 6, and 8 were presented randomly on the screen of a computer. The 0-back and 1-back tasks were used in the current study. The 0-back task was required the subjects to keep the firstShown digit in mind and press the key of the firstShown digit when the next digit was presented on the screen.

2.2.3. Social cognition assessments

The ambiguous facial expression identification in conversation task (AFEC) was developed by the first and last author of this paper (Huang et al., 2009b). Morphed facial expressions were created to depict the happiness to anger emotion continuum. An ambiguous facial expression (i.e., with 50% happy signal and 50% angry signal) was presented as an answer to a question of praising/blaming/inquiring in a conversation. The subjects were required to judge whether this ambiguous facial expression was happy or angry with different question types in the conversations. Emotion and intention identification task (EIIT) was also developed by the first and last author of this paper (Huang et al., 2009a). During the task, conversations were presented aurally with positive and negative prosody. Subjects were required to judge the emotion state and intention of the answers in conversations according to the times the character is faced with an obstacle presented by the other (e.g., a waitress making a wrong order). The subjects were asked questions assessing their ability to identify any social problems and describe them (receiving skills), to find a solution (processing skills), and to role play the solution with the test administrator (sending skills). Receiving and processing skills require brief verbal responses for assessment, whereas sending skills require a responsive role play with the test administrator. The current study adopted the Chinese version translated by Leung and Tsang (2006) who adapted the assessment scene transcripts and associated videotapes to be culturally relevant to a Chinese population. To ensure that the translation was accurate, the assessment tool was backward translated by a linguistics expert who was not aware of the original version. Discrepancies were explored for cultural significance and adjusted for. This version has shown good reliability and validity in patients with schizophrenia (Leung and Tsang, 2006). With permission from the developers, we adapted the Chinese-Hong Kong version of the CAIPSS for use in mainland China by dubbing Mandarin voices over Cantonese voices.

2.3. Procedure

Assessment was conducted on a one-to-one basis in the hospital. Each subject was administered the CAIPSS by the first author, followed by the neurocognitive tests and the social cognition tests. The study was approved by the ethics committee of the Huilongguan Hospital and written consent was obtained before participation.

2.4. Data analysis

For the primary analysis, a multivariate analysis of variance (MANOVA) was performed to compare performance on the neurocognitive tasks, social cognition tasks and social problem solving ability between the healthy controls and patients with schizophrenia. The secondary analysis was conducted only with the sample of patients with schizophrenia. To examine which of the dysfunction domains indicated in the MANOVA was associated with the dysfunction of social problem solving. Pearson’s correlational analyses were run to examine the relationships between the areas shown to be deficient in people with schizophrenia and the components of the social problem solving measure. This was followed up by a number of step-wise multiple regression which aimed to examine which of the correlated functions provided additional predictive ability to positive and negative symptomatology when identifying levels of social problem solving.

3. Results

3.1. MANOVA

MANOVA results yielded significant overall group differences on sustained attention, working memory, ambiguous facial expression perception with praise cues, negative prosody and intention identification and social problem solving. Univariate results for the different subtests of the above functions are shown in Table 2.

3.2. Correlation

As shown in Table 3, social problem identification was correlated with sustained attention. In particular, social problem processing was correlated with sustained attention, working memory, and negative emotion identification in conversation. Variables in sending skills were mostly correlated with sustained attention and working memory.

3.3. Multiple regression

Hierarchical regression analyses were used to explore which of the items that were significant in the correlation analyses could best predict social problem solving deficits when schizophrenia symptoms were controlled for (Table 4). For receiving skills, no independent variables met criteria for entry. That is, none of the neurocognitive functions and social cognitive functions explained an appreciable amount of the receiving skill area in social problem solving. For processing and sending skills, only working memory entered the stepwise model. This variable explained 17.2% of the variance of the processing skill and 13.7% of the sending skills.

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Sustained attention and correlated social cognitive functions were statistically removed from the regression model when using the stepwise method. Specifically, the 1-back test of working memory contributed an additional 10.8% of the processing skills and 8.4% of the sending skills.

4. Discussion

In the current study, we examined whether or not patients with schizophrenia were impaired in neurocognitive function, social cognitive function and social problem solving when compared to healthy controls. Furthermore, we explored which of the impaired functions were associated with social problem solving in the schizophrenia group alone. Finally, we used a stepwise regression analysis with these impaired functions to determine which variable(s) best predicted the social problem solving skills in schizophrenia.

Overall, the current research was the first known research that used the CAIPSS to investigate social problem solving deficits of schizophrenia in mainland China. We found that patients with schizophrenia in mainland China were impaired in the receiving, processing and sending skills of social problem solving. Previous studies found the deficits were specific to sending skills in high functioning patients with schizophrenia (Vaskinn et al., 2009) and their siblings (Stalberg et al., 2008). The current study provided convergent evidence of social problem solving dysfunction in chronic schizophrenia in mainland China.

The current study also found that patients with schizophrenia were impaired in sustained attention, working memory, emotion perception and intention identification. Among these impairments, sustained attention, working memory and negative prosody identification were associated with social problem solving ability. This supports the prediction of the first hypothesis of group differences and provides insight into the specific underlying mechanisms that differentiate the cognitive and social functioning of schizophrenics from healthy controls.

The second hypothesis was supported by the significant relationships between several deficient functions and components of social problem solving. The outcome of testing the third hypothesis was that working memory showed the strongest predictive strength of processing and sending skills, after symptoms were controlled. None of the neurocognitive functions and social cognitive dysfunctions predicted receiving skills.

Results derived from the assessments of neurocognitive function in the current study confirm that patients with schizophrenia were impaired in sustained attention and working memory, but not in visual memory, logical memory, or verbal fluency. Our results were consistent with previous findings which indicated that patients with schizophrenia showed poorer performance in domains of cognitive function such as sustained attention (Kumar et al., 2010) and working memory (Chan et al., 2010). This suggests that patients with schizophrenia show specific deficits rather than general deficits in neuropsychological function.

Our results also show that patients with schizophrenia tended to judge ambiguous facial expression and prosody as happiness. In the happiness context, patients with schizophrenia judge the ambiguous facial expression more as happiness than the healthy controls. In the emotion and intention identification task, patients with schizophrenia tended to choose the positive valence choice when the prosody was actually negative in valence. This was consistent with one of our previous findings which show that patients with chronic schizophrenia have an optimistic bias in emotion valence judgement (Huang et al., 2011). However, this was in contrast to the findings that patients with schizophrenia attributed neutral stimuli as negative emotions (Kohler et al., 2003; Pinkham et al., 2011). The samples in the current study are nevertheless quite different from the samples in the previous studies in terms of illness duration and symptoms. The previous samples have shorter illness duration and more positive symptoms such as delusions (Kohler et al., 2003; Pinkham et al., 2011) while the current sample has long duration of illness but low score of positive symptoms. The current finding might be due to emotion adaptation of patients with chronic schizophrenia. They tended to have optimistic rather than hostile cognitive bias towards emotional stimuli, which would likely make themselves feel better when dealing with the daily life. This result not only supported our first hypothesis of group differences but also reveal the specific perceptual bias in chronic schizophrenia.

Neurocognitive functions have been found to be predictors for social functioning in schizophrenia (Tolman and Kurtz, 2012). The current research focused on the specific social functioning of social problem solving. In the current study, we found that working memory, sustained attention, and negative prosody identification were all associated with social problem solving. However, only working memory was found to predict a deficit in social problem solving within the schizophrenia sample. Previous studies found that skill acquisition on social problem solving is related with cognitive flexibility and sustained attention (Ucok et al., 2006). Social problem solving was significantly associated with psychomotor speed, verbal learning, semantic fluency and cognitive flexibility (Stalberg et al., 2008). Memory function and negative
longer significant. This suggests that working memory was the most important predictor of social problem processing skills and sending skills. Cognitive remediation strategy has been found to improve not only the neurocognitive function but also social problem solving ability (Cochet et al., 2006). Given this, working memory training may be a generalizable strategy to improve social problem solving ability. (Ventura et al., 2013). In the current study, psychiatric symptoms only accounted for 5–6% of the variance in social problem solving. When working memory was entered into the stepwise regression, the variance explained by the symptoms of schizophrenia as well as other neurocognitive and social cognitive functions was no longer significant. This suggests that working memory was the most important predictor of social problem processing skills and sending skills. Cognitive remediation strategy has been found to improve not only the neurocognitive function but also social problem solving ability (Cochet et al., 2006). Given this, working memory training may be a generalizable strategy to improve social problem solving ability. However this idea needs further study.

In conclusion, the results of this study provide evidence of social problem solving dysfunction in schizophrenia by using the CAIIPSS for the first time in mainland China. Furthermore, the current study indicates specific deficits in neurocognitive and social cognitive functions in people with chronic schizophrenia. The discovery of the associations between these deficits and social problem solving provides support for the development of more generalizable treatment strategies. This will be achieved by target- ing these deficits to improve daily social skills and therefore daily living. Our results showed that working memory was the best predictor for social problem processing and sending skills. This identifies working memory as a main target for rehabilitation interventions.

The study has a number of limitations. Despite the inclusion of a comprehensive measurement of emotion perception, broader representation of social cognitive domains is lacking. For example, an examination of the contribution of theory of mind and empathy to social problem processing might give rise to other interesting and meaningful results. In addition, there was only one measure of working memory, the n-back task. Future research could adopt more measures of working memory to provide further convergent evidence of its contribution to social problem solving deficits in schizophrenia. Future research could also focus on the rehabilitation intervention of social problem solving in schizophrenia and further look at whether working memory is a generalized training strategy for social problem solving deficits in schizophrenia. Despite these limitations, the current results do have important implications for understanding the impairments in neurocognitive and social cognitive functions and their association with social problem solving in schizophrenia. Finally, the current study complements other results of social problem solving dysfunction in schizophrenia in mainland China.

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