Intrinsic motivation and metacognition as predictors of learning potential in patients with remitted schizophrenia

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A R T I C L E   I N F O

Article history:
Received 19 January 2012
Received in revised form 24 April 2012
Accepted 27 April 2012

Keywords:
Metacognition Learning Motivation Cognitive remediation Schizophrenia

A B S T R A C T

Background: Previous research has suggested that neurocognitive functioning predicts best the potential of patients with schizophrenia to acquire newly learned material, which, in turn may impact patients’ social functioning. Recent studies have also shown that intrinsic motivation and metacognitive abilities play a decisive role in social functioning in schizophrenia. Accordingly, the present study sought to examine the relationship between intelligence, motivation, metacognition, and learning during a cognitive remediation experimental training. We hypothesized that metacognition and intrinsic motivation would have a strong relationship and independently predict learning potential.

Method: Thirty-two patients with schizophrenia who fulfilled the criteria of functional remission were recruited. In a pre-training-post experimental design, patients’ learning potential was assessed using previously defined cognitive remediation training for WCST. Intrinsic motivation was examined using Intrinsic Motivation Inventory for schizophrenia; mastery, a domain of metacognition, was measured using the Metacognitive Assessment Scale.

Results: Metacognition significantly correlated with subdomains of intrinsic motivation. Patients with higher intrinsic motivation and preserved metacognition improved more in the learning paradigm compared to poorly motivated patients and patients with reduced metacognitive abilities. In particular, “mastery” was determined as an independent predictor of learning potential.

Conclusions: Motivation and metacognition are important predictors of learning in schizophrenia. Psychological interventions in schizophrenia may therefore consider incorporating techniques to stimulate metacognitive and motivational abilities as well as developing individualized training programs.

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1. Introduction

Since Brenner et al. (1992) introduced the Integrated Psychological Therapy (IPT) as a modularized tool to improve cognition in severe psychiatric disorders, psychosocial interventions for schizophrenia have enjoyed a rapidly increasing popularity over the last 20 years. This development can largely be explained by two key findings: one is based on evidence for the limited effects of psycho-pharmacological treatment on social functioning and residual symptoms in schizophrenia (Swartz et al., 2007), the other is the proven efficacy of cognitive remediation and cognitive behavioral therapy (Wykes et al., 2008, 2011). Despite the developments in new therapeutic techniques, there are a number of factors that have a direct influence on the efficacy of an intervention, including therapeutic alliance, neurocognition, motivation and metacognition, the individual roles of which still need to be further clarified, and may be independent of the specificity of the intervention (Svensson and Hansson, 1999).

Intervention studies of cognitive behavioral therapy in anxiety disorders and cognitive remediation in post-stroke patients (Hofmann and Smits, 2008; Rohling et al., 2009) have found higher effect sizes from treatment when compared to similar interventions in schizophrenia patients (Wykes et al., 2011). One possible explanation for this is attributed to the neurocognitive impairment in patients with schizophrenia (Wykes and Reeder, 2005), which arguably has a negative impact on the potential to benefit from training and practice (Kurtz et al., 2010), henceforth referred to as “learning potential” (LP; Sternberg and Grigorenko, 2002). Previous definitions of LP in schizophrenia largely focused on its link with...
a person’s cognitive capacity, suggesting that LP is a crucial factor in predicting performance after rehabilitation (Fiszdon et al., 2006). LP has typically been measured through repeated administration of specific cognitive tests before and after training of that particular cognitive faculty (Lauchlan and Elliott, 2001). For instance, Kurtz et al. (2010) evaluated LP using the California Verbal Learning Test (CVLT; Delis et al., 2000) and the Wisconsin Card Sorting Task (WCST; Heaton, 1981) with a pre-training-post design. They categorized a sample of schizophrenia patients into non-learners, learners, and high achievers according to the participants’ improvement in performance after the CVLT and the WCST though this failed to predict social functioning (Kurtz et al., 2009). Taken together, it is plausible to predict that the LP of a neurocognitive test has the potential to predict treatment outcome of a neurocognitive remediation program as well as work skills training (Sergi et al., 2005). A few studies have shown that LP can have predictive power for treatment outcome in schizophrenia patients beyond patients’ performance on neurocognitive measures (Watzke et al., 2009; Rempfer et al., 2011). In addition, studies of LP in educational psychology suggest that motivation and metacognitive abilities should be considered as mediating factors of learning (e.g., Flavell, 1979; McCabe, 2011).

Motivation has been defined as an “internal state, need, or desire that serves to incite, direct, and maintain goal-oriented behaviors which is believed to be implicated in all learned responses and can either foster or hinder future actions” (Kleinginna and Kleinginna, 1981). Motivation has been conceptualized with the “self-determination theory” (SDT), which describes motives along a continuum, with intrinsic motivation (IM) lying at one end and extrinsic motivation (EM) at the other (Deci and Ryan, 1985). IM refers to pursuing an action because it is inherently interesting or enjoyable whereas EM refers to performing an action because it leads to a distinct outcome (Ryan and Deci, 2000).

In general, motivational deficits in schizophrenia have previously been considered as part of a negative symptom syndrome (Barch, 2005). Studies on motivation in schizophrenia have referred to the self-determination theory of motivation (Choi et al., 2010; Nakagami et al., 2008, 2010). For example, a recent study using a standard and a motivational mathematical game reported that schizophrenia patients with higher IM levels learned better than those with lower IM levels (Choi and Medalia, 2010). In addition, Nakagami et al. (2008) found that IM, as measured using a composite index derived from the Quality of Life Scale for Schizophrenia (Heinrichs et al., 1984), mediated the relationship between neurocognition and social functioning. In view of these findings, recent cognitive remediation strategies in schizophrenia have included means to induce IM by educational approaches, computer-based tasks, and virtual reality (Medalia and Thysen, 2008; Park et al., 2011).

Self-regulation refers to the capacity for altering behavior in terms of SDT and also overlaps with features of “metacognition”. In particular, “mastery” represents a metacognitive capacity to form integrated narratives built around complex and coherent accounts of how the mental states of both oneself and others change over time, and then to use that kind of mentalistic information for purposeful problem solving. In the case of mental illness, mastery refers to the use of knowledge about oneself and other to effectively deal with subjective distress and interpersonal challenges (Semerari et al., 2003; Lysaker et al., 2005; Brüne et al., 2011). Metacognitive mastery, for instance, concerns one’s ability to respond to unexpected conflicts, emergent symptoms or psychosocial setbacks on the basis of their knowledge of themselves and others as beings with unique sets of interrelated thoughts and feelings.

A substantial amount of research has demonstrated that metacognitive deficits are related to the course of illness in schizophrenia, independent of symptomatology and neurocognition (Roncone et al., 2002; reviewed in Brüne et al., 2011). Metacognitive impairments in schizophrenia are associated with the capacity to monitor one’s own thinking and behavior (Koren et al., 2006), to mentalize (Langdon and Coltheart, 2001), and to form complex ideas of one’s own life as a narrative spanning a lifetime (Berna et al., 2011). Recently, Lysaker et al. (2010) provided substantial evidence that schizophrenia patients struggle not only with how to cope with symptoms and neurocognitive impairment, but also struggle to interpret and make sense of the challenges that they face. This could profoundly impact on variables such as IM. Although distinct but related, we assert that metacognitive capacities also regulate IM among schizophrenia patients.

The present study therefore sought to explore the influence of metacognition and IM on LP in schizophrenia. Specifically, we hypothesized that individual differences in metacognition and IM would predict a significant amount of the variance to explain LP. To minimize the confounding effects of symptomatology, we decided to study this association in a sample of symptomatically remitted patients with schizophrenia.

2. Methods

2.1. Participants

Fifty-two clinically stable individuals with schizophrenia were recruited from the Psychosis Unit at Celal Bayar University. The patients met DSM-IV criteria for schizophrenia as determined by medical records and confirmed with the Structured Clinical Interview for DSM-IV — Patient Edition (SCID; First et al., 1996). Only patients meeting the criteria of being in remission according to the Schizophrenia Working Group (Andreasen et al., 2005) were included. Of the thirty-two patients meeting the criteria for remission two patients refused participation. Thus, data from thirty patients (53 percent men) were secured. The patients’ mean age was 32.93 ± 12.35 years; the number of years of education was 11.50 ± 2.34, the mean duration of illness was 12.07 ± 10.55 years, and the number of hospital stays was 2 ± 2. All patients received second-generation antipsychotic medication. Chlorpromazine equivalent dosages (CPZ) were calculated for all patients in order to control for the medication effects (Rijken et al., 2003). Accordingly, mean dosages were 416.25 ± 220.99 mg per day. All patients provided written informed consent. The study was approved by the local Institutional Review Board.

2.2. Clinical and neuropsychological measures

2.2.1. Clinical rating and remission criteria

The Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) is a 30-item rating scale that was administered by clinically trained research staff using a chart review and a semi-structured interview. Accordingly, the average total PANSS score of the group was 57.25 ± 11.46 points. Symptomatic remission was assumed if the following items of the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) were rated as moderate, mild, minimal or absent (i.e. PANSS score for each item ≤ 3): delusions (PANSS-P1), unusual thought content (PANSS-G9), hallucinations (PANSS-P3), conceptual disorganization (PANSS-P2), mannerisms (PANSS-G7), blunted affect (PANSS-N1), social withdrawal (PANSS-N4), and lack of spontaneity (PANSS-N5). PANSS ratings were completed by a trained consultant psychiatrist working in the outpatient department.

2.2.2. Estimated general intelligence

Age-corrected indices of the memory quotient (MQ) were calculated over total WMS-WMS-III (Wechsler, 1997). The MQ is
highly correlated with standard measures of general intelligence (Tulsky and Price, 2003) and was used for reasons of practicability and time constraints of the experimental procedure.

2.3. Metacognition assessment

2.3.1. The Indiana Psychiatric Illness Interview (IPII)

The IPII (Lysaker et al., 2002) is a semi-structured interview developed to assess how individuals understand their experience with mental illness. A trained psychiatrist conducted the interview, which typically lasted between 30 and 60 min. All original procedures from the IPII were strictly followed, after the interview was translated into Turkish (IPII; Lysaker et al., 2002). The interview is conceptually divided into five sections. First, rapport is established and participants are asked to tell the story of their lives, beginning with their earliest memory. Second, participants are asked if they think they have a mental illness and, if so, whether or not this condition has affected different facets of their life. Third, participants are asked if and how their condition controls their life and, alternately, how they control their condition. Fourth, they are asked how their condition affects, and is affected by others. Finally, participants are asked about their expectations for the future. The IPII differs from other psychiatric interviews in that only minimal content is introduced to the participant to comment on and thus results in a self-report that can be analyzed in terms of the metacognitive capacities that appear spontaneously.

2.3.2. The Metacognition Assessment Scale

The Metacognition Assessment Scale-Abbreviated (MAS-A) is a rating scale designed to systematically identify the extent to which persons can engage in increasingly complex and integrated metacognitive abilities. The original MAS was developed to detect growth within psychotherapy transcripts (Semerahi et al., 2003) and, in consultation with the authors, abbreviated and adapted for the study of IPII transcripts (Lysaker et al., 2005). The MAS-A differs from other more structured assessments of metacognition in that it focuses on metacognitive functions that arise spontaneously rather than cued, as in a task or referenced in a questionnaire. The MAS-A contains four scales: “Understanding of one’s own mind”, or the comprehension of one’s own mental states; “understanding of others’ minds”, or the comprehension of other individuals’ mental states; “decentration” describes the ability to see the world as existing with others having independent motives; and “mastery”, defined as the ability to work through one’s representations and mental states, with a view to implement effective action strategies in order to accomplish cognitive tasks or cope with problematic mental states. The MAS-A asks the rater to indicate whether the participant has successfully used or failed to use a function for each task. For example, the rater must determine if the participant can identify different emotions they feel and recognize that their understanding of life events is subjective. The full presence of a function is awarded a score of “1”, whereas a score of “0.5” is awarded for the partial presence of a function. The highest score obtainable for “understanding of one’s own mind” is “9”, for “understanding of others’ minds”, a “7”, for “decentration” a “3” and for “mastery” a “9”. For all scales higher scores indicate a greater inflation for performing the task. The scale is highly associated with constructs of motivation for health-related behaviors, including perceived competency for attempting challenging tasks and autonomous treatment engagement (Choi et al., 2010). In the present study, the IM-SC was conducted after the cognitive remediation training of WCST skills.

2.4. Motivation assessment

2.4.1. Intrinsic motivation

Self-reported intrinsic motivation (IM) was measured using an adapted version of the Intrinsic Motivation Inventory (IMI; Plant and Ryan, 1985) for schizophrenia patients (Choi et al., 2010). The IMI-SC consists of 21 items rated on a 7-point Likert scale with responses ranging from “not at all true” to “very true”. It is designed to assess a schizophrenia patients’ subjective experience of an activity specifically in an experimental setting. The instrument has five subscales: (1) perceived interest and enjoyment due to task (interest/enjoyment), (2) perceived value and usefulness of the task for the proposed test (value/usefulness), (3) efforts given to successfully complete the task (effort), (4) perceived pressure and tension while performing the task (pressure/tension), and (5) perceived autonomy to perform the task (choice). Higher scores indicate a greater IM for performing the task. The scale is highly associated with constructs of motivation for health-related behaviors, including perceived competency for attempting challenging tasks and autonomous treatment engagement (Choi et al., 2010). In the present study, the IMI-SC was conducted after the cognitive remediation training of WCST skills.

2.5. Learning potential (LP) assessment

The WCST is a neuropsychological test sensitive to impairments in executive function. Participants sort cards that vary according to an unspecifed matching rule that changes periodically. The current study utilized the number of correct responses meaning the right matching rule between color, shape and number of the card presented as a goal of learning.

Participants received a 128-card computer version of the Wisconsin Card Sorting Task (WCST; Heaton, 1981) with standard instructions at baseline. Eight weeks later, a previously defined structured training procedure, based on cognitive remediation using errorless learning techniques, was administered as training with computer (for details, see Kern et al., 1996). In summary, the training procedures for the WCST used the techniques of errorless learning. The WCST was chunked into its small components to create a hierarchy of to-be-learned skills. The training was held in three steps: stimulus feature identification, card matching, single shift execution, double shift execution. A subject who repeatedly gave the correct answer for 10 trials in each phase was considered to have successfully completed the task. None of the subjects failed to complete the training. Each phase of training consisted of a series of trials that included self- and other-delivered cues, as well as modeling, explicit instruction, and response feedback to facilitate correct responding and to reduce the possibility of errors. Training was conducted by a psychiatrist who received certified training in applying cognitive remediation (C.T.). Training typically lasted 30–45 min. The training material was prepared using PowerPoint for Windows and a freely available psychological experiment tool (PsychoPy 1.71, Nottingham University, UK). After the training period, within the same session, post-training data was collected using the exact same procedure used at baseline.

2.6. Data analysis

Data was evaluated for normality and in no case was there evidence that variables included in the study violated the assumptions underlying the use of parametric statistical procedures. Pearson correlations were calculated between estimated IQ,
metacognition and motivation for exploring the relationship between variables and identifying multicollinearity among independent variables.

To define LP, we firstly conducted a categorical approach, in which patients were categorized as “non-learners”, “learners” and “high achievers” according to a previously established algorithm (for details, see Schottke et al., 1993; Wiedl, 1999). For every pretest score, a test score on a hypothetical parallel test was predicted in a linear regression model and compared with the real post-test score. We categorized a non-learner as one whose post-test score was below the predicted confidence interval. Participants whose scores were 1.5 standard deviations above the group mean gain difference were classified as “high achievers”, whereas the remaining group of patients (who scored in-between) was considered as “learners”. Furthermore, to control for ceiling effects participants whose pre-training number of correct responses was above 86 were also classified as high achievers (Wiedl, 1999; Vaskiin et al., 2009), a procedure that has been used in a similar fashion in previous studies of LP (Fiszdon et al., 2006; Rempfer et al., 2006). A between group ANOVA was conducted to identify the differences in IQ, motivation and metacognition between learning group categories.

A hierarchical regression model was performed to identify the unique contribution of each variable in predicting the WCST number of correct responses (dependent variable) after training. A hypothetical model was constructed according to the ongoing literature on motivation and metacognition and learning (Choi et al., 2010; Lysaker et al., 2008). To control for the effects of pretest performance and intelligence, we included the baseline number of correct responses in the WCST in the first step of the regression analysis, and added the estimated intelligence (MQ) score in the second step. The aim of this regression analysis was to observe the unique influence of intrinsic motivation and metacognition on learning from training (i.e. LP) when controlling for differences in baseline performance and intelligence.

3. Results

3.1. Data quality

Preliminary analyses were conducted to ensure that there was no violation of the assumptions of normality, linearity and homogeneity of variances, homogeneity of regression slopes and reliability.

3.2. Correlation analyses

The correlations between intelligence, subdomains of IMI, and metacognition (MAS-A scores) are summarized in Table 1. Accordingly, interest and enjoyment was correlated only with perceived usefulness and subjective value of the training, but not with perceived effort, autonomy and pressure to complete the training. All subdomains of metacognition were highly correlated with the subcategories of IMI, i.e. perceived value, usefulness and effort to complete training, except interest and enjoyment.

3.3. Between group ANOVA

Table 2 summarizes the between group ANOVA results comparing estimated intelligence, intrinsic motivation and metacognition between non-learners, learners and high achievers. No differences between learning categories were found in terms of medication (CPZ equivalents (F(2,27) = 1.701, p = .202). Significant group differences were found between high achievers and non-learners on all factors. In addition to this, there were significant group differences between learners and non-learners for the memory quotient, the perceived usefulness/value and effort subscales of the IMI, understanding others mind, decentration and mastery levels of metacognition. Finally, differences in self-reflectivity between non-learners and learners approached statistical significance (p = .061).

3.4. Multiple regression analysis

Before the hierarchical regression model was performed, to ensure no violation of multicollinearity, we decided to include the total IMI score instead of subscale scores and mastery levels of metacognition into the equation. Variance inflation factors were checked for before the analyses. The results of regression model including the pre-training WCST number of correct responses (Step 1), MQ (Step 2), total IMI (Step 3) and metacognitive mastery (Step 4) are presented in Table 3. In the last step we included metacognitive mastery, firstly because metacognitive mastery has significantly been found as a potential mediator social functioning in previous studies (Lysaker et al., 2008), and secondly due to the models of development of intrinsic motivation and learning (Ryan and Deci, 2000; Flavell, 1979). Accordingly, pre-training performance was entered in the first step, and significantly explained 22.5% of the variance. Including memory quotient scores in the model showed that it explained a further 6.5% of the variance, with intrinsic motivation accounting for another 8.5%, though nonsignificantly. Metacognitive mastery was found as the only variable that significantly explained 48% of the overall variance in the last step. Previous performance and metacognitive mastery uniquely predicted the post-training performance when variance from other variables was controlled for. The memory quotient and total intrinsic motivation failed to explain overall variance independently in any of the steps, although they seem to have a contributing role in the equation.

Table 1

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Inter correlations among the variables.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1. MQ</td>
<td>–</td>
</tr>
<tr>
<td>2. IMI-SC Interest/Enjoyment</td>
<td>.21</td>
</tr>
<tr>
<td>3. IMI-SC Value/Usefulness</td>
<td>.34**</td>
</tr>
<tr>
<td>4. IMI-SC Effort</td>
<td>.03</td>
</tr>
<tr>
<td>5. IMI-SC Pressure/Tension</td>
<td>.29</td>
</tr>
<tr>
<td>6. IMI-SC Choice</td>
<td>.13</td>
</tr>
<tr>
<td>7. MC-Self reflectivity</td>
<td>.27</td>
</tr>
<tr>
<td>8. MC-Understanding other minds</td>
<td>.25</td>
</tr>
<tr>
<td>9. MC-Decentration</td>
<td>.31</td>
</tr>
<tr>
<td>10. MC-Mastery</td>
<td>.50**</td>
</tr>
</tbody>
</table>

Note: MQ: Memory quotient, Correlation values in italic type remained significant after multiple correlational analyses. IMI-SC: Intrinsic motivation inventory for Schizophrenia. MC: Metacognition.

<P < .05.
**P < .01.
in a number of different ways (Lysaker et al., 2011a). Previous related to a large number of diverse processes that can malfunction predictor of LP, whereas motivation and intelligence did not inde-
sion analysis revealed that metacognitive mastery was the best 

Hierarchical regression analysis for predicting learning potential. 

Table 2
ANOVA between group analysis of learning categories.

<table>
<thead>
<tr>
<th></th>
<th>Non-learners (n:6)</th>
<th>Learners (n:14)</th>
<th>High achievers (n:10)</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
<td>S.D.</td>
<td>Mean</td>
</tr>
<tr>
<td>MQ</td>
<td>71.83</td>
<td>15.03</td>
<td>90.00</td>
<td>15.11</td>
<td>89.40</td>
</tr>
<tr>
<td>IMI-SC Interest/Enjoyment</td>
<td>32.67</td>
<td>9.00</td>
<td>36.93</td>
<td>7.00</td>
<td>42.50</td>
</tr>
<tr>
<td>IMI-SC Value/Usefulness</td>
<td>30.17</td>
<td>10.89</td>
<td>41.00</td>
<td>9.07</td>
<td>42.70</td>
</tr>
<tr>
<td>IMI-SC Effort</td>
<td>18.33</td>
<td>2.50</td>
<td>25.57</td>
<td>5.47</td>
<td>22.60</td>
</tr>
<tr>
<td>IMI-SC Pressure/Tension</td>
<td>20.83</td>
<td>5.34</td>
<td>19.07</td>
<td>7.05</td>
<td>19.40</td>
</tr>
<tr>
<td>IMI-SC Choice</td>
<td>24.00</td>
<td>8.72</td>
<td>32.64</td>
<td>7.61</td>
<td>27.70</td>
</tr>
<tr>
<td>MC-Self-reflectivity</td>
<td>3.17</td>
<td>1.03</td>
<td>5.32</td>
<td>2.24</td>
<td>6.25</td>
</tr>
<tr>
<td>MC-Understanding others minds</td>
<td>2.92</td>
<td>.38</td>
<td>4.43</td>
<td>1.14</td>
<td>4.65</td>
</tr>
<tr>
<td>MC-Choice</td>
<td>.50</td>
<td>.55</td>
<td>1.57</td>
<td>.92</td>
<td>1.85</td>
</tr>
<tr>
<td>MC-Mastery</td>
<td>3.50</td>
<td>1.05</td>
<td>5.68</td>
<td>1.91</td>
<td>6.50</td>
</tr>
</tbody>
</table>

Note: MQ: Memory quotient, IMI-SC: Intrinsic Motivation Inventory for Schizophrenia. MC: Metacognition.

4. Discussion

The present study sought to examine the relationship between intrinsic motivation and metacognition, and its impact on learning potential in remitted patients with schizophrenia. In line with predictions, we found that intrinsic motivation was highly associated with metacognitive abilities. LP correlated positively with metacognition, motivation and intelligence. Specifically, a regression analysis revealed that metacognitive mastery was the best predictor of LP, whereas motivation and intelligence did not indepen-
dently contribute to explaining the variance.

Metacognitive deficits in schizophrenia have recently been related to a large number of diverse processes that can malfunction in a number of different ways (Lysaker et al., 2011a). Previous studies reported the mediating role of mastery on neurocognition and social functioning (Lysaker et al., 2008, 2011a). In addition, metacognitive capacities were found as predictors of therapeutic alliance (Davis et al., 2011). According to our results, metacognition has a substantial influence on learning potential.

Self-determination theory (SDT), as mentioned earlier, proposes a continuous pathway where the final step to stimulate intrinsic motivation is acquired by regulating one’s own self independent from extrinsic motivators (Ryan and Deci, 2000). In other words, people who develop superior intrinsic motivation through self-regulation will be more engaged in their social lives and therefore be more willing to participate in cognitive and social tasks.

In clinical settings, attaining this most mature level of IM seems largely unlikely for patients with schizophrenia, especially in light of evidence that antipsychotic drug treatment further deteriorates motivation, induces anhedonia and impairs reward processing (Aratloyia et al., 2006). Nevertheless, a recent study found that IM in schizophrenia is a dynamic process that changes over time (Nakagami et al., 2010), and can actually be fostered by attempts to improve perceived interest and enjoyment. According to our findings, better metacognitive skills can subsequently improve learning potential. Therefore, perceived interest and enjoyment can improve IM, though this is subjective and independent of metacognition, whereas perceived usefulness and value also improves IM, but relies on metacognitive skills, particularly mastery. Our assumption is in line with SDT, suggesting that when extrinsic motivation becomes self-integrated, it can turn into an intrinsic motivator, and this can be achieved by enhancing the personal relevance of a task through conscious evaluation, i.e. metacognition.

In addition, with regards SDT, our findings suggest that patients with poor motivation, low levels of metacognitive capacity, and consequently poor LP, may be the ones who rely more on extrinsic incentives, which is the diametrical opposite of IM (Ryan and Deci, 2000). Several studies of cognitive remediation in schizophrenia have used monetary incentives to reduce dropout rates (e.g., Horan et al., 2011). This may indirectly impact upon the efficacy of the intervention, firstly because including patients who consider extrinsic incentives as important can create a bias in the sampling of patients toward a group of patients with poorer LP. Secondly, extrinsic incentives may also mask the intrinsic value and subjectively perceived usefulness of the training. This may further explain why such studies report smaller effect sizes of the intervention compared to community care-based studies (Brekke et al., 2009). Furthermore, Koren et al. (2006) found that metacognitive judgment plays a fundamental role in capacity to consent.

Wykes and Reeder (2005) have argued that the transfer from a training task to real-life performance critically depends on improving motivation and metacognition in patients with schizophrenia. This may either be achieved by explicitly teaching meta-
cognitive skills to promote active monitoring of one’s own performance, or by implementing educational techniques such as scaffolding and errorless learning, which promotes success and enjoyment. Moreover, Lysaker et al. (2011b) have supported this assumption, suggesting that metacognitive capacities can meaningfully be addressed in psychotherapy by cuing interventions according to patient’s current maximal capacity for metacognitive activity.

Our results suggest considerable variability in LP of patients with schizophrenia, which arguably interacts with patients’ motivation and metacognition. Consequently, this interdependence of LP with motivation and metacognition may have substantial implications for the efficacy of cognitive remediation training (CRT) in schizophrenia. Raffard et al. (2009) have highlighted that LP can be used as a tool in predicting treatment outcome after CRT. In sum, the benefit of CRT will be less for patients with poorer LP. Therefore

Table 3
Hierarchical regression analysis for predicting learning potential.

<table>
<thead>
<tr>
<th>Step</th>
<th>B</th>
<th>t value</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 Baseline WCST number of correct responses</td>
<td>.70</td>
<td>2.85</td>
<td>.012</td>
</tr>
<tr>
<td>Step 2 Baseline WCST number of correct responses</td>
<td>.66</td>
<td>2.70</td>
<td>.010</td>
</tr>
<tr>
<td>Step 3 Baseline WCST number of correct responses</td>
<td>.66</td>
<td>1.57</td>
<td>.127</td>
</tr>
<tr>
<td>Step 4 Baseline WCST number of correct responses</td>
<td>.50</td>
<td>2.16</td>
<td>.040</td>
</tr>
<tr>
<td></td>
<td>.07</td>
<td>.24</td>
<td>.816</td>
</tr>
<tr>
<td>Step 5 Baseline WCST number of correct responses</td>
<td>.19</td>
<td>1.20</td>
<td>.243</td>
</tr>
<tr>
<td>Step 6 MC-Mastery – Metacognition</td>
<td>.31</td>
<td>2.23</td>
<td>.034</td>
</tr>
</tbody>
</table>

Step 1: $R^2 = .225$, df = 1, 28, $p = .008$. 
Step 2: $R^2 = .390$, df = 1, 27, $p = .010$. Sig. F Change: $p = .079$. 
Step 3: $R^2 = .375$, df = 1, 26, $p = .006$. Sig. F Change: $p = .088$. 
Note: Dependent variable: Post training WCST number of correct responses. MQ: Memory quotient. IMI-SC Total score: Intrinsic Motivation Inventory for Schizophrenia Total score.
a pre-treatment assessment of LP, in consideration of IM and metacognition, could be used as a screening tool to select patients who are more likely to benefit from CRT. Conversely, in previous studies the inclusion of patients who lack LP, motivation and metacognition may also explain the low reported effect sizes of CRT (e.g., Wykes et al., 2011). For those patients, it is perhaps advisable to tailor psychoeducational approaches, which in the first place enhance IM as a window to improve LP in the second line.

This study has several limitations. Firstly, we did not take into account the impact of other neurocognitive confounders like sustained attention, which may have an influence on LP. Secondly, our assessment of estimated IQ with the MQ from the WMS-III is less common than other methods of estimated IQ evaluation. Finally, to further elucidate the relationship between motivation and metacognition it may be more reliable to perform a structured intervention with multiple sessions, as compared to the experimental design used here.

In conclusion, to our knowledge this is the first study demonstrating the direct role of IM and metacognitive capacity on learning potential in patients with schizophrenia. We present a novel perspective on approaching predictors of learning, suggesting that metacognitive capacity and motivation play crucial role, but semi-independent roles in successfully accomplishing cognitive remediation in schizophrenia. Future studies may address the question if these factors are also involved in mediating the effects of cognitive remediation on social functioning.

Role of funding sources

Drs Tas and Brown have been funded by a scholarship from International Graduate School of Neuroscience, Ruhr University of Bochum.

Contributors

Drs Tas and Brüne designed the study. Dr. Tas and Esen-Danaci collected data for this study. Dr Tas conducted statistical analyses, and wrote the first draft of the manuscript. Drs Tas, Brown, Lysaker and Brüne contributed to the writing for the subsequent drafts of manuscript. All authors have approved the final manuscript.

Conflicts of interest

None.

Acknowledgments

Drs Tas and Brüne would like to thank Zeynep Cubukcuoglu, MD and Orkun Aydin MB, for their assistance in data collection.

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