

# A Study on the Effectiveness of Metacognitive Training in Treating Negative Symptoms of Different Subtypes of Schizophrenia

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**Purpose:** This study aims to investigate the efficacy of metacognitive training (MCT) as an adjunctive treatment strategy for schizophrenia, particularly its impact on negative symptoms and potential mechanisms.

**Patients and Methods:** This study included a total of 73 inpatients with schizophrenia. 36 patients were in the MCT group and 37 patients were in the control group. Both groups of patients were receiving a single second-generation antipsychotic drug treatment. The MCT group underwent a 4-week MCT program consisting of 8 modules, while the control group received non-cognitive psychological support for the same duration and frequency. The Positive and Negative Syndrome Scale (PANSS) five-factor model and negative symptom two-factor model were used to assess psychiatric symptoms, and the Snyder's Self-Monitoring Scale (SSMS) and the Personal and Social Performance Scale (PSP) were used as functional evaluation indicators.

**Results:** After treatment, compared to the control group, the MCT group had significantly lower scores in the PANSS total score ( $p < 0.001$ ), negative factor ( $p = 0.002$ ), and hostility factor ( $p = 0.046$ ). Further, the PSP score ( $p < 0.001$ ) and SSMS score ( $p = 0.042$ ) were significantly improved. In the two-factor analysis of negative symptoms, the MCT group showed significant improvements in both diminished expression (DE) symptoms ( $p < 0.001$ ) and social amotivation (SA) symptoms ( $p = 0.010$ ) after treatment. Multivariate linear regression analysis revealed that changes in the reduction rates of P2 (Conceptual disorganization), N7 (stereotyped thinking), and SA scores had a significant impact on the reduction in DE scores; changes in the reduction rates of P6 (Suspiciousness/persecution) and DE scores had a significant impact on the reduction rate of SA scores ( $p < 0.05$ ).

**Conclusion:** MCT can improve the clinical symptoms and functions of patients with schizophrenia, especially in the DE factor characterized by conceptual disorganization and stereotyped thinking, and the SA factor prominent in suspiciousness/persecution symptom. This provides insights for the precise treatment of negative symptoms.

**Keywords:** metacognitive training, schizophrenia, negative symptoms, diminished expression, social amotivation

## Introduction

Schizophrenia is a severe mental illness that typically manifests during adolescence or early adulthood, with a chronic or recurrent course. Patients often have persistent and poorly treated negative symptoms and cognitive impairment, which seriously affects their social function and imposes a heavy burden of disease. At present, more and more research evidence support that negative symptoms occupy a central position in many symptoms of schizophrenia, and 60% of patients have significant and persistent negative symptoms, which usually occur in the early stages of the disease and



significantly reduce the ability of patients to perform daily activities. Patients with more prominent negative symptoms often experience worse functional outcomes, including impairments in occupational, household, and recreational functions, which can also lead to more relationship difficulties.<sup>1</sup> In treatment-resistant schizophrenia (TRS), which is characterized by the lack of response to two or more antipsychotic medications, patients typically exhibit more severe and frequent negative symptoms. Recent studies have also indicated that the severity of the disease in this subgroup (TRS) may be mediated by the severity of negative symptoms.<sup>2</sup> In recent years, there has been a growing demand for more effective treatment for negative symptoms to improve long-term prognosis. However, few medications for negative symptoms have shown substantial benefit. An increasing number of psychosocial and behavioral interventions have been developed and are synergistic with drug therapy to alleviate and treat negative symptoms.<sup>3</sup>

Metacognition was initially defined as the awareness of cognition, that is, the ability to monitor, evaluate, and regulate cognition itself.<sup>4</sup> Subsequently, this definition has been expanded<sup>5</sup> and is now considered as a more comprehensive ability to integrate complex representational information of self and others.<sup>6</sup> This has led to the development of interventions targeting metacognitive processes, some of which, such as metacognitive training (MCT), were specifically designed for psychosis.<sup>7</sup> The theoretical foundation of MCT is to indirectly alleviate psychiatric symptoms and associated distress by addressing cognitive biases, negative emotions, and low self-esteem that may lead to information processing errors at the cognitive level, which play an important role in the occurrence and development of mental illness.<sup>8</sup> The aim is to increase patients' "cognitive insight" and assist them in learning strategies for managing symptoms. In recent years, many studies have verified the feasibility, safety and effectiveness of MCT.<sup>9–11</sup> A considerable number of studies have demonstrated that MCT can reduce delusions and positive symptoms, and improve cognitive insight and cognitive biases. However, there are also different conclusions.<sup>12–15</sup> There is more controversy regarding the efficacy of MCT in treating negative symptoms. There is a correlation between negative symptoms and impaired ability to process self/other psychological states.<sup>5</sup> Based on this finding, low metacognitive levels can predict higher negative symptom scores in the future.<sup>16</sup> A recent meta-analysis on the short-term and long-term effects and moderating factors of metacognitive training in disease treatment suggested that MCT is associated with benefits within one year of the intervention. The short-term benefits are improvements in positive symptoms and cognitive biases, while the long-term benefits pertain to self-esteem, negative symptoms, quality of life, happiness, and functionality.<sup>17</sup> However, the exact efficacy and mechanism of MCT in the treatment of negative symptoms remain to be studied.

Negative symptoms possess a complex internal structure. The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V) distinguishes two substructures of negative symptoms: amotivation (including avolition, asociality and anhedonia) and diminished expression (including blunted affect and alogia). Currently, numerous studies have conducted factor analysis based on the PANSS scale, distinguishing negative symptoms into two factors: diminished expression (DE) and social amotivation (SA), and demonstrating that the PANSS scale can clearly differentiate between the two.<sup>18–20</sup> The diminished expression factor include: Lack of spontaneity and flow of conversation (N6), Poor rapport (N3), Blunted affect (N1), Motor retardation (G7); and the social amotivation factor include: Passive/apathetic social withdrawal (N4), Active social avoidance (G16), Emotional withdrawal (N2). There are significant differences in clinical phenotypes between these two factors (subgroups) of negative symptoms, including pre-morbid functioning, clinical course, functional outcome, disorder symptoms, social cognition, gender, and ethnicity.<sup>21</sup> This suggests that there are differences in the neural mechanisms underlying the two sets of symptoms, and different therapeutic targets may be required.

To investigate the precise efficacy of MCT on different clinical symptom clusters in patients with schizophrenia, especially its impact on different subtypes of negative symptoms and the potential mechanisms involved, this study employs MCT as an adjunctive treatment strategy for patients in the acute phase. Utilizing a two-factor structural model for negative symptoms<sup>19,20</sup> and a five-factor structural model of the PANSS based on a large-scale multi-ethnic sample<sup>20</sup> (to better align the measurement dimensions of symptoms with the psychopathological symptoms themselves), this study analyzes the improvement effects of MCT on clinical symptoms, psychological and social functions in patients with schizophrenia, particularly on different subtypes of negative symptoms. This study aims to provide further evidence for the clinical application of MCT and offer insights into treatment strategies for negative symptoms.

## Materials and Methods

### Participants

Inpatients from the Henan Mental Hospital were recruited between March 1, 2013 and July 1, 2013. Patients who met inclusion criteria were referred by each ward on a weekly basis. Patients were assigned to the MCT group and the control group according to the order in which the cases were submitted (for example, the first patient was assigned to the MCT group, the second to the control group, and so on). The grouping for each round was completed on the seventh day of the start of enrollment, with 3–10 patients in each group (if the enrollment for that round was less than 3 patients per group, the enrollment period could be extended to 10 days; otherwise, the enrollment for that round would be abandoned).

Inclusion criteria: 1. Aged 16–60 years; 2. Diagnosed with schizophrenia according to the DSM-IV; 3. Patients should be able to complete a one-hour training course; 4. Estimated that patients can complete 4 weeks of group therapy during hospitalization (the average length of hospital stay for inpatients is approximately 45 days); 5. Subjects and/or guardians fully understand and comprehend the research content of this trial, sign the informed consent form. For voluntary hospitalization, the consent form is generally signed by the patient himself, while for involuntary hospitalization, it needs to be signed by the patient's guardian. Exclusion criteria: 1. History of brain organic diseases such as brain injury and dementia; 2. Individuals with intellectual disabilities (Raven's Standard Progressive Matrices score greater than level 3); 3. Individuals with substance dependence. Dropout criteria: 1. Subjects withdraw their informed consent; 2. Completing the psychological treatment module  $\leq 3$  times (out of a total of 8 sessions); 3. Patients exhibiting impulsive, aggressive, and self-injurious or suicidal behaviors during the treatment process. Based on the preliminary exploratory research data,<sup>22</sup> the MCT group showed a significant difference with a calculated effect size of 0.64. Using a two-independent-samples *t*-test, the significance level was set at 0.05, the statistical power was set at 80%, and a two-tailed test was conducted. The calculation was performed using G\*Power software. A dropout rate of 20% was reserved for dropouts, with 50 participants included in each group. Finally, this study collected a total of 38 patients in the MCT group and 39 in the control group. After excluding patients with incomplete data, 36 patients in the MCT group and 37 in the control group were ultimately included in the data analysis.

The MCT group received MCT treatment twice a week, with one module per session lasting approximately 45–60 minutes. One cycle of the study was completed in 4 weeks. This form was chosen based on the suggestions of the MCT author.<sup>23</sup> The control group received clinical psychological care twice a week, with each session lasting approximately 45–60 minutes, providing non-cognitive psychological support and counseling. Meanwhile, both groups of patients were treated with an antipsychotic monotherapy.

In accordance with the Declaration of Helsinki, the protocol involving human participants was reviewed and approved by the Ethics Committee of the Second Affiliated Hospital of Xinxiang Medical University (Project Number: SYJS2022057). After fully understanding the objectives and methods of the study, all participants signed the informed consent form.

### Assessment and Procedure

Senior psychiatrists assessed and recruited patients, and researchers verified them according to inclusion and exclusion criteria. The included patients completed the signing of informed consent forms and the assessment of scales.

Participants used the following scales for evaluation:

#### A Self-Designed General Questionnaire

It collects general information such as gender, age, education level, family history, as well as detailed medical history including disease duration, age of onset, number of recurrences and hospitalizations, and medication status.

#### Positive and Negative Syndrome Scale (PANSS)

The PANSS<sup>24</sup> scale is a widely used clinical assessment scale that evaluates the clinical symptoms and symptom severity of schizophrenia patients through 30 symptom items.

### Five-Factor PANSS Model

Positive factor: P1, G9, P6, P3, P5;

Negative factor: N2, N4, N6, N3, N1, G16, G7;

Cognitive/disorganization factor: P2, G11, N7, N5, G13, G5, G15;

Depression/anxiety factor: G2, G3, G6, G4, G1;

Hostility factor: P7, G8, G14, P4.

### Two-Factor Structure of Negative Symptoms

Diminished expression (DE): N6, N3, N1, G7;

Social amotivation (SA): N4, G16, N2.

### Snyder's Self-Monitoring Scale (SSMS)

This<sup>25</sup> scale consists of 25 questions, with scores ranging from 0 to 25. Each question is answered with a score of 1 if the answer matches the given response, otherwise no score is given. A higher score indicates a higher level of self-monitoring. Self-monitoring ability reflects an individual's psychological tendency to pay attention to environmental cues and self-behavior in social interactions, as well as their ability to regulate self-expression.

### Personal and Social Performance Scale (PSP)

This<sup>26</sup> scale measures overall performance in terms of social function and personal abilities. By quantifying patients' performance in daily life, social interaction, self-care, and symptom control, it is used for rehabilitation assessment and treatment effect monitoring of patients with schizophrenia and other severe mental disorders. The scale adopts a grading scoring system, typically ranging from 1 to 100 points, with higher scores indicating better personal and social performance.

Re-assessment of PANSS, SSMS, and PSP were also administered within one week after the end of treatment. The rating scale was evaluated by experienced senior psychiatrists, and the raters underwent consistency training.

### Interventions

All patients received conventional treatment (monotherapy with second-generation antipsychotic medication). Patients in both the MCT group and the control group underwent 8 sessions of treatment over 4 weeks. The therapists were all psychologists or psychiatrists with long-term experience in treating schizophrenia spectrum disorders and had experience in group courses. Each treatment session in the MCT group is presented through a set of slides, including the core theories, practical examples and matching exercises corresponding to the current module, to help patients perceive their cognitive distortions and correct cognitive biases through example exercises. The specific operation is as follows: In each class, the therapist will first explain common prejudices in the module through slides; illustrate the correlation between these cognitive prejudices and mental illnesses with cases from daily life; conduct group discussions with a large number of practice cases in the course to address these prejudices; and finally, distribute homework practice sheets at the end of the course. Homework can be completed with the help of an auxiliary tool: a yellow card (containing three basic questions: 1. What is the evidence? 2. Are there different opinions? 3. Even if it seems like. Am I overreacting? This card is for patients to use when necessary, such as when they feel offended. It aims to prompt patients to rethink before engaging in inappropriate behavior). In addition, during non-treatment periods, patients can obtain necessary support through the red card (which contains the name, phone number, and affiliation of the person who can be contacted in case of emergency). Before each session, the therapist will assess the patient's response to the treatment module by checking their homework. The MCT course consisted of 8 modules, each exploring a single cognitive bias<sup>27</sup> (Table 1). The control group also received non-cognitive psychological support and counseling through slides, including lectures on mental illness-related knowledge, emotional management, and relaxation therapy.

### Statistical Analysis

Data statistical analysis was conducted using SPSS 27.0. Measurement data conforming to a normal distribution were expressed as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ), and t-tests were used for inter-group comparisons. Data not conforming to a normal

**Table 1** The Main Content and Objectives of Each MCT Module

Description of All Modules	Example Exercises
<p><b>1. Attribution - to Blame and to Credit</b> Familiarize patients with different types of extreme attribution and their potential social consequences (for instance, attributing failure to others may lead to strained interpersonal relationships). Encourage patients to offer more objective and balanced explanations for each situation (such as sharing success with others instead of attributing it solely to themselves). Patients must seek reasons for simply described events, such as why a friend did not call (negative) or why someone invited you to dinner (positive). Consider the situational, interpersonal, and personal factors.</p> <p><b>2. Jumping to conclusions I</b> By gradually adding details to make the current image a complete object, patients realize that premature and hasty decisions may lead to erroneous conclusions. Encourage patients in the same group to discuss their current assumptions (likely erroneous beliefs) based on the image, collect arguments for and against this belief, exchange ideas, and evaluate the likelihood of these arguments being valid. Clarify that such rumors arise due to hasty conclusions and questionable evidence. Therefore, generally speaking, these rumors are good examples of how delusional beliefs can arise.</p> <p><b>3. Changing beliefs</b> The comic plot is presented in reverse order, encouraging patients to re-evaluate the reasonableness of their previous explanations after adding new content each time, and to realize the importance of maintaining critical thinking until sufficient evidence is collected. For example, three objects are presented (three types of flowers). Patients are asked to think of higher-level categories that can summarize the presented objects, and are prompted that the new object belongs to that category (higher-level category: living things, food). By answering yes/no, the therapist gives feedback on whether the new object fits into the higher-level category. Because the presented objects are misleading, most people answer yes, rather than trying other hypotheses or proposing other entries to critically test their assumptions.</p> <p><b>4. Empathy I</b> By showing pictures of different characters' expressions, patients were asked to infer the feelings and identities of the characters in the photos. In order to emphasize that facial expression is an important clue to infer an individual's internal motivation, but it is not the only clue to provide clear evidence, four pictures of athletes, psychologists, actors and serial killers were shown to patients. In this exercise, most people make a wrong guess based on facial expressions! Subsequently, examples were provided to illustrate that due to different cultural backgrounds and eras, facial expressions and gestures can be interpreted differently ("When in Rome, do as the Romans do").</p> <p><b>5. Memory</b> By presenting images that remove classic elements from complex scenes, such as a typical beach scene initially being presented (eg, playing children, sunbathers, water), but intentionally omitting some items that people naturally expect to see on the beach (eg, ball, towel), patients are then typically asked to recall items they have seen but are actually not present in the scene (eg, ball, towel). The instruction slides are presented in an interactive manner, allowing patients to learn that the incidence of false memories increases in familiar contexts.</p> <p><b>6. Empathy II</b> Enable patients to analyze the entire story from the perspectives of both the protagonist and the observer, and recognize the importance of considering multiple possibilities or empathizing with others when information is unclear in social situations. Initially, patients should discuss which clues are helpful in making judgments about a person (eg, language, posture). And fully discuss the advantages and disadvantages of each criterion. Then present a comic strip, asking participants to speculate, from the perspective of the story's protagonist, what this character might think about another character or a specific event.</p>	<p>The reasons for my failing the exam are as follows: I was not well-prepared (self-related), the examiner was unfair (other-related), everyone failed, and the exam was extremely difficult (situation-related).</p> <p>"Frog": In the first stage of practice, the initial image looks very much like a lemon. Gradually add partial images until the outline of the frog is revealed. Being hasty in drawing conclusions will lead to mistakes.</p> <p>In the parking lot scene, the evidence is shown in the third picture. The first picture shows that the man's car occupies two parking spaces, but by the time the third picture appears, it is found that the man's improper parking is caused by the improper parking of the car next to him.</p> <p>The series of images, with the conclusion presented in the fourth image (currently offering four possibilities), shows the first three images in reverse order. Based on the gradually presented images, identify the correct conclusion (out of the four possibilities). For example: After the third image is presented, the man may be putting the painting onto the easel to finish it, but in the fourth image, this part of the painting is already completed (making option A unlikely). Option B is unreasonable from the beginning. In the second image, the man is planning to nail a nail onto the wall, indicating that he intends to hang something.</p> <p>We may recall some fragments of recent quarrels/disputes, where certain words were not spoken at the time, but were implied to some extent (subjective speculation), or were indeed mentioned but in previous conflicts. Or, regarding a specific incident, there are significant differences in the details described by the patient and the family members.</p> <p>A woman received bad news from her doctor. Afterwards, she was late for work, and her boss scolded her. From the last picture alone, we cannot judge whether her boss's criticism was heartless. However, it can be argued that the boss should have been more understanding, given that her employee might have seemed desperate.</p>

(Continued)

**Table 1** (Continued).

Description of All Modules	Example Exercises
<p>7. Jumping to conclusions II By presenting a painting and four potential interpretations, the patient is made aware that hasty decision-making without sufficient background information (looking at a painting alone) may lead to incorrect answers. Discuss within the group the details supporting or opposing a particular interpretation. The patient's attention will be directed to information that has not yet been noticed. After discussing all the details, ask the patient to re-evaluate the title options.</p> <p>8. Self-esteem and mood By presenting typical depressive cognitive patterns, patients are trained to adopt more constructive and positive thinking patterns. Initially, group members list depressive symptoms. Then, possible treatment options for depression and typical cognitive patterns are discussed. Subsequent exercises target depressive cognitive schemas. By collaborating with patients, trainers explain how distorted cognitive schemas can be replaced with more realistic and beneficial ones. This module also targets coping strategies commonly adopted by patients with mental health issues.</p>	<p>The clue to finding the correct answer for the question "Dramatic Performance" is: A large group of people are watching three people fighting through a small window. There is no screen (making option "C Watching a movie" impossible); it is impossible for so many people to witness a crime without intervening (making option "A Witness to a murder" impossible); the crowd is sitting in the dark, yet the scene is bright, just like in a theater.</p> <p>I cannot recognize a well-known foreign language word. Depressing evaluation: I am really stupid. Beneficial evaluation: I know other things; others are more familiar with this topic because they have been engaged in related matters.</p>

distribution were expressed as M (Q1, Q3), and Mann–Whitney *U*-tests were used for inter-group comparisons. Enumeration data were expressed as the number of cases, and chi-square tests were used for inter-group comparisons. In correlation analysis, Pearson correlation analysis was used for data that conform to a normal distribution, while Spearman correlation analysis was used for data that do not conform to a normal distribution. Multiple linear regression analysis was employed to evaluate the influencing factors of the change in negative symptom reduction rate. The reduction rate is expressed as: (baseline score - post-treatment score)/baseline score. All statistical analyses were considered statistically significant with a two-tailed *p*-value < 0.05.

## Results

### General Features

The MCT group ultimately included 36 patients, while the control group included 37 patients. There were no significant differences between the two groups in terms of age, gender, family history, onset age, disease duration, recurrence frequency, and hospitalization frequency. The number of years of education for patients in the MCT group was significantly higher than that in the control group (*p*=0.027). After 4 weeks of treatment, there was no significant difference in the medication dosages used by the two groups of patients (Table 2).

### Comparison of Clinical Assessments

At baseline, there were no significant differences in the PANSS total score, positive, negative, depression/anxiety, and hostility factors among the five factors of PANSS, as well as the PSP score and Snyder score between the two groups.

**Table 2** General Information Comparison

Variables	MCT Group (n=36)	Control Group (n=37)	Z-value/ $\chi^2$ -value	P-value
Age (years)	26.0 (23.0, 38.8)	30.0 (22.5, 37.0)	-0.116	0.908
Sex (male/female)	16/20	12/25	1.113	0.291
Family history (yes/no)	3/33	6/31	0.446	0.504
Years of education	12.0 (9.0, 14.8)	9.0 (9.0, 12.0)	-2.208	0.027
Age of onset (years)	22.0 (19.0, 25.8)	21.0 (18.0, 28.0)	-0.194	0.847
Duration of illness (years)	4.5 (2.0, 10.0)	6.0 (3.0, 11.0)	-0.697	0.486
Number of relapses	3.0 (2.0, 5.0)	3.0 (2.0, 6.0)	-1.679	0.093
Number of hospitalizations	2.0 (2.0, 3.0)	2.0 (2.0, 3.0)	-0.612	0.541
Medication dose after treatment, (mg/day) <sup>a</sup>	500.0 (400.0, 600.0)	500.0 (400.0, 600.0)	-0.323	0.747

Notes: a: Chlorpromazine-equivalent dose.

After treatment (4 weeks), both groups showed improvements in various scores. The MCT group scored significantly lower than the control group in the PANSS total score ( $p<0.001$ ), as well as in the negative factor ( $p=0.002$ ), and hostility factor ( $p=0.046$ ) scores. The positive factor score showed a downward trend, but there was no significant difference. Meanwhile, the PSP score ( $p<0.001$ ) and SSMS score ( $p=0.042$ ) were significantly higher in the MCT group compared to the control group (Table 3).

## Comparison of Negative Symptoms

At baseline, there was no significant difference in the two factors of negative symptoms between the two groups. After treatment, compared to the control group, the MCT group showed significant improvements in both DE symptoms ( $p<0.001$ ) and SA symptoms ( $p=0.010$ ) of negative symptoms (Table 4).

## Correlation Analysis of the Two-Factor Reduction Rate of Negative Symptoms

MCT treatment primarily focuses on training aimed at cognitive biases. Therefore, a correlation analysis was conducted between the DE and SA score reduction rates in the MCT group and the score reduction rates of positive factors (P1, G9, P6, P3, P5) and cognitive/disorganization factors (P2, G11, N7, N5, G13, G5, G15). After normality testing, the SA and P1 score reduction rates conformed to a normal distribution, and Pearson correlation analysis was used; the remaining indicators did not conform to a normal distribution, and Spearman correlation analysis was employed. The strength of the correlation was indicated by the correlation coefficient. It was found that there was a significant positive correlation between the DE score reduction rate and the score reduction rates of SA, P1, P3, P2, G11, N7, N5, and G13 ( $p<0.05$ ); there was also a significant positive correlation between the SA score reduction rate and the score reduction rates of DE, P1, P6, P3, P2, N5, and G13 ( $p<0.05$ ) (Supplementary Table 1).

Using the DE score reduction rate and SA score reduction rate as dependent variables, respectively, and selecting meaningful item score reduction rates as independent variables through correlation analysis, we substituted them into the multiple linear regression equation. The results showed that changes in the score reduction rates of P2, N7, and SA had a significant impact on the DE score reduction rate ( $p<0.05$ ); changes in the score reduction rate of P6 and DE had a significant impact on the SA score reduction rate ( $p<0.05$ ) (Table 5).

**Table 3** Clinical Assessment Before and After Treatment

Variables	Baseline		T-value/ Z-value	p	4 weeks		T-value/ Z-value	p
	MCT Group (n=36)	Control Group (n=37)			MCT Group (n=36)	Control Group (n=37)		
PANSS total score	72.8±20.3	75.8±20.8	-0.615	0.541	45.9±10.7	57.1±16.3	-3.459	<0.001
Positive factor	16.7±4.3	14.8±4.5	1.880	0.064	9.0 (7.0, 13.0)	11.0 (8.0, 13.0)	-1.310	0.190
Negative factor	16.5 (9.0, 23.8)	21.0 (12.5, 26.5)	-1.597	0.110	8.5 (7.0, 14.0)	14.0 (10.0, 20.0)	-3.075	0.002
Cognitive/ disorganization factor	14.0 (10.3, 19.3)	18.0 (13.0, 21.5)	-2.128	0.033	9.0 (7.3, 11.8)	14.0 (9.0, 16.5)	-3.588	<0.001
Depression/anxiety factor	9.0 (6.0, 12.0)	7.0 (5.0, 10.0)	-1.644	0.100	6.0 (5.0, 7.0)	5.0 (5.0, 7.0)	-0.184	0.854
Hostility factor	9.0 (5.0, 12.0)	9.0 (6.0, 13.0)	-0.599	0.549	5.0 (4.0, 6.0)	6.0 (4.0, 8.0)	-2.000	0.046
PSP score	52.4±17.8	48.8±17.0	0.898	0.372	74.7±12.9	62.1±14.7	3.871	<0.001
SSMS score	11.5±3.0	10.5±3.5	1.303	0.197	12.5±3.1	10.9±3.3	2.074	0.042

**Notes:** Measurement data conforming to a normal distribution are represented by mean ± standard deviation ( $\bar{x} \pm s$ ), while data not conforming to a normal distribution are represented by M (Q1, Q3).

**Abbreviations:** PANSS, Positive and negative syndrome scale; PSP, Personal and Social Performance Scale; SSMS, Snyder'Self-monitoring Scale.

**Table 4** Comparison of Two Factors of Negative Symptoms Before and After Treatment

Variables	MCT Group (n=36)	Control Group (n=37)	Z-value	P-value
Baseline				
DE	9.0 (4.0, 13.0)	12.0 (6.5, 15.0)	-1.881	0.060
SA	7.0 (3.3, 10.0)	9.0 (5.0, 11.5)	-1.344	0.179
4 weeks				
DE	4.5 (4.0, 7.0)	9.0 (6.0, 11.0)	-3.634	<0.001
SA	4.0 (3.0, 6.0)	6.0 (4.0, 8.5)	-2.588	0.010

**Abbreviations:** DE, Diminished expression; SA, Social amotivation.

## Discussion

This study is the first to employ a more precise classification model based on the PANSS scale to explore the efficacy of MCT in treating different types of clinical symptoms in patients with schizophrenia, and further elucidated the efficacy and possible mechanism of MCT in treating different subtypes of negative symptoms. The current study found that MCT significantly improved overall psychiatric symptoms, negative symptoms, and hostile symptoms, and significantly enhanced patients' self-monitoring ability and personal and social functioning. MCT significantly improved both factors of diminished expression (DE) and social amotivation (SA) in negative symptoms. This is related to the improvement of conceptual disorganization and stereotyped thinking symptoms in the DE factor, as well as the improvement of suspiciousness/persecution symptoms in the SA factor.

Previous studies have found that after MCT treatment, the overall psychiatric symptoms (PANSS total score) of schizophrenia patients significantly improve.<sup>28,29</sup> To enhance the precision of measuring psychiatric symptoms, this study further categorized the PANSS scale into five factors based on previous research evidence: positive factors, negative factors, cognitive/disorganization factors, depressive/anxiety factors, and hostile factors. To our knowledge, this is the first time to use the refined PANSS scale classification to assess the effectiveness of MCT on symptoms in patients with schizophrenia. This study found that MCT significantly improved negative symptoms and hostile symptoms. There was a noticeable trend towards improvement in positive symptoms. It is suggested that MCT can be used in targeted treatment for negative symptoms, and significant improvement in hostile symptoms may reduce patients' clinical risks, which is more conducive to clinical management and home care, providing a basis for a good prognosis of the disease. At the same time, it was found that the patients' self-monitoring ability, as well as their personal and social functions, significantly improved, indicating that the patients had become more prosocial. Their attention to environmental cues and regulation of self-expression could promote better social functioning. This may be due to the therapeutic benefits of MCT on cognitive biases being transferred to psychosocial functioning and insight into the disease.<sup>11</sup> It is more conducive to patients' integration into society, addressing challenges in the workplace, and improving work outcomes.<sup>30</sup>

A large number of previous studies have demonstrated the validity of the two-factor structure of negative symptoms.<sup>31-33</sup> The two-factor structure is associated with different clinical symptom clusters in schizophrenia, and behavioral and neuroimaging research support the possibility of different underlying mechanisms.<sup>32</sup> It is proposed that different treatment strategies may be required. The current study further explored the efficacy and potential mechanisms of MCT on different subtypes of negative symptoms. It was found that MCT, as an adjunctive therapy for patients with schizophrenia, significantly improved negative symptoms in two subtypes: diminished expression (DE) and social amotivation (SA), with potentially more pronounced improvement in symptoms of DE. Related to the improvement of the DE factor are the improvements in symptoms of conceptual disorganization (P2) and stereotyped thinking (N7), as well as the improvement of the SA factor. Related to the improvement of the SA factor are the improvements in symptoms of suspiciousness/persecution (P6), as well as the DE factor. This provides evidence for the effectiveness of MCT in treating different subtypes of negative symptoms. Previous research on the underlying mechanisms of alogia has indicated that reduced expression is associated with limited cognitive resources. Generating speech in social situations requires a high degree of cognitive processing. When cognitive resources are limited, patients' speech output may

**Table 5** Multiple Linear Regression Analysis of the Reduction Rate of Two Factors in Negative Symptoms

Dependent Variable	Independent Variable	B	SE	Beta	t	P	Tolerance	VIF
Reduction rate of DE <sup>a</sup>	Reduction rate of P1	-0.327	0.171	-0.275	-1.916	0.066	0.501	1.994
	Reduction rate of P3	0.182	0.119	0.204	1.525	0.139	0.580	1.724
	Reduction rate of P2	0.298	0.126	0.332	2.355	0.026	0.521	1.920
	Reduction rate of G11	0.093	0.060	0.175	1.542	0.135	0.800	1.250
	Reduction rate of N7	0.300	0.117	0.312	2.556	0.017	0.695	1.439
	Reduction rate of N5	-0.009	0.100	-0.018	-0.093	0.927	0.282	3.544
	Reduction rate of G13	0.060	0.095	0.120	0.637	0.529	0.289	3.459
	Reduction rate of SA	0.401	0.116	0.451	3.465	0.002	0.611	1.637
Reduction rate of SA <sup>b</sup>	Reduction rate of P1	0.360	0.211	0.269	1.704	0.099	0.513	1.949
	Reduction rate of P6	0.312	0.109	0.364	2.851	0.008	0.782	1.278
	Reduction rate of P3	-0.111	0.147	-0.110	-0.755	0.456	0.599	1.671
	Reduction rate of P2	-0.126	0.173	-0.125	-0.729	0.472	0.435	2.301
	Reduction rate of N5	-0.107	0.118	-0.182	-0.905	0.373	0.315	3.170
	Reduction rate of G13	0.026	0.115	0.046	0.227	0.822	0.307	3.262
	Reduction rate of DE	0.721	0.174	0.642	4.156	<0.001	0.536	1.865

**Notes:** a:  $R^2=0.721$ , adjusted  $R^2=0.638$ ,  $F=8.725$ ,  $p<0.001$ ,  $D-W=2.019$ ; b:  $R^2=0.642$ , adjusted  $R^2=0.553$ ,  $F=7.178$ ,  $p<0.001$ ,  $D-W=2.849$ .

**Abbreviations:** DE, Diminished expression; SA, Social amotivation.

decrease. Furthermore, aphasia is associated with poor language fluency, such as the ability to control retrieval<sup>34</sup> and semantic memory.<sup>35</sup> Current research has reversely verified the role of cognitive correction (improving conceptual disorganization and stereotyped thinking symptoms) in treating the negative symptom subtype of DE. Neurocognitive research suggests that motivational disorders are associated with abnormalities in various reward processing, including certain aspects of impairments in reinforcement learning, reward prediction, and prediction error processing.<sup>36</sup> Patients with schizophrenia can be reluctant to make efforts to obtain rewards. The underlying psychological mechanism that may cause this motivational disorder is believed to be related to negative experiences that lead to patients' negative expectations about their ability to successfully complete goal-oriented tasks, namely defeatist beliefs and negative expectations.<sup>37</sup> Therefore, we believe that MCT exerts an indirect therapeutic effect on the negative symptom subtype of SA by improving symptom of suspiciousness/persecution (negative thinking patterns about one's own situation). However, the improvements of these two subtypes are to some extent interrelated. On the one hand, the two dimensions of symptoms may not be completely independent, but there is a certain degree of overlap between them. For example, some studies have found that reduced motivation is not only the basis of the SA factor but also the basis of all negative symptoms, including DE.<sup>38</sup> On the other hand, the scope and structural clarity of the PANSS item set may play a role. For instance, the assessment of N2 and N6 relies on observable external behaviors, which can lead to ambiguity in the output results.

The current study employs the PANSS five-factor and negative symptom two-factor models to investigate the precise efficacy of MCT as an adjunctive therapy for psychiatric symptoms, and further explores the distinct mechanisms and potential treatment strategies of the negative symptom two-factor model. However, the study has certain limitations. Firstly, the sample size is relatively small, and the educational levels of the two patient groups were not matched, making it difficult to clearly determine the significance of MCT's efficacy on cognitive/disorganization factors. Furthermore, the study observed a relatively obvious trend in the improvement of positive factors by MCT. However, we believe that the limited sample size prevented the results from showing significant differences. In the future, the sample size could be further expanded for more in-depth research. Secondly, the negative symptom assessment scale used in the study is relatively simple, with limited differentiation and targeted treatment guidance for negative symptoms. In the future, other negative symptom assessment tools could be introduced to facilitate more detailed differentiation of symptoms, delve deeper into the mechanism of action of MCT, and provide clearer guidance for the selection of clinical treatment strategies.

## Conclusion

This study is the first to utilize the PANSS five-factor model and the negative symptoms two-factor model for precise classification of schizophrenia symptoms, aiming to evaluate the effectiveness of MCT as an adjunctive treatment strategy for schizophrenia. MCT significantly improved overall psychiatric symptoms, negative symptoms, and hostile symptoms, while also significantly enhancing patients' self-monitoring abilities as well as their personal and social functioning. Additionally, MCT could effectively improve the two subtypes of negative symptoms: diminished expression and social amotivation, especially in the diminished expression factor characterized by conceptual disorganization and stereotyped thinking, and the social amotivation factor prominent in suspiciousness/persecution symptom. This study further provides evidence for the application of MCT in the adjuvant treatment of schizophrenia and offers insights into the more precise treatment of negative symptoms with MCT.

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## Disclosure

The authors report no conflicts of interest in this work.

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