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Complementary group Metacognitive Training (MCT) reduces delusional ideation in schizophrenia ☆

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ABSTRACT

Background: Symptom reduction under antipsychotic agents is incomplete for most schizophrenia patients. In order to enhance outcome, cognitive approaches are increasingly adopted as add-on interventions. The present study aimed to determine the efficacy of group Metacognitive Training (MCT), which targets cognitive biases putatively involved in the pathogenesis of delusions.
Methods: A two-center, randomized, assessor-blind, controlled trial between MCT group training and cognitive training was carried out (ISRCTN95205723). A total of 150 in- and outpatients with DSM diagnoses of schizophrenia spectrum disorders were enrolled. All patients were concurrently prescribed antipsychotic medication. Assessments were made at baseline, four weeks and six months later. The primary outcome was a delusion score derived from the Positive and Negative Syndrome Scale (PANSS). The Psychotic Symptom Rating Scales (PSYRATS) as well as cognitive measures served as secondary outcomes.
Results: Completion at follow-up was 86%. According to intention-to-treat (ITT) analyses, patients in the MCT group showed significantly greater symptom reduction on the PANSS delusion subscore (follow-up), PANSS positive score (post-treatment) and PSYRATS delusion score (post-treatment and follow-up). Improvement on the PANSS positive scale at post-treatment and follow-up was positively correlated with the number of attended MCT sessions. No changes were seen for other psychopathological syndromes.
Discussion: MCT, a low-intensity training aimed at enhancing patients' awareness of cognitive biases subserving paranoia, led to improvement in delusion symptoms relative to the control condition and over and above the effects of antipsychotic medication. This improvement was sustained at follow-up.

1. Introduction

1.1. Antipsychotic medication in schizophrenia: current challenges

Schizophrenia is a severe psychiatric disorder associated with stigma (Reavley and Jorm, 2011), low quality of life (Karow and Pajonk, 2006; Saarni et al., 2010), and high treatment costs (McEvoy, 2007). While antipsychotic medication is the undisputed treatment of choice, in recent years there has been much debate regarding its efficacy, as the second generation (or atypical) antipsychotics have not lived up to initial high expectations (Kendall, 2011). They exert only a moderate effect size relative to placebo on the primary positive syndrome ($d = 0.48$) and relapse is still seen in approximately one-quarter of all medicated patients (Leucht et al., 2003, 2009).

1.2. Novel strategies beyond antipsychotic medication

Efforts to fill the apparent therapeutic gap have intensified in recent years. Different forms of cognitive therapy – especially cognitive-behavioral therapy (CBT) and cognitive remediation therapy (CRT) – are increasingly adopted as complementary strategies to psychopharmacology (Zimmermann et al., 2005; Lincoln et al., 2008; Wykes et al., 2008).

A new trend in cognitive therapy highlights social cognition and cognitive biases. It builds upon a range of studies linking abnormalities in these domains with paranoid schizophrenia (for reviews see

☆ Previous presentation: The article has not been published before nor is under consideration elsewhere. Portions of these results were presented at the plenary session of the Florence Biennial Schizophrenia Conference.

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Garety and Freeman, 1999; Bell et al., 2006; van der Gaag, 2006; Freeman, 2007). Cognitive biases are *distortions* in the collection, appraisal and processing of information (e.g., jumping to conclusions (JTC), overconfidence in errors). Examples of such novel interventions are the Social Cognition and Interaction Training (SCIT; Combs et al., 2007; Roberts and Penn, 2009), the Maudsley Review Training Programme (Waller et al., 2011) and Metacognitive Training (MCT; Moritz et al., 2005, 2010c).

1.3. Metacognitive Training (MCT) in schizophrenia

MCT is a group training for 4–10 patients and is currently available in 30 languages (free download at http://www.uke.de/mct). It consists of eight modules targeting delusion-relevant cognitive biases: dysfunctional attributions, JTC, belief inflexibility, deficits in social cognition, overconfidence in errors, and emotional problems (see also Methods section).

The primary aim of MCT is to convey knowledge to patients with schizophrenia about cognitive distortions, and to raise patients' awareness of the dysfunctionality of these biases by means of exercises (for reviews see Moritz and Woodward, 2007b; Moritz et al., 2010b). The exercises pursue the goal of providing corrective experiences, and teaching patients alternative coping and information-processing strategies. MCT can be regarded as a hybrid of existing forms of cognitive therapy, especially CBT and CRT. Like CBT, MCT ultimately targets psychotic symptoms but adopts a "back-door approach" by first dealing with cognitive processes and then proceeding to the core psychopathological symptoms. On the other hand, the presentation format is similar to CRT (e.g., exercises, error feedback), and some material is borrowed from neuropsychological paradigms.

Raising metacognitive awareness is hoped to intercept the progression from false appraisals of certain subclinical ("as if") experiences to fixed false (delusional) beliefs (Moritz and Woodward, 2007b; Moritz et al., 2010b).

1.4. Studies on MCT

A pilot study compared a beta version of the MCT to CogPack® (Marker, 2003), a computerized cognitive treatment program (Moritz and Woodward, 2007a). Both techniques received favorable feedback from the patients, with MCT being rated as significantly more fun and more useful to daily life than CogPack®. Moreover, a significantly greater number of participants stated that they would recommend MCT to other patients. A subsequent study by Aghotor et al. (2010) compared MCT to a cognitive control condition. Because the study enrolled only 30 participants, it was underpowered in its ability to detect significant differences. Nevertheless, small-to-medium effects favoring MCT were observed for positive symptoms ($d = .43$).

Since that time, several studies have been conducted. Ross et al. (2011) allocated 34 patients with delusions and a diagnosis of schizophrenia either to a brief "reasoning training" or to an attention control group. The reasoning training was essentially comprised of the JTC modules of MCT. At retest, the experimental group displayed more cautious decision-making, and, though no significant differences were found, some patients showed more flexibility and less conviction in their delusions. Decision-making was delayed in the reasoning group.

Favrod et al. (2011) ran an uncontrolled trial which was completed by 18 patients over a time frame of eight months. Significant effects were noted over time for delusion severity, awareness of delusions, attribution of the delusions to the illness, and awareness of the disorder. A more recent randomized controlled trial (RCT) by the same group (Favrod et al., in press) found that MCT was superior to treatment as usual (TAU) at both post and the 6-month follow-up for some parameters ($N = 52$). For the PSYRATS delusion subscale the difference yielded a medium effect size (post: $d = 0.56$; follow-up: $d = 0.64$).

A recent study (Moritz et al., 2011a) explored the effectiveness of the MCT approach in 36 schizophrenia patients with attenuated symptoms and a comorbid diagnosis of substance dependence. MCT was significantly superior to the TAU group on delusion distress (PSYRATS) and social quality of life over time. Unexpectedly, memory function also improved in the MCT group; data-gathering was improved at a medium effect size relative to the control group ($d = .52$).

A study carried out in India (Kumar et al., 2010) randomized 16 recently admitted patients to either MCT versus TAU. The MCT group showed a much steeper decline on positive symptoms than the TAU group. The difference across time reached a medium-to-strong effect size ($d = .68$). Significant effects were seen for items capturing formal thought disorder and tension. Similar results were seen on the Brown Assessment of Beliefs Scale (BABS; Eisen et al., 1998).

1.5. The present study

The reliability of prior results on the MCT is compromised by small sample sizes, and mainly short assessment intervals (4–8 weeks). Findings are promising but still equivocal. The present study explored the long-term efficacy of group MCT in schizophrenia within a randomized controlled trial against a control condition. Based on the rationale of the training and prior research, we predicted that MCT would be superior to computerized cognitive training for the improvement of delusions and JTC (as one of the core cognitive biases targeted by the MCT). We also expected favorable effects on subjective well-being in the MCT group, and on neuropsychological functioning in the CRT group.

2. Methods

2.1. Recruitment

The trial was conducted at two sites: the Departments of Psychiatry and Psychotherapy of the University Medical Center Hamburg-Eppendorf (Germany) and the University of Heidelberg (Germany).

2.2. Design

The trial was planned as an assessor-blind randomized controlled trial. Following baseline assessment, patients were randomly allocated to either Metacognitive Training (MCT) or CogPack® (see below) and re-assessed four weeks and six months later. Approval was obtained from the local ethics committees. The trial was registered at the International Standard Randomised Controlled Trial Number Register (ISRCTN95205723). In line with recent recommendations to include clinically representative samples for randomized controlled trials in order to maximize their relevance for clinical practice (Hollon and Wampold, 2009), we applied rather broad inclusion criteria: age between 18 and 65 years, fulfillment of DSM-IV criteria for a schizophrenia spectrum disorder according to the MINI interview (see below) as well as informed consent. A present or prior delusional episode was also mandatory. Exclusion criteria were: substance dependence, as well as IQ < 70 and scores of 5 or higher on the PANSS hostility item and 6 or 7 on PANSS paranoia/suspiciousness. Although the program targets delusions, we did not include patients with very severe symptoms because they are often not able to attend group sessions, which can negatively impact group coherence. Both inpatients and outpatients were included.

Randomization was carried out via a randomization plan. Each patient was informed about allocation by a person who was involved neither in the assessments nor in the administration of the training.

No minimal symptom threshold was defined for inclusion. This allowed us to investigate whether MCT helps in cases with reduced symptom severity, or whether it acts prophylactically (the latter point may be addressed once 3-year follow up data will become available).

The screening-to-inclusion ratio was 35% (see Fig. 1). Patients were reimbursed for the assessments (pre- and post-treatment: 15€, follow-up: 30€).

2.3. Outcomes

2.3.1. Blinding

Assessors were blind to treatment allocation, and specific measures were undertaken to preserve blinding and prevent a Rosenthal effect (e.g., assessors did not work at times when the training was performed; before each assessment participants were asked to keep group status to themselves).

2.3.2. Psychopathological assessment

The MINI Neuropsychiatric Interview (Sheehan et al., 1998) was administered to confirm diagnoses. Symptom severity was assessed with the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1989). In order to avoid repetition of questions, the MINI and the PANSS were synthesized into one interview. All ratings followed semi-structured interviews. Prior to the trial, a central rater training was held in Heidelberg using several video demonstrations. Deviations were thoroughly discussed to ensure high correspondence among raters. The same rater administered the interview throughout the trial period for each individual patient.

The PANSS has good psychometric properties and is sensitive to change (Kay et al., 1989; Peralta and Cuesta, 1994; Santor et al., 2007). Since metacognitive intervention primarily targets delusions, we computed a delusion subscore (sum score of the following items: delusions (P1); grandiosity (P5); suspiciousness (P6)) as the primary outcome parameter.

Notwithstanding its status as a standard assessment procedure in clinical trials (Suzuki, 2011), the PANSS has some major limitations (Mortimer, 2007). Perhaps most importantly, it condenses a number of distinct clinical aspects into single items. To illustrate, the delusion item (P1) collapses numerous aspects: frequency of delusional ideas, certainty, tenaciousness and interference with social relations and behavior. These characteristics are non-redundant and can show dissociations. To capture possible dissociations across different aspects of positive symptoms, the Psychotic Symptom Rating Scales (PSYRATS; Haddock et al., 1999), which consists of two subscales measuring hallucinations and delusions, was administered. The PSYRATS has yielded good to excellent inter-rater reliability, test–retest reliability, internal consistency and validity in both chronic and first-episode patients (Haddock et al., 1999; Drake et al., 2007), which have been confirmed for the authorized German version (Schneider et al., 2011).

Like the PANSS, the PSYRATS is rated according to a semi-structured interview, aided by anchor points. However, unlike the PANSS, raters have fewer liberties as the patients' responses are almost directly translated into scores. The original version of the PSYRATS was translated by a German native speaker into German and then back-translated into English by a psychologist fluent in both English and German (Schneider et al., 2011).

2.3.3. Jumping to conclusions (JTC)

A computerized variant of the probabilistic reasoning task was administered (Moritz and Woodward, 2005; Moritz et al., 2007) to capture JTC, one of several biases targeted by MCT. In contrast to the traditional version using beads/jars, fish/lakes were employed (Woodward et al., 2009; Moritz et al., 2010a; Speechley et al., 2010). Both variants yield similar results (Moritz et al., 2010a). We adopted a graded estimates procedure with simulated decisions and probability estimates. Two lakes with colored fish in opposing ratios (e.g., 80% orange vs. 20% gray fish and vice versa) were presented to the participant. After each "catch", the participant was required to make two judgments: (1) a probability judgment (0–100%) about the likelihood that the fish was/were being caught from lake A or lake B; and (2) a judgment whether the available amount of information justified a decision in the participant's view. It was explained that the fisherman would catch fish from one lake only throughout the entire experiment and that each catch would immediately be thrown back into the lake. Plausibility judgments and decisions could be altered after each item and the participant was told beforehand that the task would continue regardless of whether or not a (simulated) decision was made. To reduce the influence of memory, a possible confound, the ratio of fish in each lake was shown again on each slide and each new fish was displayed along with previous fish (Moritz and Woodward, 2005; Menon et al., 2006). In total, 10 fish were caught, whereby one lake was strongly suggested by the chain of events. JTC was defined as a (premature) decision after one fish. In some prior studies, a decision after one or two fish was coded as JTC. However, a decision after two fish is arguably justified when the base rate is 80:20% and high response conviction is not a mandatory criterion. We also computed the number of draws required until a decision was reached (i.e., draws to decision).

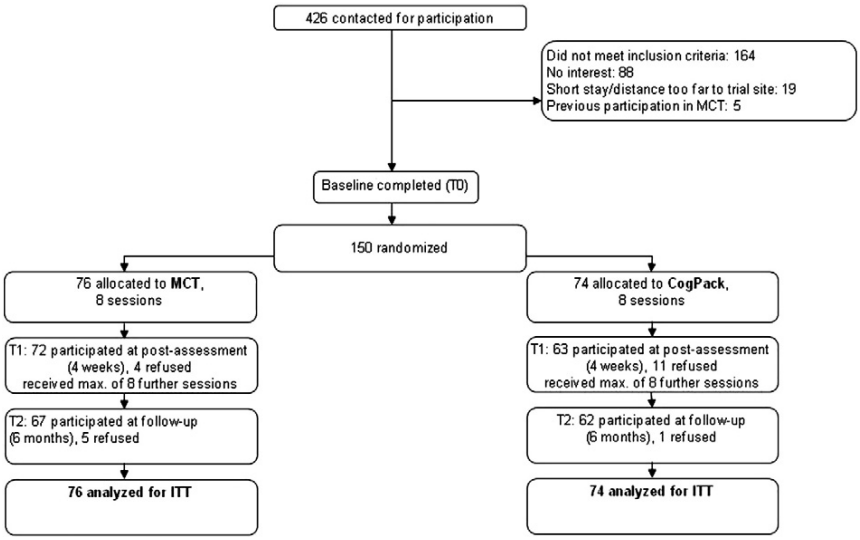

Fig. 1. Consort flow chart.

2.3.4. Self-esteem

Participants were asked to fill out the 10-item Rosenberg self-esteem scale (RSES) (Rosenberg, 1965). The Rosenberg scale is considered the gold-standard for the assessment of self-esteem, and its good validity and reliability have been confirmed for the German version (Roth et al., 2008).

2.3.5. Neuropsychological functioning

Immediate and delayed recall were measured with parallel versions of the logical memory subtest from the Rivermead Behavioral Memory Task (Wilson et al., 1985). The psychometric properties of the test battery are adequate (Wilson et al., 1989).

The Trail-Making Test (TMT) A and B were administered to assess speed of information processing and set-shifting (Reitan, 1992). The A form requires the subject to connect numbers as quickly as possible in ascending order, whereas the B part requires the subject to connect numbers and letters as quickly as possible in an alternating and ascending fashion.

Selective attention was assessed with a letter cancellation test (d2; Brickenkamp, 1978). The subject has to cross out as many *d*s tagged with two hyphens as possible while ignoring all other symbols (i.e., *d*s tagged with more or less than two hyphens or any *p*s). The psychometric properties of the test are adequate (Brickenkamp, 1978).

2.3.6. Subjective appraisal of the interventions

To assess acceptance, feasibility and subjective efficacy of the interventions, participants were asked to anonymously appraise the training at post-treatment and follow-up. The post-treatment questionnaire was modeled after versions administered in previous trials (Moritz and Woodward, 2007a; Moritz et al., 2011a, 2011b): ten questions were posed on a five-point Likert scale (1 = fully agree to 5 = fully disagree; see Table 3). The post-treatment questionnaire contained additional questions on whether patients had heard about the contents of the other intervention and whether they had benefited from these. For the follow-up, two questions from the post-treatment questionnaire regarding usefulness and recommendations to others were repeated and complemented by additional questions tapping into subjective benefit, applicability to daily life and changes in social interactional patterns, which are also displayed in Table 3. One question related to a potential improvement of memory which was expected for the control cognitive training (CogPack®).

2.4. Treatments

2.4.1. Metacognitive Training

Each MCT group usually was comprised of between four and eight patients and was delivered by psychologists or psychology trainees with one to three years of experience with the MCT (for a review see Moritz et al., 2010b). None of the trainers had completed formal training in CBT. The training was administered twice weekly. All MCT group members received a maximum of eight consecutive sessions prior to post-treatment assessment and then had the opportunity to undergo another eight consecutive sessions of MCT (parallel version) immediately thereafter (i.e., after the post assessment). Most patients ($n = 59$) took this opportunity. Groups were open so that patients could start at any module. Missed sessions could not be repeated. The parallel cycles deal with the same cognitive biases but utilize different material. Each session lasted 45–60 min and adhered to the study protocol and the instructions provided in the manual (see www.uke.de/mct).

Patients in the MCT group were told not to disclose the contents of the training to members of the control group, but since patients were treated in the same clinical environment, communication about the training could not be entirely prevented.

2.4.2. Control condition (CogPack®)

We chose CogPack® (Marker, 2003), a cognitive training program which is available in multiple languages, as the control condition. CogPack® aims to improve cognitive dysfunctions commonly compromised in schizophrenia, for example memory. Up to seven participants shared a room; treatment was performed individually on personal computers. For the present study, a fixed series of tasks ("Olbrich series") was administered, which covers a wide range of neuropsychological exercises involving memory, reasoning, selective attention and psychomotor speed. The difficulty level for each patient is adapted automatically by the program. At the end of each task, patients received individual feedback on their performance from the program. Each session lasted approximately 45–60 min. Similarly to MCT, patients could undergo a maximum of 16 consecutive sessions (8 within the pre–post interval, 8 immediately thereafter); 52 patients attended the second CogPack® cycle.

In addition to medication treatment, patients in both groups were administered occupational therapy and some also received psychoeducation and physical exercise training.

2.5. Statistical analysis

We conducted both intention-to-treat (ITT) and per protocol (PP) analyses. For the PP analyses, participants in the group were required to participate in post-treatment and follow-up assessments, respectively. ITT analysis considered data from all participants with available baseline data. Multiple imputation was adopted to estimate post-treatment and follow-up scores for non-completers/missing values (i.e., no data available at re-assessment). The main results were computed using ANCOVAs in view of statistical studies suggesting that controlling for the baseline score is superior to simple pre–post comparisons and usually leads to an increase in power (Vickers and Altman, 2001; Borm et al., 2007). An advantage of this type of analysis over mixed ANOVA models is that it accounts for baseline differences and regression to the mean (i.e., higher scores usually yield greater improvement). In addition, groups were compared using a constrained full-likelihood approach proposed by Liang and Zeger (2000). Briefly, baseline values, as well as post-baseline values, are modeled as dependent variables, whereby the baseline mean responses for the treatment groups are assumed as equal, which is reasonable in light of the randomization procedures. This constrained model also provides flexibility in handling missing data by including all observed data, which, in general, results in more power when testing treatment differences than the longitudinal ANCOVA model (Liu et al., 2009). We applied an unstructured covariance matrix along with standard errors and degrees of freedom (Kenward and Roger, 1997; Carpenter and Kenward, 2008).

Sample size calculation was performed with Gpower (Erdfelder et al., 1996) based on the assumption that a weak-to-medium effect size would be found in favor of the MCT. Effect sizes were expressed using $\eta^2_{partial}$, whereby .01 is equivalent to a small effect, .06 is equivalent to a medium effect and .14 is equivalent to a strong effect (Kinnear and Gray, 2009).

3. Results

3.1. Baseline characteristics

Patients were predominantly male, in their mid-30s and all were receiving antipsychotic medication at the time of baseline assessment. Most patients had a chronic course and only 29% were admitted for the first time. A total of 33 patients (i.e., 22%) fulfilled criteria for current major depression. Baseline characteristics for background, psychopathological and treatment-related variables were similar across groups except for age (see Table 1). Antipsychotic medication (expressed as percentages of the maximum recommended daily dose according to

Table 1
Baseline characteristics.

	MCT ($n = 76$)	Control ($n = 74$)	Statistic
Background variables			
Gender (male/female)	45/31	49/25	$\chi^2(1) = 0.79$, $p > .3$
Age in years	36.82 (11.12)	32.68 (9.54)	$t(148) = 2.44$, $p = .016$
Years of formal school education	11.34 (1.65)	11.59 (1.67)	$t(147) = 0.81$, $p > .3$
Premorbid intelligence (IQ; vocabulary test)	106.12 (13.63)	104.67 (13.84)	$t(147) = 0.64$, $p > .5$
Treatment-related variables			
Number of hospitalizations (including present)	4.67 (4.69)	3.64 (4.41)	$t(147) = 1.37$, $p > .1$
Percentage of participants meeting Andreasen remission criteria	41%	43%	$\chi^2(1) = 0.09$, $p > .7$
Cumulated antipsychotic dosage	69.72% (59.06)	80.96% (63.37)	$t(141) = 1.19$, $p > .2$

German guidelines) was comparable between groups and did not change over time, $F(1,108) = .33$, $p > .5$, $\eta^2_{partial} = .00$ (pre-treatment to follow-up). Patients allocated to the MCT group attended more sessions during the first four weeks (pre–post interval) at statistical trend level than those in the CogPack® group ($M = 6.33$ vs. 5.71, $t(146) = 1.79$, $p < .1$); a similar result emerged for the entire amount of attended sessions ($M = 10.18$ vs. $M = 8.93$, $t(146) = 1.74$, $p < .1$).

3.2. Completion

Completion at post-treatment (4 weeks later) and follow-up (6 months later) was high (MCT: $n = 72$ post-treatment (95%), $n = 67$ follow-up (88%); CogPack®: $n = 63$ post-treatment (85%), $n = 62$ follow-up (84%)).

3.3. Outcomes

PP and ITT analyses differed only with respect to the PANSS positive score: whereas the ITT analyses indicated a significant difference in favor of the MCT for the post-treatment score ($p = .03$), the PP analyses showed a statistical trend ($p = .06$). For all other analyses the level of significance (significance ($p < .05$), borderline ($p < .1$) and non-significance ($p > .1$)) remained unchanged, so that the subsequent results apply for both types of analysis. Between-group differences (per protocol) are shown in Table 2. A significant difference in favor of the MCT emerged with respect to the PANSS core delusion subscore (primary outcome) at follow-up. Differences neither emerged for the PANSS total score (see Table 3) nor the other PANSS subscales.

For the PSYRATS, significant effects were obtained for the delusion subscale at both post-treatment and follow-up. The percentage of patients who showed a reduction of at least 20% on the PSYRATS was significantly different between groups for both the post (MCT: 40%, CogPack®: 19%, $\chi^2(1) = 6.79$, $p = .009$) and follow-up assessment (MCT: 48%, CogPack®: 27%, $\chi^2(1) = 5.50$, $p = .019$). Subsidiary analyses showed that reductions in the MCT group were greater than those seen in the CogPack® condition for the items on preoccupation (PD1), amount of distress (PD4) and intensity of distress (PD5; all $p \leq .05$), while a statistical trend difference emerged for disruption of life (PD6). At follow-up, PD4 and PD5, as well as preoccupation (PD2) and conviction (PD3), achieved significance relative to CogPack® (at least $p < .05$). No differences emerged on the PSYRATS hallucination subscore.

The groups did not differ on most cognitive and neuropsychological parameters. At statistical trend level, patients in the MCT group showed delayed decision-making at follow-up relative to the CogPack® group. At statistical trend level, the CogPack® group improved more than the MCT group on the immediate story recall (difference, CogPack®, $M = 2.29$ vs. MCT, $M = 1.69$ improvement), which was not maintained at follow-up (CogPack®, $M = 0.79$ vs. MCT, $M = 0.96$ improvement). Within-subject comparisons showed that patients in the MCT but not in the control condition improved on self-esteem over time. However, the difference to controls was nonsignificant.

3.4. Subjective assessment of the training

For most parameters, positive appraisals were made, indicating that patients appreciated both interventions. For the post-treatment assessment, three out of ten comparisons yielded a significant difference in favor of MCT. At follow-up, MCT was superior to CogPack® on several parameters: application to daily life, experience of situations where the training contents were helpful, recommendation to others, thinking more about alternative explanations before judging a situation, and that the intervention was helpful in communicating with other persons. Moreover, less patients in the MCT group would have preferred to be allocated to the other condition than those in the CogPack® group. On one parameter, patients in the CogPack® group achieved a higher score: they felt more than MCT patients that their memory had improved. Approximately half (54%) of the participants reported that they had heard about or received information about the other training but groups did not significantly differ in this respect, $\chi^2(1) = 1.72$, $p > .1$.

3.5. Relationship between number of attended sessions and change scores

No patient underwent more than 16 consecutive sessions of MCT (mean: 10.2). For the MCT group, significant correlations emerged for change scores on the PANSS positive score and the number of attended sessions (post-treatment, rho = .24, $p = .04$; follow-up, rho = .25, $p = .05$). At statistical trend level, the number of sessions was correlated with improvement on the PSYRATS hallucination scale at follow-up (rho = .24, $p = .06$). For the CogPack® group, no significant correlations emerged (pre–post, pre-follow-up) for any of the variables listed in Table 2.

4. Discussion

The current trial was the first to examine the long-term efficacy of Metacognitive Training (MCT) for patients with psychosis against a control condition (CogPack®). We recruited a large heterogeneous group with respect to symptom profile and prior treatment as it is currently unknown if patients high or low on (positive) symptoms benefit most from MCT.

As expected from previous studies, MCT was superior to the control condition in improving positive symptoms, particularly delusions, which was partially sustained at follow-up; significant improvements were verified both for the PSYRATS delusion subscore and the PANSS positive and delusion subscores. Symptom decline was most pronounced for the PSYRATS delusion subscale, which yielded a full medium effect size at follow-up (i.e., $\eta^2_{partial} = .06$). Moreover, the percentage of patients showing clinically significant improvement (i.e., decline of at least 20% in the PSYRATS score) was significantly higher in the MCT compared to the control group. A fine-grained analysis asserted that at post-treatment three out of six PSYRATS items, and at follow-up four out of six PSYRATS delusion items, showed greater improvement for the MCT group than the CogPack® group, including items on delusion-related distress and delusion conviction, which is in line with previous findings (Moritz et al., 2011a, 2011b). The fact that the PANSS was less sensitive to change may reflect its symptom composition: While the MCT primarily targets delusions, this symptom is captured by only few PANSS items. Moreover, our inclusion criteria (high scorers on the delusion symptoms could not participate) may have narrowed the potential to find improvement over time. Finally, the PANSS delusion items pool several aspects of

Table 2
Group differences across time on measures of psychopathology, cognitive biases and neuropsychology. Means and standard deviations (in brackets). Significant within-subject differences across time are displayed in square brackets. Per protocol analyses.

Domain/variable	MCT			Control			Between-group comparisons (ANCOVAs controlling for baseline scores)	
	Pre-treatment	Post-treatment [within-subject difference to pre]	Follow-up [within-subject difference to pre]	Pre-treatment	Post-treatment [within-subject difference to pre]	Follow-up [within-subject difference to pre]	Pre versus post treatment	Pre versus follow-up
Psychopathology								
PANSS core delusion (primary outcome)	6.58 (3.20)	5.69 (3.25) [****]	4.67 (2.57) [****]	6.26 (3.28)	5.84 (2.83)	5.56 (2.89) [*]	$F(1,136) = 1.21$, $p = .27$, $\eta^2_{partial} = .01$	$F(1,123) = 4.04$, $p = .047$, $\eta^2_{partial} = .03$
PANSS positive syndrome	14.52 (7.37)	12.24 (6.78) [****]	10.51 (5.94) [****]	13.78 (7.26)	12.88 (6.17)	11.69 (5.80) [***]	$F(1,135) = 3.59$, $p = .06$, $\eta^2_{partial} = .03$	$F(1,121) = 1.84$, $p = .18$, $\eta^2_{partial} = .02$
PANSS total	54.64 (15.83)	47.92 (13.06) [****]	44.90 (12.32) [****]	52.23 (12.96)	47.42 (11.05) [****]	45.11 (12.26) [****]	$F(1,136) = 0.47$, $p = .49$, $\eta^2_{partial} = .00$	$F(1,123) = 0.06$, $p = .81$, $\eta^2_{partial} = .00$
PSYRATS delusions	7.24 (7.53)	4.71 (6.46) [****]	2.35 (5.23) [****]	6.40 (7.20)	6.21 (7.05)	5.12 (6.95) [+]	$F(1,136) = 5.90$, $p = .02$, $\eta^2_{partial} = .04$	$F(1,123) = 7.98$, $p = .006$, $\eta^2_{partial} = .06$
PSYRATS hallucinations	5.72 (10.07)	5.71 (9.94)	4.01 (8.75)	5.64 (11.40)	4.99 (10.21)	4.37 (9.63)	$F(1,136) = 0.72$, $p = .40$, $\eta^2_{partial} = .00$	$F(1,122) = 0.01$, $p = .92$, $\eta^2_{partial} = .00$
Rosenberg self-esteem	17.11 (8.07)	19.30 (7.29) [****]	20.75 (7.27) [****]	18.88 (9.03)	19.70 (8.21) [*]	19.84 (8.17)	$F(1,120) = 0.48$, $p = .49$, $\eta^2_{partial} = .00$	$F(1,117) = 2.23$, $p = 0.14$, $\eta^2_{partial} = .02$
Cognitive biases								
Draws to decision (fish task)	2.76 (1.98)	3.65 (2.18) [***]	3.69 (1.97) [****]	2.46 (1.69)	3.77 (2.57) [***]	3.18 (1.64) [*]	$F(1,134) = 0.08$, $p = .78$, $\eta^2_{partial} = .00$	$F(1,114) = 2.70$, $p = .10$, $\eta^2_{partial} = .02$
Jumping to conclusion in % (decision after 1 fish)	32%	17% [**]	13% [****]	35%	18% [*]	20% [*]	$F(1,136) = 0.02$, $p = .88$, $\eta^2_{partial} = .00$	$F(1,120) = 1.04$, $p = .31$, $\eta^2_{partial} = .01$
Neuropsychology								
Trail-Making Test A in sec.	33.89 (12.57)	29.51 (11.67) [****]	29.42 (12.55) [****]	30.53 (11.61)	25.70 (9.64) [****]	25.27 (9.42) [****]	$F(1,136) = 1.06$, $p = .30$, $\eta^2_{partial} = .01$	$F(1,112) = 2.48$, $p = .12$, $\eta^2_{partial} = .02$
Trail-Making Test B in sec.	86.96 (44.98)	72.46 (35.70) [****]	72.81 (43.09) [****]	65.18 (28.11)	59.86 (26.06) [****]	59.46 (24.11) [****]	$F(1,133) = 0.12$, $p = .73$, $\eta^2_{partial} = .00$	$F(1,118) = 0.67$, $p = .42$, $\eta^2_{partial} = .01$
Story recall immediate	8.65 (2.91)	10.34 (3.19) [****]	9.61 (3.39)	9.31 (3.76)	11.60 (3.67) [****]	10.10 (3.54)	$F(1,136) = 2.98$, $p = .09$, $\eta^2_{partial} = .02$	$F(1,119) = 0.34$, $p = .85$, $\eta^2_{partial} = .00$
Story recall delayed	7.07 (3.13)	9.43 (3.31) [*****]	8.57 (3.25) [***]	7.73 (4.01)	10.22 (3.62) [****]	8.77 (3.61) [+]	$F(1,136) = 0.91$, $p = .34$, $\eta^2_{partial} = .01$	$F(1,119) = 0.14$, $p = .71$, $\eta^2_{partial} = .00$
Attention (test d2)	136.53 (44.16)	148.09 (42.93) [****]	153.50 (40.78) [****]	144.86 (45.06)	159.86 (41.82) [****]	165.18 (44.79) [****]	$F(1,130) = 0.00$, $p = .97$, $\eta^2_{partial} = .00$	$F(1,116) = 0.03$, $p = .87$, $\eta^2_{partial} = .00$

Notes. Significant difference from zero: $+p \leq .1$, $^*p \leq .05$; $^{**}p \leq .01$, $^{***}p \leq .005$, $^{****}p \leq .001$.
The above results are means and standard deviations collected at each time-point and do not represent pairwise data.

Table 3
Subjective assessment of the interventions at post-treatment and follow-up (1 = fully agree; 5 = fully disagree).

	MCT	CogPack®	
Post-treatment			
The training was useful and sensible.	1.74 (0.81)	1.78 (0.74)	$t(109) = 0.28$, $p > .7$
I had to force myself to go to the training regularly.	3.49 (1.21)	3.57 (1.46)	$t(109) = 0.33$, $p > .7$
In everyday life, I do not apply the lessons learned.	3.28 (1.13)	3.02 (1.24)	$t(107) = 1.15$, $p > .2$
The training was an important part of my treatment program.	2.26 (0.99)	2.48 (1.48)	$t(109) = 1.06$, $p > .2$
I would have liked to spend the time doing something else.	3.91 (1.02)	3.76 (1.23)	$t(109) = 0.71$, $p > .4$
The training was fun.	1.85 (0.85)	2.02 (1.08)	$t(106) = 0.88$, $p > .3$
A lot of what I learned during training is useful to daily life.	2.29 (1.00)	2.96 (1.21)	$t(107) = 3.19$, $p = .002$
The goals and rationale of the training were clear to me.	1.65 (0.77)	1.98 (0.96)	$t(109) = 2.02$, $p = .046$
I would recommend the training to others.	1.98 (0.93)	2.00 (0.95)	$t(107) = 0.10$, $p > .9$
I found it beneficial that the training was administered in a group.	1.81 (0.85)	2.79 (1.31)	$t(108) = 4.71$, $p < .001$
Follow-up			
The training was useful and sensible.	1.83 (0.98)	1.98 (0.84)	$t(104) = 0.85$, $p > .3$
I have the feeling that my memory has improved because of the intervention.	2.98 (1.18)	2.53 (0.91)	$t(103) = 2.20$, $p = .03$
In everyday life, I do not apply the lessons learned.	3.30 (1.08)	2.69 (1.22)	$t(99) = 2.60$, $p = .01$
I can only vaguely remember the training.	3.30 (1.08)	3.02 (1.26)	$t(104) = 1.24$, $p > .2$
There were situations where the experiences and the message of the intervention had been useful.	2.34 (1.18)	3.33 (1.15)	$t(103) = 4.35$, $p < .001$
I have recommended the training to others.	2.98 (1.54)	3.67 (1.44)	$t(102) = 2.35$, $p = .02$
More than before, I think about alternative explanations before I judge another person or situation.	2.25 (1.02)	3.08 (1.22)	$t(104) = 3.80$, $p < .001$
The training was helpful to me in communicating with other people.	2.36 (1.09)	3.53 (1.14)	$t(104) = 5.40$, $p < .001$
I would have rather liked to be in the other group (Metacognitive Training/CogPack®, respectively).	4.17 (1.16)	3.16 (1.46)	$t(101) = 3.90$, $p < .001$

symptomatology which, according to results from the PSYRATS, are improved to different degrees by MCT. This may have also limited the likelihood of observing improvement on the PANSS.

Interestingly, a greater number of attended MCT sessions was correlated with improvement on the PANSS positive scale. Perhaps patients who attended more sessions internalized the rationale to a greater extent and were able to exercise greater caution in their judgments, a skill taught in MCT.

In line with a recent meta-analysis by Wykes et al. (2011) demonstrating beneficial effects of CRT on neuropsychological functioning, the control condition (CogPack®) was superior to MCT on immediate memory recall at post-treatment, although these effects were not sustained at follow-up (however, CogPack® patients reported better subjective mnestic effects at follow-up than MCT participants). Moreover, no effects on symptomatology were noted beyond the positive syndrome and no delayed effects emerged (i.e., significant effects at follow-up but not at post-assessment).

To summarize, symptom improvement was achieved for a low-intensity group training not tailored to individual needs and symptoms. No patient underwent more than 16 consecutive sessions of MCT (mean: 10.2). Moreover, some patients were prescribed (antipsychotic or other) medication with sedating effects which, in addition to cognitive deficits, may have limited improvement.

In line with prior studies, JTC – one of several biases that are addressed by the MCT – was significantly improved over time by the MCT. However, unlike in forerunner studies, this cognitive bias also declined under CogPack®. Patients in the MCT group asked for more information in the fish task at follow-up at statistical trend level (more draws to decision). We can only speculate as to why JTC, which is usually stable over time and not affected by standard treatment (Peters and Garety, 2006; Garety et al., 2008; So et al., 2012), may have also benefited from cognitive remediation: CogPack® provides feedback on cognitive performance and may have thus strengthened cognitive insight to a certain degree, thus alleviating the dissociation between objective and subjective performance. In addition, patients were recruited from the same environment and we could not fully prevent exchange among patients about treatment contents. In fact, exchange about the training occurred in about half of the attendants (54%). Practice effects can also not be entirely ruled out.

Self-report measures at the end of the training and at follow-up showed that both MCT and CogPack® were viewed favorably by the patients. MCT yielded superior results with respect to applicability to daily life both at post-treatment and follow-up. At follow-up, a significantly greater number of patients in the MCT group endorsed that they had experienced situations where the training contents had been helpful, would think more about alternative explanations before judging a situation, and would recommend the training to others. Finally, the MCT intervention was deemed helpful in communicating with other persons.

Self-esteem improved, particularly in the MCT, which is noteworthy since the improvement of illness insight and some forms of positive symptoms may come at the cost of well-being and an increase in depression (for a review see Lincoln et al., 2007), which, however, was not the case here. Negative symptoms did not change. Individualized training like CBT or MCT+, the latter being a hybrid of CBT and MCT, may be more powerful for tackling affective symptoms (Moritz et al., 2010b).

Some limitations need to be acknowledged. First, the follow-up interval was rather short. We are currently collecting data for a three-year follow-up period to explore whether differential effects on positive symptoms are maintained at longer intervals. Second, we adopted an alternative cognitive treatment as control condition to make trial participation more attractive for patients and to account for important effects such as therapeutic attention/engagement. For this reason, however, a true baseline condition is lacking, making it hard to attribute the effect of time or the interaction of group × time to one or both of the interventions. A covered treatment-as-usual design (i.e., patients in the control condition receive a non-specific intervention which is part of the usual treatment and just doubled to match for therapeutic effort) would be desirable to discern the specific effect of the MCT. Moreover, psychotherapeutic trials face the problem that participants are usually not naive about the contents of the other training, so that effects in the experimental condition are potentially underestimated. Further, we did not assess functional outcome such as work and social functioning so that we cannot infer whether symptom improvements translate into everyday behavior. Finally, it might be regarded as a problem that we defined no symptom threshold for inclusion, although the training is targeted at delusions (still, past or current presence of delusions was mandatory for inclusion into the trial). This was done as we currently do not know whether the training accelerates symptom reduction and/or acts prophylactically independent of initial symptom severity. Despite liberal inclusion criteria and the absence of a minimal threshold, we were able to find significant improvement on delusions in the MCT compared to the

control group, a fact which may even be regarded as a strength of the study.

The trial was conducted with an older version of the MCT. Since then, several aspects of the training have been strengthened. For example, we incorporated a section on hallucinations in module 1 and further stressed the need to attenuate response confidence if information is incomplete or inferential consequences are particularly grave. Mindfulness exercises (Fisher and Wells, 2009) have been added to module 8 and additional exercises have been implemented to raise self-esteem. Whether these additions have increased the impact of the training on, for example, hallucinations and depression, awaits to be established.

4.1. Conclusions

The current set of results suggests that a low-intensity MCT group program improved delusions over and above the effect of antipsychotic drugs relative to a control condition. We recommend that the MCT is blended with other treatment strategies, for example CRT, in order to improve neuropsychological functions that may compromise response to certain insight-based treatments in schizophrenia (Kurtz, 2011). Future research should elucidate the mechanism of action of MCT. At this point, we can only speculate on this and have put forward that the primary mechanism of action is that MCT plants the seeds of doubt. This aspect is especially stressed by using newer forms of MCT: it is not the core aim of the MCT to prevent mistakes as "to err is human", but rather to reduce (response) overconfidence. This hypothesis could be tested using brief assessments on response confidence as well as delusion intensity before and after each session. Such a design may dismantle the specific effects of single modules. We assume that response confidence is attenuated first and that a decrement in delusion conviction and intensity follows. Interestingly, this may be a common pathway shared with antipsychotic agents: a recent survey (Moritz et al., 2013) of patients prescribed antipsychotic agents found a clear response pattern of increased doubt and lowered certainty in response to antipsychotics for both psychosis and non-psychosis patients. Attenuated response confidence may open the minds of patients to alternative scenarios, delay decision-making and decrease behavioral consequences for momentous decisions (e.g., aggression towards oneself or others).

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None.

Conflict of interest
None. The study did not deal with any substances, agents, patents or products that may create a conflict of interest.

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