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ORIGINAL PAPER

Does Change over Time in Delusional Beliefs as Measured with PDI Predict Change over Time in Belief Flexibility Measured with MADS?

Louise Penzenstadler[1] · Anne Chatton[1,2] · Philippe Huguelet[1,2] · Laurent Lecardeur[3] · Javier Bartolomei[1] · Perrine Brazo[3,4] · Elodie Murys[5] · Florent Poupart[6,7] · Serge Rouvière[8] · Mohamed Saoud[9] · Jérôme Favrod[10] · Yasser Khazaal[11,12]

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Abstract
Delusional beliefs and their behavioral consequences are predominant symptoms in patients with psychosis and play an important role in the treatment. Delusional beliefs are a multidimensional concept which can be divided into three components: distress, preoccupation and conviction of delusions. These can be measured using Peters delusions inventory (PDI-21). We question, whether changes in delusional beliefs over time during treatment measured with the PDI-21 can predict changes in belief flexibility measured with the Maudsley assessment of delusions schedule (MADS). We used a group of patients from a randomized controlled trial for a cognitive intervention for psychosis or psychotic symptoms. Aside standard treatment for psychosis, half of the patients took part in a group treatment "Michael's game". Patients were assessed at baseline (T1), at 3 months (T2), and at 9 months (T3). We measured delusional beliefs using PDI-21 and belief flexibility with the MADS. One hundred seventy-two patients were included in the analysis. We measured a main effect of PDI-21scores on belief flexibility measured with MADS. PDI-21 Conviction scores predicted outcomes for all measured MADS items. Increasing PDI Distress and Preoccupation scores were predictors for being more likely to dismiss beliefs and change conviction. Time itself was a predictor for changing conviction and being able to plan a behavioral experiment. Overall the changes in PDI scores predicted outcomes for belief flexibility measured with MADS items. The PDI-21 could be a simple and effective way to measure progress in treatment on delusional beliefs.

Keywords Psychosis · Schizophrenia · Delusional beliefs · Belief flexibility · Cognitive behavior therapy

✉ Louise Penzenstadler
Louise.E.Penzenstadler@hcuge.ch

Extended author information available on the last page of the article

Introduction

Delusional beliefs and their behavioral consequences are predominant symptoms in patients with psychosis. They therefore play an important role in the treatment. However, frequently positive symptoms remain despite antipsychotic medication [1]. In the recent years a shift has been made towards second-generation antipsychotics, but the reduction of extrapyramidal side effects has been replaced by cardiometabolic dysfunction [2]. Delusional beliefs are influenced by various cognitive mechanisms, such as reasoning biases, and jumping to conclusions (JTC) [3]. A strong association has been found in various meta-analyses between JTC and psychosis, specifically to delusional thinking [4] . Belief flexibility is another factor with a strong link to delusional convictions, with low or lack of belief flexibility increasing vulnerability for such thinking [3, 5, 6].

Delusional beliefs are a multidimensional concept which can be divided into three components: distress, preoccupation and conviction of delusions. These can be measured using Peters delusions inventory (PDI-21) [7, 8]. Higher ratings on these scales are found for patients with psychotic disorders compared to controls [7]. Interestingly, a recent study found that these different delusional dimensions changed at different rates during treatment with antipsychotics over 2 weeks [9]. Distress was more responsive than preoccupation and conviction, with distress and disruption being more responsive than conviction and preoccupation.

Cognitive behavioral therapy (CBT) is an interesting approach as it targets mechanisms as mentioned earlier which are associated with delusional thinking (JTC, reasoning biases, etc.).

A recent meta-analysis suggests that changes in delusions can be brought by CBT for psychosis and is maintained over the follow-up period. However, it is not superior to other interventions [10]. Several studies have examined predictive factors for CBT for patients with psychosis with varying results. Brabban et al. found that lower delusional conviction significantly predicted a reduction in overall psychotic symptoms [7]. On the other hand, Lincoln et al. found no association between delusional conviction and outcome for positive or negative symptoms [11]. Therefore, further research is needed to find predictors for different types of successful treatment in order to offer more individualized treatments to patients.

We question, whether changes in delusional beliefs over time during treatment measured with the PDI-21 can predict changes in the Maudsley assessment of delusions schedule (MADS) [5]. The MADS enables an exact analysis of changes in participants beliefs by recording the individualized and specific delusional ideas.

Our study explored data from a randomized controlled trial on patients with psychosis examining and cognitive intervention called Michael's Game (MG) [12]. MG is a group-based intervention which aims to improve hypothetical reasoning in patients and prepare them for CBT. A significant improvement was found on cognitive insight following the intervention. The preoccupation and conviction associated with patients' delusions also decreased in the previous study [13].

We hypothesized that decrease in the PDI-21 scores over time would predict an improvement in the MADS.

Materials and Methods

Participants

For our study we recruited participants from outpatient centers and day hospitals in Switzerland, France, Monaco and Italy. The ethical committees of all four countries approved the trial. The

protocol was registered (International Standard Randomized Controlled Trial Number Register: ISRCTN37178153). In total 172 patients were recruited. The patients were asked to give oral and written consent. Participants were randomized in two groups of the same size. One group received the Michael's game (MG) intervention and the other treatment as usual (TAU).

Inclusion Criteria

- Diagnosis of psychotic disorder according to the DSM-IV
- Persistent psychotic symptoms (BPRS score of ≥3 on at least 2 items of the positive symptoms subscale)
- 18–65 years old
- Outpatient setting

Exclusion Criteria

- Unable to give informed consent
- Organic brain disease
- Learning disabilities
- BPRS conceptual disorganization score > 5
- Prior participation in MG
- Cognitive psychotherapy at inclusion

Intervention

All patients received standard treatment for psychosis according to guidelines, including antipsychotic medication, psychosocial interventions, case management, and outpatient and community follow-up. We monitored medication using chlorpromazine equivalences according to Woods [14]. The centers were equivalent in their treatment facilities, level of medical training for doctors and access to care.

One group was treated using a cognitive group-based intervention called "Michael's Game" (MG) as well as standard psychosis treatment. The intervention aims to improve patients' reasoning with hypothesis. In our previous analysis [12], MG was found to significantly decrease patients' conviction and preoccupation associated with delusions, measured with PDI-21. The group treated with MG also improved their belief flexibility measured with MADS.

Measures

We assessed the participants at baseline (T1), at 3 months (T2), and at 9 months (T3). The assessments were carried out by psychiatrists and psychologists. The latter were not involved in the treatment of the participant they assessed. The patients were compensated with 40 Swiss Francs per assessment.

- Peters delusions inventory (PDI-21) [7, 8]. Distress, preoccupation, and conviction of delusions is assessed with the PDI-21. It uses a 5-point Likert scale to measure 21 stated

beliefs. Higher ratings on these scales are found for patients with psychotic disorders compared to controls [7].

- Maudsley assessment of delusions schedule (MADS) [5]. This standardized interview allows an evaluation of the patient's principal abnormal beliefs. The MADS enables us to assess changes in the individual and specific delusional ideas for each patient. In this study we used the following items to specifically record changing belief flexibility:
- MADS 26 or Anything against the belief (*maintain delusional beliefs:0* vs. *change conviction:1*)
- MADS 28 or Response to hypothetical contradiction (RTHC) (*accommodating or ignoring or rejecting on the RTHC measure*: 0 vs. *dismissing belief or changing conviction*: 1)
- MADS 82 or Ability to plan a behavioral experiment measure (*unable*: 0 vs. *able*: 1)
- Brief psychiatry rating scale (BPRS) [15, 16]. The following scores were used for our analysis: negative and positive symptoms, affect, resistance, activation and the total score.

Statistical Analyses

We collected the following three response variables of interest on three occasions: at baseline (T1); at 3 months (T2); and 6 months after the second assessment (T3):

- MADS 26 or Anything against the belief (*no*:0 vs. *yes*:1)
- MADS 28 or Response to hypothetical contradiction (*accommodating or ignoring or rejecting on the RTHC measure*: 0 vs. *dismissing belief or changing conviction*: 1)
- MADS 82 or Ability to plan a behavioral experiment measure (*unable*: 0 vs. *able*: 1)

We used Generalized Estimating Equations (GEE) models to address the correlation nature of the binary outcomes. Considering the presence of time-dependent covariates in the model an independent working correlation structure was preferred over other options as recommended by Pepe et al. [17]. Hence, based on this approach, the MADS outcomes were regressed on Time, PDI sub-items Distress, Conviction and Preoccupation as time-dependent predictors. Medication, BPRS sub-items Activation, Affect, Negative symptoms, Positive symptoms and Resistance were entered at their baseline values (time-invariant variables) as controlling variables. Statistical significance was set at $p \leq 0.05$.

The analyses were performed with the SPSS version 22.0, IBM, Chicago, USA.

Results

Baseline Characteristics of Subjects

One hundred seventy-two patients were included in the analysis. At baseline, the patients in the MG group presented higher PDI-21 distress scores than the TAU group ($p = 0.05$). The two groups did not statistically differ in the other main clinical measures. The mean age was 37.1, 62.2% were male. Only 21.5% were married. Patients were recruited from different countries, 85 in Switzerland, 66 in France/Monaco and 21 in Italy. The main diagnosis was schizophrenia (81.4%). A smaller group was diagnosed with other psychotic disorders (18.6%). The participants presented the following BPRS symptom scores: Affect 11.0 (SD 4.3), Negative

symptoms 8.7 (SD 3.9), Positive symptoms 11.3 (SD 3.9), Resistance 7.4 (SD 2.9), and Activation 5.6 (SD 2.6). The other baseline measures can be found in Table 1.

In total, 33 patients discontinued the study (23 of the TAU group and 10 of the MG group).

Outcomes

MADS 26: Anything against the belief (*yes* vs. *no*):

In a model with Time, PDI sub-items Distress, Conviction and Preoccupation as predictors controlled for Medication, BPRS sub-items Activation, Affect, Negative symptoms, Positive symptoms and Resistance, we found that the PDI Conviction was a significant predictor of the dichotomous outcome variable. An increase of one unit in PDI Conviction scores within a subject over a certain time period was associated with a significant decreasing impact on MADS 26 ($p = 0.003$). This decrease is reflected in an odds ratio of 0.94 and a 95% confidence interval ranging from 0.90 to 0.98. In other words, subjects who increased their average PDI Conviction scores were less likely to move to the yes category of the MADS 26 compared to those who decreased their average scores. The time points, PDI Distress and Preoccupation were not significant predictors of the MADS 26.

MADS 28: Response to hypothetical contradiction (*accommodating or ignoring or rejecting on the RTHC measure* vs. *dismissing belief or changing conviction*):

In a model with Time, PDI sub-items Distress, Conviction and Preoccupation as predictors controlled for Medication, BPRS sub-items Activation, Affect, Negative symptoms, Positive symptoms and Resistance; we found that the variables PDI Distress, Conviction and Time were significant. The positive coefficient of PDI Distress was associated with a significant increasing impact on MADS 28 (OR = 1.04, 95% CI = [1.01; 1.08] and $p = 0.02$). Holding all other variables constant, the probability of "*Dismissing belief or changing conviction"* was higher for subjects who increased their average PDI Distress scores over time than for those

Table 1 Baseline variables for PDI-21 and MADS

Baseline variables	$n = 172$ Mean (SD) or %	p value
PDI		
Distress	23.2 (16.8)	0.05
Preoccupation	22.5 (15.4)	0.1
Conviction	28.4 (18.4)	0.1
MADS 26:		
Anything against the belief: Yes answers (%)	34.9	0.1
Possibility of being mistaken: Yes answers (%)	54.7	0.7
MADS 28: response to hypothetical contradiction (%)		
Dismisses belief	19.2	0.2
Changes conviction	15.1	
Accommodates	29.7	
Ignores or rejects	36.1	
MADS 82: ability to plan a behavioral experiment (%)		
Able to outline evidence and this outcome logically possible	32.6	0.4
Able to outline evidence but this outcome logically impossible	11.1	
Unable to outline evidence which would contradict his belief	56.4	

PDI Peters delusions inventory, *MADS* Maudsley assessment of delusions schedule

whose scores decreased. Similarly, the positive coefficients for T2 and T3 indicate that the probability of "Dismissing belief or *changing conviction"* increased at T2 and T3 as compared to T1 (OR = 2.21, 95% CI = [1.47; 3.33], $p < 0.0005$ and OR = 2.81, 95% CI = [1.78; 4.42], $p < 0.0005$ respectively). As for PDI Conviction, its negative coefficient was associated with a decreasing impact on MADS 28. But this association was a the limit of significance (OR = 0.97, 95% CI = [0.94; 1.00] and $p = 0.052$). PDI Preoccupation was not a significant predictor of the MADS 28.

MADS 8.2: Ability to plan a behavioral experiment (*unable* vs. *able*):

The time points and PDI Conviction were significant predictors of the outcome MADS 8.2 with an increasing impact for T2 and T3 as compared to T1 (OR = 1.76, 95% CI = [1.18; 2.61], $p = 0.005$ and OR = 3.4, 95% CI = [2.23; 5.08], $p < 0.0005$ respectively) and a decreasing impact for PDI conviction (OR = 0.97, 95% CI = [0.94; 0.99] and $p = 0.02$). The positive coefficients for T2 and T3 indicate that the probability of being able to plan a behavioral experiment increase at those times as compared to T1. Regarding PDI Conviction, subjects who increased their average scores were less likely to be able to plan a behavioral experiment compared to those who decreased their average scores. PDI Distress and Preoccupation were not significant predictors of MADS 8.2.

Discussion

We found that PDI Conviction scores predicted outcomes for all measured MADS items. Meaning that patients who decreased their average PDI Conviction scores were more likely to change conviction concerning their delusional beliefs (MADS 26), dismissing beliefs (MADS 28) and were more able to plan a behavioral experiment (MADS 8.2).

Increasing PDI Distress and Preoccupation scores were predictors for being more likely to dismiss beliefs and change conviction (MADS 28). Time itself was a predictor for changing conviction (MADS 26) and being able to plan a behavioral experiment (MADS 8.2). These abilities increased over time during treatment.

PDI-21 measures 3 different dimensions of patients' beliefs, conviction, distress and preoccupation. However, it also analyses other symptoms such as misinterpretations, different types of delusions and simple delusions based on hypochondriasis, guilt, depersonalization etc. [18]. Unlike the auto-questionnaire PDI-21, the MADS specifically examines each of the patient's delusional beliefs in a structured interview. It can therefore give a more detailed insight into the patient's beliefs.

As our analysis showed that PDI-21 and its changes over time predicted outcomes of MADS items. This can be seen as a further validation of the MADS scale by the PDI-21 and vice versa. The PDI-21 could be a simple and effective way to measure progress in treatment on delusional beliefs.

It is further interesting that not all dimensions of the PDI-21 had the same influence on changes in the MADS. This shows that it is not necessarily the content of the beliefs which influences the patients' wellbeing but the way they believe it [18]. How convinced, distressed or preoccupied a patient is, plays an important role in the ability to change and act on delusions. Cognitive treatments for psychosis can work on the different dimensions of delusions. The patient's conviction seems to be the most important factor influencing outcomes. It will be interesting to further study psychological interventions from a dimensional view point.

The study has various limits. We have only measured outcomes over a nine-month period. It will be important to investigate long-term outcomes to observe if the effects are retained through a longer period. In our assessment we only used 3 items of the MADS, as these specifically measure the changes in delusional beliefs and the attitude towards them. These were used, as the previous RCT specifically studied changes in belief flexibility using a cognitive intervention. We did not measure other cognitive functions such as IQ or a neurocognitive test battery to understand possible relations between these and cognitive insight.

On the other hand, the results of this study may possibly be generalized because of its multicenter design. The limited number of exclusion criteria could also add eternal validity to the study. Possibly other factors may influence the outcomes such as comorbid disorders (i.e. substance use disorders) or variations in cognitive deficits.

Conclusion

Overall, the changes in PDI scores predicted outcomes for belief flexibility measured with MADS items. The PDI-21 could be a simple and effective way to measure progress in treatment of delusional beliefs. Cognitive treatments for psychosis can work on the different dimensions of delusions. The patient's conviction seems to be the most important factor influencing outcomes. It will be interesting to further study psychological interventions from a dimensional view point.

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Compliance with Ethical Standards

Disclosure of Potential Conflicts of Interest This study was funded by Swiss National Science Foundation Grant 32003B-121038. Yasser Khazaal and Jérôme Favrod are the authors of the game. The other co-authors declare that the research was conducted in the absence of any commercial or financial relationships that could be conceived as a potential conflict of interest.

Research Involving Human Participants and/or Animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the national research committees. The ethical committees of all four countries approved the trial. The protocol was registered (International Standard Randomized Controlled Trial Number Register: ISRCTN37178153) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards."

Informed Consent Informed consent was obtained from all individual participants included in the study.

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Louise Penzenstadler MD, FMH, is a consultant psychiatrist at the Addictology Department of the Psychiatry Division, Geneva University Hospitals, since 2013. She graduated in medicine in 2008 from the University of Applied Sciences Munich, Germany. Between 2009 and 2013 she worked as a medical intern at the General Psychiatry Division, Geneva University Hospitals. She is specialized as a cognitive behavioural therapist. Her expertise is in treating various addictions, especially drug and alcohol related. Her current research interests are in assertive community treatment options for patients with substance use disorders and treatment for patients with dual diagnosis of psychiatric and substance use disorders.

Anne Chatton Studies: Master of advanced studies in public health (2007–2010): Geneva University. Master in statistics (1999–2001): Neuchâtel University. Master in econometrics (1992–1997) Geneva University. Current position: statistician, Addictology unit, Geneva University hospitals. Research interests: addiction, others.

Prof Huguelet is a psychiatrist, associate professor and head of a catchment area devoted to the care of adult patients. He is specialized in the care of patients with schizophrenia and performed several studies about psychosocial issues related to this disorder.

Laurent Lecardeur is psychologist and a Ph.D. He has completed a postdoctoral fellowship at the Institut Universitaire en Santé Mentale de Montréal. His research interests lie in the field of psychotherapeutical interventions (CBT, cognitive remediation) dedicated to patients with psychosis. He is currently working as a consultant and instructor in Nice, France.

Javier Bartolomei Graduation: University Medicine of Geneva. Position: MD, responsible of an ambulatory and hospital psychiatric unit, Division of Adult Psychiatry, Department of Mental Health, Geneva University Hospitals, Switzerland. Current research: Transcultural Psychiatry, Community Psychiatry

Perrine Brazo has a MD Diploma and a Specialized degree Diploma in psychiatry from the University of Rouen, France in 1992. She received her PhD from the University of Caen, France in 2003. She has been working as a MD-PhD in psychiatry CHU of Caen since 2008. Her clinical activities are: schizophrenia and psychosocial rehabilitation. Her research interests are: schizophrenia and cognitive impairments.

Elodie Murys graduated of the Nice Sophia Antipolis University. She has a master's degree in clinical neuropsychology in 2005 and an University degree (University of medicine of Marseille) in cognitive and behavioral therapy in 2010, specialized in addictology, acceptation and commitment therapy (trained and supervised by Benjamin Schoendorff) and mindfulness therapy (MBCT trained by Zindel Segal, MBRP). She is currently working in psychiatry and addictology at the hospital in Monaco since 2007. She is starting a PhD, She is looking at the effect of ACT and therapeutical tools such as metaphors for substance abuse treatment.

Florent Poupart graduated at Université Paris 5 (Master in clinical psychology) and Toulouse 2 (PhD). He is an associate professor in clinical psychology (Université de Toulouse). He is a psychologist at the Toulouse Hospital Center (Centre Hospitalier Universitaire) in the psychiatry department. He workes on psychosis, hypnosis, femininity, clinical setting, in a psychodynamic approach.

Serge Rouvière is a practical nurse and currently works at the Centre Hospitalier le Vinatier, Bron, France.

Mohamed Saoud is a M.D., PH.D. and Professor In Psychiatry at the University of Lyon since 2010. He is head of Consultation-Liaison Psychiatry in the Service Hospitalo Universitaire, Hospices Civils de Lyon, since 2010 He is team leader PsyR^2, Psychiatric Disorders: from Resistance to Response at the Centre de Recherche en Neurosciences de Lyon (CRNL). He worked at INSERM U1028 / CNRS UMR5292 / UCBL 1; Centre Hospitalier Le Vinatier from 2008 to 2016. HE is President of the Clinical Research Committee of Centre Hospitalier Le Vinatier l'Hôpital, since 2010.

Jérôme Favrod Full Professor of community psychiatric nursing at School of Nursing Sciences, University of Applied Sciences and Arts of Western Switzerland Lausanne, Switzerland. He is a trained family and cognitive-behavioral therapist.

Yasser Khazaal is Full Professor of Addiction psychiatry at the Faculty of Biology and Medicine, University of Lausanne. He is associate researcher at the Research Center, Montreal University Institute of Mental Health, Montreal, Canada. He is vice-president of the Swiss Society of Social Psychiatry, past president of the Swiss Society of Cognitive Psychotherapy, member of the launching board of the European Society of Social Psychiatry (ESSP) and Secretary General of the ESSP. He is involved in a number of studies related to addictive disorders, cognitive and behavioral treatments, e-mental health as well as in projects related to the the development and assessment of games or computer-based treatments for different mental health disorders. He is also interested in the promotion of new models of patient care aiming to promote empowerment and recovery.

Affiliations

Louise Penzenstadler[1] · Anne Chatton[1,2] · Philippe Huguelet[1,2] · Laurent Lecardeur[3] · Javier Bartolomei[1] · Perrine Brazo[3,4] · Elodie Murys[5] · Florent Poupart[6,7] · Serge Rouvière[8] · Mohamed Saoud[9] · Jérôme Favrod[10] · Yasser Khazaal[11,12]

[1] Geneva University Hospitals, Ch, du Petit Bel-Air 2, 1225 Chêne-Bourg, Switzerland

[2] Faculty of Medicine, Geneva University, Geneva, Switzerland

[3] UNICAEN, Imagerie et Strategies Therapeutiques de la schizophrenie (ISTS), Normandie University, EA4766, 14000 Caen, France

[4] UNICAEN, CHU de Caen Normandie, Service de Psychiatrie d'adultes, Centre Esquirol, Normandie University, 14000 Caen, France

[5] Unité Mobile de Psychiatrie, Centre Hospitalier Princesse Grace, Monaco, Monaco

[6] Laboratoire Clinique Psychopathologique et Interculturelle, Université de Toulouse, Toulouse, France

[7] Centre Hospitalo-Universitaire de Toulouse, Toulouse, France

[8] CRESOP, Centre Hospitalier le Vinatier, Bron, France

[9] PsyR^2, INSERM U1028, CNRS UMR5292, PSYR2 Team, Lyon Neuroscience Research Center, Lyon, France Department of Consultation-Liaison Psychiatry, Université Claude Bernard Lyon 1, Lyon, France

[10] La Source, School of Nursing Sciences, HES-SO University of Applied Sciences and Arts of Western Switzerland, Lausanne, Switzerland

[11] Addiction Medicine, Department of Psychiatry, Lausanne University Hospitals, Lausanne, Switzerland

[12] Research Center, Montreal University Institute of Mental Health, Montreal, Canada