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The effects of mindfulness-based training in virtual reality on psychotic symptoms, mood and cognitive functioning – a pilot study

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Summary

Aim. Virtual reality (VR) is growing in popularity in treating various psychiatric disorders, including psychotic ones. However, no studies have been published on mindfulness interventions aided by virtual reality in psychotic patients to date.

Method. 25 patients with schizophrenia or schizoaffective disorder were assessed at three time points with 4-week intervals using the six-item *Positive and Negative Syndrome Scale* (PANSS–6), *Quick Inventory of Depressive Symptomatology* (QIDS), *Beck Depression Inventory* (BDI), *Beck Anxiety Inventory* (BAI), *State-Trait Anxiety Inventory* (STAI), *Perceived Stress Scale* (PSS-10), and the *Addenbrooke's Cognitive Examination III* (ACE-III). Additionally, the intensity of seven emotions was rated using the *Visual Analog Scale* (VAS) before and after each training session.

Results. The subjects achieved a significant reduction in symptom severity after completing mindfulness training. This was reflected by the PANSS-6 total score, as well as by the

This study was conducted by the Krakow Psychosis Research Group COGITO

subscales for negative and positive symptoms. A significant increase in cognitive functioning (ACE-III scores) was also found. No significant changes in these measures were observed when only the standard intervention was used.

Conclusions. Our study indicates good feasibility of the developed mindfulness intervention in VR in schizophrenic patients. The results indicate potential benefits in terms of lessening of the symptoms and improvement in cognition.

Key words: mindfulness, virtual reality, schizophrenia

Introduction

Traditional treatment of people suffering from schizophrenia, based on the reduction of symptoms through the use of pharmacotherapy and various types of psychotherapy, is often insufficient [1]. In search of increased effectiveness of treatment, new psychotherapeutic approaches are emerging based on the acceptance of symptoms and meditation techniques adapted to psychotherapeutic work [2]. The third wave of cognitive behavioral therapies proposes interventions based on mindfulness (MDF) meditation, which is supposed to reduce stress when experiencing symptoms of mental disorders and diseases, and ultimately also reduce the symptoms themselves [3]. This metacognitive approach to treatment finds its justification in case of patients with psychosis. Chadwick [4] in his model postulates that the stress resulting from experiencing psychosis is not a direct effect of the content of the symptoms themselves but is related to the way in which the individual relates to this experience. A negative perception of the inability to control symptoms, i.e., their presence and content, increases stress. At the same time, avoiding experiencing symptoms increases the negative feelings associated with their presence. The metacognitive approach (in this case MDF techniques) seems to be a good complement to standard treatment in case of absence of a full response to pharmacological and psychotherapeutic treatment focused on symptom reduction.

Mindfulness can be practiced in various intensities and contexts, bringing benefits in raising the level of awareness of thoughts, feelings, emotions, desires, and actions, as well as suffering itself [2]. Numerous studies have shown a reduction in the level of stress, symptoms of anxiety and depression by introducing mindfulness-based interventions in various populations [5–9]. Over the years, mindfulness-based programs have been adapted to a specific disorder – GAD, depression, burnout (MBSR), borderline personality disorder (DBT MDFSkills), as well as for patients with a history of psychosis [10, 11].

The effectiveness of mindfulness training used in psychotic patients was confirmed in qualitative and quantitative studies, during which study participants declared less involvement in symptoms [12, 13] and a reduction in clinical symptoms of schizophrenia. There were also no negative consequences related to the nature of the intervention [10, 11].

The identification of functional factors in mindfulness, based on own research, is presented by Bear [14], including: exposure (to unpleasant thoughts and feelings), cognitive change (adaptation of thought processes and attitudes), self-management (through better self-observation), relaxation (through stress reduction), and acceptance

(mental experience). These skills gained during training enable a neutral reaction to the experienced psychotic symptoms. Chadwick's model explains the general mechanism in more detail and suggests that the experience of psychosis may still be present, but the individual learns to accept this experience through mindfulness training, perceiving it as a temporary mental event, and consequently lowering the level of distress [15]. This model is also confirmed in studies which analyzed the relationships between the level of psychopathology, distress associated with the experienced voices and basic mindfulness skills in the environment of psychiatric patients, without introducing mindfulness training [16]. The results indicate that anxiety, and therefore a negative response caused by voices, correlated negatively with mindfulness. Patients with higher responsiveness based on mindfulness skills showed less distress associated with the experienced symptoms.

Recent research also shows the potential of using mindfulness-based interventions assisted by virtual reality (VR). In the study by Kruk et al. [17], psychotic patients reported the experience of contact with VR mainly as intriguing and declared their willingness to repeat similar sessions. So far, studies have also been carried out in a group of healthy people, which showed that virtual reality significantly increases the state of mindfulness and the intensity of positive emotions, without affecting the level of negative emotions, without increasing arousal [18]. Moreover, in a case study of a patient with severe burns, a reduction in negative emotions and an increase in positive emotions was observed when the VR environment was included [19].

The use of VR makes it possible to use a repetitive, unchanging environment that reduces distractions associated with being in the environment of everyday functioning, e.g., significantly affects the control of random disruptive stimuli. In the case of people suffering from schizophrenia who struggle with cognitive difficulties, distractibility, as well as reduced motivation to act, the influence of VR is assumed to allow them to focus their attention more fully on the therapeutic process and increase involvement by providing a sufficient number of stimuli. Insufficient stimulation reduces the ability to maintain the state of mindfulness and motivation [18, 20]. In standard imaginative techniques, during which one should keep the eyes closed, the number of incoming stimuli is reduced compared to the pre-imaginative situation. The implementation of the VR environment solves this problem. The introduction of the VR environment makes it possible to reduce interactions with other people, reduces the need to learn the therapeutic procedure, putting emphasis on following the instructions. The above-mentioned advantages of the VR environment in the case of patients suffering from schizophrenia may be a significant motivator to undertake and maintain a therapeutic intervention. Many studies indicate greater involvement in treatment, while exposure in a virtual environment is used in various populations [21–25]. Study by Modrego-Alarcón et al. [26] found a higher frequency of individuals from the group subjected to mindfulness-based interventions in virtual reality than in the case of subjects participating in traditional mindfulness sessions.

The use of a natural virtual environment allows to maintain passive attention, which is confirmed by research on the perception of pain [27], as well as its use in mindfulness practices [20]. In addition, the natural environment presented as the background

for performing mindfulness exercises is in itself supporting the use of disease-limited cognitive resources, according to the Attention Restoration Theory [28]. This theory postulates less fatigue of attention in the natural environment and its supportive effect on concentration. Moreover, even a relatively short stay in the natural environment, also generated in virtual reality, positively influences the increase of mental well-being and the reduction of the level of stress [29, 30].

The intervention proposed by us is first of this type – combining mindfulness and VR training – used in a group of people suffering from schizophrenia or schizoaffective disorder.

The aim of this pilot study was to verify the assumption that an intervention based on mindfulness and implemented in virtual reality will reduce psychopathological, depressive, stress, and anxiety symptoms compared to the state before the intervention. Additionally, the level of cognitive functioning was controlled before and after the intervention with the assumption of its improvement after the intervention. It was also assumed that the level of positive emotions and relaxation will increase while the level of negative emotions will decrease each time after training in comparison to the measurement before training.

Material and method

The subjects were recruited from the Day Ward of Rehabilitation and Psychosis Treatment and the Adult Psychiatry Clinic of the University Hospital in Krakow as well as from the Community Home for Mutual Aid at Olszanska Street 5 in Krakow. 42 people were recruited in the course of the study, of which 25 completed the study meeting the criterion of presence at the level of over 50%. The reasons for discontinuation of participation in the study were: life events such as: starting work (n = 1); end of treatment in the ward (n = 10); lack of motivation to maintain participation in research (n = 3); and unstable mental health (n = 3). In the course of the study, adults aged 18–50 were qualified with a diagnosis of schizophrenia or schizoaffective disorder, made by an experienced clinician, based on the ICD-10 diagnostic criteria. The exclusion criteria were epilepsy, uncorrected visual or hearing impairment, active addiction to psychoactive substances except for nicotine, and intellectual disability. All participants gave informed and voluntary consent to participate in the study. The study was approved by the JUMC Bioethics Committee (No. 1072.6120.11.2021 of February 17, 2021).

The study was conducted in an alternating design. During the first meeting, the participant was informed about its course. Then, after voluntary consent to participate and consent to the processing of personal data, the first series of self-report tests, a cognitive examination by a psychologist, and a clinical evaluation by a physician were conducted (T1). For the next 4 weeks, treatment was continued as usual, i.e., treatment under a permanent therapeutic intervention program within the Day Ward or Community Home for Mutual Aid. Then, the second assessment with the same tools (T2) was carried out, after which the participant was subjected to therapeutic intervention for 4 weeks (3 times a week), which ended with the third measurement (T3) (Figure 1).

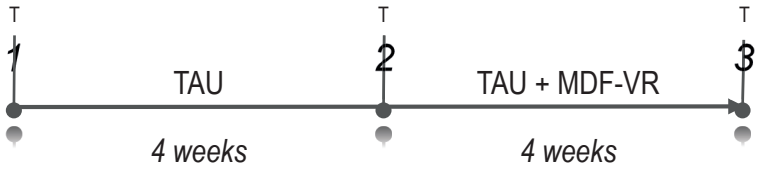

Figure 1. **Research phases**

During each of the three clinical assessments, participants were examined by a physician using the PANSS (*Positive and Negative Syndrome Scale*). It was decided to use the 6-item PANSS-6 [31, 32], completed on the basis of the semi-structured SNAPSI interview due to its very good psychometric properties, such as strong correlation with the result of the 30-item version or good sensitivity to detect changes in the severity of psychopathology. Cognitive functions were assessed by a psychologist using the ACE III (*Addenbrooke's Cognitive Examination III*) [33]. Then, the subjects completed self-report questionnaires: QIDS-SR [34] and BDI (*Beck Depression Inventory*) [35] to assess the severity of depressive symptoms, BAI (*Beck Anxiety Inventory*) [36] to assess the severity of anxiety symptoms, PSS – 10 (*Perceived Stress Scale*) [37] to assess the severity of perceived stress symptoms, and STAI [38] to assess the severity of state anxiety.

As part of the therapeutic intervention, 12 mindfulness training sessions in VR (MDF-VR) were conducted, 3 sessions per week for 4 weeks. Each session lasted approximately 30 minutes, of which 20 minutes in virtual reality delivered with the commercially available Oculus Quest 2 wireless goggles (Photo 1). At the beginning of each session, the participant configured the goggles for optimal image quality. For the next 20 minutes, she/he participated in the proprietary mindfulness training developed and adapted to the needs of the study. The training consisted of being in a virtual natural environment (Photograph 2), recorded in 5K 360-degree video technology. The image was accompanied by a soundtrack with the voice of the teacher giving instructions on how to perform the next mindfulness exercises. Additionally, before and after each session, the participants answered the questions of the Visual Analog Scale (VAS), defining the level of their emotions (sadness, anxiety, anger, surprise, relaxation, agitation, joy). After the training sessions, participants were regularly asked about the severity of discomfort related to the cyber disease.

All statistical analyzes were performed in the R environment (2022), using the tidyverse [39] package and the PMCMRplus package (Pohlert, 2022) for Durbin *post-hoc* tests. The significance level assumed for the analyzes was 0.05. Friedman's test was used to compare the results from three measurement points due to the small size of the group and the distribution of results deviating from the normal. The Durbin test was used for comparisons between pairs of measurements.

Photograph 1. **Use of Oculus Quest 2 wireless headset**

Photograph 2. **Natural VR environment**

Results

In the studied group, the mean age was 39.3 (*SD* = 11.1) years, and 60% of the participants were men. 40% of the examined patients had higher education, 48% – secondary and 12% – primary. Most of the examined patients were diagnosed with schizophrenia (84%), people with schizoaffective disorders constituted 16% of the group – according to the ICD-10 criteria. The mean duration of illness was 14.5 (*SD* = 10.0) years, and the mean number of hospitalizations due to the disease was 4.4 (*SD* = 4.4). Table 1 presents comparisons of the results from three measurement points for the ACE III, BDI, BAI, STAI, QIDS, PSS10 and the PANSS-6. In addition, the results from the first seven training sessions, where the VAS scale was used before and after training, are also presented.

Measure	T1			T2			T3			Level of significance p*			
	mean	SD	median	mean	SD	median	mean	SD	median	Friedman test	T1 vs. T2	T1 vs. T3	T2 vs. T3
ACE III Sum	89.6	7.8	91	91.0	7.7	94	93.1	5.6	95	0.009	0.308	0.002	0.031
PANSS-6 Total	11.8	5.4	11	11.9	5.9	11	9.9	5.5	7	0.000	0.411	0.000	0.000
Positive. sum	5.6	3.3	4	5.7	3.0	6	4.6	2.6	3	0.001	0.842	0.001	0.001
Negative sum	6.1	3.8	6	6.2	4.0	5	5.3	3.8	4	0.002	0.626	0.001	0.003
BDI sum[a]	10.1	11.2	8	9.1	12.7	5	7.1	10.3	2	0.059	0.268	0.017	0.180
BAI sum[a]	16.3	13.3	11	13.0	11.0	9	11.8	10.5	9	0.008	0.009	0.003	0.674

table continued on the next page

QIDS total[b]	7.0	6.1	5	6.0	6.2	4	5.2	5.3	4	0.279	0.259	0.128	0.685
STAI sum[a]	21.4	11.8	20	18.5	10.6	19	17.8	12.6	18	0.005	0.007	0.001	0.563
PSS10 sum[a]	15.7	6.5	16	14.1	6.3	15	14.1	6.4	14	0.084	0.077	0.038	0.743

* Durbin test was used for pairwise comparisons

[a] lack of data for 2 people; [b] lack of data for 1 person

There was a significant increase in ACE-III scores of the examined people after completion of mindfulness training compared to the level obtained before training (TAU + MDF-VR: $p = 0.031$), while the results did not change significantly when only standard intervention was used (TAU: $p = 0.308$). There were no significant differences in the PANSS results between the inclusion point of patients in the study and the first measurement point during the use of TAU, while after the MDF-VR training, the subjects achieved a statistically significant reduction in the severity of symptoms in the overall PANSS score (T2 vs. T3: $p = <0.001$) as well as reduction in the subscale of negative symptoms (T2 vs. T3: $p = 0.003$) and positive symptoms (T2 vs. T3: $p = 0.001$). There were no significant changes in the severity of depressive symptoms, while the anxiety symptoms before the training itself, i.e., with the use of only standard intervention (BAI: $p = 0.009$; STAI: $p = 0.007$), were significantly reduced, which then did not change significantly. Nevertheless, in the studied group, the results for depression and anxiety symptoms showed a decreasing tendency (Table 2) both between the first and second measurements, as well as the second and third (except for the PSS10). The graphs below (Figure 2 and 3) show the distribution of results in three measurements for the ACE-III and PANSS-6.

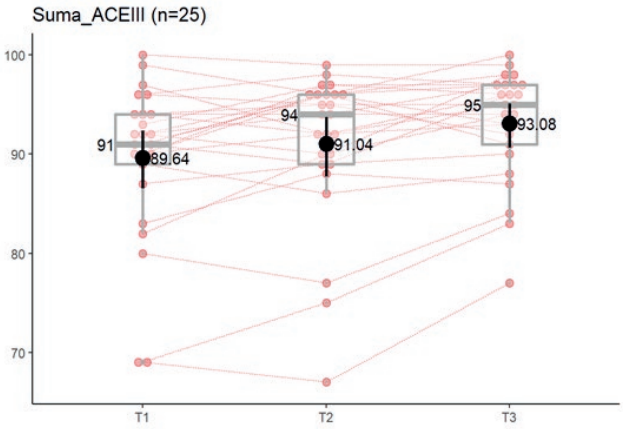

Figure 2. **Distribution of results as well as mean and median values at three measuring points for the ACE-III**

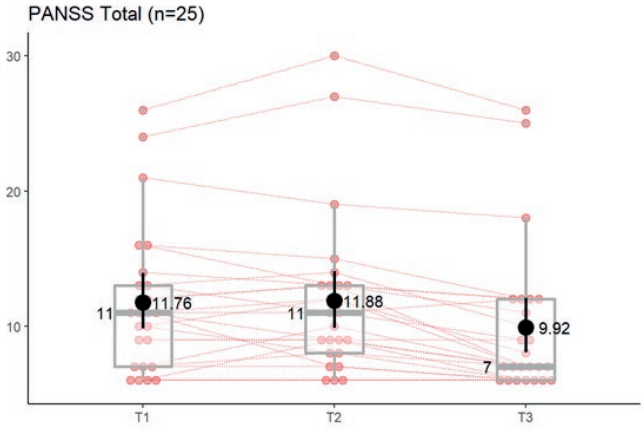

Figure 3. **Distribution of results as well as mean and median values at three measurement points for the PANSS-6 tool**

The analysis of the intensity of 7 selected emotions, on the basis of averaged data from seven trainings, showed that they underwent significant changes immediately after training compared to the state before training. The examined patients indicated that sadness, anxiety and anger were less intense ($p = 0.002$, $p = 0.001$, $p = 0.004$, respectively), while relaxation, joy and surprise increased ($p < 0.001$, $p < 0.001$, $p = 0.027$, respectively). There was no significant change in agitation.

Table 2. **Comparison of mean intensity of 7 emotions before and after training (data aggregated from the first 7 training sessions)**

Emotion	Measurement before training			Measurement after training				
	mean	SD	median	mean	SD	median	Difference in means	Wilcoxon test – p
Sadness_mean	1.771	1.695	1.714	0.954	1.244	0.143	-0.817	0.002
Anxiety_mean	2.051	2.003	1.714	1.269	1.735	0.429	-0.783	0.001
Anger_mean	1.211	1.204	1.000	0.731	0.966	0.286	-0.480	0.004
Surprise_mean	1.657	1.589	0.857	2.263	2.210	1.857	0.606	0.027
Relaxation_mean	3.537	2.199	3.143	5.903	2.416	5.143	2.366	0.000
Agitation_mean	2.166	1.723	2.286	2.600	2.350	2.000	0.434	0.390
Joy_mean	3.411	2.367	3.143	5.017	2.641	4.286	1.606	0.000

Conclusions

The presented study is the world's first report on the use of mindfulness and VR as a complementary therapy for patients diagnosed with the schizophrenia spectrum. The obtained results partially confirmed the research hypotheses and are consistent with the trends described in the literature regarding the use of mindfulness without the use of VR. The level of psychopathology after the implementation of MDF-VR interventions decreased, both in general psychopathology as well as positive and negative symptoms. This result is consistent with the results of the available meta-analyzes, according to which a mindfulness-based intervention (without the use of VR) associated with standard treatment improves overall symptomatology, including positive and negative symptoms, functioning level and awareness of the illness [40]. On the other hand, the meta-analysis by Liu et al. [41] shows that mindfulness interventions reduce general psychotic symptoms, positive, negative and depressive symptoms as well as the duration of hospitalization, and the effects in terms of negative symptoms may persist for at least 3 to 6 months. Moreover, our intervention resulted in an improvement in cognitive functioning, in line with the observations in the literature on the subject [42]. According to literature, cognitive deficits are correlated with the severity of negative and also, although less frequently, positive symptoms, and more recent analyzes take into account the so-called disorganization or cognitive syndrome that shows the relatively strongest connections with cognitive functions [43]. The improvement noted in our research, both in psychopathological and cognitive symptoms, seems to be consistent with the literature on the subject.

The hypotheses concerning the reduction in the level of depression have not been confirmed. There is a lot of data in the literature on the positive effect of mindfulness-based interventions on depressive symptoms [41]. Our study shows a trend of reduction in the severity of depressive symptoms in the BDI, but not in the QIDS-SR. This may be due to the fact that the examined symptoms in both scales only correspond in 61% [44]. The BDI scale, compared to the QIDS-SR scale, focuses mainly on the cognitive symptoms of depression. Although our data do not fully support this hypothesis, it is likely that the intervention used had a greater impact on the cognitive area of depression compared to the rest of the axial symptoms. The examined patients in the first and second measurement points of the severity of depressive symptoms obtained, in the BDI, the mean of results below the value indicating the occurrence of depression. In the case of the QIDS-SR, the mean results indicated mild depression – in accordance with the norms; in both cases a low level of symptoms may be the reason for lack of significant changes in this area.

The implementation of the MDF-VR method did not reduce the global level of stress of the examined patients, measured after the completion of the therapy cycle. This result was inconsistent with our hypothesis. So far, in the vast majority of general population studies, mindfulness-based interventions have reduced the level of perceived stress [45, 46]. However, it is difficult to relate these results to other studies on the population of patients with psychosis. In the recent reviews of the literature analyzing the impact of mindfulness interventions in the population of people with psychotic

disorder on individual symptomatic domains, the impact on the level of perceived stress was not discussed, but rather the impact on the psychopathology typical of this disorder [40, 41, 47]. Perhaps in people with schizophrenia spectrum disorders a longer period of intervention is necessary to be able to change the subjective perception of stressful situations, especially in the subgroup of chronically ill people with permanent deficits of executive functions, and such people constituted the majority of our group. The duration of training may also be crucial due to the fact that a short-term mindfulness intervention lasting several days may lead to an intensification of the physiological stress in response to social stress, especially in people with a low level of trait mindfulness [48]. At the same time, when analyzing the results on the VAS scales, an increase in relaxation in the examined patients was observed. The results also indicate episodic, but not global changes. It should be added that although we did not observe the expected change in the questionnaires, it may be due to the generally low or average declared level of anxiety and stress of the studied patients.

The expected changes in emotions before and after the training session were achieved – negative emotions (sadness, anxiety, anger) were lowered, relaxation and joy increased. A similar effect was obtained in the study by Navarro-Haro [24] in a group of healthy people subjected to mindfulness interventions in virtual reality.

So far, no studies using mindfulness interventions in virtual reality have been conducted in psychotic patients [49]. Our study shows a good feasibility of the developed mindfulness VR intervention in patients suffering from schizophrenia. The feedback received from the participants showed that the trainings were interesting for them and in their subjective opinion it led to an improvement in well-being, which was also reflected in the results of the measured emotions. None of the examined patients reported symptoms of the simulator disease. Several participants episodically reported an increase in anxiety or productive symptoms after the training session, one person withdrew from training due to experienced hallucinations, the source of the induction of symptoms could not be clearly identified.

This study was a pilot study of an innovative method of intervention in people suffering from psychosis. Its formula is associated with a number of limitations that require caution in the interpretation of the results and may be associated with lack of confirmation of some hypotheses. The first one is the short-term nature of the intervention. The positive impact of mindfulness-based interventions in psychotic patients on the dimensions of depression, anxiety and stress is visible primarily in long-term interventions [5, 47, 50]. In short-term interventions, changes are visible first of all in the measurements taken directly after the implementation of the intervention, where changes in the state anxiety have been noted [51]. Another limitation is the small group of respondents, most of whom are chronically ill and repeatedly hospitalized, i.e., with a severe course of the illness. Although preliminary data suggest that, also in chronic patients, mindfulness training may lead to a decrease in the severity of positive symptoms, but such an effect appeared only after 3 weeks of intervention [52]. Another limitation was the use of self-report tools to measure the severity of anxiety, depression and perceived stress. Perhaps an additional assessment of the above-mentioned areas by a clinician would allow to objectify the data on changes. On the other hand, in the

case of cognitive and psychotic symptoms, the clinician was not blinded and knew which phase of the study the patient was in, which could lead to observer bias. Due to the lack of a control group subjected to the classic mindfulness intervention, it cannot be stated whether the use of VR brought any additional positive therapeutic effects apart from the mindfulness intervention itself. In one of the RCT studies comparing the effect of mindfulness interventions in VR and without VR on the symptoms of perceived stress in the non-clinical population, no differences in the effectiveness of the intervention were observed, although in the group with VR, participants were less likely to miss training sessions [26]. This issue requires further studies comparing interventions in VR with the control group without VR, because it is possible that in the case of the population of people suffering from schizophrenia, VR-assisted intervention may improve concentration on training, e.g., by cutting off distractors from the environment or regenerating the effect on attention resources.

On the basis of the obtained results, it can be initially assessed that the intervention has a beneficial effect on the severity of positive and negative psychotic symptoms and on the direct regulation of emotions. The results require confirmation in a targeted study on a larger group of people and with a longer intervention time, which would also allow to verify its impact on depression, anxiety and the experienced stress.

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