Does Biofeedback Improve Symptoms of Schizophrenia (Emotion, Psychotic Symptoms, and Cognitive Function)?

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Objectives: Patients with schizophrenia tend to experience emotional distress and to have impaired cognitive function. The objective of this study was to investigate the effect of the biofeedback therapy on patients with schizophrenia. Methods: From December 1, 2012 to November 30, 2013, we recruited in- and outpatients diagnosed with schizophrenia. They were randomized into the biofeedback group (treated with individual progressive muscle relaxation therapy [PMRT], three times a week, for two weeks) and the control group. All patients were evaluated using Beck Depression Inventory-II (BDI-II), Beck Anxiety Inventory (BAI), Symptom Checklist-90-R, and Trial Making Test (TMT). Results: We recruited 25 patients, including 16 in the biofeedback group and 9 in the control group. The results showed significantly lower BAI scores \((p = 0.05)\), lower depression \((p = 0.05)\), lower anxiety \((p = 0.05)\), lower paranoid ideation \((p < 0.05)\), lower additional items (sleep disturbances and appetite) \((p < 0.05)\) and lower TMT A \((p = 0.01)\) scores in the biofeedback group compared to the control group. TMT A \((p = 0.01)\) and TMT B \((p = 0.01)\) were found to be significantly lower in the control group. No statistical significance was found in the cognitive function improvement between the two groups. Conclusion: Biofeedback could improve the clinical symptoms of depression, anxiety, paranoid ideation, sleep disturbances and appetite in patients with schizophrenia.

Key words: biofeedback, cognitive function, emotion, schizophrenia


Introduction

Schizophrenia is a chronic, severe, and disabling brain disorders. It occurs at roughly similar rates in all ethnic groups across the world. Patients with schizophrenia have three clusters of symptoms—positive, negative, and cognitive symptoms. They often experience emotional distress. Previous data in Taiwan showed that 60% of patients with schizophrenia experience anxiety [1, 2], and they also tend to have higher anxiety levels...
Those emotional distresses have negative impacts on patients with schizophrenia. Studies have shown more anxious and depressive symptoms in patients with schizophrenia, impacting their quality of life [4]. Anxiety in patients with schizophrenia damages their attention, increases sleep disturbances, decreases their motivation, as well as increases the likelihood of social withdrawal, paranoia, and mood instability [5, 6].

Those studies showed that patients with schizotypias tend to experience emotional distress which affects their quality of life, cognitive function, and social functions. Another study has shown positive correlations between social anxiety, positive symptoms, bizarre behavior, and suspiciousness/paranoia, indicating that anxiety symptoms of patients with schizophrenia can influence core psychiatric symptoms [7]. Those findings suggest that management of mood disturbance can improve the psychotic symptoms in patients with schizophrenia.

Biofeedback is a self-regulating technique when patients learn to voluntarily control what were previously thought to be an involuntary body process. This intervention requires specialized equipment to convert physiological signals into meaningful visual and auditory cues, but there is a need to have a trained biofeedback practitioner to guide the therapy. Using a screen such as a computer monitor, patients get feedback to help them develop control over their physiology, and achieve relaxation [8].

Biofeedback therapy can reduce anxiety and other mood symptoms effectively in patients with schizotypias [9, 10], and the effect can last for a year [11]. Recent studies have shown a positive correlation between biofeedback effect and cognitive performance in healthy adults. Biofeedback therapy can improve adults’ processing speed and executive function [12, 13]. Most studies have been done on the healthy individuals. But not many reports exist to describe the effects of the biofeedback on cognitive functions of patients with schizophrenia.

In this study, we intended to investigate how biofeedback affects mood disturbances, declined cognitive function, and psychotic symptoms in patients with schizophrenia.

**Methods**

**Study participants**

From December 1, 2012 to November 30, 2013, we recruited in- and out-patients diagnosed with schizophrenia. They were assessed using Beck Depression Inventory-II (BDI-II) and Beck Anxiety Inventory (BAI) for mood status, Symptom Checklist-90-R (SCL-90r) for psychiatric symptoms, and Trial Making Test (TMT) for cognitive function. All patients had anxiety or depression disturbances (BAI ≥ 8, BDI-II ≥ 14). All patients had fair medical compliance. Exclusion criteria for the study included patients who had severe psychotic symptoms, and a history of substance abuse, brain injury, stroke, muscular or skeletal disorders, or previous exposure to muscle relaxation training. This study protocol was approved by the institutional review board of Chang Gung Memorial Hospital, with the need of obtaining informed consent from study participants.

**Study procedure**

Subjects were randomly assigned in referral chronological sequence into the biofeedback group (treated with individual PMRT, three times a week, for two weeks), and the control group (no biofeedback therapy). The patients in the control group did not wait for being accepted for being enrolled into the biofeedback group.
**Study instruments**

**Beck Anxiety Inventory (BAI)**

Beck Anxiety Inventory (BAI) was created by Aaron T. Beck and other colleagues. It is a 21-question multiple-choice self-report inventory that is used for measuring the severity of an individual’s anxiety. It contains 21 questions, each is scored on a scale value of 0 to 3. According to the guideline book (published in 1993), Higher total scores indicate more severe anxiety symptoms. The score ranges are corresponding to severity of anxiety – 26-63, severe anxiety; 16-25, moderate anxiety; 8-15, mild anxiety; and 0-7, minimal anxiety. The scale includes four (neurophysiological, subjective, panic, and autonomic) symptom dimensions [14].

**Beck Depression Inventory-II (BDI-II)**

Beck Depression Inventory-II (BDI-II) was invented by Aaron T. Beck. This tool is a 21-question multiple-choice self-report inventory containing 21 questions, each is scored on a scale value of 0 to 3. Higher total scores indicate more severe depressive symptoms. The score ranges and corresponds to severity of depression – 29-63, severe depression; 20-28, moderate depression; 14-19, mild depression; and 0-13, minimal depression. The BDI-II can be separated into two subscales – the cognitive-affective dimension (e.g. mood) and the somatic dimension (e.g. loss of appetite) [15, 16].

**The Symptom Checklist-90-R (SCL-90-R)**

The Symptom Checklist 90 Revised (SCL-90-R) originally developed by Derogatis and Savitz, has been widely used to assess the general psychopathology for both research and clinical practices [17-19]. The 90-item checklist is used to evaluate a broad range of psychological problems and symptoms of psychopathology. The primary symptom dimensions include somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, psychoticism, and a category of “additional items” which helps clinicians assess other aspect of the clients symptoms (e.g. item 19, “poor appetite”) [19].

**Trial making test (TMT)**

Trial making test (TMT) is a neuropsychological test for visual attention and task switching. The test has been frequently used in neuropsychological research on schizophrenia [20, 21]. There are two parts – Forms A and B. This tool can provide information about visual search speed, scanning, speed of processing, mental flexibility, and executive function [22].

**Biofeedback instrument**

Biofeedback instrument is a computerized system, to do non-invasive examination. The machine which is to be touched by patient’s finger, is designed to detect its temperature changes of finger skin, and to understand their relaxed state. Higher skin temperature means that the patient is more relaxed. From screen-displayed data, the patient can understand the current state of relaxation, to get immediate physiologic feedback.

**Biofeedback therapy**

There were total six sessions in the biofeedback group, and each session is about 30-40 minutes in a session. First session, the researcher introduced the biofeedback mechanism. In every session, the research taught them how to follow the steps of the progressive muscle relaxation therapy (PMRT). After finishing the practice, the researcher discussed with patient about the experience during the practice and re-checking if mod-
Statistical analysis

The study data included patients’ demographic information. Data on sex, age, education, married state, and resource were summarized and presented using frequency distribution, percentages, means, and standard deviations. We used non-parametric test (Wilcoxon signed-rank test) to compare differences between pre- and post-test and post-test in biofeedback and control groups.

We used Statistical Package for Social Science software version 22 in Windows (SPSS Inc., Chicago, Illinois, USA) to compute study data. The differences between groups were considered significant if p-values were smaller than 0.05.

Results

Thirty-four patients were enrolled in this study. But one patient dropped out and eight patients did not meet the criteria of anxiety or depression disturbances (BAI ≥ 8, BDI-II ≥ 14).

Therefore, we recruited finally 25 patients, including 16 in biofeedback group and 9 in the control group. Table 1 presents demographic data of all study participants. Table 2 shows the improvement of emotional disturbances. Table 3 describes the improvement of psychotic symptoms. And Table 4 summarizes the improvement of cognitive function.

Discussion

The results of this study showed that biofeedback significantly improved the emotional disturbances (p < 0.05, Table 2), and psychotic
Table 2. The improvement of emotional disturbances

<table>
<thead>
<tr>
<th></th>
<th>BDI-II</th>
<th>BAI</th>
<th>SCL-depression</th>
<th>SCL-anxiety</th>
</tr>
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<tbody>
<tr>
<td><strong>Biofeedback group</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pre-test mean</td>
<td>27.19</td>
<td>25.25</td>
<td>1.97</td>
<td>1.80</td>
</tr>
<tr>
<td>Post-test mean</td>
<td>21.94</td>
<td>20.75</td>
<td>1.68</td>
<td>1.55</td>
</tr>
<tr>
<td>Z</td>
<td>-1.66</td>
<td>-1.93*</td>
<td>-1.96*</td>
<td>-1.95*</td>
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<tr>
<td><strong>Control group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test mean</td>
<td>23.89</td>
<td>27.33</td>
<td>1.28</td>
<td>1.43</td>
</tr>
<tr>
<td>Post-test mean</td>
<td>20.11</td>
<td>21.44</td>
<td>1.50</td>
<td>1.59</td>
</tr>
<tr>
<td>Z</td>
<td>0.00</td>
<td>-1.13</td>
<td>-1.42</td>
<td>-0.77</td>
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</table>

*p < 0.05;
SCL-depression, depression of SCL-90r; SCL-anxiety, anxiety of SCL-90r
The Wilcoxon signed-rank test showed significantly lower BAI (Z = -1.95, p = 0.05), depression (Z = -1.96, p = 0.05) and anxiety (Z = -1.95, p = 0.05) scores in biofeedback group, and there was not any significant differences in control group.

Table 3. The improvement of psychotic symptoms

<table>
<thead>
<tr>
<th></th>
<th>SOM</th>
<th>OC</th>
<th>IS</th>
<th>HOS</th>
<th>PA</th>
<th>PI</th>
<th>PSY</th>
<th>AI</th>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Pre-test mean</td>
<td>1.37</td>
<td>2.02</td>
<td>1.56</td>
<td>0.97</td>
<td>1.45</td>
<td>1.53</td>
<td>1.72</td>
<td>1.81</td>
</tr>
<tr>
<td>Post-test mean</td>
<td>1.30</td>
<td>1.94</td>
<td>1.34</td>
<td>0.80</td>
<td>1.20</td>
<td>1.22</td>
<td>1.39</td>
<td>1.45</td>
</tr>
<tr>
<td>Z</td>
<td>-0.57</td>
<td>-0.51</td>
<td>-1.65</td>
<td>-1.08</td>
<td>-1.30</td>
<td>-2.16*</td>
<td>-1.76</td>
<td>-2.11*</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test mean</td>
<td>1.12</td>
<td>1.34</td>
<td>1.20</td>
<td>1.13</td>
<td>1.25</td>
<td>1.22</td>
<td>1.39</td>
<td>1.46</td>
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<tr>
<td>Post-test mean</td>
<td>1.20</td>
<td>1.57</td>
<td>1.32</td>
<td>1.14</td>
<td>1.29</td>
<td>1.48</td>
<td>1.46</td>
<td>1.48</td>
</tr>
<tr>
<td>Z</td>
<td>-0.89</td>
<td>-1.10</td>
<td>-0.53</td>
<td>-0.77</td>
<td>-0.42</td>
<td>-0.42</td>
<td>-0.36</td>
<td>-0.56</td>
</tr>
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</table>

*p < 0.05
Symptoms of SCL-90r - SOM, somatization; OC, obsessive-compulsive; IS, interpersonal sensitivity; HOS, hostility; PA, phobia anxiety; PI, paranoid ideation; PSY, psychoticism; AI, additional items.
The Wilcoxon signed-rank test showed significantly lower scores for Paranoid Ideation (Z = -2.16, p < 0.05), Additional Items (Z = -2.11, p < 0.05) in the biofeedback group. There was no significant difference in control group.

Table 4. The improvement of cognitive function

<table>
<thead>
<tr>
<th></th>
<th>TMT A</th>
<th>TMT B</th>
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<tbody>
<tr>
<td><strong>Biofeedback group</strong></td>
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<td></td>
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<tr>
<td>Pre-test mean</td>
<td>57.56</td>
<td>144.69</td>
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<tr>
<td>Post-test mean</td>
<td>46.50</td>
<td>121.06</td>
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<tr>
<td>Z</td>
<td>-2.59**</td>
<td>-1.53</td>
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<tr>
<td><strong>Control group</strong></td>
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<td></td>
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<tr>
<td>Pre-test mean</td>
<td>57.62</td>
<td>145.44</td>
</tr>
<tr>
<td>Post-test mean</td>
<td>47.44</td>
<td>112.10</td>
</tr>
<tr>
<td>Z</td>
<td>-2.52**</td>
<td>-2.49**</td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01
The Wilcoxon signed-rank test showed that significantly lower TMT A (Z = -2.59, p = 0.01) score in the biofeedback group, and significantly lower TMT A (Z = -2.52, p = 0.01) and TMT B (Z = -2.49, p = 0.01) scores in control group.
symptoms ($p < 0.05$, Table 3) in patients with schizophrenia.

In assessing emotional disturbances, several earlier studies have reported that biofeedback therapy can reduce anxious and depressive symptoms in patients with schizophrenia effectively [9-11, 23]. The results of the study (Table 2) are in line with those earlier findings. In this study, we used the tools of BDI-II, BAI, SCL-90r-depression, and SCL-90r-anxiety. The results (Table 2) showed that in comparison to those in the control group, patients in the biofeedback-treated group were rated significantly better in BAI ($p < 0.05$), SCL-90r-depression ($p < 0.05$), and SCL-90r-anxiety ($p < 0.05$). But the BDI-II scores of two study groups were not found significantly different (Table 2).

The BDI-II includes questionnaire for the cognitive-affective dimension and the somatic dimension [15, 16], and the BAI includes questionnaire for four (neurophysiological, subjective, panic, and autonomic) symptom dimensions [14]. In accordance to the items of questionnaire, the items of SCL-90r-depression correspond mostly to cognitive-affective dimension, and the items of SCL-90r-anxiety correspond mostly to subjective and panic symptoms. In this study, the improvement of patients with schizophrenia in the biofeedback group mainly focused on the domains of cognitive-affection dimension as well as subjective and panic symptoms.

In treatment modality, progressive muscle relaxation therapy (PMRT) has been used as the biofeedback treatment, by teaching patients how to achieve a systematic muscle relaxation. Regular PMRT practice can enhance the ability of coping stressful situations [24, 25]. Many empirical studies have confirmed that PMRT can reduce anxiety, and stress, as well as increase a sense of self-control [26-28]. Unlike those studies, our findings showed improvement in subjective and cognitive dimension (Table 2). This difference might be related to individualized treatment sessions, where more in-depth conversations were engaged.

In psychotic symptoms, we measured the eight indicators of SCL-90r – somatization, obsessive-compulsive, interpersonal sensitivity, hostility, phobia anxiety, paranoid ideation, psychoticism, additional items (Table 3). Our analyses showed two significant indicators (paranoid ideation and additional items). We also analyzed the average scores of pre- and post-test between the biofeedback group and the control group (Table 3). We found that the average scores of post-test were all lower than pre-test in biofeedback group, but in the control group the average scores of post-test were higher than pre-test. Our findings suggest that biofeedback have the potential in improving certain domains of psychotic symptoms.

In cognitive function, we measured TMT-forms A and B (provide information about visual search speed, scanning, speed of processing, mental flexibility, and executive functioning). The results showed that regardless of biofeedback or control group the scores of post-test were all significantly lower than scores of pre-test ($p < 0.01$). Therefore, this study result cannot confirm whether biofeedback can improve cognitive function in patients with schizophrenia.

**Study limitations**

The readers are warned against over-interpreting the study findings because this study has two limitations.

- This study has small sample size of study patients.
- We used only limited numbers of evaluation tools.
In the future, a larger sample size and a wider selection of copies of questionnaire would be needed to validate our findings.

**Summary**

Our study suggests that biofeedback therapy (PMRT) could improve emotional distress and psychotic symptoms in patients with schizophrenia. In spite of the above-mentioned two limitations, we found that biofeedback could improve the clinical symptoms of depression, anxiety, paranoid ideation, sleep disturbances and appetite in patients with schizophrenia.

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**References**


