

Using a mobile app comprising neurofeedback-based meditation and binaural beat music to treat PTSD symptoms: A qualitative analysis

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Abstract

Background: There is a significant need for an effective and convenient symptom management and healing program for people experiencing post-traumatic stress disorder (PTSD) symptoms; however, research on this topic is lacking.

Objective: This study explored the experiences of individuals with PTSD who used a mobile traumatic stress management app with neurofeedback-based meditation and binaural beat music to promote their psychological recovery.

Methods: This study used a qualitative research method to explore the experiences of neurofeedback-based - meditation and binaural beat music using a mobile traumatic stress management app to promote the psychological recovery of people experiencing chronic traumatic stress. The research question was “What is the experience of neurofeedback-based meditation and binaural beat music using the mobile traumatic stress management app?”

Results: The thematic content analysis of in-depth interviews held with nine participants derived 26 codes, eight sub-categories, three categories, and one theme (“Holding hope for healing from agony of mind and body”).

Conclusion: Neurofeedback-based meditation and binaural beat music using a mobile app helped people with PTSD symptoms to truly understand the symptoms caused by traumatic stress. Continued use of this program provides the participants with physical and psychological stability; it instills them with faith and hope.

Keywords

Binaural beat, meditation, mobile application, neurofeedback, post-traumatic stress disorder, qualitative research, traumatic stress

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Introduction

Individuals who have experienced chronic traumatic stress may experience negative effects in their interpersonal relationships and socioeconomic activities due to physical and psychological symptoms. These experiences may not be limited to personal difficulties; they can also increase burdens on families and communities overall.¹ Chronic traumatic stress can also affect psychological well-being and emotional stability, increasing the risk of mental health disorders such as anxiety, depression, post-traumatic stress disorder (PTSD), and suicide.² Chronic traumatic

stress can cause somatic symptoms, such as headache, back pain, or menstrual cramps.³

From a neuroscientific perspective, trauma is a habitual brain response pattern in which a traumatic event is reexperienced, causing psychological pain. The electroencephalography

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(EEG) of a person who has experienced trauma shows excessive activity in the right frontal lobe, a slow wave, and a decrease in alpha-wave intensity.⁴ Previous studies have shown that inducing EEG changes through meditative interventions can improve psychological symptoms and change neurophysiology in patients with PTSD.^{5,6}

Neurofeedback using brain waves is a technology that uses the homeostasis of our body. Neurofeedback generates intentionally positive brain waves to improve cognitive ability and advance to a state where the body can control tension, anxiety, and excitement independently. Neurofeedback strengthens the ability to control brain homeostasis while measuring one's brain waves, and creating an optimal brain state through one's efforts and training without pharmaceutical intervention may be possible.³

Binaural beat music has recently emerged as a therapeutic intervention related to brain waves. Binaural beat music is acoustic psychotherapy that controls brain waves by sending two sounds with different frequencies via headphones or earphones to the left and right ears, which are then transmitted to the nuclei of the brainstem.⁷ Binaural beat music induces psychological stability and has been reported to relieve pain, anxiety, and depression.^{8–10} A study found that a group listening to binaural beats had a reduced stress response to acute psychological stressors compared with a control group.¹¹

The recent development and popularization of smartphones have promoted research on mental health management using mobile apps, such as assessment of mental health symptoms.^{12,13} Mobile mental health management apps allow individuals to obtain medical information, receive exercise management and diet control guides, measure and check biometric information, and manage their health on a daily basis at a low cost regardless of time and place.¹⁴

While studies show that meditation and binaural beat music can be applied to promote psychological stability and improve mental health, there have been limited in-depth reports of the participants' qualitative experiences. Thus, further studies are needed to confirm users' experiences with mobile trauma stress management programs that use brain waves. Qualitative research approaches can analyze individual experiences based on context through an in-depth exploration of participants' thoughts, feelings, and behaviors, which cannot be detected in quantitative research.¹⁵

Therefore, this study applied a qualitative research method to explore the experiences of neurofeedback-based meditation and binaural beat music using a mobile traumatic stress management app to promote the psychological recovery of people experiencing PTSD. The research question was "What is the experience of neurofeedback-based meditation and binaural beat music using the mobile traumatic stress management app?"

Methods

This study explored the experiences of neurofeedback-based meditation and binaural beat music using a mobile traumatic stress management app, applying a qualitative content analysis research method.

Participants

The study participants were eight women and one man who had experienced traumatic stress and agreed to use the mobile traumatic stress management app for 4 weeks and then participate voluntarily in the qualitative interview. They were initially recruited using the local community bulletin board in Seoul and the metropolitan area in Korea. The inclusion criteria were (a) adults aged 18–45 years who (b) had experienced traumatic events for more than 6 months and (c) had a moderate or higher severity level of PTSD (≥ 11 points) as evaluated by the Post-traumatic Diagnostic Scale (PDS). The exclusion criteria were as follows: (a) those who experienced active illness and (b) those who had difficulty using the mobile app. Three of the nine participants were taking medication for health problems such as depression, autonomic neurosis, and hyperthyroidism, but they voluntarily agreed to participate in the study and did not experience any additional difficulties.

Application of the mind therapy app

The participants of the study used the mind therapy app available on Google Play Store, which was developed to treat symptoms of traumatic stress using neurofeedback-based meditation and binaural beat music via a two-channel EEG headset connected with Bluetooth (Figure 1).¹⁶ The participants used the app independently at home for more than 3 days per week for 4 weeks. Based on expert advice, each treatment lasted for at least 60 min in total, comprising 30 min of neurofeedback-based meditation, 20 min of binaural beat music, and 10 min of deep breathing or butterfly hug, an easy relaxation technique that involves wrapping one's arms around each other and alternately tapping the opposite shoulder.

Data collection

Participants were interviewed individually regarding their experiences with neurofeedback-based meditation and binaural beat music using the mind therapy app. Each interview began with the questions "Please tell me your thoughts or feelings of using the mind therapy app," "How was your experience applying neurofeedback-based meditation and binaural beat music?," and "What were your positive and negative experiences of managing your

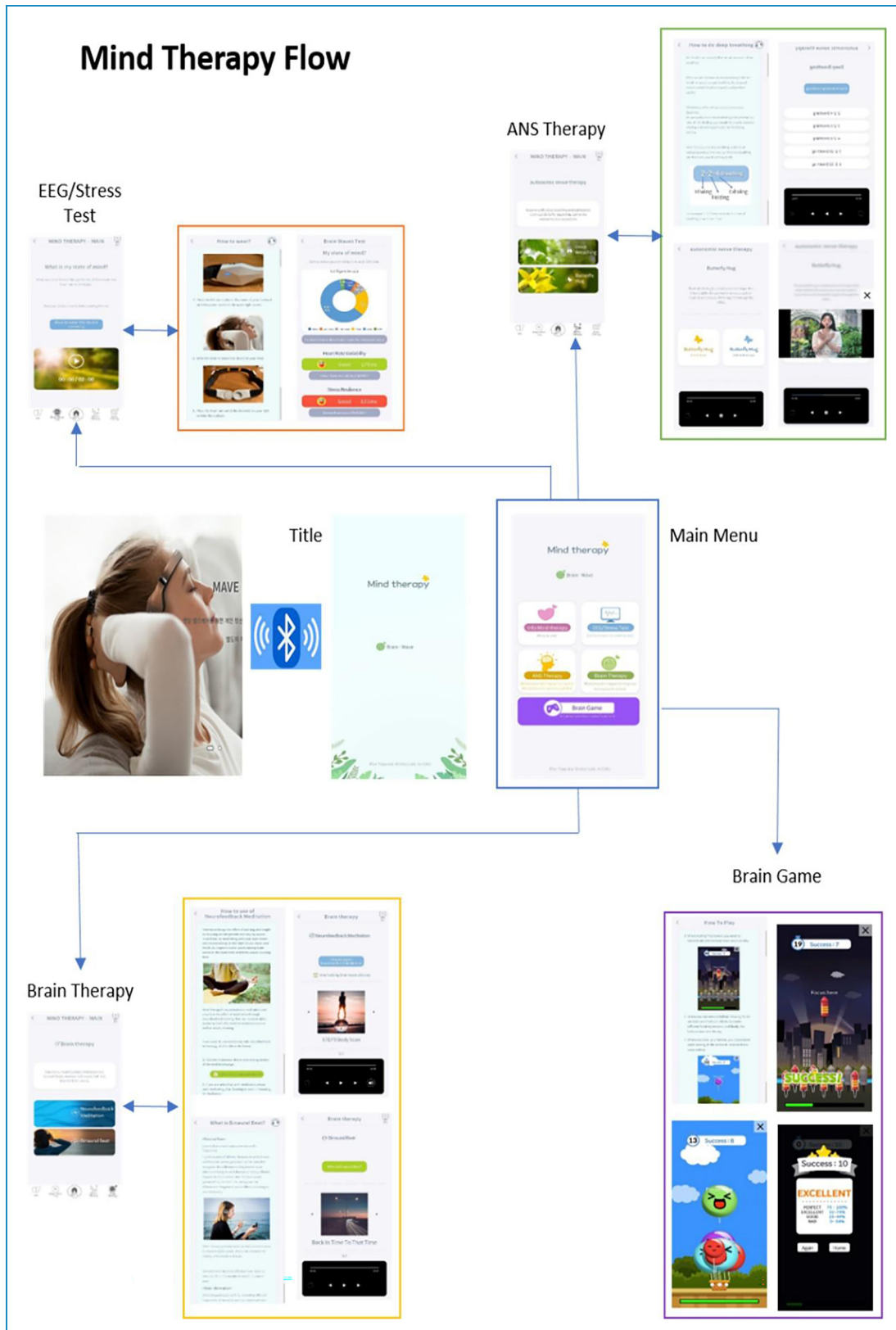


Figure 1. The mind therapy app using neurofeedback and binaural beat.
 Note: An accessible online address that allows direct download the developed mobile app in the manuscript: <https://play.google.com/store/apps/details?id=com.ngarden.mindtherapy.en>.

symptoms of traumatic stress using the app?" The interview was conducted by a female nurse researcher with experience in traumatic stress and qualitative study who participated in classes and workshops about qualitative research methodology.

Interviews were conducted once or twice in places where participants could talk comfortably, such as at home, in a counseling room, in a quiet café, or virtually. Each interview lasted approximately 60–80 min and was digitally recorded for analysis. Field notes were also completed that included the participants' nonverbal actions and reactions. Data were transcribed immediately after each interview. A journal of thoughts and feelings about the interview was kept. Data collection continued until data saturation was reached, with similar content being repeated and no new information emerging.

Data analysis

This study applied qualitative content analysis¹⁷ to explore participants' experiences of neurofeedback-based meditation and binaural beat music using a mobile traumatic stress management app. Two researchers with experience in PTSD research and qualitative analysis read the interview data repeatedly to conduct systematic interpretation. They began to derive codes from transcripts that symbolically described the summative, salient, and/or evocative attributes related to the participants' experiences. These codes were compared based on their similarities and differences, which became the basis for sub-category extraction. In this process, they compared each other's work and pointed out similarities and differences in the text content. Sub-categories were used to illuminate the nuances of each category's essential meaning. The final step in the analysis was to describe the overall results and derive themes that connected everything.¹⁷

To ensure the rigor of the study, the following criteria were applied, as proposed by Lincoln and Guba.¹⁸ To ensure validity, two researchers with experience in qualitative research coded independently, and differences in coding were noted and resolved (credibility). The researchers investigated the possibility that the study results might have implications for other groups, such as adolescents and older adults, while discussing and evaluating the results' accuracy, relevance, and dimensions (transferability). Two researchers who are experts in traumatic stress research reviewed and revised the analysis outcomes (auditability). Finally, the study results were reviewed and confirmed by study participants through face-to-face discussions (auditability).

Ethical considerations

This study was approved by the institutional review board at the university with which one of the authors is

affiliated. The participants who voluntarily signed a written informed consent form were included in the study. Their rights regarding participating in the study were fully explained. Participants could withdraw from the study at any time without penalty. The participants' personal information was kept confidential.

Results

In this study, qualitative content analysis of experiences of neurofeedback-based meditation and binaural-beat music using the mobile traumatic stress management app derived 26 codes, eight sub-categories, three categories, and one theme (Table 1). Of the 26 codes derived in this study, 85% were positive concepts, and only 15% were negative concepts.

Category 1: Acceptance of PTSD symptoms and agony

The participant had experienced traumatic stress and incomprehensible chronic pain for many years. Through this program, she was able to objectively evaluate and understand her PTSD symptoms. She gained courage to accept and treat the pain she was experiencing.

For me, the flashback state is your state of being for 24 hours. Sounds, sensations, everything is active. (Case 8)

(after experiencing several therapies) In the end, I came to the conclusion that this was a battle I had to fight on my own, so medication was only meant to help me get through it (the trauma), not to fix it. (Case 7)

Category 2: Realize stability of mind and body

While using the application, participants focused on their PTSD symptoms and agony and briefly forgot the unresolved conflicts that had been bothering them. She gradually realized her true feelings, which had been hidden for many years by the traumatic stress and pain. In doing so, she felt comfortable and experienced a sense of mental stability.

Once I felt a little bit more comfortable (with the experience of using the app), I felt a little bit more confident, so I kept it as a monument, a reminder that 'I'm not always like this.' (Case 4)

Like the absence of noise when I concentrate, the sensation of excruciating pain in my arms and legs disappeared, albeit temporarily. (Case 2)

Table 1. Neurofeedback-based meditation and binaural beat music using a mobile traumatic stress management app.

Code	Sub-Category	Category	Theme
Pain that persists for a long time	Bruised from PTSD symptoms and chronic pain	Acceptance of PTSD symptoms and agony	Holding hope for healing from agony of mind and body
Trauma that became agony			
Times of pain that were not understood			
Traces of trauma engraved on the body			
Increased intention to treat with expert support	Face agony with courage		
Adjusting the core of treatment to trauma			
Anticipation that the pain can get better			
Accept the agony as it is			
Focus on the program and relief of pain	Take away the agony	Realize stability of mind and body	
Forgetting about conflict while doing the program			
The pain I feel is my own sense	Awakening the senses hidden in agony		
A forgotten feeling revived			
Integrated treatment process of mind and body			
Notice the feeling of comfort	Noticing a sense of stability		
Realizing a stable body			
Knowing that one's mind is calm			
Comfortable to perform while lying down	Convenient healing program	Hope for continued healing	
Useful program whenever needed			
Flexible time and location			
Investigate healing principles	Pursuing effective healing methods		
Try the comfort of the program without a device			
Expect the effect to be consistent			
Pursuing continued positive effects			
Apply to one's family as well	Recommended as a useful program		
Recommend to others as a positive experience			
Expect commercialization			

Category 3: Hope for continued healing

The participant noted that the application was a convenient healing tool that could be used even while lying down,

when necessary, without restrictions on time and place. She hoped to deepen her interest in the principles that could effectively heal traumatic stress and pain, so that

the effects could last as long as possible. She also shared this useful application with her family and friends and stated that she hoped the app would be commercially available in the future so that more people could experience its benefits.

So it (the app) tells me what to do, it tells me when to do it, it tells me how long to do it, so I just pace myself and do it. (Case 6)

I'd like to spread the app to other people who are struggling to find ways to heal their own PTSD symptoms, and I've actually encouraged a lot of people to try it, even though it's something I experienced through participating in the study. (Case 7)

Theme: "Holding hope for healing from agony of mind and body"

Participants in this study began using neurofeedback-based meditation and binaural beat music with a mobile traumatic stress management application and came to accept and understand their long-standing PTSD symptoms. One participant felt that the original feelings underlying her symptoms had been revived, and she finally experienced a sense of stability in her mind and body. As she continued to manage her traumatic stress by using this app, she hoped that she could truly heal her deep-rooted trauma and relieve her symptoms.

I was so anxious that I couldn't focus on the song I was listening to (on public transportation without my medication), and that's when I remembered the app. I opened it up, and I experienced an immediate improvement in my symptoms. I felt like the outside world was blocked out, and I focused on it, and I breathed while I listened to it, and I felt really relaxed within three or four minutes. (Case 7)

I tested a lot of different things (with using the app but except the app program), like focusing on the body, focusing on space, and things like that. And I experienced the fun of doing it on my own. (Case 8)

Discussion

This study used a qualitative content analysis research method to explore the experiences of participants with PTSD using neurofeedback-based meditation and binaural beat music in a mobile traumatic stress management app. Unlike quantitative research, qualitative research elicits the thoughts, feelings, and actions experienced by participants in the situations surrounding them.¹⁵ Through in-depth interviews and analysis of the nine participants

who experienced moderate to severe PTSD symptoms, 26 codes, eight sub-categories, three categories, and 1 theme were derived.

The first category of this study, "Acceptance of PTSD symptoms and agony," indicates that the participants accepted the chronic pain and symptoms which they had experienced for many years caused by traumatic stress, which is different from general stress. Acceptance involves accepting all our experiences as they are without fighting them and being disposed to engage in new behavior.¹⁹ Accepting reality emerged as an integrated strategy used by participants to increase their well-being and resilience during the coping process. This may have helped participants develop coping mechanisms, such as regulating emotions, redirecting thoughts, facing challenges, and developing determination.²⁰ This content was reflected in the sub-categories and codes of the first category of the study's results, which could have a positive impact on the management of PTSD symptoms during participation in the program.

The second category, "Realize stability of mind and body," indicates that the participants began to experience calm and were focused and comforted, that their pain was relieved, and that their mind and body stabilized while using neurofeedback-based meditation and binaural beat music during the study. Similarly, in a qualitative study on stress management experiences using a mindfulness meditation app, participants reported feeling calm, focused, and good.²¹ Another qualitative study on anxiety reduction using binaural beat music reported that the participants experienced decreased feelings of anxiety and increased their focus, concentration, and enjoyment.²² One study used a meditation group, the binaural beat group, the meditation and binaural beat group, and the control group and found that the meditation and binaural beat group experienced the greatest improvement in sleep, stress, depression, anger, and overall mood of the four groups.²³ These results indicate that mobile traumatic stress management using neurofeedback-based meditation and binaural beat music, as was done in this study, allows users to experience a sense of calmness, focus, and stability, which helps them to manage traumatic stress.

The third category examined in this study, "Hope for continued healing," indicates that participants actively expressed hope for healing of the symptoms of PTSD in their bodies and minds by using the neurofeedback-based meditation and binaural beat music program. They also appeared to gradually restore their interpersonal relationships by sharing their experiences with their families and acquaintances. Prior research on Hurricane Katrina survivors showed that hope was associated with reduced post-traumatic stress symptoms.²⁴ Hope not only facilitates effective coping and growth; it may also buffer against the development of trauma-related psychopathology.²⁵ Within the context of trauma-exposed populations, hope may provide a clear path, and the agency needs to cope

more effectively with traumatic events and promote mental wellness.²⁶ An analysis of 732 trauma-exposed adults reported that hope was strongly related to PTSD symptoms and was a robust predictor of psychological-subjective-social well-being.²⁷ Thus, hope may play an important role in recovery from PTSD. A mobile traumatic stress management program using neurofeedback-based meditation and binaural beat music can be a useful tool to provide hope for healing PTSD symptoms and increasing expectations for the recovery of psychosocial well-being.

Analysis of these results indicates that emotional stability, psychosocial well-being, and the brain's ability to cope with traumatic stress may increase when using neurofeedback-based meditation and binaural beat music via a mobile traumatic stress management app. The limitations of this study include that it was conducted using snowball sampling among Koreans in selecting participants, which may limit the generalizability of the results; thus, caution should be exercised when interpreting the results of the study. Further studies using larger samples, various research methods, and diverse populations are needed to strengthen the findings of this study. Additional studies such as groups of subjects with the same age range, using EEG to compare their feeling better scores from using the mobile app, would be recommended.

Conclusion

The results of this study indicate that neurofeedback-based meditation and binaural beat music using a mobile app can help people with PTSD symptoms truly understand their traumatic stress-related symptoms, providing them with physical and psychological stability and instilling faith and hope for recovery through continuous use. This study is expected to provide basic data and evidence for the development of more diverse mobile app-based mental health programs to manage PTSD symptoms in people experiencing traumatic stress.

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Data availability: The data of this study are available from the corresponding author upon reasonable request.

Declaration of conflicting interests: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval: This study was conducted with the approval of the Institutional Review Board at a university in Seoul, South Korea (no. 1041078-20230331-HR-081).

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Guarantor: Y.-J. Choi

Informed consent: Participants provided written informed consent prior to participation.

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