Combined Use of Virtual Reality and a Chatbot Reduces Emotional Stress More Than Using Them Separately

Atsuko Matsumoto
(Graduate School of Comprehensive Human Science, University of Tsukuba, Tsukuba, Japan
https://orcid.org/0000-0001-5668-688X, a-matsumoto@miloqs.co.jp)

Takeshi Kamita
(Graduate School of Library, Information and Media Studies,
University of Tsukuba, Tsukuba, Japan,
https://orcid.org/0000-0001-6284-0898, s1730527@u.tsukuba.ac.jp)

Yukari Tawaratsumida
(School of Nursing and Rehabilitation Sciences, Showa University, Yokohama, Japan
tawara53@nr.showa-u.ac.jp)

Ayako Nakamura
(School of Nursing and Rehabilitation Sciences, Showa University/Dept. of Nursing, Showa
University Hospital, Shinagawa, Japan
a.nakamura@cmed.showa-u.ac.jp)

Harumi Fukuchimoto
(School of Nursing and Rehabilitation Sciences, Showa University/Dept. of Nursing, Showa
University Koto Toyosu Hospital, Koto, Japan
fukutimoto@cmed.showa-u.ac.jp)

Yuko Mitamura
(School of Nursing and Rehabilitation Sciences, Showa University/Dept. of Nursing, Showa
University Koto Toyosu Hospital, Koto, Japan
yukom1106@cmed.showa-u.ac.jp)

Hiroko Suzuki
(School of Nursing and Rehabilitation Sciences, Showa University, Yokohama, Japan
h_suzuki@nr.showa-u.ac.jp)

Tsunetsugu Munakata
(SDS Corporation, Ichikawa, Japan
munakata21@yahoo.co.jp)

Tomoo Inoue
(Faculty of Library, Information and Media Science, University of Tsukuba, Tsukuba, Japan
https://orcid.org/0000-0003-3600-214X, inoue@slis.tsukuba.ac.jp)

Abstract: In recent years, various organizations, such as companies and governments, have been required to take measures for the mental health of their employees, and the importance of self-care for mental health by employees themselves has been increasing, as well as being supported

by administrators, such as doctors and workplace managers. As a means of self-care of mental health that can be implemented by busy professionals during their workdays and daily lives, the Digital-SAT method has been developed to implement the stress-care process of the SAT method, a psychological counseling technique for resolving psychological stress problems, in a self-guided manner using digital media. To realize the Digital-SAT method, two issues need to be addressed: first, to obtain the same emotional stress reduction effect as the SAT method and, second, to ensure the continuous implementation of the Digital-SAT method. Previous studies have shown that applications (apps) using virtual reality are effective in solving the former issue, and an app using a chatbot can be effective in solving the latter. In this research, an intervention study was conducted to verify the effectiveness of combined use of the two apps to encourage continuous use, resulting in increased emotional stress reduction, with the aim of making it feasible in actual work environments. An intervention of four weeks of app use was conducted with 70 nurses working in two hospitals where measures for mental health due to emotional labour and overwork were required. The emotional stress reduction effects of the intervention were evaluated using psychological scales and blood pressure levels, and it was confirmed that combined use of apps was more effective than using them separately to practice the Digital-SAT method in an actual work environment.

1   Introduction

In various organizations, such as companies and governments, mental health measures for employees have been required, and the importance of self-care for mental health by employees themselves is increasing, as well as being supported by doctors, managers, and others. In recent years, with the growing need for individual mental healthcare, research and development of applications (apps) based on psychotherapy to improve mental health is becoming popular. The apps have been implemented on various digital media such as head-mounted displays (HMDs), smartphones, and personal computers, and used as an auxiliary tool for psychotherapy and psychiatric treatment, or as a tool for self-guided mental healthcare. Self-care apps are considered a viable means for busy professionals to take self-care in between work and life. However, unlike individuals who use the app on their own initiative, tools that require constant professional assistance to target specific cases, great effort to face the problems and verbalize them, or constant motivation for use, are not suitable for an unspecified number of employees with diverse psychological characteristics, stress problems, and motivation for mental health measures.

Thus, a method that does not use verbal approaches, such as cognitive behavioral therapy (CBT) which is one of the most popular counseling techniques and is used generally in personal self-care tools, the Digital-SAT method [Kamita 18] has been implemented on digital media and has been developed based on the SAT (Structured Association Technique) method [Munakata 06]. It represents psychotherapy that uses a physical response approach to solve stress problems by converting unpleasant physical sensations caused by stress into positive sensations through visual stimulation of viewing pleasant images such as lights and smiles. In addition, it does not necessarily require a client to verbalize his or her worries and unpleasant emotions to the counselor. This means that even in self-care with the Digital-SAT method, users can deal with

their own problems without having to verbalize them, making it easier to cover users with various types of stress. Sessions of the SAT method with a counselor are usually performed four to five times for a client. The effect is established by training with frequent stimulation, in which the client repeatedly views images of lights and smiles, as homework between the meeting sessions.

The realization of the Digital-SAT method raises two issues: Can the emotional stress reduction effect equivalent to the SAT method be obtained? and Can it be used continuously to establish the effect? First, the focus of app development was on obtaining a reduction of emotional stress, and an app using Virtual Reality (VR) HMD media (VR app) was developed. The reason for using VR was that the visual effect of VR's immersive images was considered to be highly compatible with the image-intensive SAT method. Next, the focus was on improving continuity of use and an app consisting of web pages (WEB app) was developed, which was implemented on a smartphone without using a special device, such as an HMD, thus improving its convenience of use in a work environment. Furthermore, a chatbot app (CB app), in which a chatbot automatically guides the therapy process, was developed to reduce the burden on users and enhance the continuity of use. As a result of an intervention study using the three apps separately [Kamita 18] [Matsumoto 19] [Kamita 19b] [Kamita 21], the effectiveness of the VR app and its ability to reduce emotional stress and the effectiveness of the CB app in providing continuity were shown.

In this research, an intervention study was conducted to verify the effectiveness of combined use of the two apps to encourage continuous use, resulting in increased emotional stress reduction, with the aim of making it feasible in actual work environments. The intervention using the app continuously for four weeks was conducted in two hospitals with 70 nurses as participants. The nurses and the monitoring of their mental health were considered an important issue due to the physical and mental burdens and pressures on them such as emotional labor and overwork. Participants were divided into three groups: one group used only the VR app, a second group used only the CB app, and a third group used a combination of the VR app and the CB app. Using the psychological index based on the psychological check test and the physiological index based on blood pressure values, the stress reduction effect finally brought about by the intervention was evaluated in the study. As a result, it was found that combined use of the VR and the CB app can obtain a better emotional stress reduction effect than using them separately, and the effectiveness was confirmed as a method of practicing the Digital-SAT method in an actual work environment.

2   Related Work

2.1   Virtual Reality Applications for Mental Healthcare

There is a general view that "sensory stimulation" in virtual reality (VR) technology can be used as a clinical trial or private therapy in certain fields [Bell 20]. Virtual reality exposure therapy (VRET) is a well-known app that reproduces the fear-causing object or simulates the traumatic scene in the virtual environment. It exposes the patient to the environment to become accustomed to it and is effective for various phobias such as acrophobia [Hodges 95] [Krijn 04] [Choi 04], agoraphobia [North 96], flight phobia [Rothbaum 94] [Rothbaum 96], spider phobia [Carlin 97] [Garcia 05], cockroach phobia [Botella 05], and post-traumatic stress disorder (PTSD) [Difede 02] [Rothbaum

01]. Patients have also been reported to recover physical functions, such as the partial recovery of male erectile dysfunction [Optale 03]. Similar effective applications of VR to cultivate social skills in cases of test anxiety [North 04] and attention-deficit hyperactivity disorder (ADHD) [Rizzo 04], schizophrenia [Ku 03] [Rosa 04], and social anxiety [Anderson 05] have also been reported. Using a role-playing program with VR, the tendency peculiar to depression patients who easily blame themselves was improved [Falconer 16]. Moreover, effective applications of VR to cognitive disorders, such as brain injury [Lee 03] and dementia [Flynn 03], have also been reported. In this context, many reports exist in which VR has been used to create a dedicated program for a specific case rather than for general-purpose stress care. Besides, in the case of VRET, anxiety and fear increase due to the high effect of visual stimulation. Therefore, apps with HMD are often used under the guidance of experts such as doctors and therapists rather than using them as a self-care tool.

2.2   Use of Smartphones and PCs for Mental Healthcare

With the increasing demand for mental health care, research involving smartphones, tablets, and PCs for mental health has been actively conducted. Research and development of digital drugs combined with content delivered on a digital tablet and the like as a drug substitute has progressed [Kollins 20]. A digital drug for children with developmental disabilities is covered by insurance in the United States.

Many self-care tools use cognitive behavioral therapy (CBT), which is a form of psychotherapy [Batterhama 18] [Ly 15] [Bakker 18] actively used for both research and commercial purposes [Torous 17]. CBT emphasizes a linguistic approach in which thoughts and feelings are verbalized to correct irrational cognitions. The advantage of CBT is that training content such as psychoeducation and homework is systematized, and the app development becomes easy. Training content in communication skills to control negative emotions, shifting to positive thinking, changing one's thinking depending on the situation, and guiding relaxation techniques can be provided. CBT also focuses on a linguistic approach; there are natural limits to programming to respond to the diversity of people, and the focus will be on providing learning content or reducing usage. Cases exist where CBT treatment processes are automatically guided using chatbots and WEB agents. Chatbots have evolved since the early development of ELIZA in 1966 [Weizenbaum 66]. In mental healthcare, a chatbot to support interpersonal skills was developed as a training component of a depression treatment program [Elmasri 16]. MYLO, which specialized in stress reduction, was developed as a further extension of ELIZA. It helped users to solve problems with higher levels of distress [Gaffney 14]. Woebot encourages users to learn by providing CBT knowledge through a chatbot, and a two-week study showed anxiety improvement [Fitzpatrick 17]. However, to enhance the therapeutic effect or expand the range of users, there is a need to prepare abundant dialogue examples, and there is no choice but to narrow it down to specific cases.

Research also has been conducted on apps based on the mindfulness meditation method, which has become popular as a mental healthcare treatment aid [Bennike 17], and its commercialization, such as "Headspace" [Headspace 21] and "calm" [Calm 21] is progressing. As a self-care tool used for a wider purpose, it may be the closest to the self-care tool aimed at in this study. Meditation has been reported to improve brain function by continuous administration over an eight-week period, and its effectiveness

has been confirmed [Gotink 16]. Like psychotherapy, mindfulness stress reduction using meditation and mindfulness cognitive therapy [Kabat-Z 82] [Rinske 15], a combination of meditation and cognitive therapy, has been used. The features provided by the app focus on meditation guidance and psychoeducation. When using the app, it is necessary to continue meditation while listening to voice guidance for 10 to 30 sessions of 10 minutes each, and continuity is an issue as with other healthcare apps. Besides, it is reported that the meditation method has a risk of increasing discomfort and pain [Lindahl 17], and careful handling should be considered when using it as a self-care tool.

3   Digital Content of the SAT Method

3.1   SAT Method

The SAT method is a counseling/therapy in the form of an interview developed by Munakata and is composed of multiple techniques [Munakata 06]. The temperament coaching method and the health coaching method are utilized to clarify the clients' problems and characteristics and to motivate them. As one of the techniques, the SAT image therapy for solving stress problems consists of emotional stabilization therapy and behavior modification therapy. The self-guided mental healthcare app has been developed adopting the emotional stabilization therapy. It is a technique that can be used to alleviate and solve daily stress problems such as current stress levels, past problems, and relief of physical symptoms, and can be carried out by oneself if trained. First, a client recalls a stress scene, focusing on the perception of bodily discomfort, such as stomach tingling, which is caused by a disliked image accompanying the stress scene. In response to the discomfort, the counselor presents a list of landscape images printed on a paper that make a client imagine the gentle light, lets the client select one that reminds them of the image that the discomforted body part is wrapped in and healed by the light, resulting in discomfort reduction (light image method) [Munakata 11]. In addition, images of smiling faces are selected by the client, who is reminded of the sense of security and safety that the person in the image brings to the client's side and protection. Then, the client is promoted to be aware of stress causes, such as the client's own commitments, captivity, beliefs, worries, moods, pains, images of what the client should be, and then releasing them, enhancing self-affirmation, and solving problems (surrogate face representation method) [Munakata 11].

3.2   Digital-SAT Method

In emotional stabilization therapy, the process in which the counselor asks questions and the client responds is repeated. The counselor leads the operation by calling out or asking for the eyes to be closed as needed by the dialogue with the client, by the client's facial expressions, and by the client's body movements during the procedure. The Digital-SAT method was developed as a technique allowing the therapy to be self-guided using HMD or a smartphone without the guidance of a counselor [Kamita 18][Kamita 19a][Kamita 19b].

   The structure and procedure of the Digital-SAT method have been defined as follows: (1) know the user's own mental state (assessment part), (2) reduce stress (solution part), and (3) learn to improve mental resistance according to personal characteristics clarified in the assessment part and the solution part (learning part). The

parts other than the learning part are the targets of this research. In the assessment part, the user's stress status and characteristics are measured by the psychological check test used in the SAT method (Table 1). The stress reduction effects of using the application

Scale	Contents	Total score range (SAT method criterion)
Self-esteem [Rosenberg 65] [Munakata 87]	The degree to which a person has a good or positive image for the self. Higher self-esteem is more likely to be able to cope with stress.	0-10(0-6 lower/7,8 mid/9,10 higher)
Self-repression behavioral trait [Munakata 96]	The behavioral characteristics that suppress one's own feelings and thoughts.	0-20(0-6 lower/7-10 average/11-14 slightly higher/15-20higher)
Emotional support network from family [Munakata 96]	The degree of perception that seems to be supported emotionally and psychologically from the family.	0-10(0-5lower/6-7 mid/ 8-10higher)
Emotional support network from peers [Munakata 96]	The degree of perception that seems to be supported emotionally and psychologically by outside the family (e.g., colleagues, friends, etc.)	0-10(0-5lower/6-7 mid/ 8-10higher)
Problem-solving behavioral trait [Munakata 01]	The behavior that seeks to respond positively, effectively, and realistically to immediate challenges and issues.	0-20(0-6lower/7-10 slightly lower/11-14 slightly higher/15-20higher)
Emotional interpersonal dependency inventory [Hirschfeld 77] [McDonald-Scott 88]	The degree of emotional dependence and expectancy for others.	0-15(0-3lower/4 slightly lower/5-8 slightly higher/9-15 higher)
State-trait anxiety inventory (STAI) [Spielberger 70]	The tendency to become anxious, not stated anxiety that varies over time, but a vague degree of anxiety that reflects one's past experiences.	20-80(20-31 lower / 32-34 mid/ 35-41 higher/ 42-80 much higher)
Self-rating depression (SDS) [Zung 65][Fukuda 73]	The depressive symptoms in mood, appetite, and sleep.	20-80(20-35 none/36-48 lower/49-68 higher, 69-80 painful)
Health counseling needs [Munakata 99]	Whether or not the response to stress is manifested in the mind, body, or behavior, and to what extent.	0-20(0-6 lower/7-10 mid/11-20 higher)
Difficulty in recognizing emotions [Munakata 01]	The tendency to ignore one's own feelings, either subjectively or involuntarily. Higher scores tend to accumulate stress and become chronic with physical symptoms.	0-20(0-5lower/6-8higher/9-20 much higher)
Self-pity [Munakata 01]	The degree to which they are sympathetic with their own treatment and decide not to abandon themselves alone.	0-20(0-5 lower/6-8slightly higher/9-20higher)
Self-dissociation [Munakata 01]	The degree to which a person dissociates from oneself who is troubled by a serious problem and is calmly observing oneself.	0-20(0-3 lower/4-7 slightly higher/8-20 higher)
Self-denial [Munakata 01]	A lack of interest or motivation in trying to heighten oneself, such as by being happy. Higher scorers tend to give up and feel guilty.	0-20(0-2 lower/3-4 mid/5-20 higher)
PTSS (Post-traumatic stress syndrome) [Munakata 01]	Having experienced or observed serious crises of oneself or others and tending to flashback to tension and fear of releasing noradrenaline when encountered in certain circumstances.	0-10(0-1 lower/2-3 mid/4-10 higher)

Table 1: Psychological Check Test

are clarified by differences in the test scores between before and after using it, and the results are browsed by the user.

In the Digital-SAT method, the process is advanced by turning the page on the screen, so individual steps of the emotional stabilization therapy are disassembled, and each explanation is simplified to form the solution part (Table 2). First, by recalling the stress the user is currently having (Q1) and by converting an unpleasant image into a color and shape (Q3, Q4), the perception of physical discomfort is promoted (Q5), and the stress level is set by imagining it as a number (Q6). Next, the physical discomfort is relieved with a light image (Q7), and a substitute facial representation image is used to foster a sense of security and safety (Q8), and a decrease in stress level is confirmed (Q9). If the user can have an image of a positive personality (Q.10), he/she will be encouraged to recognize that the perception of stress problems has changed and they are no longer stressed, and they are being replaced by practicable and constructive solutions or positive prospects (Q11, Q12). Finally, confirm how much the stress problem has become felt and end (Q13).

No.	Question item
Q1	What are you feeling stressed about right now? Think of it
Q2	How much stress can you feel? (5-point Likert scale)
Q3	What color is the stress?
Q4	Can you compare that color to a shape?
Q5	Where do you feel discomfort in your body?
Q6	What is your current stress level? (Answer from 0% to 100%)
Q7	What light seems to heal this discomfort?
Q8	Please choose a comfortable face that came into your eyes.
Q9	How do you feel about this companion? Will you be healed?
Q10	What kind of personality are you likely to have when the stress disappears?
Q11	How do you deal with stress with this personality?
Q12	Does that work?
Q13	How much stress did you feel?

Table 2: Process of the Digital-SAT Method

3.3   Implementation of the VR App and the CB App

The CB app was implemented as the LINE application [Line 21]. (Line is the most popular social networking service (SNS) in Japan.) In the CB app, a user selects and registers a "friend account" dedicated to the chatbot application on LINE. When the psychological check test of the assessment part and "Quick Care" of the solution part are performed, they are selected on the top menu or from a link in the automatic delivery message such as "How are you today?" from the chatbot (Figure 1). The messages include not only those that simply encourage the implementation of Quick Care, but also those that guide the user to the Quick Care after reading psychoeducational content such as how to practice self-care in daily situations, stress principles, breathing techniques, and other simple stress-care information. When a user selects Quick Care—the main therapy program—the questions in Table 2 are presented in order, and the process proceeds while answering the questions and selecting images. In addition, the

chatbot sends messages once a day, including psychoeducational messages such as how to practice self-care in daily situations, stress principles, breathing techniques, and other simple stress-care information.

The VR app was implemented using Unity5 on the Samsung Galaxy S7. The Galaxy S7 is inserted into the Samsung GearVR and used as an HMD. The user selects "Quick Care" (see processes in Table 2) on the top menu of a web page on the smartphone, answers Q1 and Q2 in Table 2, and inserts it into the GearVR (Figure 2). Then after putting the HMD on the head, the user proceeds to answer Q3 and the rest.
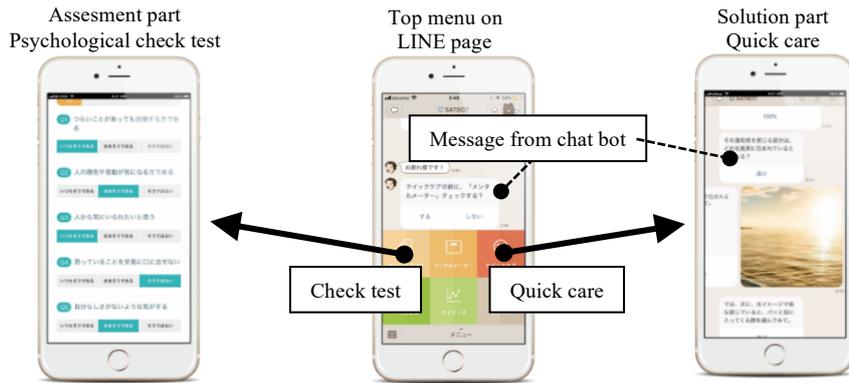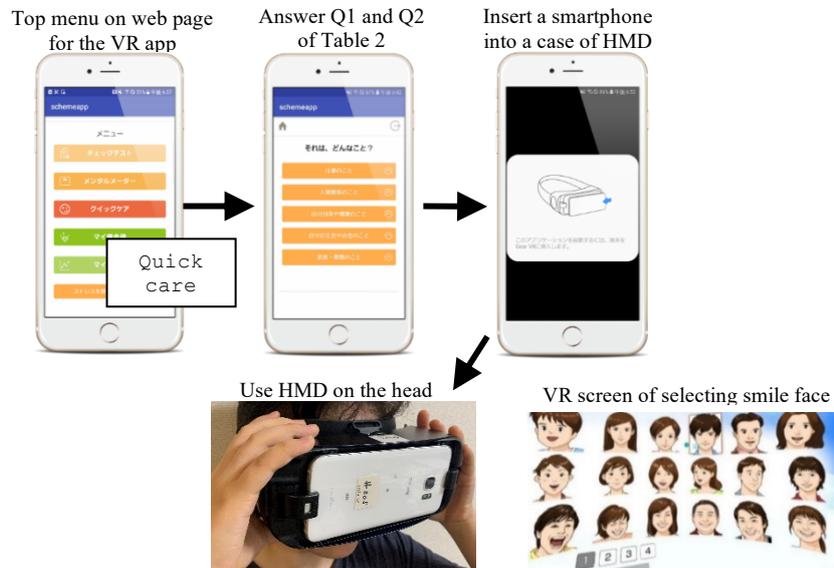

Figure 1: Screens of the CB app

Figure 2: Screens of the VR app and flow to use

4   Intervention Study of the Combination of Apps

4.1   Participants

As an intervention study in an actual work environment, a study was conducted on 70 nurses who worked at two hospitals in Tokyo and who agreed to cooperate in the study. Nurses are often exposed to mental and physical strain and pressure, such as emotional labor and excessive work, and mental health measures for them are an important issue [Sakagami 17]. This study was conducted in collaboration with researchers and nursing supervisors in a school of nursing and rehabilitation sciences of a university and its hospital. In the hospitals, new nurses are prepared for work through training programs and on-the-job training. After their second year, however, they do not receive support and are expected to work alone. Nurses are required to learn to cope properly with stress as they gain experience, but many tend to evade stress coping when they are inexperienced [Shiba 11]. In fact, the main group of nurses with burnout syndrome are 20–29 years old, with less than 5 years of clinical experience, and shift nurses [Usui 02]. In this study, the participants were general nurses who were not supervisors and were in charge of both day and night shifts with higher psychological loads.

4.2   Design

To verify the effectiveness of combined use of the VR app and the CB app, three intervention groups were formed: the VR group used the VR app only, the VR+CB group used both the VR app and the CB app, and the CB group used only the CB app. The 70 nurses were divided so that there were 24 in the VR group, 23 in the VR+CB group, and 23 in the CB group. This study was conducted with the approval of the Ethics Review Committees of the Faculty of Library, Information and Media Science of the University of Tsukuba, and the School of Health and Medical Sciences, Showa University.

4.3   Procedure

First, a pre-orientation initial psychological check test and the orientation were conducted for all three groups (Table 3). After performing the initial blood pressure measurement, the principles of the Digital-SAT method and the use of the apps were explained, and the VR app was experienced to deepen their understanding. After using the VR app, the second psychological check test was performed. After the orientation, the three groups used the apps for four weeks according to their respective procedures. Finally, after four weeks of app use, the third psychological check test and the second blood pressure measurement were performed. During the four-week period, each group was given the following conditions for message notification: the VR group had no message to encourage its use, the VR+CB group was delivered a message to promote its use during the period, and the CB group was delivered the same message as the VR+CB group. The messages included "What's going on today?" and "Try to release one of your stresses," with a link to induce participants to use app functions at a random time once a day. Since this study was conducted under low-energy conditions after the night shift, the use of apps and their frequency were up to the participants, including stopping using them in all groups. For the same reason, the psychological check tests and the blood pressure measurements were also requested but not mandatory.

Group	VR Group (n=24)	VR+CB Group (n=23)	CB Group (n=23)
Group overview	Conduct the VR app on the days after the night shift (per week). Do not conduct on the days of the day shift.	Conduct the VR app on the days after the night shift (per week). Conduct the CB app on the days of day shift.	Conduct the CB app both on the days after the night shift (per week) and the days of the day shift.
. i. Pre-orientation	Perform the initial psychological check test		
ii. Orientation	1. Explain the overview description (5 min.) 2. Complete and sign the consent form (2 min.) 3. Perform the initial blood pressure measurement 4. Logging in to the app 5. Explain the principle and how-to use the course (30 min.) 6. Experience the VR app (10 min.) 7. Perform the second psychological check test (10 min.) 8. Personal feedback of the psychological test result (5 min.)		
iii. four weeks of app use — On the days after the night shift	1. Conduct the VR app. 2.Measure the blood pressure.	1. Conduct the VR app. 2.Measure the blood pressure.	1. Conduct the VR app. 2.Measure the blood pressure.
iii. four weeks of app use — On the days of the day shift	-	1.Conduct the CB app. 2.Receive a message.	1.Conduct the CB app. 2.Receive a message.
iv. After the fourth week of app use	Perform the third psychological check test and the second blood pressure measurement		

Table 3: Groups and procedures

4.4   Measurements

The stress reduction effect was evaluated using the score change of the psychological check test consisting of 165 questions in 14 categories used in the SAT method (Table 1). The check test of the assessment part of the CB app was used for all participants. The participants in the VR group, which did not use the CB app for intervention, were also given instructions on the CB app for use only to answer the check test. The blood pressure was measured using an arm blood pressure monitor (HEM-7511T, Omron Corp.), which was set up in a special space in the hospitals.

5   Results

The results of the intervention study are shown in Tables 4 through 7. The number who completed a set of valid data excluding missing values in the initial and second psychological check tests was 23 out of 24 in the VR group, 22 out of 23 in the VR+CB group, 20 out of 22 in the CB group, and 65 of 70 in total. Because the measurement after the fourth week of app use was voluntary to reduce the burden on the participants, valid data completion for the third check test was 7 in the VR group, 6 in the VR+CB group, and 7 in the CB group, and the number of valid data completions for the blood pressure values was 9 in the VR group, 7 in the VR+CB group, 11 in the CB group, and 27 of 70 in total.

First, a Kruskal-Wallis test (5% level) was conducted on the differences in the scores of the pre-orientation initial psychological check test among the three groups to evaluate the psychological characteristics of the groups prior to the implementation of the intervention (Table 4). The Shapiro–Wilk test was conducted beforehand, and since

no normality was found, the Kruskal–Wallis test was used. Again, there was no difference among the groups, so it was concluded that the psychological characteristics of the three groups were similar and that the three groups could be analyzed as a single group.

Next, to evaluate the stress reduction effect by using the VR app during the orientation, a Wilcoxon signed-rank test (5% level) was conducted on the change from the pre-orientation initial psychological check test scores to the second psychological check test scores after using the VR app (Table 5). The Wilcoxon signed-rank test was used because the Shapiro–Wilk test was conducted beforehand, and no normality was found. There was a significant improvement in the change of scores on the self-esteem scale and the emotional support network from family scale, and a significant trend toward improvement in the change in scores on the self-repression behavioral trait scale. The improvement in these scale scores had also been confirmed in the previous study, supporting its results [Matsumoto 19].

In addition, to evaluate the stress reduction effect of the intervention of the four weeks of app use by psychological indicators, a Wilcoxon signed-rank test (5% level) was conducted on the change from the second psychological check test score in the orientation to the third psychological check test score after the intervention (Table 6). The Wilcoxon signed-rank test was used because the Shapiro–Wilk test had been performed previously and showed no normality. There was a significant increase in the scores on the depression scale and the health counseling needs scale for the VR+CB group, and a significant trend toward a decrease in the change in scores on the emotional support cognitive scale for the VR group.

Finally, to analyze the stress reduction effect of the intervention by physiological indicators, a t-test (5% level) was conducted on the change in blood pressure measurement from the initial measurement in the orientation to the second measurement after the intervention (Table 7). As the blood pressure values were normally distributed, a t-test was used. There was a significant decrease in the maximal and minimal blood pressure values in the VR group, and a significant trend in the decrease in the maximal blood pressure values in the VR+CB group.

6   Discussion

6.1   Psychological Characteristics of the Participants

Interpreted from the pre-orientation initial psychological check test scores (Table 4) based on the criteria of the psychological test shown in Table 1, the following psychological characteristics of participants in all groups can be considered.

They are quite anxious and find it difficult to maintain a positive self-image. Factors associated with anxiety include the emotional interpersonal dependency inventory, self-repression behavioral traits, and self-esteem [Munakata 06]. They tend to be self-repressed because they prioritize others and act so that others do not dislike them. They also tend to have a "slightly higher" degree of difficulty in recognizing emotions. Because they cope with stress problems by suppressing emotions and enduring them,

Scale	Median of groups (Median [25%, 75%])			p
	VR (n=23)	VR+CB (n=22)	CB (n=20)	
State-trait anxiety inventory (STAI)	48.0 [42.0, 56.0]	54.0 [51.0, 58.8]	50.5 [44.5, 58.8]	0.123
Self-rating depression (SDS)	44.0 [39.0, 47.0]	46.5 [42.0, 51.0]	45.0 [42.0, 50.5]	0.239
Self-esteem	5.0 [2.0, 8.0]	3.0 [2.0, 5.3]	5.0 [2.3, 7.0]	0.233
Emotional support network from family	10.0 [7.0, 10.0]	10.0 [8.8, 10.0]	10.0 [9.3, 10.0]	0.621
Emotional support network from peers	6.0 [3.0, 10.0]	9.0 [5.0, 10.0]	7.0 [5.3, 9.8]	0.398
Health counseling needs	5.0 [2.0, 9.0]	7.0 [4.0, 9.0]	5.0 [2.3, 8.8]	0.284
Self-repression behavioral trait	10.0 [6.0, 12.0]	9.0 [6.8, 12.0]	10.0 [6.3, 12.0]	0.883
Problem solving behavioral trait	10.0 [8.0, 10.0]	8.0 [6.0, 10.0]	10.0 [8.0, 11.0]	0.086
Emotional Interpersonal dependency inventory	6.0 [4.0, 9.0]	7.0 [5.0, 8.3]	8.5 [5.0, 10.0]	0.412
Difficulty in recognizing emotions	7.0 [4.0, 9.0]	8.0 [5.0, 10.3]	7.5 [5.3, 11.0]	0.377
Self-pity	8.0 [5.0, 10.0]	8.0 [5.8, 10.0]	8.5 [7.0, 10.8]	0.520
Self-dissociation	5.0 [3.0, 7.0]	5.5 [2.0, 7.3]	5.0 [3.0, 8.0]	0.920
			Kruskal-Wallis test *:p<0.05	

Table 4: The Diffrence in the pre-orientaion initial psychological check test score between groups.

Scale	Median of all participants (n=65) (Median [25%, 75%])		z	p
	Pre-orientation	After the VR app use		
State-trait anxiety inventory (STAI)	53.0 [46.0, 57.0]	49.0 [45.0, 56.5]	-1.219	0.223
Self-rating depression (SDS)	45.0 [42.0, 49.0]	46.0 [42.0, 49.0]	-0.651	0.515
Self-esteem	5.0 [2.0, 7.0]	6.0 [3.0, 9.0]	-4.836	0.000 *
Emotional support network from family	10.0 [8.0, 10.0]	10.0 [9.0, 10.0]	-1.995	0.046 *
Emotional support network from peers	8.0 [5.0, 10.0]	8.0 [4.0, 10.0]	-1.288	0.198
Health counseling needs	6.0 [4.0, 9.0]	6.0 [2.0, 9.0]	-0.009	0.992
Self-repression behavioral trait	10.0 [6.5, 12.0]	10.0 [6.5, 11.5]	-1.831	0.067 †
Problem solving behavioral trait	9.0 [7.5, 10.0]	9.0 [8.0, 10.0]	-0.240	0.810
Emotional Interpersonal dependency inventory	7.0 [5.0, 9.0]	7.0 [4.5, 9.5]	-1.257	0.209
Difficulty in recognizing emotions	7.0 [5.0, 10.0]	7.0 [5.0, 10.0]	-0.075	0.941
Self-pity	8.0 [6.5, 10.0]	9.0 [6.5, 10.0]	-1.349	0.177
Self-dissociation	5.0 [3.0, 7.0]	4.0 [2.0, 7.5]	-1.557	0.119
		Wilcoxon's signed-rank test †:p<0.1, *:p<0.05		

Table 5: Changes in the psychological check test scores using the VR app use in the orientation.

they cannot express their personality and maintain a realistic self-image. Self-dissociation is a slightly higher degree, allowing them to deal calmly with serious issues; however, it is easier to look at their own problems like others. This leads to the score of the problem-solving behavioral trait, which shows that the degree of constructive effort being made toward solving problems or the motivation to face problems without avoidance is somewhat "lower." Although they perceive that the emotional support network from both family and peers is "moderate," it is suggested that they struggle alone. The accumulation of potential stresses makes them more anxious as they cope inhibitory with others. Besides, self-rating depression is suppressed and is shown to be "lower" despite high anxiety due to inhibition. It is also pointed out that the self-pity is "somewhat higher," and they tend to have sympathetic

Scale	Group	n	Median of groups (Median [25%, 75%])		z	p
			In the orientation	After the four weeks of app use		
State-trait anxiety inventory (STAI)	VR	7	50.0 [42.0, 54.5]	53.5 [38.8, 58.5]	-0.316	0.752
	VR+CB	6	50.0 [47.5, 53.5]	51.0 [48.0, 59.3]	-0.943	0.345
	CB	7	55.0 [38.0, 59.0]	53.0 [36.0, 59.0]	-0.316	0.752
Self-rating depression (SDS)	VR	7	43.5 [40.5, 51.3]	46.5 [40.8, 52.5]	-1.095	0.273
	VR+CB	6	47.5 [45.8, 50.0]	49.5 [47.0, 58.3]	-2.023	0.043 *
	CB	7	47.0 [38.0, 49.0]	47.0 [35.0, 52.0]	-0.085	0.932
Self-esteem	VR	7	6.5 [2.3, 8.3]	2.5 [1.5, 6.0]	-1.473	0.141
	VR+CB	6	6.0 [3.8, 7.5]	3.5 [2.5, 4.5]	-1.378	0.168
	CB	7	6.0 [1.0, 10.0]	7.0 [1.0, 9.0]	-0.184	0.854
Emotional support network from family	VR	7	10.0 [9.5, 10.0]	9.5 [8.5, 10.0]	-1.732	0.083 †
	VR+CB	6	10.0 [5.3, 10.0]	9.5 [4.5, 10.0]	-0.535	0.593
	CB	7	10.0 [9.0, 10.0]	10.0 [9.0, 10.0]	-0.816	0.414
Emotional support network from peers	VR	7	5.5 [2.5, 9.3]	3.5 [1.8, 10.0]	-0.816	0.414
	VR+CB	6	3.5 [1.8, 5.3]	2.0 [0.8, 5.5]	-0.750	0.453
	CB	7	6.0 [5.0, 10.0]	9.0 [4.0, 10.0]	-0.680	0.496
Health counseling needs	VR	7	5.5 [2.0, 9.5]	7.0 [1.0, 10.5]	-0.843	0.399
	VR+CB	6	5.5 [3.5, 7.5]	10.5 [5.3, 12.0]	-1.997	0.046 *
	CB	7	6.0 [4.0, 10.0]	7.0 [6.0, 10.0]	-0.638	0.524
Self-repression behavioral trait	VR	7	9.5 [5.5, 10.5]	8.0 [6.0, 10.8]	-0.137	0.891
	VR+CB	6	8.0 [5.5, 10.8]	10.0 [8.8, 10.3]	-1.054	0.292
	CB	7	10.0 [6.0, 13.0]	9.0 [7.0, 12.0]	0.000	1.000
Problem-solving behavioral trait	VR	7	10.0 [8.5, 10.0]	9.0 [7.0, 10.0]	-1.633	0.102
	VR+CB	6	7.5 [4.8, 9.3]	8.0 [6.8, 9.3]	-1.069	0.285
	CB	7	11.0 [10.0, 11.0]	10.0 [7.0, 10.0]	-1.289	0.197
Emotional interpersonal dependency inventory	VR	7	6.0 [4.5, 9.5]	5.5 [3.0, 11.0]	-0.184	0.854
	VR+CB	6	5.5 [2.3, 8.8]	6.0 [3.5, 8.3]	-0.405	0.686
	CB	7	6.0 [3.0, 7.0]	4.0 [2.0, 7.0]	-0.680	0.497
Difficulty in recognizing emotions	VR	7	8.0 [4.5, 9.8]	8.0 [7.8, 9.3]	-0.843	0.399
	VR+CB	6	9.5 [5.8, 10.0]	8.5 [7.0, 10.8]	-0.846	0.398
	CB	7	10.0 [3.0, 11.0]	10.0 [4.0, 10.0]	-0.408	0.683
Self-pity	VR	7	8.0 [3.8, 10.0]	7.0 [4.8, 9.3]	-0.333	0.739
	VR+CB	6	10.0 [7.0, 10.5]	9.5 [8.0, 13.5]	-1.414	0.157
	CB	7	10.0 [9.0, 12.0]	9.0 [8.0, 11.0]	-1.000	0.317
Self-dissociation	VR	7	4.0 [0.8, 5.3]	4.5 [3.5, 7.5]	-0.962	0.336
	VR+CB	6	7.5 [1.8, 9.3]	8.0 [3.0, 10.0]	-0.744	0.457
	CB	7	7.0 [3.0, 11.0]	10.0 [1.0, 11.0]	-0.272	0.785

Wilcoxon's signed-rank test †:p<0.1, *:p<0.05

Table 6: Changes in the psychological check test score after the four weeks of app use.

feelings about themselves. Due to this tendency, discomfort is not eliminated, and the stress is more likely to cause physical disorders rather than an addictive behavior or a mental disorder [Munakata 06].

Item	Group	n	Average of groups (AVG ± SD)		t	p	
			In the orientation	After the four weeks of app use			
maximal blood pressure	VR	9	116.8 ±15.8	107.4 ± 12.4	2.800	0.023	*
	VR+CB	7	114.6 ± 13.3	107.0 ± 9.0	2.269	0.064	†
	CB	11	115.3 ± 11.0	113.1 ± 6.8	0.695	0.503	
minimal blood pressure	VR	9	79.1 ± 9.8	74.9 ± 9.9	2.365	0.046	*
	VR+CB	7	75.4 ± 8.5	69.9 ± 13.0	1.129	0.302	
	CB	11	77.4 ± 6.8	77.0 ± 6.3	0.317	0.758	
						t-test *:p<0.05	

Table 7: Changes in blood pressure value after the four-week of app use

6.2   Intervention Effectiveness by Using a Combination Use of Apps

After experiencing the VR app in all groups in the orientation, the self-esteem and the emotional support network from family significantly improved, and the self-repression behavioral trait showed a significant trend toward improvement as well (Table 5). The interpretation in the psychological characteristics of the participants is as described above, but they tend to emphasize approval from others and have a tendency toward self-repressive behavior, as well as slightly higher scores in the difficulty in recognizing emotions, self-dissociation, and self-pity. In tense medical situations, they tend to select a strategy to avoid stress, such as doing their best in isolation without appealing to others for support, suppressing their emotions and being patient. The results of the first experience of VR in the orientation suggest that the relaxation of the tension seen in the self-repression behavioral trait influenced positive self-image of being able to seek support within the family, which in turn was associated with an improvement of their self-esteem. (Table 5).

The four-week intervention showed a significant decrease in maximal blood pressure and minimal blood pressure in the VR group and a significant tendency to decrease in the VR+CB group (Table 7). This implies that physical tension and stress were relieved. On the other hand, changes in psychological check test scores have shown a significant increase in the self-rating depression and the health counseling needs in the VR+CB group, indicating that depression and bodily discomfort may have been increased (Table 6). Since the use of applications improved blood pressure measurements, mental and physical hypertension may have changed into a palliative trend, which may have made it easier for them to perceive conventionally suppressed emotions and bodily discomfort. For the participants who tend not to be conscious of stress in their daily life, the awareness of stress may have increased the need for counseling. In the VR group, there was a significant tendency to decrease in the emotional support network from family. In other words, the relaxation of physical tension led to an awareness of stress, which in turn led to an awareness of the self as being unsatisfied with the support within the family.

This study, in addition to the knowledge of the VR app obtained in the previous survey, confirmed that using the VR app multiple times in four weeks has a stress-reduction effect that relieves physical tension from changes in blood pressure. On the other hand, the participants in the VR+CB group were more likely to perceive stress that they had suppressed on a daily basis, which increased their dissatisfaction with the environment and depression, but also increased the perception of the need for

counseling. Compared to the other groups, the VR+CB group used the CB app to promote self-care and deliver psychoeducational messages in addition to the VR app.

The use of the CB app in combination with the VR app may have had a positive effect on the self-image of the participants, which not only eased their mental and physical tension, but also increased their need for counseling and allowed them to appeal to others for support. Thus, the psychological effects of combined use of the CB app with the VR app were confirmed. These results suggest that the combination of apps, the VR app, and the CB app, is more effective in implementing the Digital-SAT method than using the apps separately, and that it may be a means of self-care at the workplace.

The results of this study suggest that the participating nurses may be more likely to suppress stress mentally and perceive it as a physical sensation. While the effectiveness of the apps as a means of self-care was demonstrated, a work environment where direct human support is difficult to obtain will benefit from solutions such as an online community that aims to provide opportunities for nurses with similar concerns to share work-related experiences and challenges—and sometimes complaints—in a community inside or outside the workplace. Sharing and solving problems together in a peer counseling setting will help nurses learn how to cope with stressful working situations by using e-learning programs.

6.3   Limitation of This Study

The participants were nurses who were busy and stressed while working on night shifts. Considering their large burden, the implementation and frequency of each survey item was arbitrary. As a result, only 27 of the initial 70 participants remained enrolled until the second blood pressure measurement. Although this is a limitation of this study, it is necessary to examine the program structure that fully considers the burden on such participants in implementation of mental healthcare programs in the workplace.

7   Conclusion

The Digital-SAT method has been developed to implement the stress-care process of the SAT method, a psychological counseling technique, in a self-guided manner using digital media as self-care means at workplaces. Toward the realization of the Digital-SAT method, two issues were addressed: to obtain the same emotional stress-reduction effect as the SAT method and to ensure the continuous implementation of the Digital-SAT method. Previous research studies have shown that the app using VR is effective for the former issue and the app using a chatbot for the latter. This research has been an intervention study to verify the effectiveness of combined use of the two apps to encourage continuous use, resulting in increased emotional stress reduction, with the aim of making it feasible in actual work environments. The intervention was conducted to continue using the apps for four weeks with 70 nurses working in two hospitals and was evaluated using psychological scales and blood pressure values. As a result, it was found that the use of the VR app and the CB app in combination can obtain a greater emotional stress reduction than the use of either app separately, and its effectiveness was confirmed in an actual work environment.

References

[Anderson 05] Anderson, P.L., Zimand, E., Hodges, L.F., Rothbaum, B.O.: Cognitive behavioral therapy for public-speaking anxiety using virtual reality for exposure, Depression and Anxiety, Vol.22, No.3, 156-158 (2005).

[Bakker 18] Bakker, D., Rickard, N.: Engagement in mobile phone a for self-monitoring of emotional wellbeing predicts changes in mental health: MoodPrism, Journal of Affective Disorders, Vol.227, 432-442 (2018).

[Batterhama 18] Batterhama, P.J., Calear, A.L., Farrer, L., McCallum, S.M., Cheng, V.W.S.: FitMindKit: Randomised controlled trial of an automatically tailored online program for mood, anxiety, substance use and suicidality, Internet Interventions, Vol.12, 91-99 (2018).

[Bell 20] Bell, I. H., Nicholas, J., Alvarez-Jimenez, M., Thompson, A., Valmaggia, L.: Virtual reality as a clinical tool in mental health research and practice, Dialogues Clinical neuroscience, 22(2), 169-177 (2020).

[Bennike 17] Bennike, I.H., Wieghorst, A.: Online-based Mindfulness Training Reduces Behavioral Markers of Mind Wandering, Journal of Cognitive Enhancement, vol.1, issue 2, 172-181(2017).

[Botella 05] Botella, C.M., Juan, M.C., Banos, R.M., Alcaniz, M., Guillen, V., Rey, B.: Mixing realities? An alication of augmented reality for the treatment of cockroach phobia, CyberPsychology & Behavior, Vol.8, No.2, 162–171 (2005).

[Carlin 97] Carlin, A.S., Hoffman, H.G., Weghorst, S.: Virtual reality and tactile augmentation in the treatment of spider phobia: a case report, Behavior Research and Therapy Vol.35, No.2, 153–158 (1997).

[Calm 21] "Calm", https://www.calm.com/, last accessed 2021/1/11.

[Choi 04] Choi, Y.H., Jang, D.P., Ku, J.H., Shin, M.B., Kim, S.I.: Short-term treatment of Acrophobia with virtual reality therapy (VRT): a case report. CyberPsychology & Behavior, Vol.4, Issue 3, 349-354 (2004).

[Difede 02] Difede, J., Hoffman, H.G.: Virtual reality exposure therapy for world trade centre post-traumatic stress disorder: a case report, CyberPsychology & Behavior, Vol.5, No.6, 529–535 (2002).

[Elmasri 16] Elmasri, D., Maeder, A.: A conversational agent for an online mental health intervention. Brain Informatics and Health: International Conference, BIH 2016, Omaha, NE, USA, October 13-16, 2016 Proceedings, 243-251 (2016).

[Falconer 16] Falconer, C., J., Rovira, A., King, J., A., Gilbert. P.: Embodying self-compassion within virtual reality and its effects on patients with depression, BJPsy Open, Vol2, Issue 1, 74-80 (2016).

[Fitzpatrick 17] Fitzpatrick, K.K., Darcy, A., Vierhile, M.: Delivering Cognitive Behavior Therapy to Young Adults With Symptoms of Depression and Anxiety Using a Fully Automated ConverSATional Agent (Woebot): A Randomized Controlled Trial, JMIR Mental Health, 4(2): e19 (2017).

[Flynn 03] Flynn, D., Schaik, P.V., Blackman, T.J., Fermcot, C., Hobbs, B., Calderon, C.: Developing a virtual reality based methodology for people with Dementia: a feasibility study, CyberPsychology & Behavior, Vol.6, No.6, 591–611 (2003).

[Fukuda 73] Fukuda, K., Kobayashi, S.: SDS Manual, Sankyobo, Kyoto (1973).

[Gaffney 14] Gaffney, H., Mansell, W., Edwards, R., Wright, J.: Manage your life online (MYLO): A pi-lot trial of a conversational computer-based intervention for problem solving in a student sample, Behavioural and cognitive psychotherapy, 42(6), 731-746 (2014).

[Garcia 05] Garcia-Palacios, A., Hoffman, H., Carlin, A., Furness III, T.A., Botella, C.: Virtual reality in the treatment of spider phobia: a controlled study, Behaviour Research and Therapy, Vol. 40, Issue 9, 983-993 (2002).

[Gotink 16], Gotink, R.A., Meijboom, R., Vernooij, M.W., Smits, M., Hunink, M.G.: 8-week Mindfulness Based Stress Reduction induces brain changes similar to traditional long-term meditation practice – A systematic review, Brain and Cognition, vol.108, 32-41(2016).

[Hodges 95] Hodges, L.F., Kooper, R., Meyer, T. C. et al.: Virtual environments for treating the fear of heights, IEEE Computer, Vol.28, Issue 7, 27-34 (1995).

[Headspace 21] "Headspace", https://www.headspace.com/, last accessed 2021/1/11.

[Hirschfeld 77] Hirschfeld, R.M.A., Klerman, G.L., Gough, H.G., Barrett, J.: A measure of interpersonal dependency, Journal of Personality Assessment, vol. 41(6), 610-618 (1977).

[Kamita 18] Kamita, T., Matsumoto, A., Munakata, T., Inoue, T.: Realization of self-guided mental healthcare through the digital content based on the counseling technique SAT method, IPSJ Transactions on Digital Content, Vol.6, No.2, 32-41 (2018).

[Kamita 19a] Kamita, T., Ito, T., Matsumoto, A., Munakata, T., Inoue, T.: A WEB Course Based on the SAT Counseling Method that Reduces Anxiety by Continuous Use, International Journal of Informatics Society (IJIS), vol.11, no.2, 75-84 (2019).

[Kamita 19b] Kamita, T., Ito, T., Matsumoto, A., Munakata, T., Inoue, T.: A Chatbot System for Mental Healthcare Based on SAT Counseling Method, Mobile Information Systems. Hindawi, Volume 2019, Article ID 9517321, 11p (2019).

[Kamita 21] Kamita, T., Ito, T., Matsumoto, A., Inoue, T.: A Chatbot Promotes Continuous Use of a Self-Guided Mental Healthcare Course, IPSJ Transactions on Digital Content, Vol.9, No.1, 1-10 (2021).

[Kollins 20] Kollins, S.H., DeLoss, D.J., Cañadas, E., Lutz, J, Findling, R.L., Keefe, R.S.E., Epstein, J.N., Cutler, A.J., Faraone, S.V.: A novel digital intervention for actively reducing severity of paediatric ADHD (STARS-ADHD): a randomised controlled trial, Lancet Digital Health, 2(4): PE168-E178 (2020).

[Kabat-Z 82] Kabat-Z, J.: An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: Theoretical considerations and preliminary results, General Hospital Psychiatry, Vol. 4, Issue 1, 33-47(1982).

[Krijn 04] Krijn, M., Emmelkam.M.G., Biemind, R. et al.: Treatment of acro- phobia in virtual reality: the role of immersion and presence, Behavior Research and Therapy, Vol42, No.2, 229–239 (2004).

[Ku 03] Ku, J., Cho, W., Kim, J., Peled, A., Wiederhold, B.K., Wiederhold, M.D., Kim, I.Y., Lee, J.H., Kim, S.I.: A virtual environment for investigating schizophrenic patients' characteristics: assessment of cognitive and navigation ability, CyberPsychology & Behavior, Vol6, No.4, 397–404 (2003).

[Lee 03] Lee, J., Ku, J., Cho, W., Hahn, W.Y., Kim, I.Y., Lee, S., Kang, Y., Kim, D.Y., Yu, T., Wiederhold, B.K., Wiederhold, M.D., Kim, S.I.: A virtual reality system for the assessment and rehabilitation of the activities of daily living, CyberPsychology & Behavior, Vol.6, No.4, 383–388 (2003).

[Lindahl 17] Lindahl, J.R., Fisher, N.E., Cooper, D.J., Rosen, R.K., Britton, W.B.: The varieties of contemplative experience: A mixed-methods study of meditation-related challenges in Western Buddhists, PLOSONE, e 12(5): e0176239(2017).

[Line 21] "LINE", https://line.me/ja/, last accessed 2021/1/11.

[Ly 15] Ly, K.H., Janni, E., Wrede, R., Sedem, M., Donker, T., Carlbring, P., Andersson G.: Expe-riences of a guided smartphone-based behavioral activation therapy for depression: A quali-tative study, Internet Interventions, Vol.2, Issue1, 60-68 (2015).

[Matsumoto 19] Matsumoto, A., Kamita, T., Munakata, T., Komazawa, M., Itao, K., Inoue, T.: Stress Reduction Effect in Female Managers of a Self-Guided Mental Healthcare VR Content for Smartphone Based on the SAT Counseling Technique: A Psychological Scale and Heart Rate Variability Analysis, Alied human informatics, 209, 1(1):18-37 (2019).

[McDonald-Scott 88] McDonald-Scott, P.: Interpersonal dependency inventory Japanese Short Form, The Japanese Journal of Nursing Research 21, 451-460 (1988).

[Munakata 87] Munakata, T., Bell, L.G., Bell, D., Kohno, Y.: Adolescence and the Family Environment, A Cross Cultural Study, Japanese Ministry of Health and Welfare Scientific Research Fund (1987).

[Munakata 96] Munakata, T.: Health and disease from the view point of behavioral science, Medical Friend Co. Ltd, Tokyo, 25-29, 128-129 (1996).

[Munakata 99] Munakata, T.: Health Counseling Encyclopedia, Nissoken Syuan (1999).

[Munakata 01] Munakata, T.: The science of mind recollection, communication, and conversation, Health Counseling, 3(6), 94-102 (2001).

[Munakata 06] Munakata, T.: SAT therapy. KANEKOSHOBO, Japan (2006).

[Munakata 11] Munakata, T.: The alicability of the simple edition of SAT method in promoting universal health, Journal of Health Counseling, 17, 1-12 (2011).

[North 96] North, M.M., North, S.M., Coble, J.R.: Effectiveness of virtual environment desensitization in the treatment of agoraphobia, Presence Teleoperators & Virtual Environments, vol5, No.3, 25–34 (1996).

[North 04] North, M.M., North, S.M., Crunk, J.: Virtual reality combats test anxiety: a case study re-port, Studies in Health Technology and Informatics, Vol.98, 278-280 (2004).

[Optale 03] Optale, G., Marin, S., Pastore, M., Nasta, A., Pianon, C.: Male sexual dysfunctions and multimedia immersion therapy (follow-up), CyberPsychology & Behavior, Vol.6, No.3, 289–294(2003).

[Rinske 15] Rinske, A.G., et al.: Standardised Mindfulness-Based Interventions in Healthcare: An Over-view of Systematic Reviews and Meta-Analyses of RCTs, PLOS ONE (2015).

[Rizzo 04] Rizzo, A.A., Buckwalter, G., Bowerly, T., Zaag, C.V.D., Humphrey, L., Neumann, U., Chua, C., Kyriakakis, C, Rooye, A.V., Sisemore, D.: The virtual classroom: a virtual reality environment for the assessment and rehabilitation of attention deficits, CyberPsychology & Behavior, Vol3, No.3, 483–501 (2004).

[Rosa 04] Rosa M.E.M da Costa, Luis A.V de Carvalho: The acceptance of virtual reality devices for cognitive rehabilitation: a report of positive results with schizophrenia, Computer Methods and Programs in Biomedicine Vol.73, No.3, 173–182 (2004).

[Rosenberg 65] Rosenberg, M.: Society and the Adolescent Self-Image, Princeton New Jersey, Princeton University Press (1965).

[Rothbaum 94] Rothbaum, B.O., Hodges, L.F., Kooper, R., Opdyke, D., Williford, J.S., North, M.: Virtual reality graded exposure in the treatment of acrophobia: a case report, Behavior Therapy Vol.26, No.3, 547–554 (1994).

[Rothbaum 96] Rothbaum, B.O., Hodges, L., Watson, B.A., Kessler, G.D., Opdyke, D.: Virtual reality exposure therapy in the treatment of fear of flying: a case report, Behavior Research and Therapy Vol.34, No.5-6, 477–481 (1996).

[Rothbaum 01] Rothbaum, B.O., Hodges, L.F., Ready, D., Grap, K., Alarcon, R.D.: Virtual Reality Expo-sure Therapy for Vietnam Veterans with Posttraumatic Stress Disorder, J Clin Psychiatry Vol.62, No.8, 617-622 (2001).

[Sakagami 17] Sakagami A., Aijo, R., Nguyen, T., Katayama, M., Nagata, K., Kitaoka, K.: Burnout-related effects of emotional labor and work-related stressors among psychiatric nurses in Ja-pan, Journal of Wellness and Health Care, Vol.41(19, 97-111 (2017).

[Shiba 11] Shiba, M., Yoshikawa, Y.: Stress Management of Nurses on the Review of Researches, Bulletin of the University of Shimane Junior College Izumo Campus, Vol.5, 259-273(2011).

[Spielberger 70] Spielberger, C.D.: STAI manual. Palo Alto, Calif, Consulting Psychologist Press (1970). (Kotobuko Mizuguchi, Shimokanaka, Katsuji Nakasato, Japanese version of the STAI Use Guide, Sankyo (1982))

[Torous 17] Torous, J., Levin, M.E., Ahern, D.K., Oser, M.L.: Cognitive Behavioral Mobile Alications: Clinical Studies, Marketplace Overview, and Research Agenda, Cognitive and Behavioral Practice, Vol.24, Issue 2, 215-225 (2017).

[Usui 02] Usui, N., Nimura, Y., Abe, K., Mori, A.: A Study of Realities and Stress Factors of the Burnout on the Nurses -The Findings of 2 Prefecture Hospitals -, Departmental Bulletin Paper of Mie Prefectural College of Nursing, Vol.6, 103-109(2002).

[Weizenbaum 66] Weizenbaum, J.: ELIZA: a computer program for the study of natural language communication between man and machine, Communications of the ACM, vol.9, Issue 1, 36-45(1966).

[Zung 65] Zung, W.W.K.: A Self-Rating Depression Scale, Archives of General Psychiatry, 12, 63-70 (1965).