

RECOVER: REALISING COLLABORATIVE VIRTUAL REALITY FOR WELLBEING AND SELF-HEALING

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ABSTRACT

In early 2016 the ReCoVR team evaluated a novel system for remote acquisition of a meditation based stress and anxiety reduction therapy, mindfulness. The system is based on a cloud server web-interface and remote clients, using Samsung smartphones, with GearVR virtual reality (VR) glasses. The application enables group sessions in the virtual world, 3D videos and real-time interactions, as well as standalone meditation. An 8-week mindfulness based stress reduction course has been designed for this VR application. The course was preliminary tested with 8 participants; 4 employees and 4 patients with traumatic brain injuries. Their outcomes were evaluated using the Mindful Attention Awareness Scale (MAAS), the Satisfaction with Life Scale (SWLS), and the Mini Mental State Examination (MMSE). The results are encouraging and may accelerate the development of innovative uses of tele-psychology technologies.

KEY WORDS

Virtual reality, VR, 3D, Samsung, Psychology, Mindfulness, Telepsychology, Telehealth technology, Telemedicine services

1. Introduction

Mindfulness, a recognised therapy that teaches awareness of self, maintaining own thoughts, sensations, feelings, emotions and appreciation of your living environment. The technique may help to control potential negative outcomes and thus improve general wellbeing by controlling thoughts of failure (unselfconsciousness). In addition, avoiding problems associated with the future, focusing on the present, action and being “now”, controlling the tracking of time – all this may lead to mindfulness. A person who can achieve such an active and open attention state may be able to control his/her thoughts from a distance without judging them as good or consider them as bad. In this sense it may be an appropriate psychological tool for dealing with anxiety and stress; both being a consequence of stress disorders in

the workplace, incurable diseases or neuromuscular disorders: Parkinson disease, light traumatic brain injury (TBI), multiple sclerosis or other diseases of the muscular or central nervous system.

Attention impairment is often a hallmark of various mental illnesses. However, meditation, especially attention training, can improve the ability to sustain attention [1]. Therefore mindfulness as a meditation tool has an important role in psychology, self-awareness and also wellbeing. The authors Brown and Ryan [2] reported that mindfulness over time was related to a reduction in variable mood and stress in patients with cancer.

Deficits in executive functions, memory and learning are often documented after TBI. In addition, at least half of the individuals with TBI experience chronic pain and/or sleep disorders, depression and substance abuse [3]. A review of the literature shows that neural systems are modifiable networks and changes in the neural structure can occur in adults as a result of training [4]. The recent study reported that anatomical MRI images from sixteen healthy meditation-naïve participants had been obtained before and after they underwent the eight-week program [4]. The results suggested that participation in Mindfulness Based Stress Reduction (MBSR) was associated with changes in gray matter concentration in brain regions involved in learning and memory processes, emotion regulation, self-referential processing, and perspective taking.

Therapy is usually effective in the early period of rehabilitation. However, patients normally stay in hospital for a very limited time and are quickly discharged to come back to hospital as outpatients. This may be convenient only for those patients residing close to the psychologists, but could be very inconvenient for those who are in need of ongoing care, dependent on public transport, or in the worst case do not have access to transport at all. In addition, busy workers often suffer from modern diseases caused by stress, anxiety, but are usually not able to leave their offices [5] whilst at work. Psychotherapy has been applied over the phone and even over videoconference. Nowadays patients, especially if a mental disease is related to work or working conditions

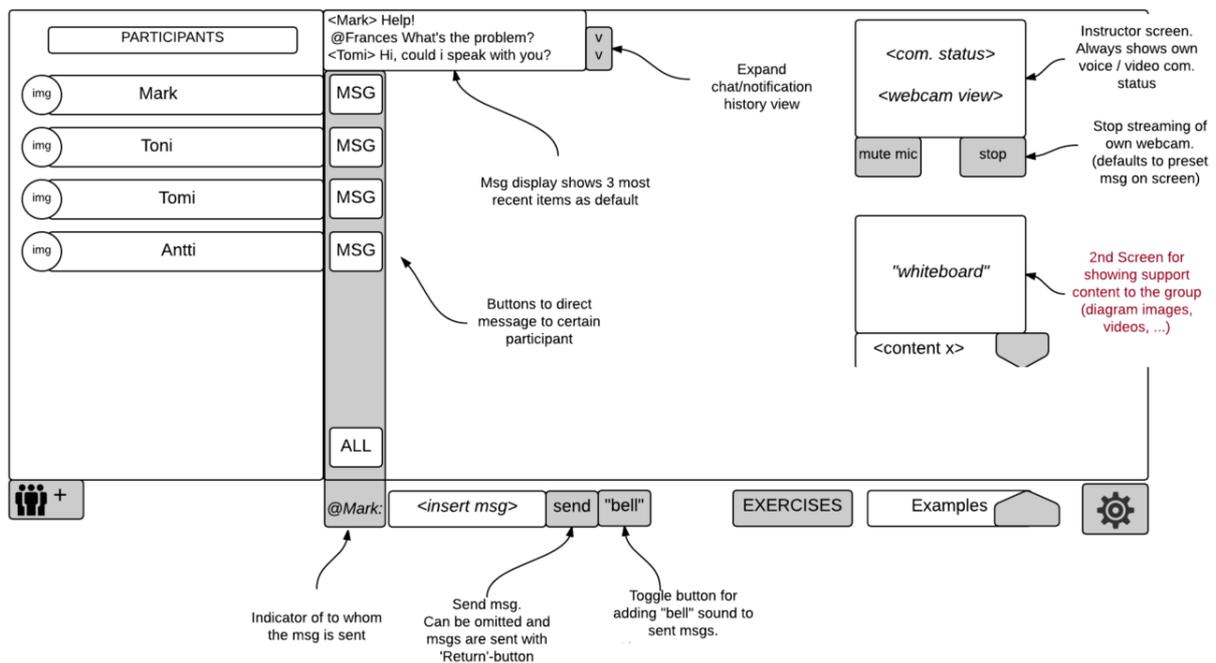


Figure 1. The design of the therapist's web interface; see all participants as avatars in VR, their names/IDs, send/receive messages, group, video communication, document sharing and assign exercises to all or individuals.

prefer maintaining anonymity. Virtual reality (VR) may be an emerging technology that may replace mainstream videoconferencing techniques [6]. It may fulfill expectations [7] and enhance presence [8]. Also, these gaming and cloud technologies enable virtual avatars to represent real people in real time, to make groups, delivering tasks and other communication paradigms. The easy to use technology, simple enough for independent use at home, workplace, requires no need for cables, allows remote interaction with other users residing thousands of miles away, and may provide the mindfulness experts a novel environment to work from their own remote locations.

The designed system requires only a mobile smartphone, a suitable VR head mounted display and a server application in the cloud. Nevertheless, it is expected that such an easy to use system may demonstrate a novel mindfulness course and provide an effective solution to (tele) psychology.

2. Methodology

2.1 Equipment and virtual reality environment design

The standalone application (mindmyths.eu) has been developed in the Unity 3D environment and built for the Android (Lollipop 5.1) OS and the .apk were installed on

a Samsung Smartphone S6 and Note4. The app has been tested with Samsung GearVR head mounted display only. The GearVR requires only Samsung smartphones (S6, S7, Note 4 or Note 5) to operate.

In order to connect to the web-application and join the group session, each smartphone must provide a unique ID (a security and privacy feature). The web-application was run on a cloud server (heroku.com). The therapist / operator / mindfulness instructor accessed the application through a web-browser (Chrome/Firefox with WebGL support). Each user, who prior to the session provided the phone's ID, could connect to the server directly with the smartphone using the WiFi or LTE/3G connection only.

The web-application's user interface (Figure 1) was designed for the therapist who was leading the group session. Each user participating in the group session or standalone session communicated within the VR (Figure 2).

2.2 Mindfulness Attention Awareness Scale

The MAAS [2] is a 15-item scale (Table 1) designed to assess a core characteristic of dispositional mindfulness, namely, open or receptive awareness of and attention to what is taking place in the present. The scale shows strong psychometric properties and has been validated with college, community, and cancer patient samples [9].



Figure 2. The mindfulness instructor (right) is leading the (tele)mindfulness therapy of the patient (left) at the same time. The patients wear the GearVR Samsung equipment and running the app on the Samsung smartphone.)

Correlational, quasi-experimental, and laboratory studies have shown that the MAAS taps a unique quality of consciousness that is related to, and predictive of, a variety of self-regulation and well-being constructs. The measure takes 10 minutes or less to complete.

A collection of statements about the everyday experience is rated with a 1-6 scale, indicating how frequently or infrequently the experience occurred. The answers reflect one's experience rather than what the subject thinks his experience should be. Each item should be treated separately (Table 1).

Table 1
Mindfulness Attention Awareness Scale (MAAS)

Item	Score
1. I could be experiencing some emotion and not be conscious of it until sometime later.	
2. I break or spill things because of carelessness, not paying attention, or thinking of something else.	
3. I find it difficult to stay focused on what's happening in the present	
4. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.	
5. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.	
6. I forget a person's name almost as soon as I've been told it for the first time.	
7. It seems I am "running on automatic,"	

without much awareness of what I'm doing.	
8. I rush through activities without being really attentive to them.	
9. I get so focused on the goal I want to achieve that loses touch with what I'm doing right now to get there.	
10. I do jobs or tasks automatically, without being aware of what I'm doing.	
11. I find myself listening to someone with one ear, doing something else at the same time.	
12. I drive places on "automatic pilot" and then wonder why I went there.	
13. I find myself preoccupied with the future or the past.	
14. I find myself doing things without paying attention.	
15. I snack without being aware that I'm eating.	

The subjects were asked to be honest and rate the items (Table 1) on the 6 points scale:

1 = almost always 2 = very frequently
 3 = somewhat frequently 4 = somewhat infrequently
 5 = very infrequently 6 = almost never

The mean of the 15 items presents the MAAS score; higher score means higher level of dispositional mindfulness.

2.3 Satisfaction With Life Scale

SWLS Items and Factor Loadings) [10]:

The subjects were asked to be honest and rate the items (Table 2) on the 7 points scale:

- 1 = strongly disagree 2 = disagree,
- 3 = slightly disagree 4 = neither agree nor disagree
- 5 = slightly agree 6 = agree,
- 7 = strongly agree

Table 2
Satisfaction with Life Scale (SWLS)

Item	Score
1. In most ways my life is close to my ideal	
2. The conditions of my life are excellent.	
3. I am satisfied with my life	
4. So far I have gotten the important things I want in life	
5. If I could live my life over, I would have changed almost nothing	

2.4 Mini Mental State Examination

The Mini Mental State Examination (MMSE) is a common test for complaints of problems with memory or other mental abilities. The clinicians use the test to diagnose dementia and cognitive abilities. The National

Institute for Health and Care Excellence classifies 21-24 as mild, 10-20 as moderate and <10 as severe impairment. Scores >24 (max is 30) are considered normal.

2.5 Modified Mindfulness Based Stress Reduction Course

Mindfulness Based Stress Reduction Course (MBSR) is an 8-week course with 2 hours' mindfulness group therapy and homework [11], [12], [13]. However, our design of having a group session within the virtual room with VR goggles reduced this to a much shorter (25-30 min) sessions. There were noted technical limitations (overheating of the smartphone [14]) and tolerance issues from overuse of the VR goggles.

All patients/workers took functional and clinical tests before and after the mindfulness program. Additional midterm evaluation was carried out after 4 weeks. During the sessions all patients/workers sat in separated rooms, but in the same virtual room (Figure 3). At the end of the session a "body-scan" was carried out with pre-recorded text. Two different 3D video sceneries (lake, river) and 1 VR environment (Mountain View) were used during the sessions. The participants attended 1 group session in VR per week for 8 consecutive weeks, completed breathing exercises and homework (Table 3).



Figure 3. The VR interface for the user; video communication within VR, see other participants as avatars, send/receive on-line messages and VR exercises in group or standalone session.

Table 3
Modified Mindfulness Based Stress Reduction Course

Functional tests	Sessions		Sessions	
MAAS [11] SWLS[10] MMSE (for patient only)	25 min VR mindfulness	Functional tests (MAAS, SWLS; MMSE)	25 min VR mindfulness	Functional tests (MAAS, SWLS; MMSE)
	2 min breathing exercise per session		2 min breathing exercise per session	
	1 session / week for 4 consecutive weeks		1 session / week for 4 consecutive weeks	
	homework		homework	
Week 1	Week 1-4	Week 4	Week 4-8	Week 8

2.6 Subjects

In the preliminary mindfulness study 8 persons participated. 4 workers/employees (aged from 27 to 40) and 4 outpatient patients (aged from 24 to 48, with TBI, one with brain tumour) participated in the study and were divided into 2 groups. The patients suffered from stress and anxiety due to their uncertainty of the neurorehabilitation program's outcome.

All participants have signed the written consent approved by the local ethics committee.



Figure 4. The mindfulness tests outcomes for employees

3. Results

The workers/employees kept their MAAS score on the same level (4.3 SD 0.7) as at the beginning (4.3 SD 0.8) when the expectations were high. Therefore a slight decrease has been expected in midterm assessment (3.8

SD1.0). SWLS was slightly lower at the end (5.5 SD 0.6 vs 5.2 SD 0.9) of the study (Figure 4).

On the other hand the patients achieved very high level of satisfaction (SWLS) at the end of the study (4.6 SD 0.4 vs 3.8 SD 0.7). A slight increase in MASS score (Figure 5) is also noticeable (3.4 SD 0.6 vs 3.3 SD 0.4) and could have been much higher, if patient 1 had cooperated better (Table 4). This particular patient demonstrated the most significant progress in SWLS (3.2 to 4.2), but his MASS score dropped even in midterm (significant drop of score in items 8, 15).

All patients had MMSE score 30, except the patient nr. 2; his score was 19 at the beginning, 29 at midterm and 26 at the end of study.

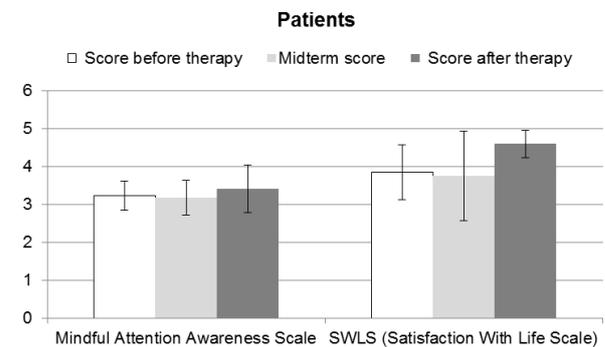


Figure 5. The mindfulness tests outcomes for patients.

Table 4
The outcomes of the study for each individual patient.

Patient	Test	Tests' scores		
		before	midterm	after
1	MAAS	3.3	2.7	2.3
	SWLS	3.2	3.6	4.2
2	MAAS	4.2	4.1	4.8
	SWLS	4.0	2.2	4.8
3	MAAS	3.1	3.4	3.6
	SWLS	3.4	4.2	4.4
4	MAAS	2.4	2.5	3.0
	SWLS	4.8	5.0	5.0

4. Discussion

The users have been so far predominantly [6] enthusiastic about the VR technology and they found the UI rather simple and easy-to-use [15]. However, sometimes they had some difficulties understanding what they were required to do and how. Some of them expressed a desire to make the game more cooperative among the users. They often listened to the instructor only and did what was requested.

The study revealed some weaknesses of the equipment (phone overheating and consequently gradual loss of

graphics details and voice communication). The reliable network communication was solved by changing to the dedicated Wi-Fi network, but the overheating problem is still present (this is a known issue of the Samsung Mobile Phones [14]). The low resolution of the smartphone prevented sharing of documents with small characters and comprehensive text. Participants were not able to read such documents (whiteboard, text), thus only pictures were presented and the text was often read by the instructor.

We might have expected higher score in the MAAS scale at the end of the trial according to the patients' enthusiasm. Nevertheless, we need to emphasize that the actual improvement of MAAS was more than 10% in all participants, except 1 who's score was even lower than at the beginning. The detailed insight into the MAAS score reveals that his memory functions improved, but he had difficulties focusing only on the present happenings. This particular patient also had some family matters. Overall the patients' satisfaction with the mindfulness therapy resulted in a higher satisfaction with life (SWLS score). Even the standard deviation was rather small, meaning that all patients' level of life satisfaction has increased. The midterm drop of score has large standard deviation, which is common in patients. They are often confused during the therapy and unsure of their future.

The employees' MAAS score dropped in midterm, but remained the same as at the beginning of the trial. 2 of the employees had high MAAS score (>5) and the other two rather low (<4) and were both preoccupied with the future or the past. However, one of them successfully overcame this problem at the end of the therapy.

5. Conclusion

Practical tests using virtual reality for mindfulness revealed some strong points of the developed novel technology: easy to use, simple enough for independent use at home stress management in the workplace, no need for cables, remote interaction with other users residing thousands of miles away and with a mindfulness expert from a remote location. Such therapy may be very important for workers [5] who suffer from modern work related illnesses, such as stress and anxiety, but are not able to leave their office. On the other hand, the mindfulness instructor can also be present remotely; even the language barrier can be overcome. Within the living lab trial our psychologists/mindfulness instructors learned how to use the software effectively and became familiar with the technical deficiencies (overheating [14], Wi-Fi disconnection) and could react in the case of malfunctioning until the software re-established the connection.

The patients who were enthusiastic about the novelty, also improved in several points of the tests. In particular, the life satisfaction rate significantly increased in patients after the therapy [11], even though our mindfulness program was shorter than the classical MBSR defined by Dr. Kabat-Zinn [12],[13] which is seen as a strong

positive result. The developed prototype is promising, however for full mindfulness benefit within the group session the instructor should take a training course.

Acknowledgements

The authors would like to acknowledge the coordination and management support from MindMyths Ltd., technical support from PlaySign Ltd., and the financial support from FICHe (Future Internet CHallenge for eHealth) under the European Commission Fifth Framework Programme (FP7).

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