Usability of a Virtual Reality Human-Human Interface to deliver cognitive-behavioural Psychotherapy to people experiencing auditory verbal hallucinations.

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Abstract

Background: Digital technologies have expanded the possibilities of Psychotherapy, especially for the treatment of Schizophrenia with the Avatar Therapy. Despite its vast possibilities, this treatment method is still not disseminated; the operability and functionality are unknow.

Objective: We aim to study the usability of a therapeutic virtual reality human-human interface created in a game engine with psychiatric hospital staff.

Methods: Participants introduced to the therapeutic platform in a "hands-on" mode. The System Usability Scale (SUS) was employed for the evaluation of the system. We will conduct descriptive statistics, chi-square test, an ANOVA, and multilevel factor analysis for statistical evaluation.

Results: In total, 109 staff members were introduced to the therapeutic tool and completed the SUS. The mean SUS global score was 81.49±11.1. Among the professional groups, psychotherapists (86.44±8.79) scored significantly higher (F (2, 106) = 6.136; p = 0.003) than nursing staff (79.01±13.30) and administrative personnel (77.98 ± 10.72). A Multilevel Factorial Analysis (MLFA) shows a different factor structure for each profession.

Conclusions: By different professions, the usability of a digital psychotherapeutic tool developed using a game engine achieves the benchmark for an excellent system, scoring even highest among the professional target group. The usability of the system, therefore, also depending on the professional background of the operator. With gaming technology and platforms, it is possible to create and customisation of novel therapeutic psychotherapeutic approaches. Clinical Trial: clinicaltrials.gov (NCT04099940)

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Conclusions:

By different professions, the usability of a digital psychotherapeutic tool developed using a game engine achieves the benchmark for an excellent system, scoring even highest among the professional target group. The usability of the system, therefore, also depending on the professional background of the operator. With gaming technology and platforms, it is possible to create and customisation of novel therapeutic psychotherapeutic approaches.

Trial Registration: clinicaltrials.gov (NCT04099940)

Keyword: system usability; virtual reality psychotherapy; verbal auditory hallucinations

Introduction:

Psychotherapy is an effective and cost-efficient method for the treatment of psychiatric and psychological disorders [1]. Over the last decades, it has continuously evolved, demonstrating its feasibility and efficacy practically in all diagnostic categories; in several of them, it has become the first-line treatment [2, 3]. In patients with Schizophrenia, psychotherapy as a treatment option was largely neglected; nowadays it is recognised as an effective treatment, when used in conjunction with pharmacological treatment [4, 5], furthermore current guidelines encourage the early implementation of psychotherapy in the treatment process[6, 7].

In several pioneer studies, psychotherapeutic treatment using digital technologies, especially virtual reality, seems at least equal efficacious [8]. In some fields, especially Schizophrenia, digital technologies have even expanded the therapeutic possibilities [9-11]. With the novel implementation of Avatar Therapy, psychotherapy is delivered through a computer interface [12, 13]. Patients with auditory verbal hallucinations create an avatar of a human entity, to which they attribute the voices. With the help of a therapist, they progressively gain control over the voices, which leads to a reduction of symptoms and distress while increasing quality of life [14].

Despite first encouraging studies and the vast possibilities, this treatment method is still not disseminated in research and clinical practice [10]. We attribute their limited deployment to its unavailability as over the shelf tools, making its implementation difficult [15, 16]. From previous research, it is known that for the optimal delivery of therapy through digital technologies, the technology's operability and functionality are fundamental; only once these are well established, the therapist can include digital technology confidently [16, 17]. Indeed, the proper use of technology is essential for the optimal delivery of the therapy, allowing for the unfolding of the therapist's therapeutic competency [10].

We aim to study the usability of a virtual reality human-human interface created in a game engine with a psychiatric hospital staff disregarding their clinical-therapeutic skills.

Methods:

Personalised avatar therapy system

Building upon previous studies, we created a virtual reality human-human interface using a game engine to deliver the Avatar Therapy for people experiencing auditory verbal hallucinations [12, 18, 19]. The basic design employs two computer sites connected through a network, including bi-directional audio (full-duplex VoIP connection) communication. The first computer hosts a personal avatar creation tool (VRAT-CT) to design and customise a humanoid avatar, to whom patients attribute their auditory verbal hallucinations to. This computer is also the one that renders the Virtual Reality (VR) through a Head Mounted Display (HMD) for the therapeutic session. The voice of the therapist is modulated through a voice transformer to match the auditory verbal hallucination. The therapeutic session is initialised and controlled from the second computer with a Control Center (VRAT-CC) that allows the therapist to control the Avatar and to speak through the Avatar using lip synchronisation. (see Figure 1).

Insert Figure 1 around here.

The System Usability Scale (SUS)

The System Usability Scale (SUS) is an approximate tool for measuring the usability of a wide variety of products and services including hardware, software, mobile devices, websites and applications [19, 20]. It is a ten-item questionnaire, with a five-point Likert Scale from 1 (strongly disagree) to 5 (strongly agree). The scale items alternatingly change the positive response. Therefore, for scoring, the scale has to be corrected. For odd-numbered items 1 has to be subtracted from the user's response while for even-numbered items, the user's response has to be subtracted from 5, yielding a score from 0 to 4 for each item. For interpretation, the scores are summed and multiplied by a factor of 2.5. The final score ranges between 0 and 100 [20].

Insert Textbox 1 around here.

Participants and Assessment

Employees (disregarding their professional background and occupation) of the Psychiatric University of Zürich were invited to see and test the virtual reality human-human interface to deliver the Avatar Therapy to people experiencing auditory verbal hallucinations. Basic demographic characteristics (age, gender and occupation) were gathered. According to their professional background, participants were divided into three categories: psychotherapists (either psychiatrists or psychologists), nursing staff, and administrative personnel.

Participants were individually informed about the study and introduced to the therapeutic platform in a "hands-on" mode. They were provided with information about the theoretic-therapeutic background of the therapy and the design and implementation process of the virtual reality human-human interface in practice. Each step of the therapeutic process was explained. Finally, they were allowed to create an avatar and customise its voice and experience it through virtual reality (VR). Afterwards, they were allowed to control the Avatar. After their first use, participants completed the System Usability Scale for each component.

Statistical Analysis

Descriptive statistics (percentages, means, standard deviations) will be used to represent demographic characteristics of the sample. Differences in the sample will be calculated with the chi-square test for proportions. An ANOVA will be performed for continuous variables. The SUS score for the system will be calculated: as well as the scores for avatar creation tool (VRAT-CT) and the control center (VRAT-CC) will be evaluated separately. The system’s SUS will be evaluated at the item level, as well as at its global score.

Additionally, we will conduct a multilevel factor analysis. Results will be presented as graphics and tables. Statistical analysis will be performed using the statistical language program “R” (Version 4.0.3, *http://www.R-project.org*).

Ethics:

The study is designed according to current ethical standards and local regulations. The ethics committee of the Canton of Zurich approved the study protocol (BASEC 2019-01386). The study is registered at clinicaltrials.gov (NCT04099940).

Results:

Sample Demographics

In total, 109 staff members were introduced to the therapy. They were able to use the therapeutic tool. In the process, they created and customised their Avatar for therapy, and they also controlled a therapeutic session. The sample was made of: psychotherapists *(n*=40), nursing staff (*n*=43), and administrative personnel (*n*=26); with a mean age of 34.76 ± 12.69; with altogether 74 female participants (67.89%). There were no statistically significant differences regarding age or gender distribution among the different professions. Further details of the sample are summarised in Table 1.

Evaluation Outcomes, System Usability Scale

There were no missing items. Therefore, an imputation of values was not necessary. The SUS scores were normally distributed with only a few outliers. The mean SUS global score was 81.49 ± 11.1. The mean score for the VRAT-CT was 82.00 ± 12.55 and the mean for the VRAT-CC 80.99 ± 12.67. Male participants scored slightly higher (81.71 ± 15.24) than female participants (81.39 ± 11.19) without a statistically significant difference (See Table 1). Among the professional groups, psychotherapists (86.44 ± 8.79) scored higher than nursing staff (79.01 ± 13.30) and administrative personnel (77.98 ± 10.72). The difference between the psychologists and the other professional groups was statistically significant (See Table 1 and Figure 2).

Multilevel Factorial Analysis (MLFA)

The System Usability Scale had a Cronbach's alpha value of 0.80 with a good correlation between the single items. Items loadings ranging from 0.2 to 0.8. The performed MLFA with Chi-Square < 0.000; a Comparative Fit Index (CFI) of 0.905, Sample-size adjusted Bayesian (BIC) of 5028.078 and a Root Mean Square Error of Approximation (RMSEA) of 0.075 shows a different factor structure for each profession (See Table 2).

Discussion:

We studied the usability, by different professions of, a digital psychotherapeutic tool developed using a game engine. The SUS score obtained by the virtual reality human-human interface achieves the benchmark for an excellent system [21, 22], scoring even highest among the professional target group. The sample's demographic characteristics did not alter these results: the SUS score was similar regardless of age and gender. This is the first study assessing the usability of a therapeutic system to deliver psychotherapeutic treatment for acoustic verbal hallucinations to the best of our knowledge.

Our study's main strengths are the large sample size and the naturalistic design, particularly the personalised introduction and the practical “hands-on” approach to the system [16, 17]. We choose this approach to emulate the introduction and instruction of psychotherapists in clinical and research practice. Furthermore, through the system's personalised introduction, we sought to compensate for the differences in theoretic background between the professions involved.

The system usability scale was originally developed to evaluate the usability of products and services, including hardware, software, mobile devices, websites and applications. Due to the nature of the developed product, as well as the previous use of SUS to test medical devices and products [23-25], we choose that metrics; allowing for easy comparison with similar and dissimilar products and devices [21]. In this comparison, the digital therapeutic system tested yield a score, ranging between good and excellent depending on the professional background [21, 22].

The virtual reality human-human interface achieved a higher scoring among those professions with a psychotherapeutic training (i.e. Psychiatrists and Psychologists). Since all participants were naïve to the system, differences cannot be attributed to user experience [26]. In our opinion, this reflects the need for a specific professional background and training to fully understand and use the virtual reality therapeutic tool we created [16]. Post hoc analysis revealed no differences among psychiatrists and psychologists: therefore, we consider this a unique group with the psychotherapeutic training as a binding factor [27-29].

The SUS scale's further analysis yields a similar scoring between psychotherapists and non-psychotherapists only on items 3, 5, and 7. These items are closer related to the handling of the system than to its actual implementation and use in clinical and research practice. The SUS scale also has a different factor structure for each profession, signalling different valuation patterns for the usability of the system [30]. Therefore, we believe that the system is overall easy to use, and we see

this as a way for the therapists to become familiar and feel confident with the system, thus becoming more likely to treat and deliver their therapeutic skills through this system [17, 31].

We were able to show that the virtual reality human-human interface for clinical and research practice can be developed using an existing and available game engine. The results show that the usability of the digital therapeutic tools depends not only on the system but also on the operator's professional background. Thus, the system, enabling and encourages the psychotherapists to expand their therapeutic skills and routinely use this technology in clinical and research practice [15, 32-34]. Gaming technology and platforms seem suitable for the creation and customisation of novel therapeutic approaches in psychiatry.

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Conflict of Interests

"none declared."

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Textbox 1: The System Usability Scale

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

Table 1: Sample characteristics and outcome evaluation.

	Profession				
	Psychotherapists	Nursing Staff	Administrative Personnel		
	n = 40	n = 43	n = 26	Statistics	p
Age (mean±SD)	33.25 ± 9.00	33.51 ± 15.85	30.15 ± 10.60	F (2, 106) = 2.09	n.s.
Gender					
Female (%)	21 (52.50%)	31 (72.09%)	19 (73.08%)	X^2 (2, 109) = 4.451	n.s
SUS- Score					
Global (mean±SD)	86.44 ± 8.79 [a, b]	79.01 ± 13.30	77.98 ± 10.72	F (2, 106) = 6.136	0.003
VR- Avatar (mean±SD)	87.00 ± 9.83 [a, b]	79.71 ± 13.56	78.08 ± 12.50	F (2, 106) = 5.597	0.005
Control Center (mean±SD)	85.88 ± 9.53 [a, b]	78.31 ± 14.54	77.88 ± 11.68	F (2, 106) = 5.064	0.008

Post-hoc analysis, with Bonferroni Correction. [a] Psychotherapists > Nursing Staff. [b] Psychotherapists > Administrative Personnel

Table 2: Mean Score on the System Usability Scale and Loadings for each Item.

	Profession							
	Psychotherapists		Nursing Staff		Administrative Personnel			
	Loadings	Mean (SD)	Loadings	Mean (SD)	Loadings	Mean (SD)	Statistic	p
Item 01	0.489	4.42±0.67[b]	0.356	4.16±0.79	0.396	3.92±1.04	F (2, 215) = 6.048	0.003
Item 02	0.591	1.25±0.46[b]	0.670	1.35±0.59[c]	0.687	1.60±0.66	F (2, 215) = 5.993	0.003
Item 03	0.672	4.453±0.57	0.665	4.28±1.01	0.565	4.33±0.86	F (2, 205) = 1.929	n.s
Item 04	0.520	2.00±1.07[a,b]	0.428	2.49±1.26	0.328	2.81±1.28	F (2, 215) = 97.663	0.000
Item 05	0.500	4.44±0.65	0.405	4.31±0.58	0.575	4.38±0.53	F (2, 215) = 0.896	n.s.
Item 06	0.523	1.30±0.54[a,b]	0.513	1.73±0.90	0.579	1.79±0.64	F (2, 215) = 10.070	0.000
Item 07	0.335	4.31±0.76	0.805	4.24±0.85	0.554	4.08±0.62	F (2, 215) = 1.3510	n.s
Item 08	0.501	1.30±0.58[a]	0.506	1.71±1.13	0.793	1.40±0.57	F (2, 215) = 4.946	0.008
Item 09	0.561	4.22±0.73[b]	0.523	3.90±1.01	0.5552	3.81±0.97	F (2, 215) = 4.219	0.016
Item 10	0.291	1.50±0.78[b]	0.566	2.02±1.13[c]	0.535	1.73±0.79	F (2, 215) = 6.519	0.002

Post-hoc analysis, with Bonferroni Correction. [a] Psychotherapists > Nursing Staff; [b] Psychotherapists > Administrative Personnel; [c] Nursing Staff > Administrative Personnel

Figure 1: Virtual Reality Human-Human Interface

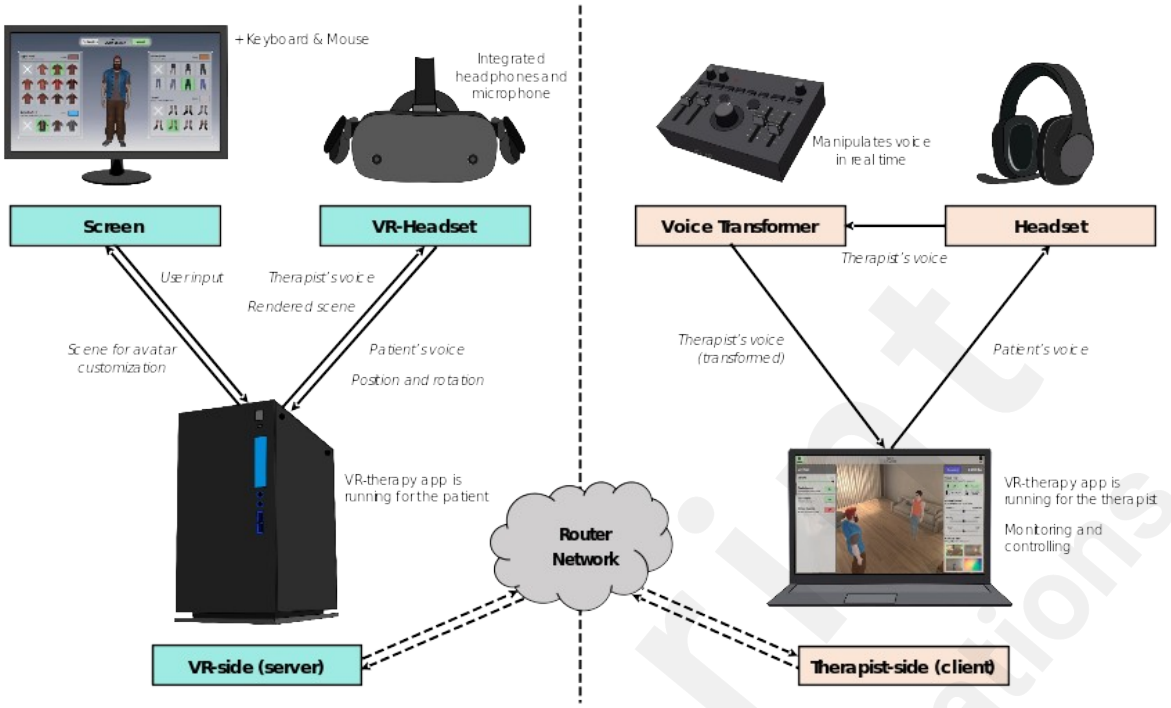
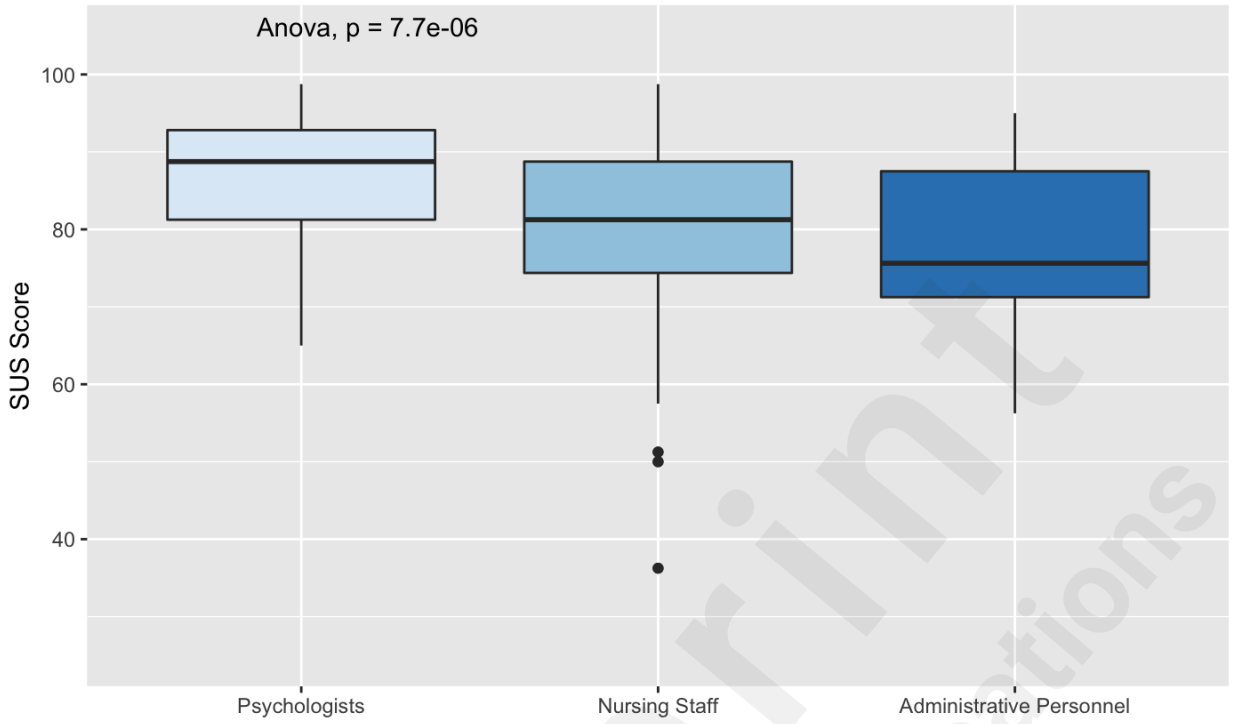


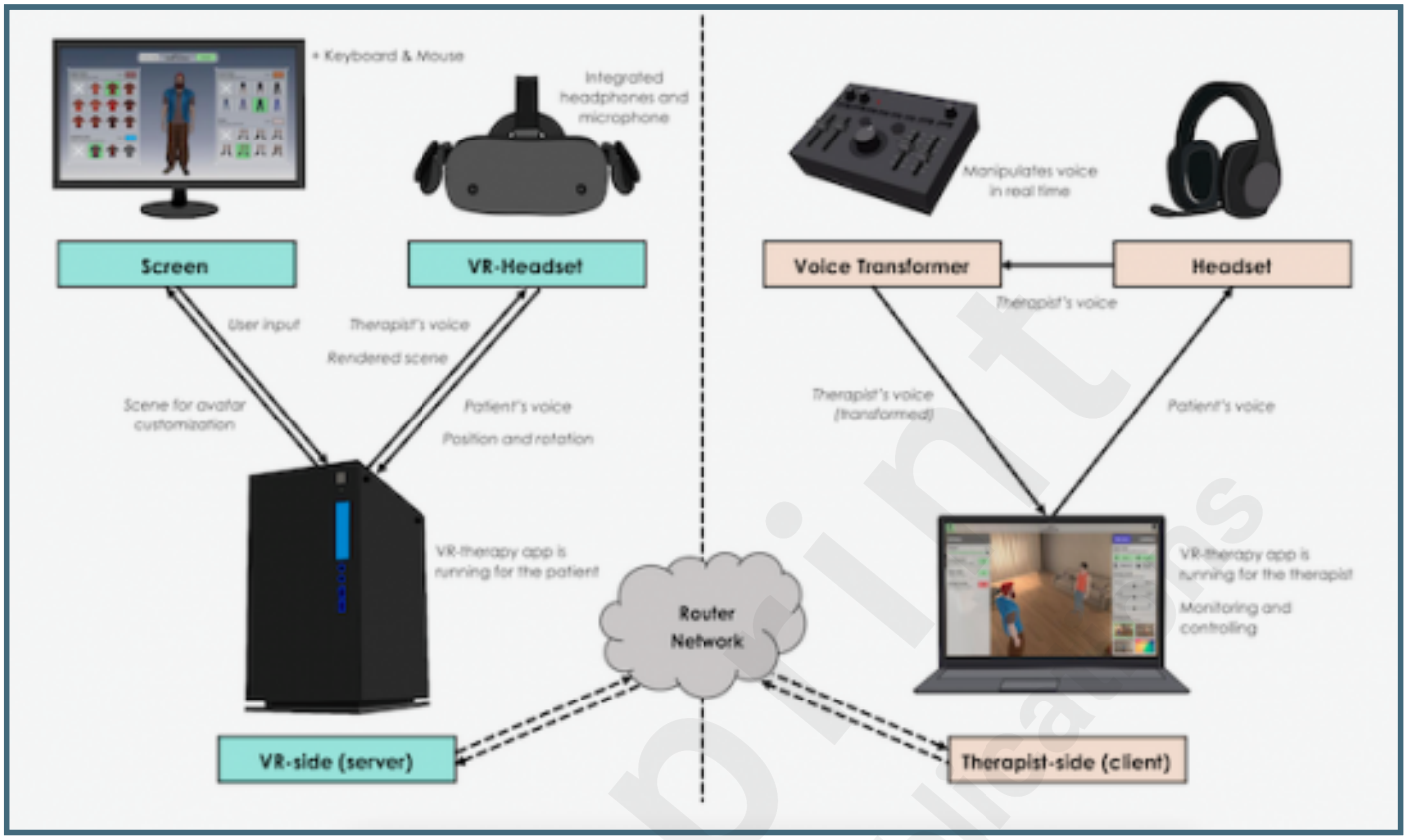
Figure 2: SUS-Scores, according to the participants' profession and the virtual reality Human-Human Interface System Component.



Supplementary Files

Figures

Virtual Reality Human-Human Interface.



SUS-Scores, according to the participants' profession and the virtual reality Human-Human Interface Therapy System.