ExPhobia: A mHealth Technology based on Augmented Reality for Support the Treatment of Arachnophobic Stimulus

Fabiana Neiva Veloso Brasileiro[1], Tauily Claussen D'Escragnolle Taunay[2], José Eurico de Vasconcelos Filho[3], Manuela Melo Santana[2] and Ântonio Plínio Feitosa Bastos[3]
[1]*Laboratório de Investigações em Análise do Comportamento, Universidade de Fortaleza, Ave. Washington Soares, Fortaleza-CE, Brazil*
[2]*Graduação em Psicologia, Centro de Ciências da Saúde, Universidade de Fortaleza, Ave. Washington Soares, Fortaleza-CE, Brazil*
[3]*Núcleo de Aplicação em Tecnologia da Informação, Universidade de Fortaleza, Ave. Washington Soares, Fortaleza-CE, Brazil*

Keywords: Arachnophobia, Augmented Reality, Systematic Desensitization, mHealth.

Abstract: Anxiety disorders attack a significant part of the population and have been treated, mainly, by pharmaceuticals or psychotherapies. Augmented Reality technologies have gotten some space in the treatment of these diseases, with promising results. The current paper presents the prototype ExPhobia that holds concepts and tools from the mHealth and Augmented Reality areas for the support to the facing of arachnophobia. We have as a main goal the development and the performing of the initial tests of ExPhobia for the systemic desensitization on levels of anxiety and escape/dodge in people with arachnophobia. The used methodology for the development of ExPhobia contemplates a laboratorial phase for the conception of this functional prototype, supported by the stages of the interaction design and, after the initial tests, the program is being planned in a way that a research in a method almost experimental can be done, with only one individual, applying the ABA designing. For measuring the levels of anxiety and phobia of the participants in scales, inventories and questionings, in addition to the heart frequency measuring. It is a hypothesis that can be used in the Augmented Reality as a technique of systematic desensitization, from an analytic-behavioral perspective, the positive and viable results for the treatment of specific phobias.

1 INTRODUCTION

Anxiety disorders, based on DSM-V (APA, 2013), are differentiated from adaptive anxiety or fear because they persist beyond normal time and are excessive, in other words, disproportionate to reality, occurring with a frequency greater than expected and often compromising the quality of life of the individual. Phobias are considered a type of anxiety disorder and one of its subdivisions includes specific phobias, among them arachnophobia, which is the object of study of this work and corresponds to the disproportionate and excessive fear of spiders. According to Zaminagni and Banaco (2005) and with most of the current literature on the subject, from an analytic-behavioral perspective, the behavioral pattern characteristic of anxiety disorders is phobic avoidance, that is, the individual will emit a response that softens, defer or eliminate (escape / dodge) an aversive event, that is, a threatening or uncomfortable event.

Treatment for anxiety is usually performed with psychological, pharmacological or both intervenetions, but drug use is not always necessary (Haydu *et al*., 2014). Within psychology, some techniques can be used so that anxiety disorder or, more specifically, exacerbated and irrational fear (phobia), can be minimized or eliminated. Among the possible strategies, systematic desensitization (SD) is a very effective procedure for the treatment of specific phobias. It has been proven in several studies, such as those shown in the literature review by Turner (Caballo, 1996).

Technological advances have provided new possibilities and benefits in the use of high technology in the field of mental health (MH), contributing favourably to new forms of interaction (Wrzesien *et al*., 2013). Among the developed

Brasileiro, F., Taunay, T., Filho, J., Santana, M. and Bastos, Â.
ExPhobia: A mHealth Technology based on Augmented Reality for Support the Treatment of Arachnophobic Stimulus.
DOI: 10.5220/0007580604740480
In *Proceedings of the 12th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2019)*, pages 474-480
ISBN: 978-989-758-353-7

technologies, some stand out as a very useful tool for psychologists in interventions to treat specific phobias, which are Virtual Reality (VR) and Augmented Reality (AR) (Tsai *et al*., 2018; Opris *et al*., 2012; Juan and Pérez, 2010). Studies suggest the efficacy of VR and IR in the treatment of specific phobias, however, many of them point out the need for more research in the field and, therefore, to support the use of these technologies as a complementary and facilitative form of therapeutic interventions (Haydu *et al*., 2016).

AR technology is used to blend digital (virtual) content into the real world: computer-generated images along with relevant information are displayed in the user's real view field. It is able to give support to different areas and applications satisfying the need to connect the real world with virtual worlds (Hugues *et al*., 2011). It also enhances the user experience through mobile applications designed specifically to utilize this technology, thereby integrating the mobile health – mHealth - area (WHO, 2011). Analysts predict that the global AR market will grow at an annual growth rate of 65.24% over the period 2017-2021. Treatments with the use of Augmented Reality with exposure to phobic stimulus prove effective not only when compared to other treatments, but also through measurement with well-defined inventories and scales, as in the study by Wrzesien *et al*. (2013).

Considering the high prevalence of anxiety disorders in our environment, specifically the phobias, coupled with modernization and current technological advances, such as Augmented Reality was necessary, in order to corroborate the tendency of current research, to develop a functional prototype, using AR, that can be applied by psychologists as an important complementary tool in the treatment of specific phobias (eg arachnophobia), with clinical-therapeutic purpose.

2 METHODS

Before applying and testing the prototype in participants with arachnophobia, three phases were performed: 1) development of the ExPhobia prototype, 2) usability test and 3) development of an application protocol; and a phase that is still in progress which is: 4) intervention. In order to perform these phases, this research had as methodological basis the evaluation of programs, which had been developed to support the future application of the almost-experimental method.

The evaluation of programs "is about researches that propose and implement programs to achieve some positive effect on a group of individuals" (Cozby, 2003). Within the Program Evaluation, Rossi *et al*. (1999) identified five (5) types of evaluations, namely: 1) needs assessment; 2) evaluation of the program theory; 3) evaluation of the process; 4) evaluation of the result and 5) evaluation of efficiency. The present study aims the two first evaluations, that is, the needs assessment, based on an extensive bibliographic research, and the evaluation of the program theory, covering usability tests and development of a protocol.

For the future application of the prototype, the fourth phase aims to use an almost experimental method (Cozby, 2003) and intends to use a single subject delineation, in which each participant will be exposed to an Initial Bond, then the measuring for the basis line (A), then they will pass through the Intervention condition (B) and at the end will be submitted to the new evaluation, in the Final Result (A) (Sampaio *et al*., 2008).

For data collection, one (1) Questionnaire will be used to measure the level of the spider phobia - Fear of Spiders Questionnaire (FSQ), one (1) Sense Inventory of Presence (SIP), adapted for Augmented Reality (RA), one (1) Subjective Units of Discomfort Scale (WASP), and a portable device to measure heart rate (Fitbit Alta HR®).

In the initial Baseline (A) the FSQ and SUDS questionnaire will be applied to understand the level of phobia of the participant, in addition to exposing the participant to the equipment that will be used (Oculus Rift), while collecting the heart rate (Fitbit Alta HR®) to have a base before the intervention. The Intervention (B) does not have a necessary number of steps to be performed per session, always respecting the participant's time. There will be eight (8) steps in total and each change from one stage to the next is already pre-determined. In the final result - Final Baseline (A) will be the reapplication of the SUDS, ISP and FSQ tests, being the same of the beginning of the treatment, for data collection and comparison between the Baseline and the Final Result; besides contrasting the data recorded in the Fitbit Alta HR®, for physiological measurements.

For the statistical analysis of the collected data, the IBM® SPSS program will be used. It should be emphasized that the data of the experimental sessions are the primary data and the questionnaire data are secondary.

2.1 Procedures

Three (3) phases were developed to achieve the objectives of this study and one phase is still in progress.

Phase 1 - Development of the ExPhobia Prototype: In this first phase, the prototype Exphobia was developed, based on Interaction Design (Preece *et al*., 2015), along with the professionals and students of each area (Psychology, Computer Science, Design), whose objective is the treatment of arachnophobia with use of systematic desensitization. For this, an extensive bibliographic review was carried out in databases available on CAPES (PubMED, Scielo, Web for Science) and Scholar (scholar.google.com.br) with the descriptors "phobia", "augmented reality", "Virtual reality", "exposure therapy" and "systematic desensitization" and their Portuguese translations, twenty (20) articles being selected.

The program, which aims the intervention based on a protocol, was planned to have the inventories and questionnaires applied in two conditions: pre-test (baseline - before intervention) and post-test (final result - after intervention), in addition to measuring the participant's heart rate throughout the session's conduction period, using the Fitbit Alta HR ® portable device (smartband), as an objective measure of the anxiety response, from a physiological point of view. Based on the research done and the theoretical basis of the systematic desensitization technique (Caballo, 1996), the intervention has eight (8) stages (St) (table 1), hierarchically pre-defined (a) Size (S) in three (3) levels: small, medium, and large (S, M and L); b) Realism (R) in three (3) levels: low (L), medium (M) and high (H); c) Quantity (Q) of spiders, being possible to see 1, 5 or 10; d) Movement (M), whether static (S) or mobile (M).

Table 1: Stages of Systematic Desensitization.

(St)	(S)	(R)	(Q)	(M)
1	S	L	1	S
2	M	L	1	S
3	M	L	1	M
4	M	M	1	M
5	M	H	1	M
6	M	H	5	M
7	L	H	5	M
8	L	H	10	M

* underlined items indicate which variable was changed at step change.

Phase 2 - Usability Test (Preece *et al*., 2015 p 341): After the prototype was developed by students and professionals in Computer Science and Design, a usability test was performed with ExPhobia, which consisted in exposing 20 typical users to use the mobile application of the prototype, measuring their performance on specific tasks and, at the end of the test, collecting their impressions in a questionnaire.

Phase 3 - Development of an Application Protocol: Based on the results of the Usability Test, an ExPhobia Application Protocol was developed with the objective of better delineating the use of the product, aiming at its greater effectiveness.

Phase 4 - Intervention: After the complete development of the prototype and initial tests, it is planned to proceed to the intervention phase, which should evaluate the efficacy of ExPhobia in phobic participants, through an almost experimental, single subject study with a design ABA.

2.2 Materials

The materials and tools needed to apply some phases are:

- ExPhobia: functional prototype that was developed, for which users can interact and evaluate. Such a prototype was developed for a responsive web platform that will pass data from a psychologist-mediated session to a mobile application (Android) in which the patient visualizes the object of specific phobia in Augmented Reality with the help of Oculus Rift for better immersion.
- A notebook, where the psychologist controls and follows the whole process, such as what the client is seeing at that moment and the stage that the client is in that session;
- A device with Android developer system (e.g. smartphone) to use in phobic object exposure along with Oculus Rift;
- Portable heart-monitoring device (smartband) – Fitbit Alta HR® to record a type of physiological change in anxiety scales before (baseline - pre-test), during and after treatment.

2.2.1 Software

The following platforms were used for the development of the ExPhobia prototype:

- Blender® (for the modelling of the Spider);
- Unity® (to show the Spider in the mobile application);

- Android Studio® (mobile application for the client);
- Eclipse® IDE (web functions);
- Design of Alternatives: main design activity that consists of suggesting ideas to satisfy the requirements.
- Pencil® (for low-fidelity displays, where the concept and the initial idea of the product are shown);
- Photoshop® (for high-fidelity screens, which will look similar to the final product, used for exploration and testing).

2.2.2 Inventories and Questionnaires

For application within the provisions of the Protocol, the following inventories and questionnaires are required:

- Fear of Spiders Questionnaire (FSQ) consists of eighteen (18) items graded on a Likert scale of seven (7) points ranging from zero (0 - totally disagree) to seven (7 - agree totally) for situations related to the fear of spiders. The total score varies from zero (0) to one hundred and twenty-six (126), the average of some studies, such as Botella, Pérez-Ara, Bretón-López, Quero, García-Palacios, and Baños (2016), about 89.1 (DP = 19.6);

- Displacement Subjective Units (SUDS) Scale (Wolpe, 1969) is a scale of 0 to 10 points. The participant will indicate a reference number to the level of anxiety / discomfort felt, with larger numbers indicating a higher level of anxiety and 0 (zero) indicating no discomfort;

- Sensory of Presence Inventory (SPI), adapted for Augmented Reality (AR), contains 14 statements that describe sensations related to the augmented reality in terms of virtual stimuli, non-virtual environment stimuli, physiological reactions during the exposure and behaviors presented throughout the exhibition. Items should be answered on a five-point Likert scale: "I totally disagree" to "I totally agree." The punctuation of items 3, 4, 7, 10, 11 and 14 must be reversed in the correction. The total score represents the level that the participant feels involved with Augmented Reality.

3 RESULTS

The results are divided by the phases, aiming a better explanation of what was reached.

3.1 Phases

3.1.1 Phase 1: The ExPhobia Prototype Development

The ExPhobia system was idealized and conceived by a multidisciplinary research team (Computer Science, Psychology and Communication) of the University of Fortaleza - Unifor - to be composed of two applications:

- Mobile application: initially for Android platform, for serving a significant portion of the Brazilian population, about 93.2% of the national market in 2017 (Carvalho, 2017). In the application:

- The psychologist can check the list of patients with treatment details and obtain information. In addition, you can allow your patient to use appropriate glasses to initiate the RA experience using QR Code for each step of the proposed desensitization technique.

- Patients can follow their progress in treatment, obtain information and train completed steps using specific QR Code for each step already achieved, provided by the professional, without needing any other equipment for the RA experience.

- Web application (administrative): used only by the professional to manage, monitor and configure the variables of each stage. At each therapy session, measurements and information for monitoring are recorded manually, such as: anxiety / fear level; heart beats; galvanic measurement, and; observations.

Figure 1 shows the applications and tools that make up the designed system.

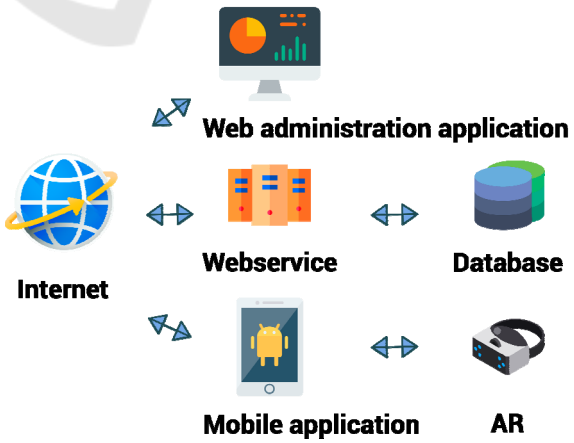

Figure 1: ExPhobia architecture.

The systematic desensitization technique proposed for the system consists of eight progressive

and gradual steps. For each step, there are variations of the four configurable variables of the phobic object in 3D (in this case, spider), being defined as:

- Size: shows the patient's perception of the size of the phobic object on the screen, being small, medium or large;
- Realism: shows the patient's perception of how realistic the phobic object can be, pixelated (similar to Minecraft game objects), medium-term or realistic;
- Quantity: one, five or ten phobic objects shown in the application, and;
- Movement: stopped or not.

The steps can be understood as:

- 1st: one small spider, pixelated, stopped;
- 2nd: one medium spider, pixelated, without movement;
- 3rd: one medium spider, pixelated and with movement;
- 4th: one medium spider, medium term and with movement;
- 5th: one medium spider, realistic and with movement;
- 6th: five average, realistic and with movement;
- 7th: five large, realistic and with movement;
- 8th: ten large, realistic and with movement.

Figure 2 shows an example of the image of one of the steps, accessed by the professional.

Figure 2: Image accessed by the professional.

The Figure 3 shows an example of viewing of one of the steps, accessed by the professional.

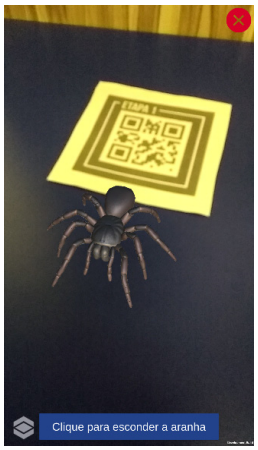

Figure 3: Step accessed by the patient.

The functional prototype of the mobile application was developed to be accessible from version 4.4 of the Android platform, KitKat. The choice of the version was made to suit a large number of users who, according to the Android Studio platform, reached approximately 90.9% of Android devices in November 2017. The prototype was based on Material Design (a guide to Google's design recommendations) that allows you to implement the look of an application in a consistent, simple and intuitive way (Lecheta, 2016).

3.1.2 Phase 2: Usabilty Test

With the functional prototype ready, it was possible to perform usability tests of the mobile application. For the patient's vision of the application, tests were performed with 20 users (1 woman and 19 men), of university level and adults. Of these participants, 30% knew the application, but never interacted directly with it before the tests.

In the view of the professional, tests were carried out with 10 users (8 women and 2 men), university level, adults, from the psychology area who did not know the application. Phobics were not invited for usability tests, since the purpose of the tests is to evaluate the usability of the technological artifact, that is, technical questions of the technology.

Some results recorded were: 1) in the accomplishment of tasks, some participants had doubts because they did not know terms of the health area; 2) as to the ease of starting and using the augmented reality experience, the majority (55%) had no difficulties; 3) As for the level of realism of the spider, it has been that 7 people (35%) voted in, between zero and five, being zero unreal and five very real, five.

3.1.3 Phase 3 – Development of an Application Protocol

In order for the intervention to be carried out in a correct and standardized manner, an application protocol has been established which presupposes:

Initial Link: The patient will enter the application room and will explain how the program works, presenting the project, the objectives, the procedure and then the interested participants and that fit the criteria of inclusion must sign the Term of Consent Free and Informed (TCFI).

APPLICATION

Preliminary Baseline (A):

First, the FSQ and SUDS questionnaires will be applied to understand the level of phobia of the participant.

After that, the patient will be presented and experiment the Oculus Rift to know the tool and the scenario, but without the phobic stimulus (spider in augmented reality).

During the presentation the patient will be connected to the Fitbit Alta HR® device to heart rate monitoring. The heart rate data will be collected 40 seconds before the start of the session and will continue for another 40 seconds after the end of the session, so that the physiological data can be measured throughout the process. The objective is to measure the data before the intervention in order to effectively compare the variation during the session, reducing the probability of foreign variables.

Intervention (B):

There are no pre-determined number of sessions in the intervention, varying according to each patient's response.

Each session has 8 stages (previously defined hierarchically), already mentioned before. Each stage will have 3 equal repetitions of exposure (1-adaptive, 2- real, 3-confirmatory) of 20 seconds, with an interval of 1 minute between one exposure and another and 1 minute for other issues (equipment setting, some necessary break), totaling about 5 minutes.

Every new stage requires a baseline (BL per stage), which refers to: 1) the patient will be asked if he feels comfortable moving to the next stage. If 'yes', the patient goes to the next stage after 5 minutes (interval between one stage and another); If ‘no', there will be a 5 minute stop, the equipment will be removed and there will be some relaxation exercise, after the procedure, the question will be redone and, if it persists, there is the postponement or end of the intervention; 2) The heart rate will be checked, if it is above 120bpm, it will be recommended to repeat the stage or pause the intervention; 3) Application of the SUDS discomfort level scale (range ranging from 0-10).

Throughout the procedure, the patient may want to stop the stimulus to the phobic object and, for this, it will be agreed that it is sufficient to raise the hand that, immediately, the exposure will be suspended. Raising the hand is the escape for the exposed patient.

Final Baseline (A):

After the intervention, the ISP tests will be applied (applied only in this phase, since it is the assessment of immersion to the prototype), SUDS and FSQ, these being the same as the beginning of the treatment, for data collection and comparison between the Baseline and the Final Result; in addition to contrasting the heart rate data recorded in the Fitbit Alta HR®, for physiological measurements.

ENVIROMENT

The psychologist must have a closed room to avoid strange noises and contact with uncontrolled variables;

- Table to support the QRcode, which should be printed in a minimum size of 20x20cm on an acrylic plate;
- Chair for the patient;
- The distance between the QRcode and the patient, who will be seated, should be 1 meter;
- The QRcode should be located in front of the patient under his direct sight, without him having to lower or raise his head so that he can have access to the phobic stimulus.

CLOSING

Each stage, if carried out without difficulties, has a forecast of 5 minutes;

- Between one stage and another, if there are no problems, there will be a break of 5 minutes;
- If there is no difficulty during the entire intervention (exposure to the 8 steps previously defined), the process ends in approximately 2 hours.

3.1.4 Phase 4: Intervention

This last phase is under development, however, it is hypothesized that the use of augmented reality as a tool to the technique of systematic desensitization, from an analytic-behavioral perspective, elicits

positive and viable results for the treatment of specific phobias, assumptions, given the research conducted, as well as the various tests and protocol established for application, that when applied to phobic participants, the effects will be favorable.

The intervention is, in fact, the application of ExPhobia as proposed by the Phase 3 protocol, with the proposal to develop a research, as previously mentioned in the methodology, which covers the almost experimental, single subject, and ABA, searching for relevant data and comparing, in fact, between preintervention and postintervention.

4 CONCLUSIONS

The current paper is a tangible result of the junction between health and technology, aiming the treatment for the phobia of spiders (arachnophobia). The developed prototype has as final focus the improvement of the life quality of the participants, but it also aims the psychologist who will work with the technology, providing new ways of treatment.

It is understood, therefore, that new technologies, such as augmented reality, can be combined with health treatments; facilitating procedures or expanding techniques.

REFERENCES

American Psychiatric Association (APA), 2013. Diagnostic and statistical manual of mental disorders (5ª ed.). Arlington, VA: American Psychiatric Publishing. p. 189-190.

Caballo, V., 1996. *Manual de técnicas de terapia e modificação do comportamento*. São Paulo: Santos.

Cozby, P. C., 2003. *Métodos de pesquisa em ciências do comportamento*. Atlas.

Carvalho L., 2017. Android cresce no Brasil e aumenta distância para iOS e Windows Phone. Olhar digital. Disponível em: https://olhardigital.com.br/noticia/android-cresce-no-brasil-e-aumenta-distancia-para-ios-e-windows-phone/68023. Acesso em: 11maio 2018.

Haydu, V. V.; Fornazari, S. A.; Borloti, E.; Haydu, N. B., 2014. Facetas da exposição in vivo e por realidade virtual na intervenção psicológica no medo de dirigir. *Psico,* 45(2). p. 136-146.

Haydu, V. B.; Kochhann, J.; Borloti, E., 2016. Estratégias de terapias de exposição à realidade virtual: uma revisão discutida sob a ótica analítico-comportamental. *Psicologia Clínica*, 28(3). p. 15-34.

Hugues O.; Fuchs P.; Nannipieri O., 2011. *New Augmented Reality Taxonomy: Technologies and Features of Augmented Environment*. New York, NY, USA: Springer.

Juan, M. C.; Pérez, D., 2010. Using augmented and virtual reality for the development of acrophobic scenarios. Comparison of the levels of presence and anxiety. *Computers & Graphics*, 34(6). p. 756-766.

Lecheta R. R., 2016. Android Essencial. São Paulo: *Novatec*.

Opris, D.; Pintea, S.; García-palacios, A.; Botella, C.; Szamosközi, S.; David, D., 2012. Virtual reality exposure therapy in anxiety disorders: a quantitative meta-analysis. *Depression and anxiety*, 29(2).

Preece, J. Sharp, H. Rogers, Y. 2015. Interaction Design: Beyond Human–Computer Interaction. 4ed. Chichester: John Wiley & Sons.

Sampaio, A. A. S.; De Azevedo, F. H. B.; Cardoso, L. R. D.; De Lima, C.; Pereira, M. B.; Andery, M. A. P. A., 2008. Uma introdução aos delineamentos experimentais de sujeito único. *Interação em Psicologia*, 12(1).

Tsai, C. F., Yeh, S. C., Huang, Y., Wu, Z., Cui, J., & Zheng, L., 2018. The Effect of Augmented Reality and Virtual Reality on Inducing Anxiety for Exposure Therapy: A Comparison Using Heart Rate Variability. Journal of Healthcare Engineering.

World Health Organization (WHO), 2011. mHealth: New Horizons for Health through Mobile Technologies: Based on the Findings of the Second Global Survey on Ehealth (Global Observatory for eHealth Series Volume 3); World Health Organization: Geneva, Switzerland.

Wolpe, J., 1969. The practice of behavior therapy. Oxford, England: Pergamon.

Wrzesien, M.; Alcañiz, M.; Botella, C.; Burkhardt, J. M.; Bretón-lópez, J.; Ortega, M.; Brotons, D. B., 2013. The therapeutic lamp: treating small-animal phobias. *IEEE computer graphics and applications*, 33(1). p. 80-86.

Zaminagni, D. R.; Banaco, R. A., 2005. Um panorama analítico-comportamental sobre os transtornos de ansiedade. *Revista Brasileira de Terapia Comportamental e Cognitiva*, 7(1). p.77-92.