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TOOL TO HELP THERAPISTS FOR THE TREATMENT OF SPECIFIC PHOBIA USING SYSTEMATIC DESENSITIZATION WITH AUGMENTED REALITY SUPPORT

Alessandra Bauab Azar

<https://orcid.org/0000-0002-9409-4161>

Edgard Lamounier Junior

<https://orcid.org/0000-0001-6293-9521>

José Ederaldo Lopes

<https://orcid.org/0000-0002-8835-238X>

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Abstract: This work consists in the construction of a tool to help psychologists who aim to minimize costs and obtain ease during treatments of specific phobias that use the Systematic Desensitization technique applied to Cognitive-Behavioral Therapy (CBT), since the minimization of the proposed costs by this research reflects the use of Augmented Reality exhibitions replacing in vivo exhibitions. The research aims to develop a free-form platform to be applied to any specific phobia and with the use of any type of relaxation, not limited to progressive relaxation. In addition to the development of the tool, the research aims to validate the proposal through an evaluative questionnaire applied to health professionals, but specifically, psychologists in order to evaluate the applicability and usability of the tool. So far, the research has a pilot study whose questionnaire was applied to one (1) participant.

Keywords: Augmented Reality, Cognitive-Behavioral Therapy, CBT, Systematic Desensitization, Specific Phobias.

INTRODUCTION

The Diagnostic Statistical Manual of Mental Disorders (DSM-5:..., 2014) classifies the types of phobias within the pathology of Anxiety Disorder, whose approach separates phobias into social phobia, agoraphobia and specific phobias. Specific phobias refer to phobias associated with an object or situation that triggers high anxiety in the individual. The specific phobia differs from the others because it is an isolated phobia not related to social issues (GUIMARÃES et al., 2015), (GENTIL et al., 1997).

However, it is worth noting the difference between fear and phobia. Phobia is irrational fear that affects important aspects of an individual's life. When the fear becomes persistent, overwhelming and prevents the individual from their normal function, it

is considered a phobia (DOCTOR et al., 2008). This diagnostic term alters the person's physiological functions, causing an increase in heart rate, blood pressure, hormonal level and increased anxiety (DOCTOR et al., 2008). There are several techniques and ways to treat specific phobias, such as meditation, yoga, psychotherapies, hypnosis, drug administration. The techniques commonly used to treat specific phobias consist of drug administration, psychotherapies and sessions of real exposure to the phobic object or situation (CHOY et al., 2007). However, real exposures to the phobic object or situation generate limitations such as the cost of travel to the exposure environment, the cost of drugs for intervention in case of patient discomfort, travel time, among others.

One of the psychological approaches used to treat specific phobias is the so-called Cognitive-Behavioral Therapy (CBT), which is based on the cognitive analysis of an individual capable of reflecting on their behavior.

CBT has techniques that can be used to treat anxiety, depression, bipolar disorder, specific phobias, among others. Among these techniques we can highlight the Systematic Desensitization (DS), which consists of submitting the patient to a state that is contrary to the state of anxiety (CABALLO et al., 1995). The researchers Joseph Wolpe, Pavlov and Jacobson realized that by submitting an individual to two opposing states, one of these states is alleviated, that is, by submitting an individual to a state of relaxation and then subjecting him to an anxiety-generating state, it will not be able to enter an anxious state once it is relaxed. This way, the individual is able to disassociate the situation/stimulus/object causing fear and/or anxiety from a danger alert, that is, to disassociate the anxious situation from an anxiety-inducing situation and, thus, start to associate it with a common

situation/object/stimulus. This way, it may even be possible that the person manages at some point to find himself in a state of relaxation when subjected or exposed to the object/situation/stimulus that previously caused him fear and/or anxiety (CABALLO et al., 1995).

The DS developed by Jacobson (JACOBSON et al., 1925) consists of four steps for applying the technique:

1st step: SUDS scale training (*Subjectives Units of Distress Scale* – Wolpe (WOLPE et al., 1969)). The therapist presents and applies the SUDS scale to the patient to rate the patient's level of fear regarding the phobic object/situation;

2nd step: Patient behavioral analysis and development of a fear hierarchy;

3rd step: It consists of training the patient in relaxation techniques;

4th step: It consists of the combination of exposure to the phobic object/situation, the fear hierarchy together with deep relaxation in the patient.

The application of this technique is usually applied around 15 therapy sessions and always accompanied by a professional.

The relaxation techniques that can be used in these types of treatments are: progressive relaxation, autogenous relaxation, passive relaxation and relaxation response. However, the progressive relaxation developed by Jacobson in 1925 (JACOBSON et al., 1925) is the most used in DS practice and consists of teaching the patient, through a series of standardized exercises, to contract a muscle group or more. and then relax this muscle group, in order to be able to assimilate and perceive when a muscle group is contracted and when it is relaxed (CABALLO et al., 1995), (JACOBSON et al., 1925).

The effectiveness of using SD to treat phobias has been studied since the 1960s, based on studies conducted by Wolpe

(WOLPE et al., 1973). The use of DS in clinics for the treatment of phobias is a reality, however, professionals face certain limitations during the application of this technique, such as, for example, the displacement to specific environments for *in vivo* exposures and the cost and availability of the patient and the therapist. for displacements. These limitations found a solution with technological advances, making it possible to replace *in vivo* exposures with unrealistic exposures.

The advancement of technologies and Computer Graphics, suggested a new and possible technique capable of assisting in the treatment of specific phobias, replacing traditional exposures - *in vivo* - the so-called Virtual Reality (VR) and Augmented Reality (AR). VR consists of immersing the user in a virtual environment while AR consists of inserting 3D virtual objects into a real environment, being the visualization, both of VR and AR, through a camera or an HDM (Head-MountedThree) helmet. Dimensional Display). It can be said that AR, as one of the variations of VR, emerged with the purpose of providing improvement in user perception and interaction, as well as improving the sensation of reality by inserting virtual elements in the real environment (FURHT et al., 2011).

- The researcher Botella presented studies that compare the use of VR, AR and exposure to real elements (*in vivo*) in phobia treatments (GARCIA-PALACIOS et al., 2007), (BOTTELA et al., 2010). One of her studies showed that 76% of participants (in a sample of 150 participants) preferred VR exposures over *in vivo* exposures (GARCIA-PALACIOS et al., 2007). The advantages of using both VR and AR compared to *in vivo* exposures presented by Botella are (GARCIA-PALACIOS et al., 2007):
- Reduction of monetary costs in relation

to displacement and logistics to the real environment;

- No manipulation of a real animal;
- Greater comfort for the patient and the therapist, since the treatment can be performed in the office;
- Greater control of the treatment by the therapist, since all exposure control is virtual via computer.

Now, when it comes to comparing the use of VR and AR in the treatment of phobias, Botella has advantages in the use of AR, which are (BOTELLA et al., 2010):

- Capacity of AR to provoke a greater sense of presence and realism in patients, due to the fact that virtual objects are inserted in the real environment.
- Possibility for the patient to see his own body interacting with the virtual object through the helmet. Situation not possible with the use of VR.
- The cost of an AR system is cheaper compared to a VR system, due to the fact that it is only necessary to virtually model the phobic objects. In VR it is necessary to model all virtual environments and not just the phobic objects.

Both technologies (AR and VR) consist of virtual exposures to phobic elements, minimizing costs and therapy time, also providing for the exclusion of physical danger, by exposing the patient to a virtual (unreal) object. In other words, VR and AR have great potential to promote improvement and assistance in the treatment of specific phobias, since they eliminate the limitations of displacement and costs arising from the “traditional” therapies used today. Another way to improve the limitations of displacement is to have a tool that can be accessed remotely,

for example, a platform in web format. Tools in web format have the advantage of remote access of information, which can improve limitations of displacement and information storage.

From the year 2000 onwards, the literature presents studies that present the combination of VR and DS for treatments of specific phobias in order to evaluate the effectiveness of this sum in treatments. However, it was not possible to find studies in the literature that evaluate the effectiveness nor the proposal of treatment of specific phobias of small animals using AR together with DS. The literature presents only the use of AR, purely, for these cases of phobias, which makes this article a proposal capable of integrating the application of DS with exhibitions in AR, in addition to being a free platform that does not limit the professional to use only one type of relaxation technique or just a type of phobic object and allowing remote use, both by the therapist and the patient, considering that the tool is in *web* format.

The main objective of this research is the development of a free tool for SD treatments applied to specific phobias, replacing real exposures with AR (unreal) exposures in order to minimize the costs of these psychotherapies. In addition, making the tool remote by hosting it on a web server, further minimizing costs and facilitating the control and storage of therapies.

MATERIALS AND METHODS

The proposed tool consists of a website whose access is based on two types of login: login by the professional and login by the patient. The therapist must register on the site and create their own login. When accessing the site, the therapist can register patients, register 3D models, view registered 3D models, register systematic desensitization audios, view registered audios and customize

therapies. To view the 3D models, the computer's camera is activated and the model is displayed on top of a marker that is positioned in front of the camera. And for the visualization of the audios, the sound player of the computer is activated.

The website source code was developed by the VSCode platform (CODE, 2020) and hosted on the AmazonAWS server (AMAZON, 2006).

The entire system was developed freely, allowing the therapist to register 3D models designed for any specific phobia but in .gltf format and to register any audio that is in .mp3 format, without having to be a single type of relaxation. The therapist can create an access for the patient and allocate therapies to this patient. Providing patient access is the responsibility of the professional.

In the software architecture design process, 3 tools were used for project planning, namely:

- Figma (FIGMA, 2020) – online environment for prototype design;
- Draw.io (FLOWCHART, 2020) – online tool for drawing diagrams;
- Trello (TRELLO, 2020) – online project management tool;

The research was approved by the Ethics Committee of the Federal University of Uberlândia and the system was presented and evaluated - through a questionnaire - to a psychologist in order to obtain a pilot evaluation of the proposal.

The architecture, requirements elaboration and website development stage had the participation of a psychologist.

A. System use case

For the development of the tool, first, analysis of architecture of *software*, The best representation of the tool's functionality is the sketch of a Use Case model. Figure 1 represents the Use Case diagram of the proposal.

Actors:

- *US1: Main user of the tool, Therapist;*

- *US2: Secondary tool user, Patient.*
- *Tasks:*
- *Therapist Registration: Task performed by actor US1. Refers to registering a new US1 user. Upon completion of registration, a link will be sent to the user's email for confirmation.*
- *Patient Registration: Task performed by US1. Possibility of registering patients and the possible creation of the US2 access. If the US2 access is created, US1 must select therapies which will be visible to US2. This way, US2 will only have access to what US1 selects to access.*
- *Registration of 3D models: Task assigned to US1 only. Here it is possible to register 3D models through images and/or 3D animations so that they can be viewed in AR. All registered models, in a login, are available for viewing, from a list The format of the files that can be imported from the computer to the website is .gltf.*
- *Audio Registration: Task assigned to US1. Here, US1 has the possibility to load and register audios for DS that will be used in therapy. These audios can be of any nature, as long as the file format is .mp3. Similar to the listing of 3D models, the recorded audios were arranged for viewing in the form of a list.*
- *Customize Therapies: Task assigned to US1. From the 3D models and audios registered in the US1 login, it is possible for it to customize therapies as desired. The tool allows the creation of 3 types of therapies, namely:*
- *Exposure therapy: 3D model viewing only. Here it is possible to select up to 15 3D models and it is possible to open only one 3D model at a time;*
- *Desensitization Therapy: DS audios*

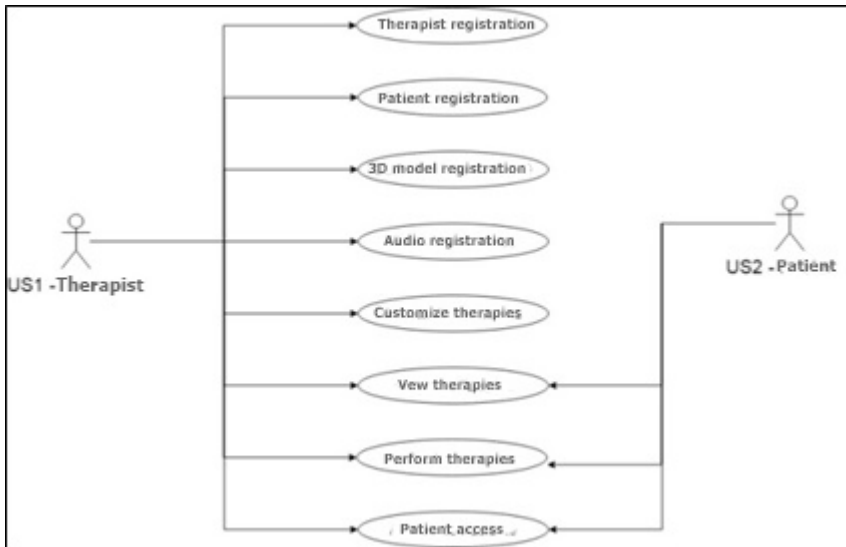
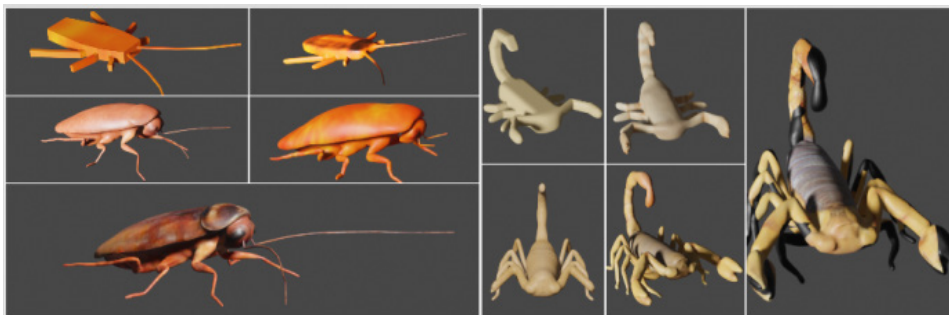


Fig.1. Use Case Diagram of the proposed tool



Fig. 2. Marker used in this research tool.

Source: ARToolKit



(a)

(b)

Fig. 3. (a) Five 3D models of the cockroach animal. (b) Five 3D models of the scorpion animal

only. Here you can select up to 3 audios for therapy. When more than one audio is included in the therapy, there is a pause interval with a time of 2 minutes between each audio;

- DS Therapy: DS audios and exposures. Here it is necessary to select files for each moment of the therapy:
- Pre-exposure: Selection of up to 3 DS audios;
- Exhibition: Selection of up to 15 3D models;
- Audio exposure: Selection of up to 3 DS audios that will be started together with the exposure;
- Post exposure: Selection of up to 3 DS audios.
- View Therapies: This task, when accessed by US1, has the functionality of viewing the therapies created in the form of a list by the name that the therapy was created. When accessed by US2, the visualization of therapies is also in the form of a list, however, it is restricted only to the therapies that were designated by US1.
- Run Therapy: This task is allowed for both US1 and US2. The US1 user can start a therapy by entering the list of therapies and clicking on the "PLAY" button, with the possibility of pausing and ending it at any time. The same applies to US2.
- Patient Access: This access is intended for US2 users. But as the US2 access was created by the US1 user, he can access using the login and password that was created. When entering the site with US2 user access, all the icons of the main menu of the site are visible,

but inaccessible, with the exception of the icons "Run therapy" and "View therapy".

B. Visualization in AR

The application of expositions in RA format of the tool was developed in the backend of the system and was developed in Java script language using two libraries: three.js and AR.js.

In order to be able to visualize the objects/images in AR, the system renders the modeled 3D images/objects and recognizes the marker whose images will be rendered. This research carried out the modeling of 3 small animals (cockroach, lizard and scorpion) and for each animal 5 different models were created with different levels of reality, totaling 15 different 3D models to exemplify the research proposal. The use of the three.js library of the WebGL framework (Web Graphics Library) has the function of exporting and importing 3D images/objects in a rendered form. This library also makes it possible to export and import files created by the Blender tool – from which the 3D images/objects were modeled – transforming the files into .json format. This described step consists of rendering the 3D images/objects for viewing in AR.

For the marker recognition step, a marker model (represented by Figure 2) present in ARToolKit was used, in addition to the AR.js library, whose function is to integrate the three.js, WebRTC and jsartoolkit5 tools, enabling recognition, rendering and visualization of 3D images/objects in AR. And so that it is possible to perform the video capture function of the computer camera, the WebRTC tool was used.

C. Modeling 3D

As mentioned before, 3 small animals were selected for 3D modeling, namely: gecko, cockroach, scorpion. The choice of these animals was based on the fact that they are venomous animals - scorpions - or that generate a feeling of disgust in individuals - lizards and

cockroaches. The tool used for modeling the animals was “ZBRUSH” (PIXOLOGIC, 2020) and “Blander” (FOUNDATION, 2020), in these tools, 3D modeling as well as texturing were performed for the gecko, cockroach and scorpion animals. For each animal, 5 different models were modeled in order to provide different levels of reality, totaling 15 3D models for exemplification.

The reality level criterion of the models was based on the high-poly to low-poly concept. The term Poly refers to polygons, when mentioning the term “high-poly” it can be considered that the image has a high number of polygons resulting in a greater degree of realism. On the other hand, when mentioning the term “low-poly”, it can be considered that the image will have a low number of polygons, which will refer to an image with a low level of realism. This concept is widely used in 3D modeling (WEBSTER et al., 2017), (GAI et al., 2016).

This way, the small animal models developed to exemplify the tool constituted the concept of “high-poly to low-poly” and, thus, each animal has 5 levels of realism for use in the tool.

Application of evaluative questionnaire

The tool was presented to a psychology professor at the Federal University of Uberlândia in order to evaluate the system created. Before the presentation, the professor signed the TCLE (Term of Free and Clarified Commitment) and agreed to carry out the evaluative research of the system.

The presentation was performed remotely using the zoom application (VIDEO CONFERENCING, 2020) where the system’s features were explained. After the presentation, the evaluation questionnaire was made available through the GooglForms tool (FORMULARIOS, 2020) to the professional.

The questionnaire contains 6 multiple-choice questions regarding usability, 5

multiple-choice questions regarding the applicability of the system and 4 essay questions that refer to a general feedback of the survey.

The statistical analysis of the questionnaire takes into account the answers to each multiple choice question. Multiple choice questions have a 5-level Likert scale, of which:

- 1 - Strongly Disagree
- 2 - Disagree
- 3 - I can’t and/or don’t want to answer
- 4 - I agree
- 5 - Strongly Agree

The results were evaluated by questionnaire session, excluding the Feedback session that contains essay responses. The weighted average of the responses was calculated, where results with an average value between 1 and 2.9 imply that the tool does not provide an ease or a possible real use for treatments of specific phobias. Results with an average value between 3.1 and 5 imply that the tool allows for ease and possible real use for treatments of specific phobias. And results with a mean value of 3 imply that it is not possible to evaluate the tool based on the questionnaire that was applied.

RESULTS

Next, the resulting images of the 3D modeling of the small animals and the result of the applied evaluative questionnaire will be presented.

A. Models 3D

The 3D animal models that were developed to exemplify the tool are shown in Figures 3 and 4.

B. Evaluation Questionnaire

Table 1 presents the results referring to the usability session of the questionnaire. And Table 2 presents the results regarding the applicability of the system.

From Table 1, it can be seen that the system has a good usability, since the result of the



Fig. 4 . Five 3D models of the animal gecko

	1	2	3	4	5	6	TOTAL
Strongly Disagree							0
I disagree		x					2
I can't and/or don't want to answer							0
I agree			x	x		x	12
Strongly agree	x					x	10
Weighted Average							4

Table 1. Usability of the tool

	1	2	3	4	5	TOTAL
Strongly Disagree						0
I disagree						0
I can't and/or don't want to answer						0
I agree		x		x	x	12
Strongly agree	x		x			10
Weighted Average						4.4

Table 2. Applicability of the tool

answers was equal to 4. since the result of the answers had a value equal to 4.4.

DISCUSSION

The evaluative research of the tool applied to a professional in the target area who will use the tool presented as a preliminary result a possible application of the system in real conditions and strengthened the hypothesis that the system presents an ease of use to users. Both from the point of view of usability and from the point of view of applicability, the tool presented satisfactory results so that the research can proceed to the next step - to evaluate the system under real conditions.

On the other hand, the results of the development of the tool and the 3D modeling were satisfactory, the visualization in AR occurred quickly and with good resolution and the website did not show any failures during use.

CONCLUSION

This research aimed to create a tool with potential for real use in Psychology clinics, in order to facilitate psychotherapies for specific phobias. This is because the system is capable of encompassing the registration of patients, registration of 3D models that reflect objects or phobic situations, relaxation audios for the use of the DS technique, as well as the possibility of remote access by the patient because it is a Web site.

The tool was developed in a free way, that is, it is capable of treating any type of specific phobia, just developing specific 3D models for the phobia. In addition, it is capable of using any type of relaxation during the application of the DS technique, not being limited to the progressive relaxation of Jacobson (GARCIA-PALACIOS et al., 2007).

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