# Analysis of Biofeedback Through Heartbeat Obtained by Exposure to Phobia Through Virtual Reality

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**Abstract.** This article aims to analyze the biofeedback (result obtained, through an analysis made based on data of human aspects through some method of evaluation) of deaf individuals male and female listeners by means of Beats Captured through a smart watch (a device that measures heart beats with a certain accuracy). This analysis was possible by conducting an experiment, where individuals with acrophobia or fear of heights were exposed to it, through two videos, representing places with a certain level of height, but with different perspectives through Virtual Reality (VR) technology. At the end of the experiment, a database was organized, and from that, some analyses were presented that we can draw from the gathered data, in addition, some curiosities are presented about this new type of technology aimed at the treatment of Phobias by means of exposure therapy through virtual reality (Vret), subsequently, some comparisons of (Vret) with other existing therapies that do not use virtual reality technology (VR) are made and describing the benefits and advantages of Use of the (Vret).

**Keywords:** Biofeedback's · VRET · Virtual Reality

## 1 Introduction

Virtual Reality (VR) has been used in a wide range of contexts; Having its efficiency accepted in the health area, using more varied technology with experimental purposes in the treatment of phobias [1]. It is possible to observe the use of (VR) in a broad context in mental health, as an example the treatment of anxiety disorders, anorexia and bulimia nervosa, support for diagnosis and psychotherapeutic counseling [1].


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This new VR utilization paradigm is responsible for the profound social and technological transformations observed in the last decade. In the United States, Canada, Italy, Belgium and other countries that developed VR applications, it is observed the use of technology employed even for professional training [1]. These experiments simulate, for example, the interaction between the physician and the patient, phobias scenarios and situations that compromise the normal state of the individual.

Products and services related to VR virtual reality have been applied in several contexts, including Vret virtual reality therapy for clinical support in the treatment of phobias, among others. The use of this technology in the sessions is mainly associated with the patient's report and the therapist's careful observation and the use of this therapy works with the focus of a cognitive and emotional education for the individual to deal better with the Phobias. In order to investigate (a) the use of heart rate monitoring as biofeedback, that is, a biological indicator of the individual's experience and (b) the difference in reception between hearing and non-hearing individuals, this paper proposes an experiment with adults who present the clinical picture of acrophobia, a phobia popularly known as "fear of height".

In this article, virtual reality (VR) will be used to design a scenario of the individual's discomfort object, such as acrophobia due to being a necessarily common phobia and to offer a low impact /risk and to verify its biofeedback and to assemble through the data collected a statement of emotional and physical stress levels.

## 2 Theoretical and Conceptual Bases

In this section, we present the theoretical bases of this study.

### 2.1 Virtual Reality

The age of virtual reality comes in full force. For years, science fiction productions, whether in the movies, video games, books, comics, used and abused "super" characters who have used virtual reality devices for various reasons, then in the year 2016, some glasses (VR) are released with this vision of science fiction and has become increasingly popular among technology fans, allowing you to see the virtual world in a different way and sensations.

The term virtual reality refers to an immersive experience based on a set of three-dimensional images or recordings. One of the goals of this technology is to enable the user to enjoy an equally satisfying feeling equally for the real world. To provide this sense of presence in the "real" world VR integrates sophisticated devices such as sensors in the headset and motion sensors that must be kept with one's hands or just with one. and several others that can be docked. A person using an equipment VR along with their sensors can interact with the items, move around and look around in the artificial world. This effect is commonly created by virtual reality equipment, for example headphones and movements; The headset consists of two small screens that are and face the user's eyes, but there is also how to recreate the effect in larger rooms, designed with several large screens replacing the glasses and giving 3D vision through these screens.

Other equipment helps in immersion, such as systems known as Haptic, which recaptures sensations such as touch, applying forces, vibrations or movements to the user, thus giving a greater sensitivity of the virtual world that overflowed the "new experience" as a very rewarding thing.

### 2.2 Definition of Fear and Phobia

Fear is an emotional behavior that has phylogenetic (unconditional) and ontogenetic (conditional) origin. According to the Darwinian model of natural selection, stress behaviors are selected throughout evolution and are typical of a large part of the species. In addition to unconditional fear, a large part of the animal species, as well as man, presents behaviors of fear that are acquired during life (Ontogenetic), through conditioning of the respondent type (Pavloviano) and operant type.

It is good to highlight that fear, like other behaviors, can be developed without any pairing between neutral stimulus and unconditional stimulus, this is an individual may never have made contact with the aversive stimulus that he avoids. When this occurs, the behavior may have been established by (a) behavior of a model (Bandura 1969), (b) rules formulated from the behavior of the model or taught by the model (Albuquerque et al. 2013; Catania et al. 1990), (c) transferência de função; A complex process that happens when equivalence classes are formed between arbitrary stimuli (Dack et al. 2012).

Fear can acquire highly harmful functions for the individual and thus generate what in the literature is called "phobia". Phobia is a type of anxiety disorder characterized by persistent fear or repulses of an object or situation. If she is unable to avoid the objects or the situation, the person begins to show signs of distress, such as faint, or panic attacks. In these cases, beyond behavior there may be other alterations such as insomnia, feelings of guilt, pessimism, inability to concentrate and total lack of interest in something that relates to phobia. It may be a generalized or specific fear, private or public, being characterized as a simple discomfort or something extremely harmful to your physical or mental health (American Psychiatric Association 2013).

### 2.3 Casual Psychological Interventions

Traditional treatment of people with specific phobias or fears is done through psychological or pharmacological intervention. Meanwhile, Baldwin et al. (2005) recommended only to consider pharmacological intervention with the use of selective serotonin reuptake inhibitors or benzodiazepines when clients exhibit disabling phobias and considerable distress and did not respond to less invasive psychological approaches.

### 2.4 Phobia Treatment Using Virtual Reality

In addition to the evolution that psychotherapies for fear and phobias have presented regarding their methods of intervention, they are being modified by the introduction of computational technologies. Techniques such as exposure to the object of discomfort underwent an enormous modification when virtual reality technologies emerged, thus having a safe and controlled form of the results of the reactions of the individuals, with,

for example, the use of simulators, which made the exposure would be increasingly explored and applied to the area of Health and Psychology. The influence and updating of techniques that use virtual reality.

In 1993 there were no publications in the area of Health, on virtual reality and 6 years later (1999) 53 articles were located. However, when comparing this data with what we have today, the difference is very great: a new search made in the PUBMED database, returned 8,852 references, by typing the keyword "virtual reality".

## 3 Method

The evaluation was made with 10 different individuals, where we asked the participants a few questions, the participants were male and female listeners and deaf people over 18 years of age with the same phobia; among the asked questions, one of them was about what each felt after the experiment and opinions about Virtual Reality technologies.

The participants of this study were chosen through a set of 30 people by a psychologist from the Federal University of Paraíba. Taking into consideration the aspects of the individuals for better analysis and data capture for the experiment. The experiment was carried out under the supervision of the psychologist and during the experiment there was no contact with the individual so that there were no changes in the data and in the immersion of the individuals. The participants and the psychologist did not know themselves, so that it is the first time that all participants and the psychologist met together, thus avoiding some analysis bias due to already knowing each other.

### 3.1 Experiment Description

It was presented two videos A and B. The former consisted of a scene where there was a bridge located above a lake, and the goal was to reach the other side of the bridge; with the immersion of the virtual reality stimulating vision, and through wind and birds sounds from the headphones, the participant could move his view to any angle (side), so that it was all dynamic (360°) while the video was playing, showing the displacement to the other side of the bridge, it was the participant's responsibility to control the direction he could look . The later video was incorporated by a passenger into a roller coaster trolley where the same presented dynamic in the 360° view video A was composed, and the sounds of people screaming, and more ambient sounds; we utilized a precision clock of precise beats during the experiment; before and after the experiment a professional heartbeat was used and the same intelligent clock the two gave very similar values.

### 3.2 Equipment

It was used a video game PlayStation 4 Fat, the player of the videos that was used was the Youtube application, the interface of visualization was the Sony Virtual Reality

glasses from the PlayStation itself of the following specifications Display: 5.7, "OLED, field of view 100°, Graphics: 1080p RGB (960xRGBx1080 per eye; 90–120 Hz refresh rate), Sound: 3D audio, via TRS connector and microphone input available; Input: Positional tracking of 9 LED's via Playstation Camera; Connectivity: PlayStation 4 connection via HDMI (with a size of 3 m), an Earphone: Samsung Brand, Model: In-Ear Stereo IG935, PlayStation Camera with two lenses (cameras) to check the 9 Sensors of the (VR), with a resolution of 1280 × 800 pixels (with lenses having a f 2.0, with 30 cm focus distance, and 85° field of view). With the dual camera configuration, the camera can operate in different modes, depending on the application destiny. The two cameras can be used together for the perception of depth of objects in their field of vision, or only one can be used for motion tracking and another for recording videos, the Tv playback of the images for observation was a Tv 60 in., LG LCD.

### 3.3 Equipment

The environment used was a room of size 5 × 3 m with totally free space for the movement of individuals at 2.5 to 3 m from the video capture camera and recording motion sensors to have a good average movement space of the space was isolated so that there was no disturbance of external lighting.

### 3.4 Results and Discussion

We asked a series of 20 questions about the experience of exposure to phobia with VR, such as whether people already had contact with this kind of technology, if they had any negative aspect after its use, if they could tell the difference between virtual and real, whether the sound mattered or not in the experience, among other questions. All participants had notoriously a great experience due to the encounter with a technology they had never used. Aside the questions, we also created tables with the levels of variation of the beats and we have also separated the sex of the person and whether or not he was a listener so that we can verify in his subsets the data whether or not there was any coherence between the same subsets.

An important part was the analysis of the experiment in the aspect of sound, because, as the research was conducted on listening and deaf participants, sound was a fundamental part, and certainly the biggest difference between the two sets of participants, and ended up making the greater curiosity between the aspects of the participants, because the sound really made a difference between the listeners and the deaf. The listeners had a greater reaction to the fear of height in relation to the deaf. In addition, deaf people had an average change in heart rate less than the listeners heart rate, showing the uncontrolled situation or lack of immersion or real understanding of the situation or simply a natural reaction of the functions thus, showing greater control in terms of phobia in height. It is worth mentioning that the two minor variations were deaf; Showing in this study that the sound in the view of our current virtual reality (VR) technology and according to the videos A and B presented and the analyzes done with the established points were more effective with sound.

The following tables named Tables 1, 2, and 3 show the summary of what was done in the experiment where we analyzed the participant's results one by one, placing

the pulse reader on his wrist, thus storing the heartbeat before the tests and give with the smartwatch on his arm, during the experiment every 2 s he calculated the heart rate again, the intelligent clock sent the calculation to the computer through his application (pre-established by the watch manufacturer) in the case "Background Wear" after saving the heart rate soon after performing the experiment we do another check of the beats without the virtual reality apparatus and headphones of the experiment and we move on to the questions about the experience with the experiment, catalog the data and move on to the next individual to shut down people, Table 1 consists of a table of the 10 individuals selected in general, deaf people and listeners where we can see their variations and the observations of the experience as well as their sex Tables 2 and 3 result in a separate analysis only to confirm that we did tests before with listeners and with sound and without sound so that we can really know the importance of the sound in the experiment and giving an even greater security to the data and final conclusion of the test.

**Table 1.** Table of general results listeners and deaf.

| Individual | H.Before | H.During | H.After | Variation | Sex | Condition | Note |
|---|---|---|---|---|---|---|---|
| 1 | 83 | 90 | 96 | 15 | F | Listener | Little fear |
| 2 | 72 | 85 | 78 | 13 | F | Listener | Fear |
| 3 | 86 | 92 | 90 | 6 | F | Deaf | Happiness |
| 4 | 102 | 110 | 105 | 8 | F | Deaf | Dizziness |
| 5 | 94 | 100 | 98 | 6 | M | Listener | Dizziness |
| 6 | 76 | 82 | 80 | 6 | M | Deaf | Curiosity |
| 7 | 92 | 98 | 90 | 6 | M | Listener | Distrust |
| 8 | 84 | 87 | 80 | 3 | M | Deaf | Curiosity |
| 9 | 85 | 89 | 87 | 4 | M | Deaf | Anxiety |
| 10 | 100 | 127 | 105 | 27 | M | Listener | Fear |

Table 1 shows the data of the hearing and deaf individuals doing the test, the listeners made the headset test by emitting sound from the respective videos A and B, as shown in the subsequent tables, which are the Tables 2 and 3 the listeners when exposed to the test without the sound showed results of very low immersion, different from when it was with the sound, showing the immersion data much more expressive, the three tables were placed so that any questioning that may be made can be answered, for example: Why did not they test with soundless listeners? then Tables 2 and 3 may respond.

We put as general table in the case the Table 1 a new experiment of deaf and hearing with results different from the Tables 2 and 3 by the factor that we repeated the experiment with the listeners to give the certainty of the greater immersion due to the video with the sound of any form can if we observe the similarity of data from both Tables 1 and 3 that are experiments with sound listeners.

**Table 2.** Experience without sound.

| Individual | H.Before | H.During | H.After | Variation | Sex | Condition | Note |
|---|---|---|---|---|---|---|---|
| 1 | 88 | 92 | 90 | 4 | F | Listener | – |
| 2 | 90 | 88 | 92 | −2 | F | Listener | – |
| 3 | 90 | 95 | 94 | 5 | M | Listener | – |
| 4 | 100 | 98 | 94 | −2 | M | Listener | – |
| 5 | 105 | 108 | 98 | 3 | M | Listener | – |

**Table 3.** Experience with sound.

| Participant | H.Before | H.During | H.After | Variation | Sex | Condition | Note |
|---|---|---|---|---|---|---|---|
| 1 | 83 | 98 | 96 | 15 | F | Listener | – |
| 2 | 72 | 85 | 78 | 15 | F | Listener | – |
| 3 | 94 | 100 | 98 | 6 | M | Listener | – |
| 4 | 92 | 98 | 90 | 6 | M | Listener | – |
| 5 | 100 | 127 | 105 | 27 | M | Listener | – |

Table 2 shows how the results of the Variation were low, this is the experience without sound for listeners showing no immersion in the experiment.

In the table we separated the subjects from 1 to 5, the beats before the procedure the average sum of the beats during the video, and the beats after the video, we calculated their variations in the difference of beats before the experiment and during the experiment, we also show the sex and the condition, which in the case of this table were all listeners, Table 2.

Table 3 shows the great variation of the heart beats of the experiment with sound to the listeners, thus showing the great difference between Tables 2 and 3, showing the sound function for a greater immersion in the experiment.

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The technologies that exist today in VR are not totally geared towards equality between deaf people and listeners. There is a great disparity between these sets, this is what this article also shows, that a technology like RV is a breakthrough in many areas such as health, education, entertainment, thus demonstrating great flexibility in many ways, to be desired when it comes to the fairness of satisfaction and /or immersion of the two sets of participants studied, i.e. deaf and hearing, this may be due to the low demand of buyers who are deaf compared to hearing buyers, or to participants who consume products in general do not need such drastic changes because of the custom of having only a median rather than a maximal experience or someone whose disability does not fully immerse, thus making people with specific disabilities out of the target public of companies that produce for this technology.

## 4 Conclusion

There were some limitations in the research due to a few points. The main one was the exclusive use of a single virtual reality glasses model, which was PlayStation VR, so there would be no way to analyze and see the data that were based on other virtual reality glasses, such as Gearvr or Sansung HMD Odyssey. The fact that this technology is still very expensive and we couldn't afford it, that everyone in this test should have the same phobia /fear containing something that was equal to all participants and it could be that the data were with a variation of much higher beats are available from a more immersive environment, obtaining a greater reality in the experiments, like a Digital cave.

With the data extracted from this evaluation through biofeedback and the questions asked, we can evaluate that VR draws attention, due to its interaction but efficient response to human body actions, with almost instantaneous response of its movements through its sensors. Also, the participants ability is embedded in the scenario of interaction due to his set of lenses to give the 3d look, in the case of this work, the immersion was of his phobias and /or fears of height, as shown in videos. A and B, where it was collected from the cardiac variation, thus leading us to understand that even with the deafness deficiency and the set of participants being eclectic all had a similar behavior of increased anxiety before the display of the point of discomfort, shown that yes virtual reality resembles the real world; With some participants more intensity and others with less intensity, as shown in Tables 1, 2 and 3 of tests. In any case we have to have a greater discussion, due to the immeasurable possibility of the evolution of this technology of Virtual Reality VR in the area of health as well as in the area of entertainment and studies thus giving a huge range of experiments that can be done and studied so that with the advancement of studies.

We need to open up more discussion space to the technological aspects, taking into account people with disabilities, we have to take the technology to the people who are unable to have, or at least appreciate such technology making the VR technology a force of union, not of segregation, we have to create technologies and technological advances that can be inserted in any group of people, and we do not segregate people by their differences; this work then shows that it does have the possibility of finding a junction of factors because the data are similar between deaf and hearing all the two sets tend to have an increase in the beat before the exposed of their phobias showing the importance of terms that advance in the technology through the study of the most varied cases, with or without special needs with the most varied individuals, and of different types of forms.

One part that became peculiar in the test was the aspect of sound because as the research was done over listeners and deaf, the sound eventually became a fundamental part and it certainly is the biggest difference between the two sets of individuals. This was something that was not expected among the proposed aspects due to being a joint thinking team that would not make the sound difference due to the fear of height seemingly to be almost all visual, however the sound really made a difference between listeners and deaf. Listeners presented a greater reaction to fear when exposed to fear

along with sound as shown in Table 1 (general) and the notorious difference in Tables 2 and 3 that was presented while the deaf.

Deaf people had a lower average heart rate (measured by the smart evaluation clock) than the hearing loss. In addition, the two worst heart rate variations were deaf people, we considered the higher the heart rate variation, but the individual would be anxious and more immersive to the experiment treating the virtual world as real hence the more anxious the greater response to the experiment we can then classify the people who had the most reaction to the experiment when separated showed that the set of people with more reaction were the listeners; showing in this study that the sim sound in the vision of our current Virtual Reality technology and according to the videos A and B presented were more effective with sound, this raises a hypothesis will be that we are not forgetting to create a truly inclusive technology of parameters equal to all? and how can we do this analysis? and really understand the reality of every great group in society how can we create something egalitarian for the use of all?.

We tried to perform a more effective treatment of Phobias and /or fears to confront in an immersive way and compare with the existing treatments for such purpose using virtual reality. We created a more interactive environment not only in the video part but rather that individuals can, through moving controls, interact with the proposed scenario. We conducted a test with more people of different aspects to expand the scope of future research findings. We created a model of study that will progress in the future to a method that in addition to measuring the stress in some way, will calm the individual through something stimulus that makes the scenario more comfortable.

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