Measurements to Determine the Effectiveness of the Phobias Treatments

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Abstract: With the levels of stress that involve the everyday activities of human being, the number of phobias and the people who suffer of these phobias has increased. The phobia treatments by direct exposure used by the psychologists have shown be effective, but in many cases it can be a danger for the physical and psychological health of the patient. In some treatments additional trauma or physical damage might be caused as a consequence of an incorrect control of the treatment; thinking about the decrease of the traumas caused by the treatment of the direct exposition, some medical centers use new technologies as the virtual reality. The doctor does not have a certain control of the variables of measurement for the determination of the level in the phobia conditions, which show an indication of the medical evolution.

The article explain the research with the objective to determine if the virtual environment has any influence in the person's psychological change seen through the changes of the controlled vital signs.

Key - Words: virtual reality, Experimentation, Security, Standardization, Measurement, Performance, Reliability, phobia, vital signs, measurements, phobia environment, phobia treatment Graphical environment, Interactive environments Design.

1 Introduction

At the stress levels that imply the daily activities of the human being, the number of phobias and the people who suffers from these phobias has increased. The treatments of phobia by direct exposure used by the psychologists showed are effective, but in many cases can be a danger for the physical and psychological health of the patient in treatment [2]. In some Cases, the trauma or the physical damage might be greater, caused as a consequence of an incorrect control of the treatment.

Then, thinking about the decrease of the traumas caused by the treatment of direct exposition, a new technology known as virtual reality, it has been used (figure 1)[11]

The term Virtual Reality, is a specific group of technologies; hardware (Head Mounted Display, Glove Input Device, Audio) and a computer simulation of a real or imaginary system with the possibility of operations on the simulated system and with very realistic effects in real time.

Fig. 1. *Medical center for phobia treatment: Mary Levin, University of Washington.*

It is a form of interaction between the human and the machine in an imaginary environment. The users interact and manipulate the virtual environment in three-dimensional computer worlds.

Using virtual reality has been a constant in the technological field [8]. Virtual reality can be applied in a variety of ways, its use with flight simulators and games (As a form of entertainment), Medicine (practice

new surgical procedures on simulated individuals) (figure 2,3), Industry (prototype designs for new products) (figure 3), architecture, weather simulation, work Training (personnel for work in dangerous environments), chemistry and other applications in most of the disciplines.

Fig. 2. *VrMedLab, College of Applied Health Information Center Science. Medicine Application (learning)*

Fig. 3. *VrMedLab, College of Applied Health Information Center Science. Medicine Application*

Fig. 4. *VRMC (Virtual Reality Medical Center), San Diego*

With the introduction of this technique in the treatment of phobias, we expect to create virtual reality situations for the patient and his virtual direct exposure to environment, where the patient can suffer a specific phobia (claustrophobia; scare of heights, fears of driving a car…) but in a safety environment created by the computer in a virtual way; trying to obtain a better control of this environment, giving to the patient the possibility of changing to a relaxed environment in a possible dangerous psychological reaction, without any delay. [7]

One of the input devices used in a virtual environment is a tracker. This device is capable of reporting the location of the people in space. The Tracking device using in this research is optical. The optical tracker device is more comfortable and ease to install. We do not use other traditional computer input device (joystick, mouse, keyboard...) because is very important the similarity with the real world.

There are some possible questions about this new technology. For instance, if it's really true that it can create the conditions that can make the patient feel the same effects of the real life? [4]. And secondly, if this new technique could be a useful instrument for the treatment of phobia; having in mind, that there is no valid method of his effects in the patient, different one from the subjective evaluation that the doctor does based on the patient perception, which is the traditional diagnosis of this kind of disease.

Just doing a simple assessment of the evolution of the patient with the current procedures, it would be dangerous if the results were done in wrong way specially to determine the progress on the patient before and after the treatment, where his psychological and physical health could be affected in a real environment (figure 5)

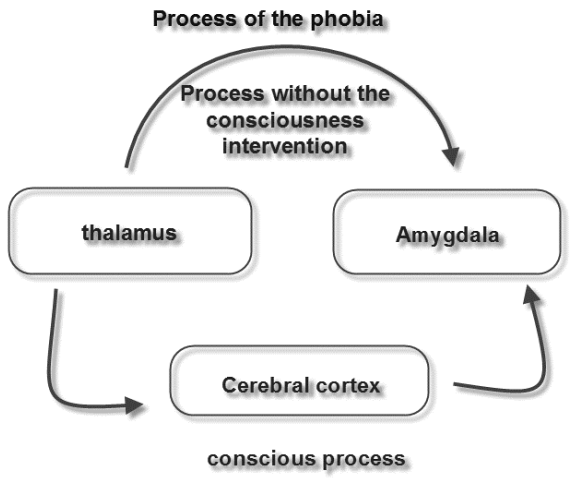

Fig. 5. *Phobia Process*

To produce the virtual environment in this research, some equipments of virtual reality are going to be used, like, infrared tracking and Head Mounted Display (These unit use goggles to displays video in front of each eye, with special optics, fig. 6) [9]. The equipments used to measure the reactions are: cardiac frequency meter, software for processing the frequency of the voice and thermograph camera. Virtual environments are created in order to simulate the reality; they will be projected in the Head Mounted Display.

Fig. 6. *Virtual reality equipment.*

The methods used nowadays to measure the effectiveness of the treatment are the survey [2], That's why we are thinking about using a quantitative assessment, different on the patient perception, that allow us to measure in a specific scale, the treatment development and additional his use as a tool of assessment for phobia treatment [3].

An answer to this consideration could be found in the vital sign. It has been proved by medical specialist methods, that the vital sign are affected with some changes in his stress level. The idea carried out in the current research is based on the identification and measurement of specific vital signs of a person in a real relaxed environment, doing subsequently measurement of the same vital sign in a virtual environment, that shows situations of possible dangers or phobia that the person has been exposed, trying to find a measurement that allow us to determine, if this environment exerts any influence over the patient. The vital signs identified and used in the research are the cardiac frequency and corporal temperature.

Another additional element to take into account is the fundamental frequency of the voice, in which free software for voice processing is used [10]

We expected to prove with this research that the use of these parameters would have the quantitative measurement of the influence of the virtual reality on the patient's stress, without the influence of personal criteria. The phobias chosen to develop this project are claustrophobia (fear of being locked, figure 7) and acrophobia (fears of height, figure 8).

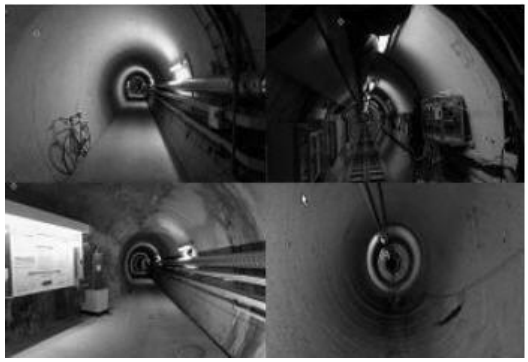

Fig. 7. *Virtual Reality images of closed spaces*

Fig. 8. *Virtual reality image for the research*

2 Argumentation of the Method

In every research project, where the results have a direct influence with the medicine and the procedure have possible effects on the people who are under test, some requirements have to be considerate to comply with ethical and safety methods for the people who are going to be exposed to the studies.

Thinking about the medical implications, some working sessions were made with medical team experts in vital sign who made a deep analysis of the research and they conclude that:

- It is important to avoid epilepsy attack in the patients by photosensitivity or a reaction to some stimulation patters of light with a final wrong ECG result. They suggest the limit time, for the virtual reality session, less than 3 minutes thinking about dropping the head tracker reaction and to check out the movement of the images during the session.
- For the hand, is necessary to use insulation material to avoid any heat transfer between the hands and the table. Additional to that, the researcher must include the loss of heat by the environment using formulas of transfer of heat.
- The initial survey we question about the treated phobias different from the previous ones (fears of height and fear of closed spaces) to have a special care with these patients.
- The patient has to read carefully and understand that these tests do not represent any body or mental risk and his participation is voluntary. The patient has to sign at the end of the survey.
- Before starting the treatment, the patient has to undergo a visual test because the people with visual problems can suffer tiredness, so they would need virtual glasses compensation or the other recommendation is not working with this kind of patients.

Doing an examination of the some elements like the heart rate frequency, the cardiac variability and the temperature, likewise the fundamental frequency of the voice, we expect to have a quantitative scale of patient's assessment, especially for the doctors to know the stress level of the patient and of course, the treatment progress or evolution of the phobias in closed spaces and heights.

The selection of the vital sign was determined by the facility in the measurement methods and the magnitude of the changes on the stress levels. On the other hand, there are no studies that show the bigger changes on the other vital signs.

2.1 Situation of Stress and Regulation of Temperature

When a patient is under intense stress, he feels strong changes in his emotions and feelings, due to the effects of a high tension; it causes a bad regulation of heater system of the human body. These changes are more remarkable in some body places where capillary irrigation is higher, for example, the hands.

In Chronic stress situations, people manifest reactions with cold hands caused by problems on the efficiency of body heating system The physical cause of this reaction is the hormone segregation with elements potentially blood vessel constrictor, the muscles spasms of the walls of the arteries, the rusting that damage the red cellular membranes making them thicker and the clots formation because of the platelets [1].

Adrenaline is a hormone with vasoconstrictor characteristics. This hormone, can cause spasm in arterial walls, reducing the lumens, especially in capillary system because is more thin. As a consequence, the flow of blood cannot be transported and also the flow of blood has difficulty to reach the tissues and final consequence; the temperature fall down in the hands.

The accelerated oxidative injury in the membranes of red blood cells cause also temperature fall, because blood platelets form clumps causing more blood coagulation.

The temperature of the thermographic tests in the hand shows a percentage little higher in increase. The correlation of the temperature in the different environments is high it does not allow to differentiate the groups in the closed space and height virtual environments (fig. 9)

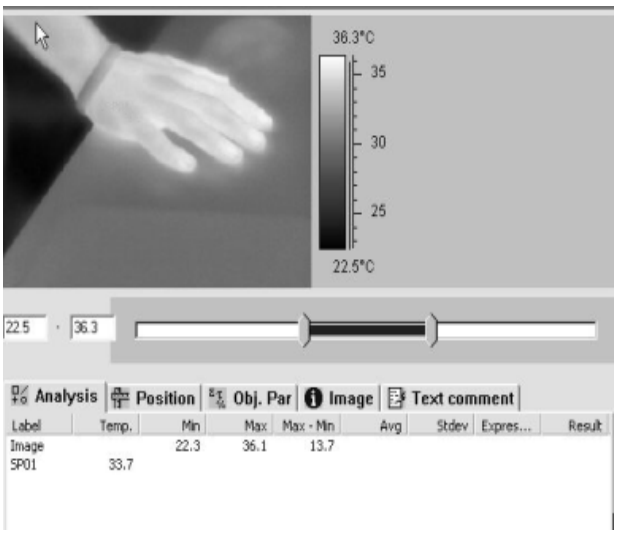

Fig. 9. *Termographic data.*

2.2 Heart Rate variability

It refers to arrhythmia or rhythm not symmetrical of sinusal node, which is the one that works as heart's pacemaker [6]. It happens at breathing phase. It is an easy influenced parameter by emotional changes of the persons[5]

If the heart rate variability is studied instead of the cardiac frequency (figure 10), it shows a drop in the measure in both virtual environments with a big difference that allows us to identify the virtual environment in which the patient is (figure 11).

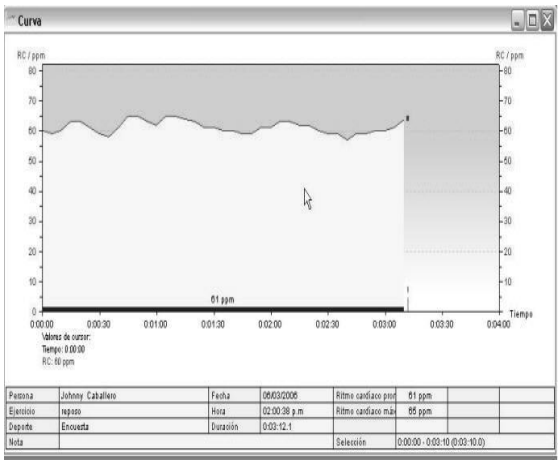

Fig. 10. *Heart rate measurement*

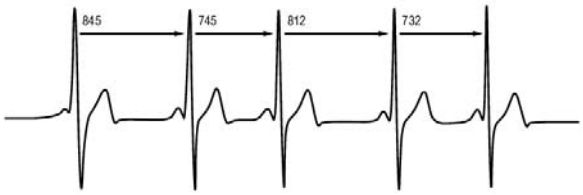

Fig. 11. *Heart rate Variability measurement*

2.3 Fundamental frequency of the voice

The muscles of the human body vibrate at a specific frequency and it includes the vocal chords. In some stress situations, the muscular vibration changes and the voice frequency too (figure 12) .

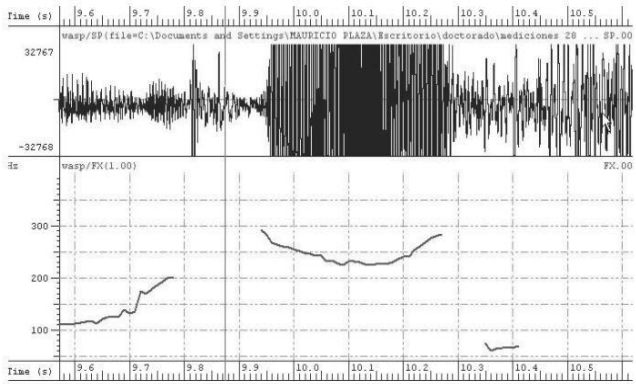

Fig. 12. *Fundamental frequency of the voice*

Some different techniques can be used in the behaviors of vocal cords. One of these is the fundamental frequency of the voice. It consists in obtaining the frequency of the sound produced by the vocal chords, which is highly correlated with the intonation and stress levels.

A decrement is show in fundamental frequency of the voice, the correlation of the average values of the fundamental frequency in the two environments show that there is a difference, allowing us to distinguish the two environments [9]. The duration of the voice goes down but in the same way of the voice energy, they do not present any significant change, so they are not a good parameter to determine the influence of the virtual reality.

3 Experimental procedure

From the previous analysis, the experimental work will consist in creating, first of all, virtual environments of height and closes spaces for the people who voluntarily accept to be part of the analysis.

It will allow us to measure the vital signs identified as in a real relaxed environment without any level of stress, like in virtual environment made; and since the result, we can contrast the two results and with it, we can determine if the virtual reality has any influence in the patients.

The main achievement is to find, with this experimental test and with some virtual reality tools, if the synthetic environment produce similar effects to the real ones and the possibility of using these results as a tool of the phobias treatment.

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Working with a experimental design, we found the selection of a sample for the research; beginning with some engineering students from Universidad Libre , Bogotá, Colombia (ULC). In order to have a starting point to determine the size of the sample, we use statistical procedure. The result of the analysis offered the necessity of making studies over total of 308 students between 1350 students at the ULC, for a standard minor or equal error to 0,015 and a probability of change of the average value of 90 %.

Due that in the literature there is no information that shows results of assessment of virtual signs in people under treatment of phobias using virtual reality technology, in order to have a starting point to determine the size of the sample, we use the following procedure:

1. Considering a normal error ($\sigma 2$) and with the possibility of the some real value variability (p).
2. After having these definitions, we calculate the size of the sample according to the expression.

$$n' = \frac{s^2}{\sigma^2}$$

S^2.- is the variability of the sample and mathematically is equal to p(1-p). $\sigma 2$.- It is the normal error (standard) of the population who would be mathematical equal to Se^2.

3. Finally adjust the size of the sample by the expression

$$n = \frac{n'}{1 + n'/N}$$

The result of the analysis offered the necessity of making a studies over total of 308 students between 1350 students at the ULC. The standard error was 0.015 and a possible variability of the value of 90%.

In the sample of the selected population, 43 % of the subjects showed having some type of phobia, whereas 57 % of them do not show any type of phobias. Of the group of persons who showed some type of phobia, 56 % of them, manifest fear of heights, whereas other 18 % show phobias to the closed spaces and the rest manifest some type of different phobia.

The steps for experiment was defined as follow:

- √ First of all, the people were informed about all the process and they all were trained on how to use the virtual reality equipments. When a person initially use a virtual world, tend to be very disoriented but, if there is training in sufficient time, they can develop practice with the virtual world's images similar to the ability of the real world
- √ Once training is finished, we ask the person to fill a simple survey, during the survey, the vital sign data is recorder.
- √ In the next step, the patient is to undergo to virtual environments of height and closed spaces and the researcher must register the same vital sign parameters. The virtual environment used consist of images of 360X360, Head Mounted Display (True 800 X 600 resolution, PC/SVGA, figure 13), an Infrared Tracker (SmartNav 4, figure 14) , a Polar system for cardiac frequency (Polar S625X, figure 15,16,17), a microphone and software for processing the voice frequency (SFS), figure 18), a fan and a thermograph camera (Flir system).
- √ Afterwards, a contrasting of information data is done under the two different environments in order to find some differences that allow us to validate the method of this research.
- √ At the end of this test a survey is done again. The patient is asked about his feeling or impression of the experiment and the generated stress level. This information will be correlated with the vital signs data.

Fig. 13. *Head Mounted Display*

Fig. 14. *Infrared head tracker*

Fig. 15. *Polar heart rate monitor*

Fig. 16. *RF Belt transmitter*

Fig. 17. *Hear rate monitor System*

Fig. 18. *Noise cancel headphones*

4 Result of the Research

47 % of the persons who had shown to be afraid to the heights informed to feel a little affected by the virtual environment, whereas 5 % of these individuals felt very affected. This means that it is necessary to improve the interfaces of virtual reality to obtain systems more fitted to the reality.

8.8 % of the individuals submitted to the virtual environment showed symptoms as sickness, during the test and later to the test. These symptoms are known like "motion sickness " and " simulation sickness " (figure 19). It is caused by the difference between the response that hopes to receive the brain and the response that the senses receive. With the current systems of virtual reality exists still a difference in the way, as the brain perceives the real world and the virtual world.

Fig. 19. Simulation sickness effects

The vestibular conflicts are caused by the time delays between a person's movements and how the Head Mounted Display reflects those movements. Additional

to that, the optical quality of the displays has high importance in the virtual reality perception (figure 20).

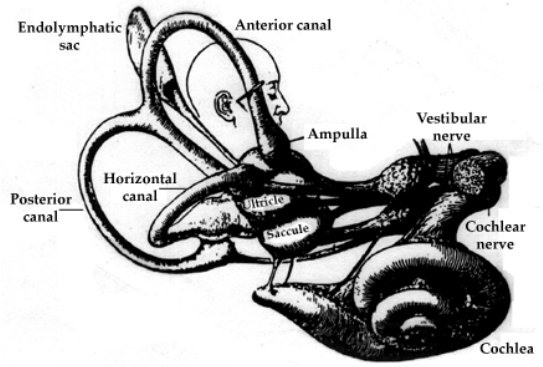

Fig. 20. *The Vestibular Apparatus*

For individuals with fear of the heights, the cardiac frequency presented a similar value in rest and in the virtual environment (Rest environment: 83.3 bpm (pulsations per minute); virtual environment: 84.4 bpm; ANOVA Sig: 0.754). With these results we conclude that the average cardiac frequency is not a good parameter to evaluate if a patient is affected by the virtual reality. On the same way, in virtual environment of closed spaces, there does not exist a significant difference between the environments (ANOVA, Sig: 0.413) and the averages of the cardiac frequencies are similar, indicating that it is not a useful parameter.

The corporal average temperature allows identifying the level of stress of an individual submitted to virtual environment compared with the ambiences of rest, across a light but significant increase of the corporal temperature. This conclusion is achieved by an analysis of variance (ANOVA), for a group of homogeneous subjects, which have fear of the heights and of these obtained values, his average are compared with the test of Student - Newman – Keuls. In contrast to the virtual environment of heights, the corporal temperature is not a useful parameter to determine the influence of the virtual environment of closed space (ANOVA Sig: 0.558). Only this parameter can be used in the virtual environment of heights. The changes in average temperature in the virtual environment of closed spaces is low (Rest Environment: 28.26 Celsius, Virtual Heights: 28.7 Celsius, Virtual closed space: 28.5 Celsius)

The difference of two environments presents itself as an increase in the corporal temperature, in contrast to the medical literature. In medical research results an individual submitted to stress situations, presents a decrease of his corporal temperature. This difference is explained in that the virtual environment does not generate a very strong reaction, but the fear of the environment produces a high level of attention, that produces symptoms similar to the relaxation and as turned out, a increase of the corporal temperature in this research.

In the individuals with fear of closed spaces and realizing the same previous statistical analysis, we conclude that the parameter of fundamental frequency of the voice is appropriate to determine if an individual is affected emotionally by a virtual environment of heights, which demonstrates for an increase of the fundamental frequency of the voice.

In the individuals with fear of the heights, the energy of the voice does not present significant changes as the statistical analysis ANOVA (Sig: 0.383). In the results of descriptive statistics, the energy of the voice does not present significant changes in rest environment, virtual environment of heights and virtual environment of closed spaces (81.4, 80.5, 80.7 decibel, respectively). This statistical result indicates, that the energy of the voice is not a parameter appropriate to determine the influence of the virtual reality in individuals with phobias.

With the result of the ANOVA analysis, considering two groups of work, one that corresponds to an environment of rest, and other, considering both virtual environments, it is possible to observe that differences exist in the behavior of the cardiac variability, between the group of individuals in study, when they are in state of rest in relation to when they are under the virtual environment of phobia (ANOVA Sig lower than 0.005).

The average of the cardiac variability changes in significant form (rest: 3.5, environment of heights: 1.05, closed Space: 3.1), showing a decrease in the value that agrees with the medical literature.

The parameter of cardiac variability, as result of research, is the only one that allows identifying the level of stress generated by two virtual environments of heights and closed spaces. The other parameters can be used only in virtual environment of heights. This result indicates that the virtual environment of closed spaces does not present the same level of similarity with the real environment.

5. Conclusion

Fig.21. *Virtual reality center for the research.*

The virtual reality is a tool used for the phobia treatment by some medical centers [12] (fig. 21). Due to the necessity of having a tool to measure a quantitative scale, the effectiveness of the treatment and the patient evolution, the present research, based on medical studies about the influence of the stress in the vital sign, is trying to determine the effectiveness of the virtual reality and establish a scale that can be used by the doctors in the treatments.

With vital signs and the fundamental frequency of the voice found and checked, we can conclude that there are some parameters like the average cardiac frequency, energy of the voice and duration of the voice, which does not allow us to distinguish the reaction of the person in virtual and rest environment. Some others parameters like the temperature, cardiac variability and fundamental frequency of the voice let us distinguish the estate of rest and virtual environment. Only the parameter of cardiac variability can be used in the virtual environment of closed spaces and heights. The parameter of temperature and fundamental frequency of the voice are only useful in virtual environment of heights.

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