Development Of A Virtual Environment Based On The Perceived Characteristics Of Pain In Patients With Fibromyalgia

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Abstract. Fibromyalgia (FM) is a disorder characterized by chronic physical pain. The perception of this pain has psychological effects on mood, anxiety, and the degree of perceived control. In turn, these factors may increase the experience of pain. This study aims to develop a new virtual environment for the treatment of FM in order to enhance the therapeutic effects of traditional interventions. The first phase included a sample of 19 patients in order to identify common characteristics of the representation of pain and absence of pain, through drawing. The results showed that patients used different colors and different physical states to depict pain (red, motionless) and the absence of pain (blue, in motion). These features were then included in a 3D representation of the human body. ANOVA analysis showed that the degree of anxiety and depression influenced the perceived characteristic of movement.

Keywords. Virtual reality, Fibromyalgia, characteristics of pain, clinical sample.

Introduction

Fibromyalgia (FM) is a disorder characterized by chronic widespread pain in different areas of the musculoskeletal system, including hyperalgesia and allodynia. FM patients may present other related symptoms such as intense fatigue, sleep disorders, paresthesias, stiffness, headaches, and a feeling of swelling in the hands. Due to the variety of the symptoms, patients commonly present hypervigilance toward pain perception, and frequently engage in testing behaviors by touching the parts that are painful (1).

In addition to these physical effects, various psychological states have also been shown to be directly involved with pain. Studies have shown that negative mood correlates positively with pain perception and a lower quality of life (2). The level of anxiety also presents a positive, statistically significant relationship with pain intensity (3). In addition, an increased perception of control encourages patients to believe that they are able to cope with the pain, and increases the use of active coping strategies (4) which reduce the physical and psychosocial impact of FM (5).

Cognitive Behavioral Therapy (CBT) has only a moderate effect on these psychological variables (6). Developing alternative treatments based on new

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technologies may enhance the therapeutic benefits. Virtual Reality, for example, achieves greater effectiveness than exposure in vivo in anxiety-related disorders (7). This new software aims to promote an active confrontation with pain rather than focus on the distraction of attention which characterizes other environments for the treatment of chronic pathologies.

In a preliminary study, Gutiérrez and colleagues (8) created a virtual environment to represent states of acute pain and no pain. This virtual environment was able to reduce pain intensity and increased participants' tolerance (9). These authors concluded that this environment also increased auto-efficacy, and reduced catastrophism (10).

Continuing this line of research, the aim of the present study was to develop a virtual representation of pain and no pain states for patients with FM. A second objective was to identify pain-related characteristics that may be conceptualized as continuous, to enable individuals to transform their own perception of pain. Finally, a third aim of study was to find relations between perceived characteristics of pain and anxiety and mood.

Based on previous research (8, 9, 10), this new virtual environment was developed from FM patients' experiences of pain of and was specifically designed for use with these patients to complement their standard treatment which consisted in CBT for FM. Pain experiences were recorded on a Visual Analog Scale (VAS) included in the software to quantify specific pain variables. Based on the procedure developed by Gutiérrez and colleagues (8), the VR environment also allowed patients to modulate these pain-related variables. In the light of previous results (9), we expected to find a pain reduction that would lead to an improvement in mood and a reduction in anxiety, finally raising patients' quality of life and enhancing their perceptions of efficacy (10).

1. Methods

Nineteen patients diagnosed with FM participated voluntarily in the study. First, they were asked to draw their representation of pain and to write down the most relevant characteristics of pain experienced. Then, they drew a representation of the absence of pain and again had to write down its most important characteristics. In order to quantify their experience of pain, participants also completed the McGill Pain Questionnaire (MPQ) (11), containing 21 items divided in four subscales: sensory, emotional, evaluative, and pain intensity. The degree of anxiety and depression was also quantified using the Hospital Anxiety and Depression Scale (HADS) (12), which has 14 items measuring anxiety and depression.

2. Results

Pain variables were categorized by color, image drawn, and the participant's depiction of the key feature of their pain. Over half the participants (57.9%) chose red as the color to represent pain. The most frequent image drawn was the human body (36.8%). The most prevalent description of pain was the feeling of stiffness (68.4%).

Blue was used by 31.6% of the participants in their representation of absence of pain, and green by 26.3%. As regards the shape, 42.1% of participants drew a human body,

and as the feature that best described the absence of pain, 52.6% of participants mentioned movement

The contingency tables revealed that 36.4% of those who chose red in the figure of pain also chose blue in the figure of absence of pain. Another 36.4% chose green to represent the absence of pain. Meanwhile, 85.7% of participants who drew a human body in their representation of pain also drew the human body when asked to represent the absence of pain. Finally, 61.5% of participants who described the key feature of their pain as a sensation of stiffness also defined the absence of pain by a description of movement.

According to these results, a 3D representation of the human body was created in order to maintain a continuum between the graphic representations of pain and the absence of pain

The MPQ-SV pain location scale was used to identify the most frequent pain locations. Areas in which more than 60% of the sample reported pain were considered significant enough to merit virtual representation. The human figure was divided into 27 parts: neck, right shoulder, left shoulder, lower back, front left and right forearm, forward left and right forearm, left and right front hand, left and right back hand, front left and right arm, back left and right arm, back left and right thigh, front left and right foot, back left and right foot, left and right chest and head.

Ambient sounds of creaking wood and the sea were also included to induce discomfort and relaxation respectively. The pain variables described above were also included to represent the continuum between pain states and the absence of pain: red-blue, stiffness-movement.

Analysis of variance was conducted to assess whether the degree of depression and anxiety influenced the characteristics of the figure. For this analysis, the sample was divided into two groups according to the cutoff scores on each subscale of the HADS (13)**:** $M_{\text{Low-Anxiety}}$=8.05±2.61, n=12 vs. $M_{\text{High- Anxiety}}$ =15.14±2.11, n=7, and $M_{\text{Low-Depression}}$=6.57±2.56, n=5 vs. $M_{\text{High-Depression}}$ =14±1.87, n= 5. The results showed that anxiety ($p = 0.008$) and depression ($p = 0.004$) affect only the movement of the figure, and presented an inverse relationship.

3. Conclusions

The results provide useful information for the creation of a virtual representation of perceived pain in people with FM, consisting of a 3D figure of a human body. As regards our second objective, we found two central continuous variables (color, and movement) which differed in the quantitative representation of pain and no pain. A third continuous variable was also included: background sound, which can be modulated to improve the immersive sensation. The incorporation of these features in in each part of the 3D human body allows participants to modulate perceived pain.

In this software, the subject selects the body part that presents the most pain, and the intensity of pain is assessed by means of a VAS that ranges from 0 (no pain) to 10 (extreme pain). According to this measure, the software assigns to each patient the corresponding value of intensity of pain represented in three pain variables in the selected body part: color, movement and sound. Each of these three variables are displayed in independent VAS. The patient can gradually transform the pain variables into a pleasant and less painful environment. After completing the task, pain intensity is assessed again by VAS. Returning to the selection area, users can select another area to represent pain and reduce it. They can choose between all areas in which the pain is

significant, until there are no painful areas to modify. Then, they can leave the software. Following on from the results obtained by Gutiérrez and colleagues (9) a significant reduction in pain levels is expected, with a decrease in the presence of catastrophic thoughts and an increase in self-esteem.

Despite the exploratory nature of the study, it presents several similarities to previous publications in the literature. First, the fact that patients who have higher levels of anxiety show less movement may be due to the fact that anxiety has a large avoidant component which diminishes the subject's degree of movement (15).

Second, with regard to depression, according to Seligman's theory about learned helplessness (15) when the patient considers that s/he lacks the skills needed to overcome the situation, s/he reduces the number of activities.

Third, identifying areas of the body as painful simulates the new diagnostic criteria for fibromyalgia (16). However, some areas were not significant: the buttocks, abdomen and jaw. The software is able to enter all areas that may be considered important in future research.

Finally, when patients observe the movement of a body part, mirror neurons are activated. As a result, they have the same brain activation as if they were moving the painful area, and a significant reduction in perceived pain is achieved (17).

Therefore, these results are concordant with previous literature, and suggest that this virtual representation has good construct validity. Future research should aim to determine whether this environment is useful as a component of the traditional CBT treatment for FM. It should also be determined whether this virtual environment is able to reduce pain perception by people with fibromyalgia, thus improving their psychiatric symptoms and facilitating active coping strategies for pain.

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