The Design and Evaluation of a Body-Sensing Video Game to Foster Empathy towards Chronic Pain Patients

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ABSTRACT
Chronic Pain (CP) has been identified as a complex medical condition, one that is difficult for sufferers to articulate and for others to discern. This may interfere with the ability of a patient's family, friends and healthcare practitioners to understand what it is like to live with CP, or to even believe it exists. A reluctance by or ability of others to believe a CP patient may in turn exacerbate pain and sequelae common in CP, such as depression, frustration, stigma or social isolation. The goal of this research is to help foster empathy of what CP patients experience by designing and evaluating a body-sensing video game titled *AS IF*. In this game, players "inhabit" a virtual body or avatar of a CP patient. The virtual body simulates physical limitations and displays red areas meant to indicate painful areas. A pilot study with 15 participants was conducted. Results show that while not every aspect of the game proved successful, players had a significant increase in their willingness to help patients. This research demonstrates an approach that may help foster empathy towards CP patients through an embodied game simulation, and has design implications for future research and gameplay explorations.

Author Keywords
Empathy; chronic pain; embodied simulation; body-sensing games; serious games; gaming for a purpose.

INTRODUCTION
Chronic Pain (CP) is a persistent disease affecting 20% of populations in developed countries [1]. It is defined as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described regarding such damage" [9]. It is noteworthy that this definition includes both physiological and psychological aspects, and that many pain researchers use a biopsychosocial method; thus, implicitly, patients' psychological and social contexts are meaningful. Unlike other medical conditions, the presence and identification of CP mainly rely on patients' self-reports. Until now, no objective medical exams or biomarkers have been discovered for the diagnosis of CP [2]. This adds to the difficultly of patients' family, friends, and their doctors or caregivers to understand or even believe the existence of CP, and the suffering of patients. Feeling neither believed nor understood leads many patients to frustration, anger, and vulnerability to stigma, shame and social isolation [7]. For instance, Park and Chen's research [12] showed the difficulties people with chronic conditions had in communicating their symptoms and they called for technologies that could help patients get social support (including physical help) during pain spikes by sharing their pain level. In this paper, we discuss *AS IF*, a body-sensing game we created for non-patients. The major goals of this 'serious game' are to raise awareness, gain empathy and understanding, and foster positive attitudes towards CP patients to the degree possible by a game. Our hypothesis was that an embodied video game can contribute to raise awareness, gain empathy and understanding, and to foster positive attitudes. From the results of our study, we learned which game components and mechanics worked and were understood by participants and which did not. The main contributions of this paper are the quantitative and qualitative evaluation of the game's effects on fostering empathy for patients, as well as the articulation of design implications that may inform similar or future research.

RELATED WORK
Video games have been shown to provide a relevant vehicle for people to gain understanding and empathy [5]. Several games have been designed to increase understanding and eliminate discrimination of certain groups of patients. For instance, *Labyrinth Psychotica* is a virtual environment created to simulate the visual and audio experience of schizophrenia [10], while *Elude* mirrors the struggle against the rising tide of depression [8]. Specific techniques may enhance the understanding of what certain groups of patients experience. For instance, players in *Depression Quest,* an interactive text-based storytelling game, are given daily choices that face a person who suffers from depression. This game uses text to enable players to experience the consequences of depression on their work, family, or social relationships [11]. In another example, biofeedback sensors were used in a game that immerses the players in contexts and thus the experiences of trauma patients. The biofeedback appears to provide a more embodied sense than would otherwise be possible [6]. However, few qualitative or quantitative evaluations regarding the games' ability to elicit people's empathy have

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been conducted. Further, very few current games were specifically developed to better understand a CP patient's experience.

GAME DESIGN AND DEVELOPMENT

AS IF was developed in Unity3D 5.0 game engine with Microsoft Kinect as the body motion sensor. As users try to perform everyday tasks, they witness specific physical limitations while they simultaneously hear the musings of an actual CP patient. In these ways, the game simulates the experience of having a body that is in pain, albeit in very limited ways. Decisions to focus the game on movements and an avatar build on the Embodied Simulation Theory, which suggests that people reuse their mental states or processes represented in a physical format in functionally attributing them to others [4].

The game starts with an introductory tutorial that shows the player how to interact with the system, and how the motor tasks work. When players move their limbs, the body sensor changes the position and orientation of the avatar in microseconds; this creates an illusion that the player "inhabits" or is mirrored by the avatar. As players perform tasks, they experience some of the avatar's mobility limitations "as if" they are facing these physical limitations in real life, like CP patients might. Players hear the voice of the avatar, a CP patient who provides directions about how to perform the game's tasks. The avatar also talks about what it's like to live with pain, and how it affects things as simple as everyday tasks. "Pain" is made visible by red areas that appear on the avatar's joints (as the red and yellow arrows indicated in Fig. 1 and Fig. 2). This indication of pain appears when the avatar's range of motion becomes limited, and therefore hinders the player's ability to accomplish tasks through the avatar.

After completing the tutorial level, the player is introduced to a narrative of a grandmother in a kitchen. The avatar communicates with the use of voice-clips, that she is baking a birthday cake for her granddaughter. Using the avatar, players then perform tasks (connecting dots in one line to form certain shapes) of making a cake step-by-step while they hear audio self-talk of what it is like to perform such everyday tasks from the perspective of a real patient. When the player completes each task, audio feedback and ambient sounds are triggered. Currently, the game offers only one scenario – playing as the grandma to bake the cake for her granddaughter's birthday party.

THE MIXED-METHOD STUDY

Study Intent, Participants and Procedures

The aim of this study was to find out whether *AS IF* can motivate empathy and improve non-patients' willingness to help patients given the timeframe of the study intervention. Participants were recruited through a convenience sampling method, with ads placed in university campus media and emails sent to faculty and student groups. The exclusion criterion was any reported history of a CP diagnosis. Fifteen people participated in the study, aged from 20 to 34 years old (M = 24.8, SD = 3.8); 27% were female (N = 4). Among all participants, 2 of them had healthcare-related jobs and 3 of them had contact with CP patients. Upon arrival at the lab, participants were briefly introduced to the study procedure and were instructed to read and sign the consent form. Before the gameplay, participants were asked to fill out the pre-intervention questionnaire, which included a revised Compassion Scale and the Willingness to Help Scale. Next, they were given instructions about the game's rules and thereafter played *AS IF* for 10-15 minutes. After playing the game, players were asked to fill out the post-intervention questionnaire (the same as the pre-intervention). Finally, researchers conducted a 10-minute semi-structured interview with players, which were audio-recorded. Afterwards, the data were transcribed and coded.

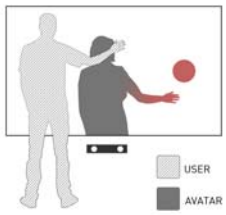

Figure 1. The setup and game mechanism of *AS IF*.

Figure 2. A participant interacts with *AS IF* through a virtual body (an "avatar"). The red arrow points to the avatar's body part affected by chronic pain (the elbow), while the yellow arrow indicates the player's mirrored gesture in real world.

Study Instruments

To measure quantitative changes in empathy and attitude before and after playing the game, the study used two instruments: an empathy questionnaire and a scale measuring a willingness to help People With Chronic Pain (PWCP). The self-report empathy questionnaire was modified from the Compassion for Others Scale, developed and validated by Pommier et al. [3] In our revised version, the term "other people" was replaced by "people with chronic pain" in all of the questionnaire's items. The word "when" was modified to "if" since participants may not have had the chance to interact with PWCP, and since they responded to a hypothetical scenario in the game. The original scale consists of six subscales: kindness, indifference, common humanity, separation, mindfulness, and disengagement. Each subscale has four items. We adopted the kindness, indifference, separation and disengagement subscales as those most closely related to

CP. The revised scale had 14 (vs. 24) items in total, as shown in the Appendix. For each statement, players indicated how often they behaved in the manner stated on a 5-point Likert scale. The total score of the Empathy Scale was calculated and then the summations of each subscale were added together. For the willingness to help PWCP, a scenario was presented: *You're preparing for an important interview tomorrow. However, a friend who has chronic pain asks you to help by giving him a ride to the airport, a two-hour drive.* Participants indicated their willingness to help on a 10-point Likert scale.

RESULTS AND DISCUSSIONS

For the quantitative data, the pre- and post-intervention comparisons of the Empathy Scale and Willingness to Help Scale were analyzed using one-tailed paired-samples t-test. For the qualitative data, the in-person interviews were first transcribed into electronic textual data. The text data were then coded into categories based on pre-existing knowledge or hypotheses. Significant patterns were highlighted, summarized and grouped into themes. As shown in Fig.3A, for the scores of Willingness to Help before and after the game intervention, a significant increase in the post-intervention score was observed (M = 8.00, SD = 1.49) compared to the pre-intervention score (M = 6.89, SD = 2.73), t (13) = 2.132, p = 0.026. The effect size for this analysis was found to be a median effect (d = .50) according to Cohen's (1988) convention. For the Empathy Scale, the total scores in the pre-intervention (M = 60.27, SD = 7.53) and the post-intervention score (M = 62.93, SD = 6.97) did not reach statistical significance; t(14) = 1.480, p = 0.081. For the Compassion Scale's subscales of kindness, indifference, separation and disengagement, the separation subscale showed a statistically significant decrease in the pre-intervention (M = 9.90, SD = 3.09) and the post-intervention scores (M = 8.57, SD = 2.27); t (14) = 2.098, p = 0.027. The kindness (p = 0.44), indifference (p = 0.14), and disengagement (p = 0.23) subscales were found to be statistically non-significant between pre-intervention and post-intervention scores (Fig. 3B-F).

The quantitative results indicate that while completing tasks in *AS IF,* players achieved a significant increase in the Willingness to Help score with a median effect size. However, the game failed in increasing empathy towards PWCP. This lack of eliciting empathy may result from flaws in the game design and other factors, such as a short duration of gameplay and not enough repeated exposure to the game. The findings from the interview below may be used as potential design implications for future empathy games. Three main themes emerged: building body-mind connections, visually representing pain and storytelling increases emotional attachment and empathic attitude.

Building the Body-Mind Connections: Relating a Real Body to a CP Patient's Virtual Body (Avatar) Helps Generate Immersion and Fosters Empathy

Creating a sensible and reasonable body-mind connection is an important way for players to feel immersed in the game world and especially to feel that they are "in the shoes of" a CP patient. The game's tasks require full-body movements, which are mirrored by the avatar. Because the avatar moves in concert with the player, some players reported they felt they were immersed in or were embodying a CP patient. Some players reported that they liked how the physical limitations led to frustration, and that they felt tired and hopeless at the end of the game. For instance, P01 said, "*I gained some understanding of these people psychologically. I realize they live in a depressed way, their body encounter(s) frustration. I, therefore, have some sympathy for them*." Other players, however, interpreted the disabled movements as software bugs.

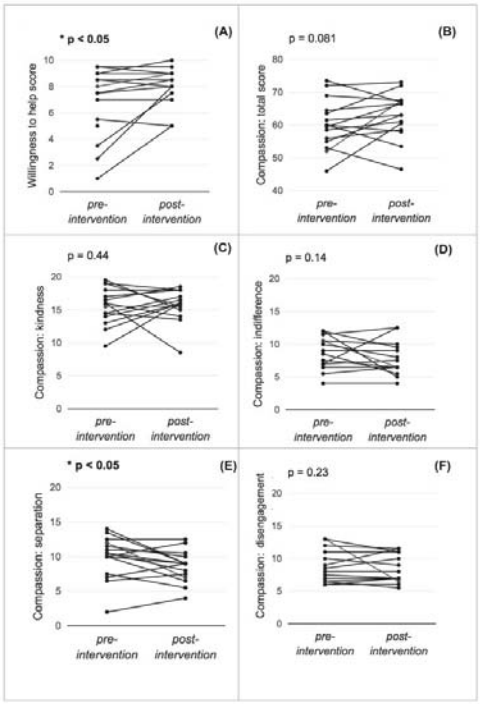

Figure 3. The data before and after the game intervention: (A) Willingness to Help Scale; (B) Compassion scale: total score; (C) Compassion: kindness subscale; (D) Compassion: indifference subscale; (E) Compassion: separation subscale; (F) Compassion: disengagement subscale.

Visually Representing Pain: Providing More Feedback

The visual depictions of pain in *AS IF* appeared less successful than movement constraints. Most participants, for instance, did not notice the red areas on the avatar. As P03 reported, "*I sometimes saw the visual effect changed in the game, but I didn't realize it is related to chronic pain.*" Some participants suggested adding more visual and sound effects to make the pain areas more obvious. P08 said "*I would prefer to have more pain-related sound effects like "ouch!" and visuals in the game to remind me that I were a patient.*" A few participants said that the visual feedback the red areas – was not enough, so they suggested that in addition to visual responses, tangible feedback like pressure or heat would be more helpful ways to more fully experience some pain-related sensations.

Narrative Storytelling Creates Emotional Attachment and a Empathetic Attitude

Narrative storytelling and role-playing in *AS IF* helped to create a connection between the player and avatar, and helped players identify with a greater sense of what CP patients ay experience. Situating the players appropriately in a pain-related identity was an important way to elicit an empathetic response from the players. Most reported they felt a sense of relatedness through the narrator's (a patient) musings, and said that it provided them with a mission to help this patient complete her job. In these two ways, players reported that they felt "as if" they were the patients, e.g. P11: "*The story, you hear the story so you get emotionally attached. She still has to work and cook the cake,*" and P04, "*I felt like the old grandmother. I am touched with emotion… When the non-harmonious sound plays when you do wrong… it is very emotional*." Other aspects of the game were not successful. Some participants, for example, mentioned that the connect-the-dots puzzle "pulled them out" from the actual game experience. As P04 mentioned: *"Dots are too noticeable, (and they) distract me from (the) character. I was too busy trying to solve the puzzle.*" Moreover, some participants reported that while the actual actions of a task (like blending eggs and flour in the bowl) worked, tasks should be more commonly experienced. According to P04: "*Design something that everyone does for sure in real life, like wash dishes."*

Although results of the study did not indicate a significant effect on the total score of the revised Empathy Scale, it did show a significant decrease in the separation subscale. The sense of separation is when individuals see another person as separate from themselves and tend to stay isolated in the instance of an other's suffering [3]. The game's embodied simulation, whether intentional or not, may lead to frustration, similar to CP patients' suffering. This shared frustration may explain the decrease in separation from PWCP after the gameplay. Such quantitative findings were in line with the qualitative interview data. The study limitations include a non-randomized, uncontrolled quasi-experimental design which precludes a causal inference of the game intervention to the outcomes. Other limitations of the study were its small sample size, uneven gender distribution and possibly the youthfulness of participants. Furthermore, we only have one scenario in this game, which could be a limitation, as the players may not feel the context is relatable.

CONCLUSION

To put non-patients "in the shoes of" patients, the players "inhabit" a virtual body or avatar of a CP patient who attends to everyday tasks. It simulates a few experiences common to CP: physical limitations of movement and musings verbally articulated by a CP patient. The visual-motor synchronicity of a player's full-body movements mirrored by the avatar appears to elicit identification with the avatar. Results from the mixed-method study revealed that the game was effective in improving the willingness to help CP patients, but did not show a significant increase in compassion towards PWCP. In the future work, we will iterate *AS IF* according participants' feedback, and will conduct a randomized, controlled study with a larger sample size that is more diverse in gender and age.

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APPENDIX

Evaluating the empathy for Chronic Pain patient fostered through a body-sensing interactive video game – *AS IF*

1. Pretest Questionnaire

Note: the following 16-item questionnaire is based on the "Compassion Scale" (Pommier, 2011), modified for Chronic Pain

HOW I TYPICALLY ACT TOWARDS **P**EOPLE **W**ITH **C**HRONIC **P**AIN (PWCP)*

* Chronic Pain is defined as any pain that lasts longer than six months. With chronic pain, signals of pain remain active in the nervous system for months or even years. This can take both a physical and emotional toll on a person.

Please read each statement carefully before answering. To the left of each item, indicate how often you behave in the stated manner, using the following scale:

1. If PWCP cry in front of me, I often don't feel anything at all.

Almost Never Almost Always

1 2 3 4 5

2. Sometimes if PWCP talk about their problems, I feel like I don't care.

Almost Never Almost Always

1 2 3 4 5

3. I don't feel emotionally connected to people in chronic pain.

Almost Never Almost Always

1 2 3 4 5

4. I feel detached from PWCP if they tell me their tales of woe.

Almost Never Almost Always

1 2 3 4 5

5. If I see someone with chronic pain going through a difficult time, I try to be caring toward that person.

Almost Never Almost Always

1 2 3 4 5

6. I will tune out if PWCP tell me about their troubles.

Almost Never Almost Always

1 2 3 4 5

7. I will like to be there for PWCP in times of difficulty.

Almost Never Almost Always

1 2 3 4 5

8. If I see PWCP feeling down, I feel like I can't relate to them.

Almost Never Almost Always

1 2 3 4 5

9. Sometimes I am cold to PWCP if they are down and out.

Almost Never Almost Always

1 2 3 4 5

10. I don't concern myself with PWCP's problems.

Almost Never Almost Always

1 2 3 4 5

11. My heart goes out to PWCP who are unhappy.

Almost Never Almost Always

1 2 3 4 5

12. If I saw PWCP are feeling troubled, I usually will let someone else attend to them.

Almost Never Almost Always

1 2 3 4 5

13. I don't think much about the concerns of PWCP.

Almost Never Almost Always

1 2 3 4 5

14. I can't really connect with other PWCP when they're suffering.

Almost Never Almost Always

1 2 3 4 5

15. I try to avoid PWCP who are experiencing a lot of pain.

Almost Never Almost Always

1 2 3 4 5

16. If PWCP feel sadness, I try to comfort them.

Almost Never Almost Always

1 2 3 4 5

The following question ask you to imagine a scenario and what you would do accordingly.

You're preparing for an important interview for tomorrow. However, a friend who have chronic pain ask you if you can help with a ride to airport (a 2 hour drive each way). Please indicate how willing are you to help the person?

1 2 3 4 5 6 7 8 9 10

Not at all Very willing to help

The following questions will ask you some personal information regarding chronic pain and demographic information. Your answer is completely anonymous. And we will keep these information in secure condition.

Do you know of any families or friends who had ever been diagnosed with chronic pain?

a. Yes b. No

Have you ever been diagnosed with chronic pain before?

a. Yes b. No

Could you tell us your age?

_____

Could you tell us your gender?

a. Female b. Male c. Other d. Prefer not to disclose

2. Post-test Questionnaire

HOW I TYPICALLY ACT TOWARDS **P**EOPLE **W**ITH **C**HRONIC **P**AIN (PWCP)

Please read each statement carefully before answering. To the left of each item, indicate how often you behave in the stated manner, using the following scale:

1. If PWCP cry in front of me, I often don't feel anything at all.

Almost Never Almost Always

1 2 3 4 5

2. Sometimes if PWCP talk about their problems, I feel like I don't care.

Almost Never Almost Always

1 2 3 4 5

3. I don't feel emotionally connected to people in chronic pain.

Almost Never Almost Always

1 2 3 4 5

4. I feel detached from PWCP if they tell me their tales of woe.

Almost Never Almost Always

1 2 3 4 5

5. If I see someone with chronic pain going through a difficult time, I try to be caring toward that person.

Almost Never Almost Always

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6. I will tune out if PWCP tell me about their troubles.

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1 2 3 4 5 6 7 8 9 10

Not at all Very willing to help

3. Post-test semi-structured Interview Guide

1. Do you have any difficulties while playing the game? If so, what they are?

2. What do you think about the game interaction, such as controlling your avatar or interacting with the game objects, connecting the dots, etc.?

3. Can you describe how the virtual physical limitations on your avatar made you feel?

While playing the game, what were your physical sensations, if any?

While playing the game, what were your emotional experiences, if any?

4. How do you feel about the "fisheye" lens effect and glowing limbs as a visual representation for chronic pain?

5. In your opinion, does the game reflect the real patient's sufferings, i.e.: put you into the shoes of chronic pain patients? Why or why not?

6. How would you design or redesign this game if you were the game designer?

That is the end of study. Thank you very much for your participation!