Body awareness in Virtual Reality therapy for chronic pain

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Abstract

Background: The ability to listen to one's body is essential to enhance treatment effects for chronic pain patients. Using immersive Virtual Reality has already proven to be effective for acute pain. In Virtual Reality, there are possibilities to improve body awareness which makes it also a promising tool for chronic pain rehabilitation. Our aim was to investigate how particular techniques used to improve body awareness can be implemented in immersive Virtual Reality for chronic pain patients.

Methods: Six occupational therapists participated in a focus group to investigate how body awareness is achieved in current treatment of chronic back pain. In a second phase, the occupational therapists performed individual think-aloud sessions to evaluate the first prototype of a Virtual Reality game developed for chronic back pain patients, called: "Dinner is ready". These evaluations resulted in a second set of requirements which was further discussed and validated in a new focus group with occupational therapists.

Results: In the focus group, it became clear that ACT is in the basis of occupational therapy rehabilitation for chronic pain patients. After testing the Virtual Reality prototype, therapists identified ways in which the body awareness techniques used in current care can be implemented in Virtual Reality and provided recommendations to follow-up versions. The last phase showed the designed requirements for a new prototype corresponded to the view of the occupational therapists.

Conclusion: Our results suggest that the techniques graded exposure, relaxation, cognitive defusion, mindfulness, breathing exercises and distraction which are used to improve body awareness for chronic pain patients can be implemented in immersive Virtual Reality. According to the therapists, using Virtual Reality to enhance treatment effects for chronic pain patients is very promising.

Key words: Body consciousness; Cognitive behavioural therapy; Acceptance and Commitment therapy; Augmented Reality; immersive Virtual Reality; Biofeedback.

Introduction

Chronic pain is a common problem in Europe with the mean prevalence of 19% (1). In the 19th and 20th century, pain was considered as a purely biomedical process with pain severity and symptoms considered to be one-to-one related with pathology in the body (2). The gate-control theory was one of the first models to shift focus to central bodily processes and integrates psychological aspects of pain (3). This model incorporates psychological aspects such as past experience, attention and the meaning of the situation (4). This biopsychosocial approach to chronic pain is now widely accepted (5).

According to the Fear Avoidance Model, due to the fear of experiencing pain, chronic pain patients avoid doing their normal activities, restraining their normal behaviour entering in a vicious circle and often provoking more pain (6, 7). Multiple studies address the extreme attention of chronic pain patients to pain (8-11). This means that pain is a criterion that is influencing their behaviour. The location and nature of pain are most of the time well described but patients are often unaware of thoughts, feelings and bodily sensations that contribute to the pain (12). Failure in awareness of changes in the consciousness of physiological signals contributes to inadequate coping behaviour and would thereby increase the probability of symptom occurrence (13).Treatments aimed at improving body awareness might enhance treatment effects (14-19). The ability to listen to one's body can change perception of chronic pain. Improving body awareness can help patients to use other signals and cognitions than pain to determine the physical and mental state they are in (20). When body signals are interpreted without negative thoughts, catastrophizing can decrease (21).

Most of the rehabilitation programs for chronic pain share a common theoretical framework: Cognitive Behavioural Therapy (CBT) (22, 23). The aim of CBT is to increase patient functioning and reduce psychological distress and pain intensity. Techniques that are used to achieve this include relaxation training, cognitive restructuring, problem-solving training and step-by-step goal setting (24, 25). CBT is proven to be effective for chronic pain (26-30), though it is still not beneficial for all patients (31). Treatment adherence of current rehabilitation programmes can be a weakness (32-35) and the transfer towards daily life difficult (36). As such, new engaging eHealth technologies, in particular Virtual Reality, are upcoming. While the treatment effect of Virtual Reality for acute pain has already been proven (37-44), applying Virtual Reality for chronic pain

is still in the infancy state. However, it is promising because of the possibilities in Virtual Reality for body awareness. Body representations are important for structuring cognition and the self. Virtual Reality can modify the inner experience by structuring, altering or replacing the body self-consciousness (45). For example, training in Virtual Reality integrated with biofeedback can be used to assess and control specific body signals (46).

The objective of this study is to research how Virtual Reality can support chronic pain patients to become more aware of their body.

Background in body awareness

Mehling et al. defined body awareness as follows: "Body awareness involves an attentional focus on and awareness of internal body sensations. Body awareness is the subjective, phenomenological aspect of proprioception and interoception that enters conscious awareness, and is modifiable by mental processes including attention, interpretation, appraisal, beliefs, memories, conditioning, attitudes and affect" (p.1) (47).

A few approaches aimed at body awareness are upcoming for chronic pain, for example Psychomotor therapy (PMT), Body Awareness Therapy (BAT) and Acceptance and Commitment Therapy (ACT). An overview of these approaches is given in Table 1. PMT focusses on the interaction between physical activity and the mind (48-51). A few studies have proven BAT has positive treatment effects for multiple conditions on short and long term (52-55). Whether PMT and BAT are effective in the treatment of chronic pain has not been proven yet and therefore more research is required (14, 50).

ACT consists of awareness and non-judgemental acceptance of all experiences, both negative and positive (56). Evidence from literature supports the main assumptions of ACT (57-59). It is proven that acceptance can result in positive treatment effects for chronic pain (60-66). ACT is rated as more satisfactory than CBT. This is important since it is more likely that patients remain engaged in a treatment when they find it enjoyable (67).

Some of the techniques that are described in Table 1, are already applied in Virtual Reality or other digital therapies, namely graded exposure (68-80), relaxation (46, 81), step-by-step goal setting (82), mindfulness (83, 84) and breathing exercises (85-87). In Table 2 an overview of applications in Virtual Reality, or other digital therapies, supporting these techniques is provided. Some of these applications might also be possible in Virtual Reality therapy for chronic pain patients. What is noticeable is the use of biofeedback in some of the applications, which is effective for chronic headache (88-90). Studies also showed positive effects for chronic pain and chronic back pain treated with biofeedback (91, 92). As can be seen in Table 2, cognitive defusion, acceptance therapy, value-based therapy and homework are not yet applied in Virtual Reality.

Methods

The aim of this research is to investigate how particular techniques used to improve body awareness can be implemented in Virtual Reality for chronic pain. This research consists of three phases, namely the exploration, experience and validation phase. An overview of these phases can be found in Figure 1.

Techniques	*Exposure*	*Relaxation*	*Cognitive defusion*	*Step-by-step goal setting*	*Mindfulness*	*Breathing exercise*	*Acceptance therapy*	*Value based therapy*	*Homework*
CBT	X	X	-	X	-	X	-	-	X
ACT	X	X	X	X	X	X	X	X	X
PMT	X	X	X	X	X	X	X	-	X
BAT	X	X	-	-	X	X	-	-	-

CBT: Cognitive Behavioural Therapy
ACT: Acceptance and Commitment Therapy
PMT: Psychomotor Therapy
BAT: Body Awareness Therapy

Table 1. Overview rehabilitation programs and techniques used for chronic pain therapy

Technique	Study/studies	Application
Graded exposure	(Pull, 2005; Opdyke, Williford, & North,1995; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001; Parsons & Rizzo, 2008; Difede & Hoffman, 2002; Krijn, Hulsbosch, De Vries, Schuemie, & Van der Mast, 2002; Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1996; Gerardi, Rothbaum, Ressler, Heekin, & Rizzo, 2008; Krijn, Emmelkamp, Olafsson, & Biemond, 2004)	Expose patients to specified stimuli that they fear. Rate the anxiety that they experience regularly. After anxiety has been reduced, encourage patients to take a next step which provokes more anxiety.
	(Keefe et al., 2012; Moseley & Flor, 2012; Morris, Grimmer-Somers, Spottiswoode, & Louw, 2011; Parsons & Trost, 2014)	Expose patients to movements that they avoid because of fear or pain. Provide different challenges and progressively expose to more difficult situation.
Relaxation	(Repetto, Gorini, Algeri, Vigna, Gaggioli, & Riva, 2009)	Environment combined with biofeedback. For example: The less stress that is measured, the calmer the waves of the sea are getting.
	(Gorini & Riva, 2008; Ohsuga, Shimono, Kimura, Maeda, & Mizukura, 2001)	Visual presentation of relaxing images and providing sounds, wind and fragrance.
Step-by-step goalsetting	(McLaughlin et al., 2005)	Provide a menu of pre-set goals from which patients can choose.
Mindfulness	(Botella, et al., 2013)	Provide instructions on how to observe different elements and remain focused in the present. Ask pain patients to observe the pain and then direct their attention to other visual and audio stimuli.
	(Gromala, Tong, Choo, Karamnejad, & Shaw, 2015)	Visual feedback based on biofeedback. For example: in a forest, the fog thickens when arousal levels increase.
Breathing exercise	(Meldrum, Glennon, Herdman, Murray, & McConn-Walsh, 2012)	Inhale and exhale while moving your head from side to side.
	(Qin, Vincent, Bianchi-Berthouze, & Shi, 2014)	Inhale and exhale. The exhale must be at least three times slower.
	(Lamson, 2002)	Breathe deeply in combination with relaxation exercise.

Table 2. Applications of the techniques in Virtual Reality or other digital therapies

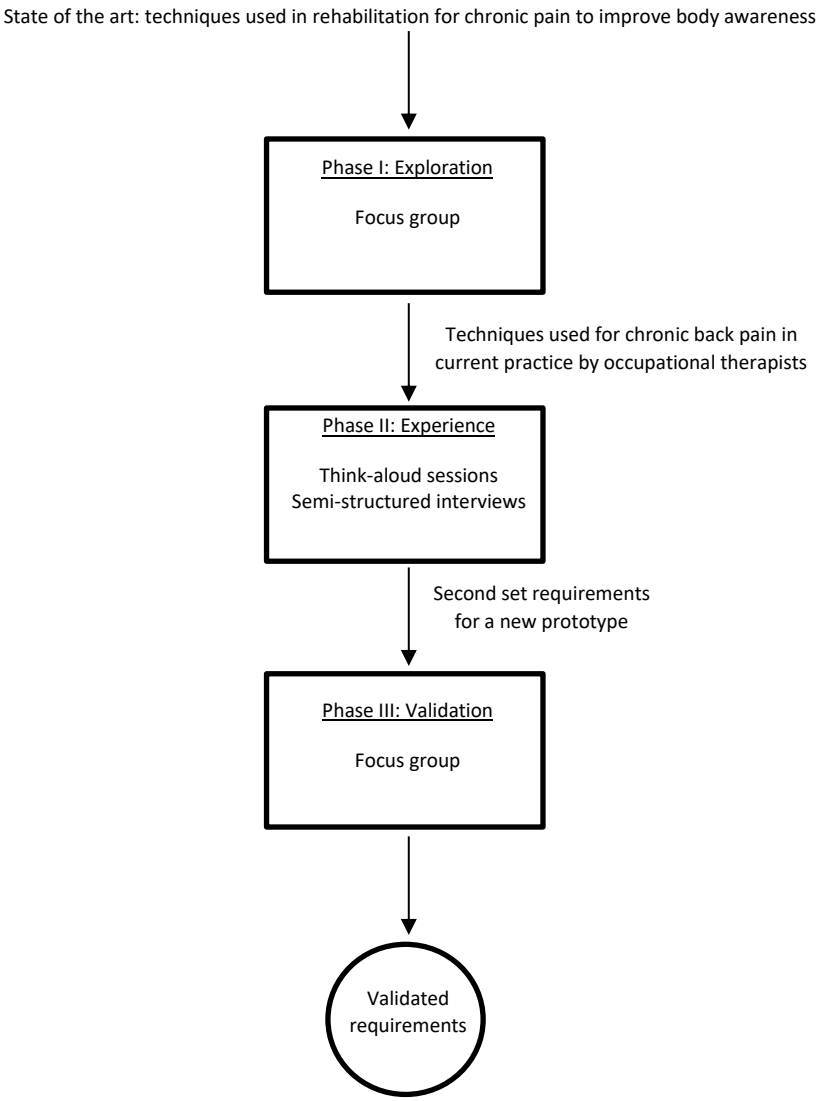

Figure 1. Research method

In phase I the aim was to get insight in techniques used to improve body awareness in chronic pain treatment. This was done through a focus group with six occupational therapists from Roessingh, a rehabilitation hospital in Enschede, the Netherlands. A semi-structured interview based on the literature research was used as input for this focus group. The audio-recorded meeting took approximately 60 minutes with open questions being discussed among all participants. The results were transcribed and used in the design of the semi-structured interview in phase II.

For phase II of this study a Virtual Reality environment from the VIREP project was used. The environment was displayed on a head-mounted device. In the Virtual environment, developed in collaboration with occupational therapists, different daily activities are simulated, namely picking apples, carrots and tomatoes, making soup and reorganizing a bookshelf (Figure 2-6).


Figure 2. Game task: Picking carrots

Figure 3. Game task: Picking apples

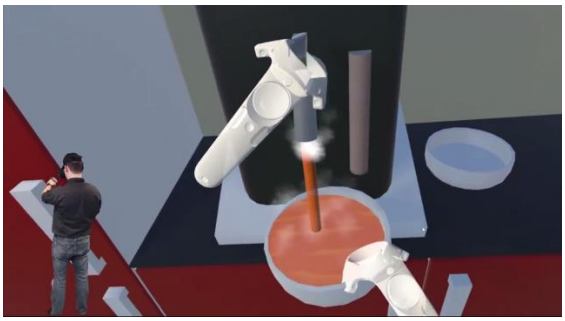

Figure 4. Game task: Making soup

Figure 5. Game Task: Serving soup

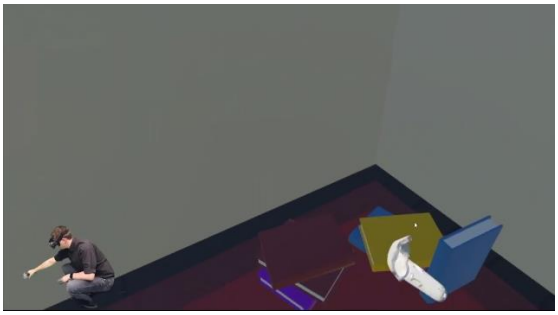

Figure 6. Game task: Reorganizing books

The activities require the player to perform similar body movements to those performed in the current occupational therapy and at home, such as bending, reaching on the longitudinal axis and rotating the upper body. Results from earlier meetings within this project, showed distraction is a technique which therapists apply in current practice. Therefore, this prototype allowed to add distraction in the form of bees flying around and rain.

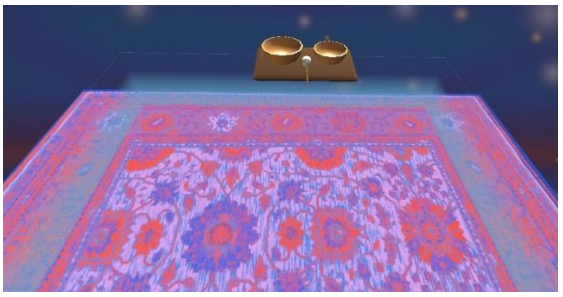

Figure 7. Carpet in the Relaxation chamber

Figure 8. Sounds scales in the relaxation chamber

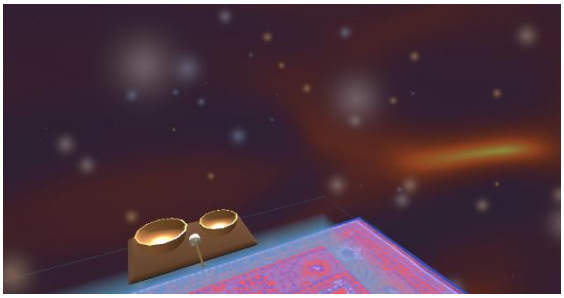

Figure 9. Overview relaxation chamber

Among the Virtual environments, there was a relaxation chamber (Figure 7-9). This environment was created to give patients the opportunity to relax between exercises or whenever necessary. For phase II, the aim was to get insight in the experience of occupational therapists and discuss possibilities for Virtual Reality regarding body awareness. Individual sessions were conducted in which the same therapists from phase I trained around 15 minutes in the Virtual environment while speaking thoughts out loud, including a visit to the relaxation chamber. After trying the Virtual Reality, a semi-structured interview was conducted. After the semi-structured interview, a questionnaire with closed questions was used to get more information on the importance of the different elements. All interviews were transcribed and coded by the first author and by an independent researcher for cross-validation, using the guidelines for thematic analysis from Braun & Clarke (93). The results of phase II were translated to a set of requirements to be implemented in a follow-up version of the Virtual Reality environment, using the notation template from van Velsen et al. (94).

The aim of phase III was to discuss and validate the requirements. This was done through an audio-recorded focus group with all the therapists from the individual sessions in phase II. The results were transcribed and used as input for defining a validated set of requirements.

Results

Results Phase I

Six occupational therapists were included in the focus group. ACT was stated as the basis of rehabilitation therapy at Roessingh. Consequently, the therapists used most techniques identified in the literature research to improve body awareness for patients with chronic pain. Step-by-step goal setting was not used but the therapists would like to use it. Acceptance therapy and value-based therapy were used. Though, the therapists saw this as a part of cognitive defusion. According to the therapists, the techniques do not improve body awareness on its own, but are used as part of the therapy to improve body awareness.

Results phase II

Six occupational therapists participated in phase II. The results are described through different categories:

Target group

According to the therapists, chronic pain patients could be divided in two "types", namely the cautious-type and the busy-type. The cautious type is hardly moving because of the fear of pain. The busy type is constantly moving to try to distract themselves from pain. Also a few risks for using Virtual Reality were named. A lot of chronic pain patients are sensitive for stimuli. However, the therapists thought it would be different for every person. Also, migraine, epilepsy and balance disorders might cause problems. Some of the therapists said they would not let patients with anxiety or other psychiatric disorders use a Virtual environment:

"*Patients are sometimes "psychiatric" and struggle with the distinction between what is real and what is not. You should watch out for that." (T6)*

First experiences game features

Overall the first experiences with the Virtual environment were positive. Therapists thought Virtual Reality challenges them to move and most therapists spent a longer time training than estimated. Therapists mentioned that Virtual Reality would give them more possibilities for daily exercises which they can use for the treatment of chronic pain patients. In real life, many exercises are not possible because there is limited space and attributes in the therapy room.

Graded exposure and graded activity

Conducting activities in Virtual Reality that require feared movements is a form of exposure for chronic pain patients. In daily practice graded exposure and graded activity is used, which means that the difficulty of the activities must build up. The more difficult the activity, the more fear would be provoked for the patient. Therefore, therapists suggested to make levels. To achieve graded activity, adjusting the number of activities that a patient must complete and slowly increasing the weight that a patient needs to lift would be valuable. Reaching on the transverse axis, a common movement within rehabilitation, was missing in the first prototype.

Two of the therapists did not see the link between graded exposure and body awareness. The other four therapists did, since they apply exercises related to body awareness, such as focusing on own breathing, during exposure. To improve body awareness for more experienced patients, the therapists advised to implement some cognitive challenge in the exercises. For example, solving mathematical questions while performing an activity.

Relaxation

Therapists recognized the added value of the relaxation chamber to improve body awareness among patients with chronic pain. However, there were too many stimuli in the relaxation chamber. According to the therapists, there must not be too many stimuli because that distracts from the body while the aim of body awareness is to reflect/focus on the body. When there are too many stimuli it is only possible to use the relaxation chamber with very experienced patients in body awareness.

The therapists did not appreciate the yoga and zen look-and-feel of the current version of the relaxation chamber (Figure 7-9).

According to the therapists, a relaxation chamber in a Virtual environment should be linked to what is possible in real life. The hardest part is that each patient is different. What is relaxing for one patient, might not be relaxing for another patient. Letting patients choose between different environments was what the therapists suggested.

Therapists liked the idea of a relaxation chamber in the form of a sea combined with biofeedback (Table 2, (46)), for example with lower heart rate being translated in the virtual environment with calmer sea. Biofeedback is an

objective measurement and therefore might enable patients to have the feeling that they can influence body signals.

The relaxation chamber can be used to improve body awareness but according to the therapists it was necessary that the patients sit down. Therefore, there must be a chair or a couch in the Virtual Reality and in real life.

The Virtual Reality system or the therapist must intervene with an exercise in the relaxation chamber to improve body awareness, since most chronic pain patients are not able to be aware of their body without any instruction. For example, a breathing exercise in the relaxation chamber with the help of voice instruction. Music has added value for relaxation. However, opinions on music are very diverse and therefore multiple options to choose from were recommended.

Cognitive defusion

In cognitive defusion the mind is central. The therapists made clear that they do not ask about the pain of the patient. The reason for this is because chronic pain patients are most often too focussed on pain. The most important factor for the therapist, looking at cognitive defusion and body awareness, was that patients are "stopped" in the middle of an exercise. When patients are stopped, they must sit and think about their thoughts, emotions and experiences in an observational way. The therapists would like this in Virtual Reality.

"Normally I would do that as a therapist. I would prefer a stop sign in the middle of an exercise, not after exercising" (T1)

"I would like a stop sign so the patient can reflect on their thoughts at that moment and also about what they are doing. Just get out of there for a minute" (T5)

Mindfulness

Therapists suggested to perform mindfulness exercises in the relaxation chamber.

"I think it would be an added value if patients in the relaxation chamber are helped with focussing on the here and now" (T1)

"Yes, if the patient is helped to go to the here and now although he is in another world, I even think that is crucial" (T6)

Though one worry mentioned was the difficulty for the therapists to make contact with the patients since the patients are in their "own world".

"I do not know if I as a therapist would like it though. The patient is in its own world so I do not have contact and do not know what is happening and as a therapist I want to know" (T2)

In mindfulness, the patient is asked what they are noticing, for example their muscle tension, breathing, heart rate and temperature. A concern from the therapists was that the patient cannot see the own body in the Virtual Reality which might contradict with some mindfulness exercises. If mindfulness is applied, it was suggested to use either an automatic voice instruction (like in mindfulness cd's) or a voice instruction by the therapist. Looking at what kind of mindfulness exercises might be valuable, a so-called body scan exercise came up. The patients should focus on different parts of their body and observe the physical feelings and sensations while not judging. It is simply about being aware of the body in this present moment.

Breathing exercise

Breathing exercises are very important according to the therapists. The questionnaire showed that most of the therapists would like an exercise in which patients must breath on a pre-defined rhythm. However, one therapist suggested it would be better if a comparable exercise is provided as patients get in relaxation training which they have in their rehabilitation program. Besides, most therapists thought that breathing exercises should be applied in the relaxation chamber as well as during exercises since patients often hold their breath during physical exercise.

Feedback

Results on whether therapists would like patients to be reminded about the goal of their treatment were inconclusive. Therapists would like to use it for discovering patterns that patients have. In this case, they do not want the patient to be reminded about the goal of their treatment. Therapists would also like to use the Virtual Reality intentionally, which means the patient must go in the Virtual Reality with a specific goal. For example, being aware of their breathing while performing an exercise. In this case, they do want to remind the patient about the goal of their treatment.

Feedback about posture was not desirable, according to the therapists. The exact posture of the patient is not relevant for occupational therapy, as the focus is placed on the goal of the task. However, the body posture/language is representative for the attitude of the patient towards the training (e.g. slouchy posture shows lack of enthusiasm).

Most therapists were positive about biofeedback. Examples given were muscle tension, breathing and heart rate. Though all therapists were also a little sceptic about biofeedback, adding that biofeedback is only valuable when technology is working properly.

Distraction

The therapists thought the applied distraction (bees and rain) might be good for learning patients how to keep focus on the body. However, they mentioned that it would be more valuable for chronic pain in general than for chronic pain patients with localized pain. Chronic pain patients in general often have difficulties with stimuli, while patients who experience pain only at one place do not always show difficulties with stimuli. The applied distraction, rain and bees, was not distracting enough according to the therapists. They suggested to make the distraction heavier, more unexpectable and to implement sounds that correspond to the applied distraction. It would be valuable if the patient must do something with the distraction. An example was given:

"Maybe children are playing and a basketball is accidentally thrown in the garden and you have to respond to that as soon as possible" (T5)

Implementation

The therapists would use Virtual Reality as a tool for exposure, training body awareness, to motivate patients, a reflection tool and as a link to daily life. All the therapists would use it in an individual setting. First an "open" session would be valuable to discover patterns in the behaviour of the patient. After the open session, intentional sessions would be valuable. Filming the patient during the Virtual Reality and showing it afterwards would be valuable as a reflection tool. Results on the frequency of use were inconclusive. Therapists thought it depends on the person how often and how long it can be used. It also depends on the variety of tasks or environments in the Virtual Reality. The more variety, the more often therapists would use it. Most of the therapists said it does not matter in what place Virtual Reality is used since the patient cannot see the "real" environment, as long as there is enough space to play safe.

The therapists found it important that they could manage the distraction themselves. Besides, they thought instructions are necessary. This can be given by the therapists themselves or by the system. If the system will give instructions and feedback, it is important that the system does not do this too frequently to avoid becoming cumbersome. Besides, it would be an added value if the system can rephrase the same instructions and feedback in different ways, since therapists also do this.

To monitor the progress of patients, it would be valuable to keep track of the time spent exercising and achievements. Both less time spent and more time spent can be progression, depending on the type of chronic pain patient, cautious or busy. If biofeedback would be used, insight in the data to monitor the progress is necessary.

In the end of the questionnaire, therapists were asked to rate all the techniques from most important to least important, with the results being shown in Figure 10. The more points, the more important the technique is rated. There did not seem to be meaningful differences in the rating given to the separated techniques. Mindfulness followed by breathing exercises, relaxation and cognitive defusion was considered as most important.

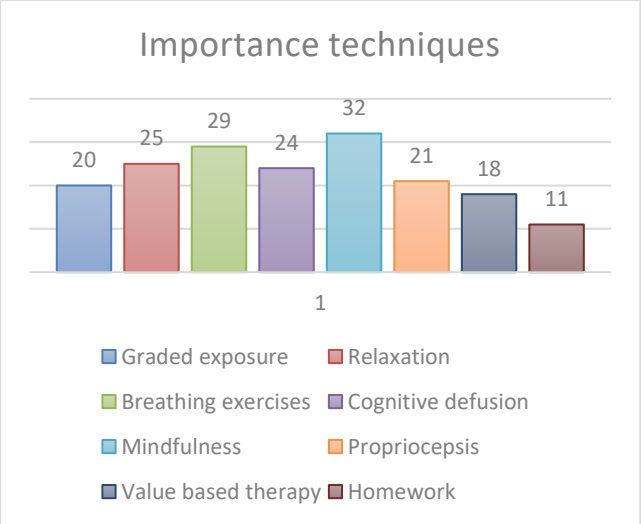

Figure 10. rated importance of the techniques

Results phase III

After phase II, requirements were established. Not so many stimuli in the relaxation chamber is an example of a requirement with high priority. There must be no bright colours and no distraction. Another example is the possibility to combine the relaxation chamber with biofeedback. Also, a chair or a couch in the Virtual Reality and in real life is a high priority requirement.

All the requirements were discussed with the therapists through a focus group. In general, the requirements corresponded to the opinions of the therapists. However, a few differences were discovered. While in the individual sessions time pressure during

exercising in Virtual Reality was hardly suggested, during the validation phase therapists discussed it was critical for good use. Another factor that was only mentioned in the validation phase, was that muscle tension is the most preferred form of biofeedback.

The questionnaire that was provided in the experience phase showed that breathing on a rhythm was the preferred breathing exercise for Virtual Reality therapy. However, during the validation phase therapists stated it would not be good at all. They suggested to implement an exercise that requires breathing in and out deeply.

The results of the interviews showed therapists thought it was important to monitor the time spent in Virtual Reality, while during the validation phase it was mentioned this was not important at all. No more differences were found during the validation phase.

Discussion/recommendation

The aim of this study was to investigate how particular techniques used for body awareness can be implemented in immersive Virtual Reality for chronic back pain.

From our three-phases study with occupational therapists, it can be concluded that Virtual Reality is a promising tool to improve body awareness within the rehabilitation of chronic back pain. Graded exposure, relaxation, cognitive defusion, mindfulness and breathing exercises are techniques that can be implemented in Virtual Reality for chronic pain according to the therapists. Mindfulness followed by breathing exercises and relaxation were considered as most important. These three techniques are used in the core of most rehabilitation therapies for chronic pain, particularly in ACT. Another factor that is very important to the therapists is the possibility to "stop" patients during exercising to give them the opportunity to think about their body, thoughts and emotions.

According to the results of this study, biofeedback would be valuable in Virtual Reality treatment for chronic pain because this allows patients to have real time insight in their own body signals. In this way, patients can take immediate actions to achieve their training goals. For the therapists, biofeedback can be used as a tool for monitoring the progression of the patient over time. Literature showed biofeedback is already used in Virtual Reality for relaxation and mindfulness exercises (46, 84). Literature also showed other techniques used for chronic pain treatment, namely step-by-step goal setting and homework. However, therapists thought this could better be applied outside of the Virtual Reality. Also, acceptance therapy and value based therapy were named in literature. These techniques are not specifically named by the therapists, but they are used in current practice.

While distraction is not itself a technique mentioned in literature to improve body awareness, it is often applied in the training room, e.g. by turning on the radio. According to our results, the distracting elements in the Virtual Reality prototype are not strong enough and thus should be reviewed. This is an advantage of Virtual Reality, as it provides many opportunities to add distractions to the training when compared to the conventional training. Future Virtual Reality applications targeting pain therapy should explore the role of distraction not only as a mechanism to distract from the pain itself (95), but also as a disturbance from the required task within the game.

According to the therapists, patients could be divided in two types, namely the cautious and the busy type. A similar categorization is suggested by Weering et al. (96), in which the behaviour of chronic pain patients is described as over- or underestimating their level of physical activity. We recommend that Virtual Reality applications targeting pain therapy should have a modular architecture allowing functionalities to be switched on and off to adapt to the type of patient.

A limitation stated by the therapists for body awareness in Virtual Reality was the fact that the patients are not able to see their own body while immersed in the Virtual environment. In other rehabilitation areas, for example body image disorders, 'body swapping' has been used as a representation of the own body (97-99). In the future, motion tracking bodysuits, such as those used in the gaming industry, or simple tags/beacons in body parts (e.g. feet) (100), might eliminate this concern by providing a representation of the real body of the patient in the virtual environment.

The therapists were very enthusiastic about the use of Virtual Reality for chronic pain, especially when the discussed techniques are implemented to achieve improvement of body awareness and it is based on daily activities. It provides a safe environment for the patient and there are more possibilities in Virtual Reality than in therapy rooms.

Strengths and limitations

A strength of this research is that the requirements which resulted from this study were validated in phase III. Most of the results and thus requirements corresponded to the

wishes of the therapists. However, validation of the results and requirements was done with the same therapists from the individual experience sessions. Validation with another group of therapists might have provided another view. Since the Virtual environment was specially designed for Roessingh rehabilitation center, only therapists from Roessingh were included in this study. This means that the external validity might be low. Though, this same study is currently performed in Germany.

A limitation to take in mind, is that the results are based on the provided prototype and thereby might be influenced. Everything therapists said, was with the used Virtual Reality environment in mind. Therapists without experiencing the Virtual Reality environment might have had a different view. However, from experience we know that it would be very hard for therapists to imagine the possibilities in Virtual Reality without experiencing it.

Research to Virtual Reality for chronic pain has hardly be performed. This study shows the importance of body awareness for chronic pain treatment and the added value of Virtual Reality since the patients are out of their trusted environment. Besides, Virtual Reality offers a lot of possibilities provided in a safe environment for the patient.

In this study we tested a new prototype and according to the new stage approach for the evaluation of telemedicine a small sample size was required (Stage I, (101)). This study resulted in a set of requirements for future versions of the Virtual Reality application. Therefore, we recommend a new small evaluation. After feasibility and usability of the new application have been confirmed, it is recommended to perform a larger clinical study focused on working mechanisms and potential clinical effect (Stage II, (101)). Such study, would allow for a better understanding on how, when and to whom Virtual Reality can support body awareness in chronic pain rehabilitation.

Conclusion

In this study, we have investigated how techniques used for improving body awareness can be implemented in Virtual Reality for rehabilitation of chronic pain patients. From our focus groups and individual interviews with occupational therapists, we concluded graded exposure and graded activity, relaxation, cognitive defusion, mindfulness and breathing exercises can be implemented in treatment with immersive Virtual Reality. To achieve graded exposure and graded activity, the difficulty of exercises must build up. The relaxation chamber, a virtual place where patients can relax at any moment during or after the exercises, must have as little as possible stimuli and incorporation of biofeedback, such as respiratory rate, is advised. To apply cognitive defusion and mindfulness, Virtual Reality should support patients in “stopping” whenever desired by the therapist to give them the opportunity to think about their body, thoughts and emotions. Breathing exercises should be applied in the relaxation chamber as well as during the game tasks. Therapists agree that Virtual Reality assisted training is promising to improve the rehabilitation of chronic pain patients. Our next step is to make a new prototype, including the requirements which resulted from this study, and to test the prototype with potential end-users. This way, we will be able to say which techniques have the most importance and if Virtual Reality would have an added value compared to conventional care.

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