Zürcher Hochschule
für Angewandte Wissenschaften

Gesundheit

Watch Your Back

Exploration of the Practical Usability of a Visual Feedback Apparatus for Patients with Chronic Non-specific Low Back Pain

Heussler, Moana
06-731-244

Winter, Jasmin
17-668-682

Departement: Gesundheit
Institut für Physiotherapie
Studienjahrgang: PT17

Betreut von:
Dr. Sabina Hotz Boendermaker
Dr. Christoph Bauer

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Abstract

Background

An effective treatment of chronic lumbar back pain is still one of the challenges in physiotherapy. So far, numerous treatment methods exist, but the use of real time visual feedback is one of the newer therapeutic approaches. Its implementation possibilities, however, should be investigated further by more research.

Objective

Therefore, the aim of this bachelor thesis is to develop a video-supported system for visual feedback and to test its usability.

Procedure

As 85 percent of chronic back pain in the lumbar spine is not due to structural pathologies, this patient population was targeted. Based on the current literature, the clinical picture was presented in a use case. A prototype of a device for a video transmission of the back was developed and tested on a patient with chronic non-specific lumbar back pain.

Result

The system was evaluated using the system usability scale and reached a value of 77.5 out of 100, which represents a good usability.

Conclusion

By means of technical adjustments to avoid a delay in transmission and by an exact positioning of the monitor, an improvement of the usability can be achieved. Further research is required to evaluate the developed system for its efficacy in the treatment of chronic lumbar back pain.

Keywords

Chronic (non-specific) low back pain, visual feedback (therapy), video-supported

Darstellung des Themas

Chronische lumbale Rückenschmerzen erfolgreich zu therapieren gehört nach wie vor zu den Herausforderungen in der Physiotherapie. Zahlreiche Behandlungsmethoden existieren, der Einsatz von visuellem Echtzeit-Feedback gehört jedoch zu einem neueren Therapieansatz, dessen Implementierungsmöglichkeiten aber noch durch weitere Forschung genauer untersucht werden sollte.

Ziel

Daher ist es das Ziel dieser Bachelorthesis, ein videogestütztes System für visuelles Feedback zu entwickeln und dieses hinsichtlich dessen Anwendbarkeit zu überprüfen.

Vorgehen

Da 85 Prozent der chronischen Rückenschmerzen in der Lendenwirbelsäule nicht auf strukturelle Pathologien zurückzuführen sind, wurde der Fokus auf diese Patientenpopulation gelegt. Anhand der aktuellen Literatur wurde das klinische Bild in Form eines Use Case dargestellt, der Prototyp eines Apparates zur Videoübertragung des Rückens entwickelt, und an einem Patienten mit chronischen unspezifischen lumbalen Rückenschmerzen getestet.

Ergebnis

Das System wurde mit der System Usability Scale überprüft, und erreichte 77,5 von 100 Punkten, was einer guten praktischen Anwendbarkeit entspricht.

Schlussfolgerung

Anhand technischer Anpassungen zur Vermeidung einer zeitlichen Verzögerung bei der Übertragung und durch eine exakte Positionierung des Monitors könnte eine Verbesserung der praktischen Anwendbarkeit erreicht werden. Weitere Forschung ist erforderlich, um das entwickelte System auf seine Wirksamkeit bei der Behandlung chronischer lumbaler Rückenschmerzen hin zu untersuchen.

Keywords

Chronische (unspezifische) lumbale Rückenschmerzen, visuelle Feedback (Therapie), videogestützt

1 Introduction

1.1 Topic Description

According to a representative sample from the Rheumaliga Switzerland, about 80 percent of the adults in Switzerland suffer from back pain at least once a year. Nine out of ten of those affected are impaired in their everyday activities, which also leads to absences from work, university or school. Extrapolated, well over 10 million days of absenteeism due to back pain occurred in the Swiss population within one year (Gerfin, 2011). Wieser et al (2014) have estimated the direct and indirect economic costs of back pain in Switzerland for 2011 to range from 5.4 to 11.2 billion CHF. This ranks back pain among the most common health-related problems in Swiss society (Gerfin,2011). In the same year, low back pain was identified worldwide as the condition that causes most years of living with disability (Hoy et al., 2014).

As Moseley (2017) notes, the development of new, innovative treatment methods is still required if the burden of back pain is to be reduced. He claims that it is essential to investigate the mechanisms of action and the clinical applicability of such methods before they can be proven to be effective. Because visual feedback therapy seems to be an auspicious treatment method, the present project focuses on the question of the clinical usability concerning a video feedback apparatus in patients with back pain (Moseley, 2017). The subject of this bachelor thesis was tendered by the Department of Research and Development within the Institute of Physiotherapy at the Zurich University of Applied Sciences (ZHAW).

1.2 Theoretical Background

Low Back Pain

The main problem zone of the affected people is the lower back (Gerfin, 2011) or more precisely: “Low back pain (LBP) is defined as a pain arising from lower part of the spine, between thoracal vertebra 12 (Th12) and first sacral vertebra (S1), which can be local but can also radiate to lower extremity” (Waddell, 2004 cited after Luomajoki, 2010). Most people recover from an exacerbation of acute LBP within four weeks, but recurrences are frequent (O`Sullivan, 2005). A systematic review which included 36 studies revealed that after the first period of LBP, an average of

62 percent of the patients still experience pain after twelve months (Hestbaek et al., 2003). If the LBP lasts more than three months, it is defined as a chronic low back pain (CLBP) (e.g. Airaksinen et al. 2006). Only 15 percent of low back pain incidents are based on structure-specific medical diagnoses, such as fractures, tumors, anomalies, nerve root affections or spinal canal stenosis; they are, therefore, called specific low back pain (SLBP).
In contrast, non-specific low back pain (NSLBP) cannot be attributed to a clear cause. They represent the majority (85 percent) of the cases of LBP (O`Sullivan, 2005; Airaksinen et al. 2006).

Current State of Research

In his article “Innovative treatment for back pain” (2017), Lorimer G. Moseley points out that back pain is still one of the most serious non-fatal diseases in the world – at least in those countries where data has been recorded. Although numerous different treatment approaches exist, the current literature shows that previous methods have none or only a small effect on back pain (Moseley, 2017) and interventional therapies still face the challenge of the management of chronic non-specific LBP (Wand et al. 2012). It is assumed that this is, *inter alia*, due to the fact that researchers and clinicians have long pursued a structure-based treatment approach although back pain and structural pathologies rarely correlate (Moseley, 2017). The approach of an “end organ dysfunction”, meaning to assume the source of the pain in the painful site, seems to be unsuccessful (van Tulder et al., 2006).
It is known that CLBP patients show a reorganization of higher centers of the brain, such as the somatosensory cortex, the motor cortex and the pain matrix. These maladaptive changes in the brain, which develop over time and are proportional to the chronicity of symptoms, are thought to be associated with CLBP (Wand et al., 2011).
The increasing possibilities of imaging lead to new findings regarding a cerebral activity in pain and a cortical reorganization in chronic pain (Wand et al., 2011).The results of a study using functional magnetic resonance imaging (fMRI) observed that visual information of a body part during the application of a painful stimulus affects the interaction between the brain’s pain system and the network for body

perception, which, in turn, modulates the pain experience (Longo et al., 2012). However, these findings are probably not directly transferable to patients with CLBP, since only the brain activity of healthy subjects without a cortical reorganization, as occurs in chronic back pain patients, was investigated.
Innovative treatment approaches that aim at modifying cerebral processes and brain function have already been tested in other diseases where a cortical dysregulation is characteristic. For example, mirror visual feedback (MVF) or graded motor imagery (GMI) is used in the treatment of the complex regional pain syndrome (CRPS) or phantom pain in the limbs (Wand et al., 2011).
Regarding CLBP, neurochemical and structural changes as well as modifications in the cerebral body representation have been observed in affected patients. Some researchers suspect that the disruption of a bodily representation is both a consequence of and a cause for persistent pain (Wand et al., 2011). The reason might be that the back is a part of the body that is normally not visible for a person without a mirror, a photograph or on video display. The back is only perceived when the attention is drawn to it, for example by pain (Diers et al., 2016).
At present, the authors of this paper are not aware of any study that examines the brain activity altered by visual information of the back in chronic pain using imaging techniques. However, the authors of recent studies have investigated the effect of visual feedback (VF) on subjective pain perception in chronic back pain (CBP) (Diers et al., 2016; Diers et al., 2013; Löffler et al., 2016) or CLBP (Trapp et al., 2015; Wand et al., 2012).
The visual feedback comprises the visualization of the moving back of the standing subjects by using two mirrors (Wand et al., 2012) or, by means of real-time video, of the resting back while the subjects were lying prone (Diers et al., 2016; Trapp et al., 2015; Löffler et al., 2017) or sitting (Diers et al., 2013).
In the randomized controlled trial by Trapp et al. (2015), a tactile stimulation (two-point discrimination test) had to be evaluated in addition to the pain intensity. On average, the pain values in the intervention group decreased more than in the control group, while the threshold values for the two-point discrimination increased.
Two further studies investigated the implementation of visual feedback in combination with tactile interventions. Löffler et al. (2017) integrated the VF with a

massage therapy treatment and Diers et al. (2013) applied either pressure or electric stimulation on the upper back in their case control study. The evidence from all these studies indicates a statistically significant effect of visual feedback on the pain intensity. Heinrich et al. (2019), who examined the studies in a recently published review, pointed out, however, that on the one hand, the researchers were only able to demonstrate a moderate average pain intensity reduction, and, in addition, there was a lack of information about the methods and a certain risk for bias. They also stated that further studies are needed and that these studies should focus more on the risk of bias and the applicability to clinical practice (Heinrich et al., 2019).

New therapeutic approaches, for instance visual feedback therapy, that aim at reducing the pain intensity and the disability in daily living in CLBP patients, appear to be a promising approach in multimodal therapy interventions for patients with chronic low back pain (Moseley, 2017).

1.3 Research Objective

As described in the trials mentioned above, visual feedback seems to be a promising approach in the management of CLBP (Moseley, 2017). Yet, up to now, it is not systematically established in interventional therapies.

In moderately equipped physio practices, visual feedback is commonly generated by the means of mirrors. However, for back patients, mirror visual feedback (MVF) involves some disadvantages: Depending on the patient's position, the reflection cannot be seen ideally (Herinrich et al., 2019) so that a not intended movement of the spine is necessary. Furthermore, the image becomes downsized by using two mirrors. Using just one mirror, the image is inverted. The hypothesis is that with video feedback, most of these downsides could be avoided and video visual feedback could be used more commonly in therapeutic settings for the treatment of CLBP as well as in further research in this field.

Since video devices are not (yet) part of normal practices, the objective of this bachelor thesis is to develop a simple and cost-effective device for video-supported visual feedback (VSVF) and to investigate the clinical usability of the system on an exemplary chronic non-specific low back pain (CNSLBP) patient.

1.4 Research Question

How good is the practical usability of a video-supported visual feedback system for patients with chronic non-specific low back pain?

1.5 Organization of the Thesis

In the following chapter, the clinical picture of patients with chronic non-specific low back pain and the inclusion criteria for the test patient will be described. Chapter three gives an overview on the development process of the video feedback apparatus. The fourth and fifth chapters provide an insight into the test process and its results. Finally, the findings are evaluated in the discussion section and in the last chapter, conclusions are drawn with regard to potential improvements of the visual feedback device and possible future research.

2 Use Case

Since the non-specific back pain of the lumbar region with a share of 85 percent represents an absolute majority of back pains (Airaksinen et al. 2006) and about 65 percent of it become chronic (Itz et al., 2013), the present bachelor thesis focuses on this population. In the following section, it will be further explained how CNSLBP could be clinically presented. On this base, the clinical criteria will be defined, and a use case generated which is likely to benefit the most from the video-supported visual feedback system. This use case serves as a guideline for the characteristics of the test patient on whom the appliance is to be tested. The clinical criteria of the test patient will be described by means of assessments.

2.1 The Multi-Dimensional Clinical Picture of CNSLBP

Chronic pain

Every chronic pain (CP) has its origin as an acute pain experience. CP has, so far, been primarily defined by duration, ranging from three to twelve months, with the three-months variant being the most common (Schürer, 2016). A working group, commissioned by the National Institute of Health (NIH) in the USA to develop standards for research of CBP recommends defining CP as a pain that has existed for at least three months or at least half of the days in the last six months (Deyo et al., 2014). But concerning the heterogeneity of CP, a definition only at the temporal dimension does not seem to be sufficient (Schürer, 2016). A new general classification of chronic pain was developed by the International Association for the Study of Pain (IASP) and is based on current scientific evidence and the biopsychosocial model (Treede et al. 2019).

The WHO released the new International Statistical Classification of Diseases and Related Health Problems (ICD 11) in June 2018, which was adopted by all member states in May 2019 and will enter into force worldwide in 2022:

Chronic primary musculoskeletal pain is chronic pain in the muscles, bones, joints or tendons that is characterized by significant emotional distress (anxiety, anger/frustration or depressed mood) or functional disability (interference in daily life activities and reduced participation in social roles). Chronic primary

musculoskeletal pain is multifactorial: biological, psychological and social factors contribute to the pain syndrome.
In contrast to the predecessor version ICD 10, chronic pain is now recorded as an independent clinical disease the multifactorial basis of which also influences the course of chronic non-specific low back pain.
In the first instance, it is important to identify patients with chronic non-specific low back pain and distinguish them from those with specific low back pain. For this purpose, it is recommended to conduct a diagnostic triage (Airaskinen et al., 2006). This diagnostic process (fig. 1) also serves to exclude “red flags” by history taking and physical examination, which indicate a serious or systemic underlying pathology (e.g. O'Sullivan, 2005; Airaskinen et al., 2006).
Furthermore, the assessment of “yellow flags”, such as work-related and lifestyle factors, psychosocial stress, psychological factors, functional disability and pain behavior is recommended (O’Sullivan et al., 2014). Tagliaferri et al. summed up the main bio-psychosocial characteristics in their review (2019).

Biological and functional outcomes

Disability due to CNSLBP seems to be a more important reason for individuals to seek care than the pain intensity (Tagliaferri et al., 2019). High disability of physical function could lead to a significantly reduced performance in Activities of Daily Living (ADL) (Ferreira et al., 2010). Also, reduced muscular endurance and strength, especially of the trunk muscles, is suggested to be associated with CNSLBP (Taylor et al., 2014). In addition, CNSLBP patients are more likely to be overweight and obese (Hodselmans et al., 2010).

Psychological outcomes

Terms like kinesiophobia, fear-avoidance and pain-catastrophizing are commonly used to describe the CNSLBP patients' psychological outcomes. The individuals are afraid of a pain onset due to particular movements or positions. They believe that their back is vulnerable and that they must avoid particular activities. These beliefs and fears can lead to increasing restrictions in ADL and muscular deconditioning (Tagliaferri et al., 2019). A longitudinal study showed a bidirectional relationship

between CLBP, depression and anxiety (Gerrits et al., 2015). An epidemiological study found a higher prevalence of depression and anxiety in people with CLBP (Stubbs et al., 2016).

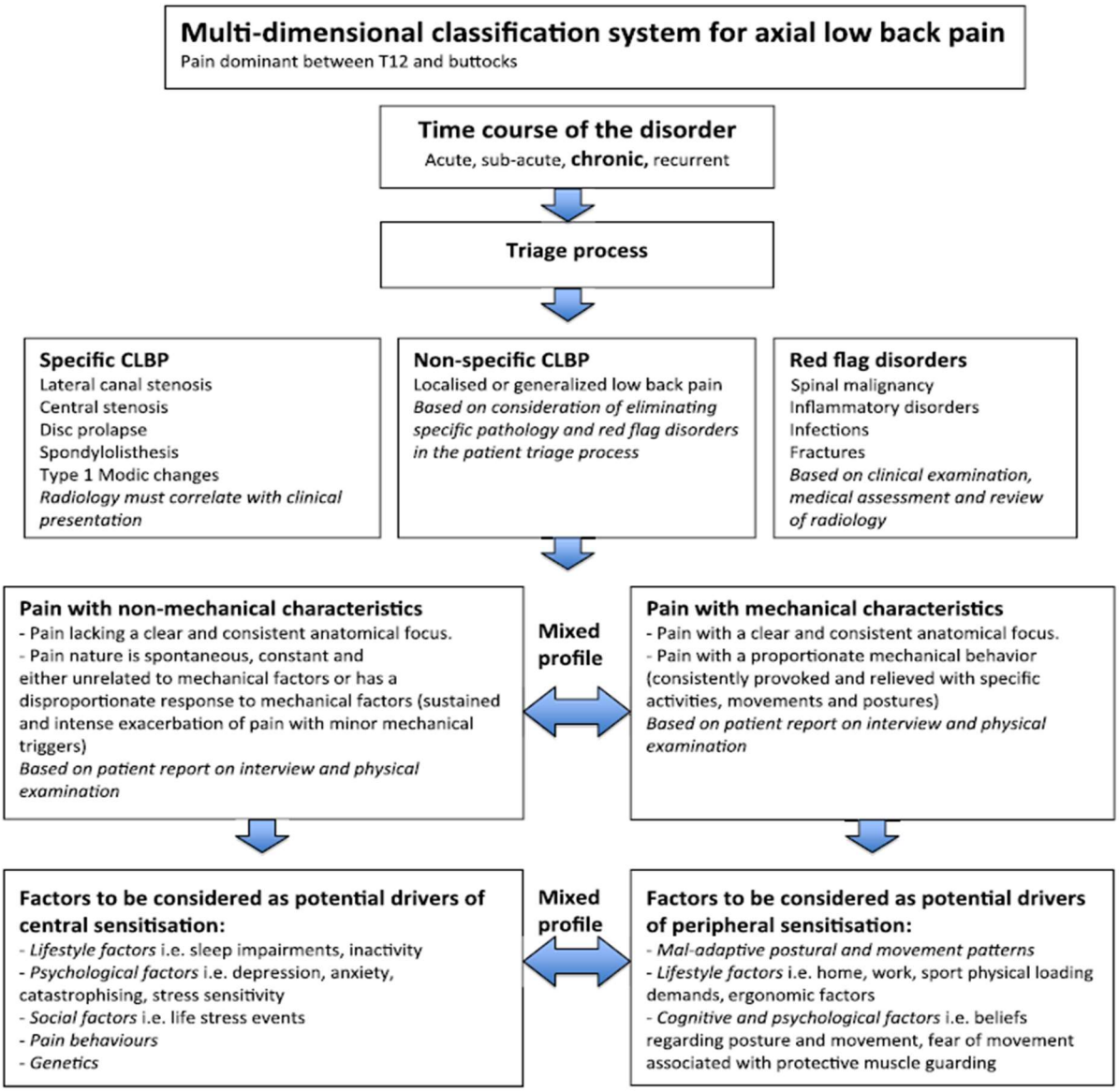

Figure 1: Multi-dimensional classification system for chronic non-specific low back pain (O'Sullivan, 2014)

Social outcomes

Social functioning is the ability to take part in social activities and to perform tasks at home and at work. In particular the capacity for housework, for recreational leisure activities and for work tasks are impaired in those individuals with CLBP

(Tagliaferri et al., 2019). This impairment has a negative impact on the health-related quality of life (Lamé et al., 2005).

Pain behavior

Complementary to the biopsychosocial factors, O'Sullivan et al. (2014) also categorized CNSLBP patients according to the behavior of back pain (fig. 1). They differentiated between motion-dependent (pain with mechanical characteristics) and motion-independent (pain with non-mechanical characteristics) pain because they assume that different neurophysiological processes are involved. However, they stated that further research was needed in this area.

Altered body perception

In recent years, there has been an increasing amount of research on whether patients with CLBP have an altered perception and if their cortical representation of the back changes. For instance, numerous studies on patients with CLBP indicate deficits in proprioception (Wand et al., 2011). The tactile acuity also appears to be reduced (Luomajoki & Moseley, 2011). Flor et al, (1997), for example, showed that the representation of the lower back in CLBP patients is shifted medially in the primary somatosensory cortex and leads to the area where the legs are normally represented. Another study stressed similar findings, but only in those patients who also reported high scores for stress. According to the authors of the study, this might indicate that the cortical changes are more likely a consequence of the emotional impact of CLBP (Lloyd et al., 2008).

Due to the still incomplete understanding of the complex processes in the brain, conclusions on this are currently still speculative. Nevertheless, it can be said with sufficient certainty that the cortical representation of the back in people with CLBP is altered compared to people without CLBP and that these changes are related to the clinical manifestations of the disease. These observations are also supported by the current understanding of the brain function (Wand et al., 2011), however, further research is required.

Central sensitization

In addition, at least a quarter of the patients with CLBP develop a chronic widespread pain (e.g. Clauw et al., 1999). These are characterized by a general lowered pain threshold (Peterson et al., 2017) or an increased pain response to repeated mechanical, thermal or electrical stimuli, which is designated as the wind-up phenomenon (Tagliaferri et al., 2019). The underlying mechanisms are not fully understood yet, but there is increasing evidence that changes in the central nervous system lead to a central sensitization and the development of pain hypersensitivity (Peterson et al., 2017).

Heterogenity in clinical appearance

Rabey et al. (2019) highlighted in their study the high variability of presentations of people with CLBP at an individual level. They conducted a cross-sectional cohort study with 294 patients. This study investigated classification patterns in three one-dimensional subgroup studies based on data from three clinically modifiable dimensions (pain sensitivity, psychological profile and pain response during repetitive flexion of the spine). 26 out of 27 possible combinations were found and these results contradict the idea that most CLBP patients would be found in only a few combinations. Therefore, it cannot be assumed that, for example, high psychological questionnaire scores are usually associated with a high pain sensitivity. This illustrates the high variability and heterogeneity in the clinical appearance and biopsychosocial factors involved in individuals with CLBP.

2.2 Test Patient

To define the characteristics for patients that correspond with the CNSLBP profile and can benefit from VSVF, the pain duration, the localization and the severity will be recorded. The categories of kinesiophobia, depression, anxiety and a disability in the everyday life may be present in the test patient but are not mandatory to fit the clinical picture of CNSLBP. However, the authors of this paper assume that individuals with limitations or higher scores in these categories may be particularly suited for the use of a video-based visual feedback therapy and may benefit most from this therapeutic approach. Therefore, the above categories are covered by the

corresponding assessment questionnaires. When selecting the assessments to be used, care was taken to ensure at least a moderate to strong validity for the intended target group patients with CNSLBP (Tagliaferri et al., 2019). Although an altered perception of the back and the cortical representation is assumed in patients with CNSLBP, predictions of the actual correlation are still speculative, and, therefore, this aspect is not included in the mandatory clinical criteria of the test patient.

2.3 Descritpion of the Assessments Used for the Test Patient

Kinesiophobia

The Tampa Scale of Kinesiophobia German Version (TSK-GV 11) serves as an instrument for measuring the fear of movement and re-injury. The version with eleven questions and the two subscales of somatic focus and activity avoidance has been proven to be the most suitable implementation in the German language. The eleven items of the scale each have four response options; all anchored with the answers “strongly disagree”, which scores 1 point, and “strongly agree”, which scores 4 points. The score to be reached ranges between 11 and 44 points. The higher the achieved score, the more pronounced the fear of movement/re-injury or kinesiophobia. The internal reliability (Cronbach’s Alpha) is a partial aspect of the reliability of a questionnaire. In the TSK GV-11 the Cronbach’s Alpha value of 0.73 is within an acceptable range (Rusu, Kreddig, Hallner, Hülsebusch & Hasenbring, 2014).

Depression, anxiety and stress

The short version of the depression, anxiety and stress scale (DASS-21) German Version is a questionnaire with 21 items, seven each for depression, anxiety and stress. A maximum of 3 points can be achieved per item, which results in a maximum possible total score of 63 points. The cut-off score for the subscale depression and stress is 10 points each, for anxiety 6 points. The characteristic values for the internal reliability (Cronbach’s Alpha) was with 0.88 for depression, 0.80 for anxiety and 0.87 for stress, which are each in a sufficient to good range (Nilges & Essau, 2015). The DASS-21 also appears to be a suitable method for

measuring depression, hyperarousal and tension in clinical and non-clinical groups (Gloster et al., 2008).

Disability

The Owestry Disability Index 2.1 German Version is a questionnaire to assess the function and the effects of back pain on the ability to cope with everyday life. The questionnaire is completed in reference to the patient's functional status ''today''. Each of the 10 items is scored on a scale of 0-5. The total for all items is summed up, then multiplied by two. The result is expressed as a percentage.
Interpretation (Mannion et al., 2006):

- 0 % -20 %: minimal disability
- 21 %-40 %: moderate Disability
- 41 %-60 %: severe Disability
- 61 %-80 %: crippling back pain
- 81 %-100 %: these patients are either bed-bound or have an exaggeration of their symptoms

Pain characteristics

The Pain DETECT (PD-Q) is a self-reporting questionnaire originally developed to detect neuropathic pain components. A maximum score of 38 points can be achieved. With a score of 19 or more, a neuropathic component is present with a probability of more than 90 percent (Freynhagen et al., 2006). But, the PD-Q can also be used to record the localization of the pain in a body chart. Furthermore, the pain intensity and the pain behavior (constant or intermittent) can be documented. This questionnaire will be used to describe the pain characteristics of the test patient of this bachelor thesis.

2.4 Fact Sheet of the Clinical Criteria

Localization of pain:

- Pain with mechanical or non-mechanical characteristics arising from the lower part of the spine, between the thoracal vertebra 12 (Th12) and the first sacral vertebra (S1), which can be local, but can also radiate to a lower extremity
- Assessment: Pain DETECT questionnaire

Duration of pain:

- Pain that has existed for at least three months or at least half of the days in the last six months
- Assessment: Additional question in the context of the medical screening

Functional outcome:

- Disability in ADL
- Assessment: Owestry Disability Index German Version

Psychological co-factors:

- Kinesiophobia, depression and/or anxiety
- Assessment: Tampa Scale German Version and DASS- 21 German Version

Exclusion criteria:

- Age under 18
- Red flag signs
- Specific structural cause
- An ICD 11 psychiatric or physical diagnosis that would better account for the presented symptoms or which makes the implementation of a video-supported visual feedback therapy impractical
- Persons who reach a value of 10 or higher in the subscale depression in the DASS-21 to rule out that the test patient foremost has a depressive disorder

3 Video Feedback Apparatus

3.1 Visual Feedback Technology

Different forms of visual feedback are used in pain management as a non-pharmacological form of analgesia. As imaging technologies become more and more sophisticated, the possibilities of applying real-time visual feedback are getting broader and more accessible.

Not only visual feedback of the real body and the environment, but also virtual environments are part of newer therapies and research. In therapeutical virtual reality (VR) settings, the patient can e.g. move a body part that is viewed on a screen without moving his or her body. When the patient must complete a task in the virtual setting, the feedback is combined with a feed-forward component. The downsides of VR are the high costs, the complexity of the apparatus and the software and the side effects on the patient, such as cyber sickness that includes symptoms like nausea, headaches and dizziness (Rebenitsch et al., 2016). Apart from that, VR always builds an illusion, it does not show the real body which leads to an unprecise or even disrupted image of one's body part.

For the effects of visual feedback as described in the introduction, the image of the body should be displayed as accurately as possible. Also, for economic and applicability reasons, a simple video feedback can be promising for the use in everyday physio practices.

3.2 Method: Agile Development Process

The development of an apparatus is a complex innovation process. Initially, there is only a rough idea of the final product. To manage the uncertainty of the appearing problems and the possible solutions, one can choose an agile development approach. This means that the development process is not linear and projectable, but rather needs to continuously be adapted. The product or subproduct is tested and retested in an iterative process. In each iteration, the subproduct is analyzed and the deficits defined as well as the design adapted to improve the apparatus. In this manner, new requirements can be identified along the way (Link, 2014).

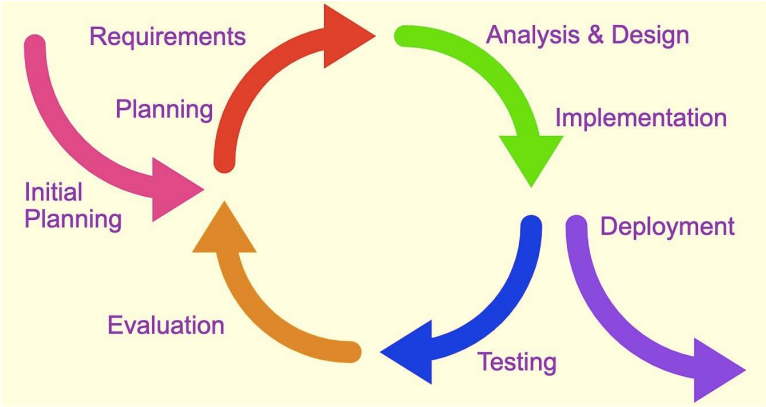

Figure 2: Iterative development process
"Iterative and incremental development", (2020) in *Wikipedia*

3.3 Initial Planning/Requirements

The video feedback system consists of three units: recording, image transmission and display. To design and test a video feedback apparatus in a first step, the requirements the recording device, the display system and the data transmission must meet are identified.

Recording

The recording apparatus should be adaptable in space. On the one hand, the apparatus should be portable and easy to handle so that it can be stored away and moved to the places where it is needed. On the other, the recording device itself (camera/smartphone/tablet) should be adaptable in height and angle so that the patients back can be recorded in varyious positions and the needed perspective relative to the patient can be set up. The recording should be able to zoom, and, in addition, should be low-priced and easy to use.

Transmission

The data transmission of the imaging from the recording device to the display is preferably wireless to avoid an interference in the video feedback session. Additionally, it is not possible to link two smartphones with a cable, the display device would need to be a mere display. The transmission should be as fast as possible so that no delay of the visual feedback in respect to the movement occurs. The software or application should be easy to acquire, user-friendly and cheap.

Possible transmission applications: Team Viewer, screen mirroring, streaming, remote apps for cameras (e.g. Fuji Camera Remote).

Display

The display of the patient's own back should be visible at all times during the movement. This means that a monitor is required that could move with the patient's head and should, therefore, be mounted to his or her head. The distance of the display to the test patient's eyes must be approximately 20 centimeters or more. Due to the eye's accommodation, the minimal visual range rises with age (fig. 3). Head Mounted Displays, such as VR-headsets, are very close to the eyes. Such systems require special video formats because each eye has its own screen. This technology is too elaborate and not practicable for this trial. The head-mounted display should be as light as possible to avoid inconvenience for the patient. For the reasons given above, the use of a smartphone seems to be the preferable option.

3.4 Description of the Iterations

1st Iteration

Description: The first test focused on the transmission technology. After a consultation with a friend who is a computer scientist, the simplest way seemed to be Team Viewer for the data transmission. Team Viewer is a free screen-sharing software, which means that the screen of a device shows the same image as the one it is linked to. Two smartphones were connected via Team Viewer. The test patient held his smartphone in one hand and the examiner recorded the test patient's back during a spinal flexion in a standing position.
Evaluation: The transmission had no perceivable delay and a good visibility and resolution.

2nd Iteration

Description: For the second testing, the recording device and the display were set up. The recording device is composed of a tripod, a bendable support arm and a smartphone holder.

The display is a head mountable strap with an inflexible, slightly bent arm and a smartphone holder at the end in a 23 centimeter distance to the eyes.

Figure 3: Head strap for smartphones (own photo)

Evaluation: The recording can be positioned in various angles and moved in the room. For small and middle movements of the test patients' body in the room, the recording meets most of the requirements. For bigger movements, e.g. squatting down and standing straight, a good vision of the back is not provided. The tripod that was used costs around 200.- CHF, but there are cheaper tripods available for 30.- CHF.
Because the weight of a smartphone pulls the head strap down, there is pressure on the forehead which leads to discomfort. For the transmission, the two smartphones were connected via Team Viewer which still worked well.

3rd Iteration

Description: The display device was modified by mounting the strap to a helmet instead of the head itself.

Evaluation: With the helmet, there is a better stability of the apparatus and the pressure is distributed more evenly around the head which provides more comfort. A downside is the bulkiness of the helmet and the additional weight.

Mechanical considerations

The aim of the further iterations is to improve the comfort of the head-mounted display. Because of the weight of the smartphone, there is a tilting effect of the plastic plaque at the forehead, and, thus, a pressure point at the lower edge of the plaque. To reduce the local pressure point, the moment of force is to be eliminated. A possibility to achieve that is with a tension ring that distributes the force around the head. A second way is to add a counterweight that pulls the arm with the smartphone back and up (fig. 5).

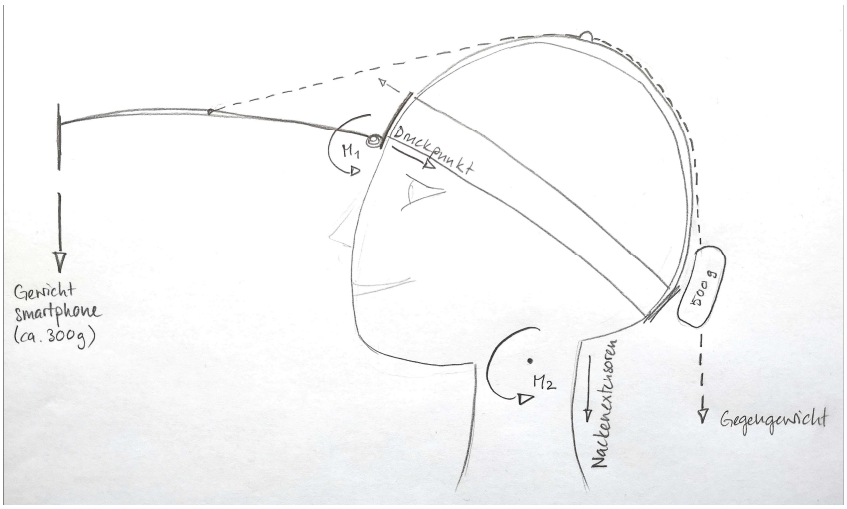

Figure 4: Mechanical forces that have an impact on the wearing comfort of the head strap (own sketch)

4th Iteration

Description: Additional padding was applied to the forehead with foam rubber. The inlay of a building site helmet is removed and placed over the elastic head strap in a way that the upper edge of the plaque at the forehead is pressed to the head and the tilting effect should thereby be reduced.

Evaluation: The pressure is more evenly distributed around the head, but additional pressure is applied to achieve this. An improvement of the local pressure point can

be observed. But the weight of the smartphone still pulls the head in flexion so that a constant muscle activity in neck extension is required to even out the moment of force. The wearing comfort cannot decisively be improved by this adaption.

5th Iteration

Description: Additional padding is applied at the forehead with foam rubber. Two cords are fixed to the inflexible arm at the front which pass over the crown of the head to the occiput where a counterweight of 300 grams is attached to the cords.
Evaluation: The moment of force is noticeably reduced and therefore the pressure point at the forehead as well as the necessity of muscular activity of the neck is reduced. When moving the head in lateral flexion, the counterweight dangles from side to side which is uncomfortable.

6th Iteration

Description: To avoid the dangling of the counterweight in a lateral flexion, it was fixed to the head strap inhibiting a lateral movement while allowing a slight cranial/distal movement. The counterweight was replaced by a weight of 500 grams used for diving equipment.
Evaluation: The comfort of the head-mounted display was improved noticeably through this adaption, even though a slight tilting of the arm with the smartphone remains in a lateral flexion movement of the head. Although there is more weight in total, the wearing comfort of the head-mounted apparatus could be improved. A good result was achieved in almost all categories. Only the lateral stability and the weight of the head-mounted display show small deficiencies.

Figure 5: Modulated display system with counterweight (own photo)

Rating of the Evaluation Criteria

	1st iteration	2nd iteration	3rd iteration	4th iteration	5th iteration	6th iteration
Recording						
relocatable	-	✓✓	-	-	-	-
Adjustable height	-	✓✓	-	-	-	-
Adjustable angle	-	✓✓	-	-	-	-
Low costs	-	✓✓	-	-	-	-
Easy application	-	✓✓	-	-	-	-
Transmission						
Wireless	✓✓	✓✓	-	-	-	-
Fast (no delay)	✓✓	✓✓	-	-	-	-
Easy to acquire	✓✓	✓✓	-	-	-	-
Low costs	✓✓	✓✓	-	-	-	-
Easy application	✓✓	✓✓	-	-	-	-

Display						
Comfort: no pressure point	-	x	✓✓	✓	✓✓	✓✓
Comfort: stability	-	✓	✓✓	✓	x	✓
Comfort: minimum effort for the neck	-	x	x	x	✓✓	✓✓
At least 20 cm distance to eyes	-	✓✓	✓✓	✓✓	✓✓	✓✓
Display always visible during motion	-	✓✓	✓✓	✓✓	✓✓	✓✓
Light weight	-	✓✓	✓	✓✓	✓	✓

Table 1: Rating of the evaluation criteria (own table)

Description of signs:

-	not tested	✓	somewhat complied
✓✓	fully complied	x	not complied

3.5 Costs

One condition for the visual feedback system is its cost efficiency. For the prototype, the total costs are 113 Swiss Francs for the particular components. The costs are shown in the following table.

Component	**Cost (**CHF)
Smartphone holder	29.-
Bendable arm "gooseneck"	33.-
Tripod	30.- (as seen in online sales)
Head strap with smartphone holder	12.50
Counterweight	8.50
	Total: 113.-

Table 2: Costs for the individual parts of the VSVF apparatus (own table)

4 Testing

4.1 Apparatus

After the development process of the video feedback apparatus had led to a satisfactory solution, the system was tested on a test patient. The apparatus consists of the following components: The recording system is composed of a tripod with a bendable arm and a smartphone holder. The display system consists of the modulated head strap with an inflexible arm and a smartphone holder. Elastic straps, adjustable in length, allow the head strap to be adapted to the size of the head. The industrially manufactured head strap was modulated with additional padding at the forehead and a counterweight at the occiput. The two smartphones were linked via the screen-sharing software Team Viewer so that the display showed the same image as the recording device.

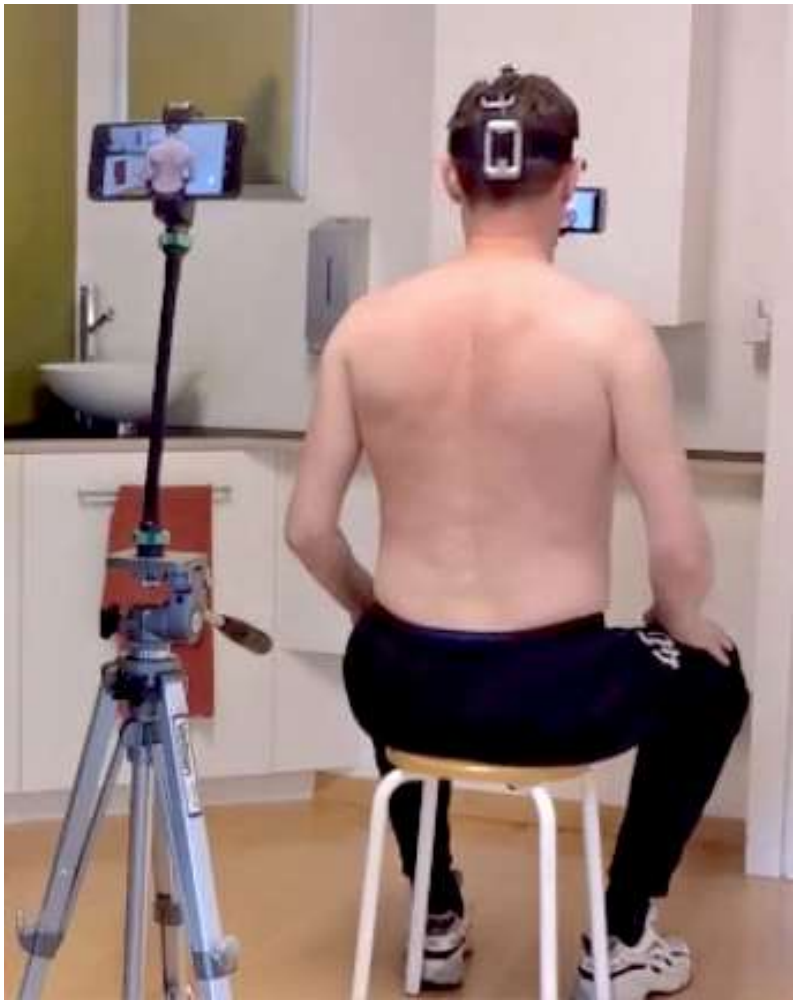

Figure 6: Test configuration, video of the recording of the test sequence (own photo)

4.2 Recruitment of the Test Patient

To find a suitable person for the preclinical study to assess the applicability of the visual feedback system “watch your back”, emails were sent to practicing physiotherapists. These messages contained a list of the clinical criteria that should be met by the test patient to fit the CNSLBP target group.
A male person with chronic LBP agreed to participate in the test. An appointment was then made and the questionnaires on his back pain were sent to him by e-mail. These were completed by him independently and returned to the authors of this thesis. A written informed concent was obtained before the testing started.

4.3 Testing Setup

The test sequence was conducted in a physiotherapy practice/facility, in a room of approximately 15 squaremeters. There was good artificial illumination as well as windows providing additional daylight. The test patient’s back was facing the window for optimal lighting. The tripod with the recording device was positioned at one and a half meters behind the test patient in a hight of one meter 40 centimeters. For the exercises, two stools, a box and a medicine ball (weight: 2.5 kg) were provided. In absence of a fast wireless internet connection, TeamViewer was connected via mobile internet.

4.4 Testing Protocol

The testing started with a short information about the project and the goal of the testing. The test patient was asked to constantly express his experiences and thoughts concerning the apparatus during the testing procedure. Sitting on a stool with the upper body undressed, the head mounted display was put on the test patient’s head. In a first sequence, the patient was asked to perform isolated repeated spinal movements in the following directions: flexion, extension, rotations and lateral flexions while observing his back on the screen. During the second sequence, the test patient was standing and was asked to move a medicine ball to predetermined positions. He was invited to touch the wall in front of him at overhead height with the ball, as well as the two stools standing each to his left and right and the low box in front of his feet. Verbal instructions for the movements were

given by the authors of this thesis and supplemented with visual instructions when needed. The testing sequence in which the test patient wore the head mounted display took 16 minutes.
After the exercises were completed, a short evaluating interview was conducted to learn about the overall impression on the apparatus as well as possible downsides. After the interview, the test patient filled out a german version of the standardized System Usability Scale questionnaire (SUS). The german translation proposed by a group of usability experts was independently retranslated back into English by British and US native speakers to ensure that the translated text had the intended meaning (Rummel,2015). This questionnaire consists of 10 items that quantify the subjective usability of a system. Each item can be evaluated on a five-point scale ranging from „strongly disagree“ to „strongly agree“. To calculate the final usability, the sum of scores is multiplied by 2.5, so that the score ranges from 0 to 100.
Figure 7 below shows three ratings, namely acceptability ranges, grade scale and adjective ratings, all based on SUS score ranges. A SUS score below 50 indicates poor usability (not acceptable), while a score between 50 and 70 indicates marginal acceptability, and a score above 70 indicates an acceptable (good, excellent and best imaginable or better) level of usability (Bangor, Kortum & Miller, 2009).

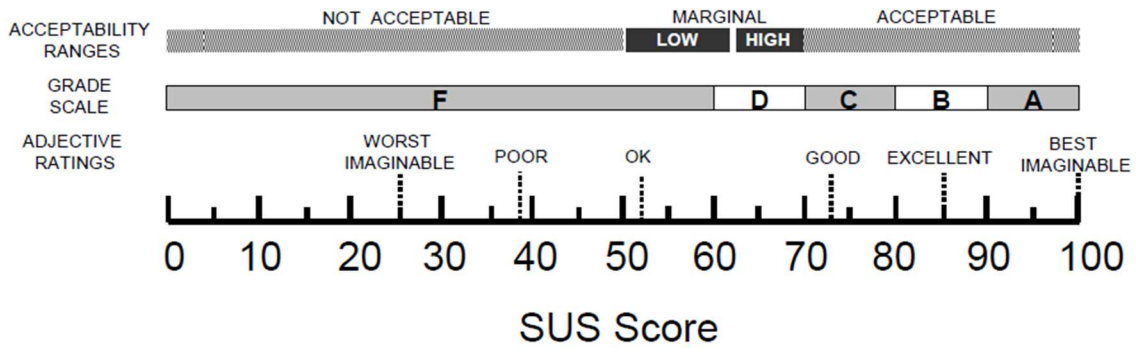

Figure 7: Interpretation of the SUS scores (Bangor et al., 2009)

5 Results

5.1 Evaluation of the Assessment Questionnaires

The previously completed painDetect questionnaire shows that the participant has permanent pain with slight variations. These are manifested in the lumbar region of his back with radiation towards the left lower extremity. Currently the pain intensity on the numeric rating scale (NRS) is 1/10, and in the last four weeks the pain intensity was on average 3/10 (NRS). Overall, a total score of 5 points was achieved in the painDetect. Since painDetect does not record any specification on pain duration, the patient was asked for this data separately. On the date of the trial, the pain had been present for 5 months.

The evaluation of the ODI resulted in a score of 10%, which corresponds to a minimal disability. The evaluation of the TSK-GV resulted in an overall score of 19 out of a maximum of 44 points. There is no fixed cut off value for the TSK-GV, a score higher than the minimum value of 11 points indicates that the test person has a fear of movement.

In the DASS-21 in subscale for depression, zero points were achieved, which corresponds to the lowest possible score and therefore a depressive component can be excluded.

5.2 Summation of the Statements from the Open Interview

The respondent considered it disturbing that there was a time delay between movement and image transmission. In summary, he described the wearing of the head mount as comfortable, only during the lateral flexion to the right he had the impression that the display mount could be dropped to the side. Another important aspect he mentioned was that the smartphoneholder formed a central vertical axis (Fig. 8), and the image of the back respectively the spine was slightly displaced sideways. This discrepancy also irritated the respondend when observing his movements of the back.

5.3 Evaluation of the SUS

The SUS completed by the respondent received a score of 77.5 out of 100 possible points. This score corresponds to a good level of usability.

three of ten items received the highest possible score: “I thought the system was easy to use” (strongly agree) and “I found the system unnecessarily complex”; “I needed to learn a lot of things before I could get going with this system” (strongly disagree). The respondent would only use the system occasionally for therapeutical purpose, according to him, a frequent use is not indicated or useful. He assumed that the system could be applied by the user him-/herself after a short introduction. Support of a technically experienced person is not mandatory, and he did not have to learn a lot before he could use the system himself. The various functions are well integrated, no inconsistencies occurred.

6 Discussion

In this thesis, the authors developed a device for a real-time video feedback in an iterative process by testing and re-testing the subproducts on themselves. The apparatus was then applied to one test patient with CNSLBP to gather unbiased information about the practical usability of the apparatus.
The test was highly interesting for everybody involved and the overall impression of the apparatus was mostly positive. One deficiency of the device was already known beforehand (the instability of the head-mounted display during the lateral flexion of the neck) and could be verified in the testing. But new insights were also gained regarding limitations as well as positive aspects. The evaluation of the SUS questionnaire confirmed that the test patient regarded the system as simple and easy to use. In the following, the main findings are discussed.

6.1 Test Patient

The symptoms described by the test patient basically correspond to the clinical picture of a patient with CNSLBP, and, therefore, the person seemed to be qualified for the test: The pain is located in the lumbar region and radiates on the left side towards the lower extremity. At present, the permanent pain that existed for five months is very low with an NRS of 1/10. The ODI questionnaire shows that the patient's back pain only increases when lifting heavy objects or standing for a long time. His pain then prevents him from sitting down for more than an hour.
In TSK-GV 11, the two items with the highest agreement (each with 3 points, which corresponds to "somewhat agree") were: "I'm afraid I might injure myself if I exercise" and "Pain lets me know when to stop exercising so that I don't injure myself". All other statements were rated as "somewhat disagree" (2) or "strongly disagree" (1). The score for kinesiophobia increased to 19 points but only to a slight extent, meaning that the test patient met the clinical criteria but is very mild in terms of his current pain intensity and psychological outcomes.

6.2 Recording

The recording system, consisting of a tripod and a smartphone as a camera mounted to a bendable arm, showed no disadvantages during the field test. When

positioned in a one and a half meter distance to the test patient and on one meter and 40 centimeter height, the back of the test patient was sufficiently visible on the monitor in any position and movement. Due to the bendable arm, the angle of the smartphone used for recording could easily be adjusted.

6.3 Transmission

The biggest shortcoming of the apparatus in the test sequence was a delay between the recording- and the display device. As a result, the test patient saw his body move up to one second later than he had actually performed the movement. This led to an irritation because the affiliation of the picture of the back seen on the screen to one's own body scheme is disrupted. The delay in the data transmission can be explained with the poor Internet connection. The circumstance that this problem appeared for the first time in the test sequence is due to a weak point in the development method: During the iterative development process, each subproduct was only further developed if it showed deficiencies. Because the transmission was tested with a fast Internet connection, possible difficulties occurring in other circumstances were not considered. In the test sequence, this downside could be diminished by performing slow movements so that the delay was not so apparent. Apart from the fact that the transmission via Team Viewer is dependent on a fast Internet connection, the software suits the recommendations of the apparatus: It is cost free, easy to handle and well compatible between different devices.

6.4 Display

The display system consists of the head-mounted strap with an inflexible arm, a smartphone holder and a smartphone as monitor. The development of this part of the apparatus took up most of the time of the development process because this aspect particularly important for the usability. After the width of the head strap was loosened a little, the head-mounted display was found to be comfortable to wear. In general, the stability of the head-mounted system during the movement was satisfactory, but during the lateral flexion, the test person stated that it felt as if the arm with the smartphone holder might tilt sideways. The instability is mainly

explained by the simple construction of the display system. The weight of the smartphone is reinforced by the 20-centimeter arm and cannot be sufficiently compensated by the elastic straps or the counterweight at the back in a lateral flexion of the neck.
One advantages of the display system is that the system is open to the sides and enables the test person to be aware of his surroundings while looking at his back so that he is able to grasp an object and place it in several positions.
The test further showed that the respondent perceived the visible parts of the smartphone holder as a central vertical axis. Irritation occurred when the spine in the image did not correspond to this perceived orientation axis because the smartphone was not fixed exactly in the middle and the recording did not center the test patients back in the image.

Figure 8: Vertical axis of the smartphone holder corresponding to the central line of the back (own photo)

6.5 Usability

The complementary comments made by the test patient during the completion of the SUS questionnaire made it possible to understand which aspects led to a reduction of the usability score. These were mainly: the time delay of the transmission, the instability of the head-mounted system during a lateral movement and the

discrepancy of the perceived vertical axis to the actual positioning of the back. It follows that an improvement of these aspects can also improve the usability of the video-based visual feedback apparatus.

7 Conclusion

With regards to the research question how good the practical usability of the video-supported visual feedback system at issue is, a positive result can be deduced from the field test and its evaluation. The results of this investigation indicate that the apparatus is easy to use for the patient as well as for the therapist, generally comfortable to wear and the total costs are moderate.

7.1 Findings

In the test process, three main findings concerning the usability of the apparatus were identified:

- **A fast Internet connection is a prerequisite for the use of the apparatus.** A delay of the displayed picture in relation to the movement of the patient is irritating and adverse to the purpose of the apparatus. As an alternative to the transmission via Team Viewer, a camera that is connected to a small screen via cable could be considered. This would avoid the delay, but the cable could complicate the handling and disturb the patient's motions. Furthermore, the display system would have to be adapted and costs would increase due to necessary additional parts.
- **In lateral flexion of the trunk and/or neck, there is an instability of the arm with the smartphone holder.** As an isolated lateral flexion is not a very functional everyday movement, it can be considered rather marginal, and, therefore, neglected. To eradicate this downside, additional modulations of the display system would be necessary, which, in turn, could also have a negative effect on the ease of use.
- **The vertical axis that is generated by the visible parts of the smartphone holder is to be aligned with the central axis of the patient's back.** The irritation that evolves when the central axis of the smartphone holder does not correspond to the central axis of the patient's back is easy to avoid. This impediment of the apparatus can be prevented by the therapist through a correct adjustment when setting up the head-mounted system.

7.2 Practical Transfer

The apparatus developed in the presented project is a prototype. A prefabricated headset was manually adapted by means of a counterweight and improved padding to increase the wearing comfort. A direct use in physiotherapy practices is not (yet) realistic. Especially for the head-mounted display system, an industrially manufactured improved version would be required for its extensive use in physiotherapeutic facilities.

7.3 Limitations

The generalizability of these results is subject to certain limitations as the usability was only assessed by one single test person. A risk of bias is caused by the fact that the presence of the authors during the usability test may have influenced the test person in his judgement of the system.
From the perspective of the authors, despite the limitations of this initial trial, valuable information on further necessary adjustments to the VSVF apparatus could be obtained.

7.4 Outlook

This bachelor thesis can provide the basis for usability improvements so that this system can be used in future research, and, if possible, also in physiotherapeutic establishments. To obtain a more representative result for the practical usability, in a next step, the test should be repeated with a larger sample size, taking into account the adjusted settings.
A natural progression of this work could be to analyze the effect of the VSVF system on the impairments caused by CNSLBP, such as disability, pain severity and the impact on psychosocial factors. The approach to use visual feedback therapeutically aims at changing the brain function. This has already been investigated in other chronic pain syndromes, such as CRPS and phantom pain after a limb amputation (Wand et al., 2011). Further research on the visual feedback therapy in CLBP in general is needed to gain a better understanding of the exact mechanisms and to explore the possible indications for its use.

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List of Abbreviations

ADL	activities of daily living
CLBP	chronic low back pain

CNSLBP	chronic non-specific low back pain
CP	chronic pain
CRPS	complex regional pain syndrome
DASS-21 GV	depression, anxiety and stress scale 21, German version
e.g.	exempli gratia
fMRI	functional magnetic resonance imaging
GMI	graded motor imagery
LBP	low back pain
MVF	mirror visual feedback
n. d.	not dated
NSLBP	non-specific low back pain
ODI 2.1 D	Owestry disability index 2.1, German
PD-Q	Pain DETECT questionnaire
SLBP	specific low back pain
S1	sacral vertebra 1
TH12	thoracal vertebra 12
TSK-GV 11	Tampa scale of kinesiophobia German version 11
VF	visual feedback
VR	virtual reality
VSVF	video supported visual feedback

Declaration of Word Count

The abstract contains 215 words.

The present work contains 8’134 words, excluding the given exclusion criteria.

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Declaration of Independence

We hereby declare that we have written this thesis independently, without the assistance of third parties and using the sources cited in the text.

April 23, 2020

Jasmin Winter and Moana Julia Heussler

Appendix A: SUS (System Usability Scale German)

Fragebogen zur System-Gebrauchstauglichkeit

1. Ich denke, dass ich das System gerne häufig benutzen würde.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
○	○	✗	○	○

2. Ich fand das System unnötig komplex.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
✗	○	○	○	○

3. Ich fand das System einfach zu benutzen.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
○	○	○	○	✗

4. Ich glaube, ich würde die Hilfe einer technisch versierten Person benötigen, um das System benutzen zu können.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
○	✗	○	○	○

5. Ich fand, die verschiedenen Funktionen in diesem System waren gut integriert.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
○	○	○	✗	○

6. Ich denke, das System enthielt zu viele Inkonsistenzen.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
○	✗	○	○	○

7. Ich kann mir vorstellen, dass die meisten Menschen den Umgang mit diesem System sehr schnell lernen.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
○	○	○	✗	○

8. Ich fand das System sehr umständlich zu nutzen.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
○	✗	○	○	○

9. Ich fühlte mich bei der Benutzung des Systems sehr sicher.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
○	○	✗	○	○

10. Ich musste eine Menge lernen, bevor ich anfangen konnte das System zu verwenden.

Stimme überhaupt nicht zu 1	2	3	4	Stimme voll zu 5
✗	○	○	○	○

Appendix B: Pain DETECT (PD-Q)

painDETECT

SCHMERZ-FRAGEBOGEN

Datum: ..... Patient: Name: ..... Vorname: .....

Wie würden Sie Ihren Schmerz jetzt im Augenblick einschätzen?

0 1 2 3 4 5 6 7 8 9 10

kein max

Wie stark war der stärkste Schmerz in den letzten 4 Wochen?

0 1 2 3 4 5 6 7 8 9 10

kein max

Wie stark war der Schmerz in den letzten 4 Wochen im Durchschnitt?

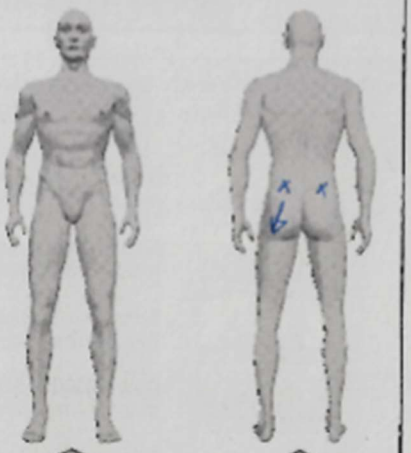
0 1 2 3 4 5 6 7 8 9 10

kein max

Kreuzen Sie das Bild an, welches Ihren Schmerzverlauf am besten beschreibt:

- Dauerschmerzen mit leichten Schwankungen [X]
- Dauerschmerzen mit Schmerzattacken [ ]
- Schmerzattacken dazwischen schmerzfrei [ ]
- Schmerzattacken dazwischen Schmerzen [ ]

Bitte kennzeichnen Sie Ihren Hauptschmerzbereich



Strahlt Ihr Schmerz in weitere Körperregionen aus? ja [X] nein [ ]

wenn ja, dann zeichnen Sie bitte die Richtung ein, wohin der Schmerz ausstrahlt.

	nie	kaum	gering	mittel	stark	sehr stark
Leiden Sie in den eingezeichneten Bereichen an einem Brenngefühl (z.B. Brennnesseln)?	[X]	[ ]	[ ]	[ ]	[ ]	[ ]
Haben Sie im Bereich Ihrer Schmerzen ein Kribbel- oder Prickelgefühl (wie Ameisenlaufen, Stromkribbeln)?	[ ]	[ ]	[X]	[ ]	[ ]	[ ]
Ist leichte Berührung (Kleidung, Bettdecke) in diesem Bereich schmerzhaft?	[X]	[ ]	[ ]	[ ]	[ ]	[ ]
Haben Sie im Bereich Ihrer Schmerzen blitzartige, elektrisierende Schmerzattacken?	[X]	[ ]	[ ]	[ ]	[ ]	[ ]
Ist Kälte oder Wärme (Badewannenwasser) in diesem Bereich gelegentlich schmerzhaft?	[X]	[ ]	[ ]	[ ]	[ ]	[ ]
Leiden Sie in den von Ihnen eingezeichneten Bereichen unter Taubheitsgefühl?	[X]	[ ]	[ ]	[ ]	[ ]	[ ]
Löst ein leichter Druck z.B. mit dem Finger in diesem Bereich Schmerzen aus?	[ ]	[X]	[ ]	[ ]	[ ]	[ ]

(vom Arzt auszufüllen)

nie	kaum	gering	mittel	stark	sehr stark
[ ] x 0 = 0	[0] x 1 = 0	[ ] x 2 = 0	[ ] x 3 = 0	[ ] x 4 = 0	[ ] x 5 = 0

Score-Gesamtsumme 0 von 35

R. Freynhagen, R. Baron, U. Gockel, T.R. Tölle, CurrMed ResOpin Vol 22, 2006, 1911-1920 ©Pfizer Pharma GmbH 2009

Appendix C: ODI-D 2.1

Behinderung bei Rückenbeschwerden:
Oswestry Disability Index – Deutsche Version (ODI-D)

Quelle: Mannion AF, Junge A, Fairbank JC, Dvorak J, Grob D. Development of a German version of the Oswestry Disability Index. Part I: cross-cultural adaptation, reliability, and validity. Eur Spine J 2006a; 15:55-65.

Code der Versuchsperson:

Bitte füllen Sie diesen Fragebogen aus. Er soll uns darüber informieren, wie Ihre Rücken- (oder Bein-) Probleme Ihre Fähigkeit beeinflussen, den Alltag zu bewältigen. Wir bitten Sie, jeden Abschnitt zu beantworten. Kreuzen Sie in jedem Abschnitt nur die Aussage an, die Sie heute am besten beschreibt.

Abschnitt 1: Schmerzstärke
- ☐0 Ich habe momentan keine Schmerzen
- ☒1 Die Schmerzen sind momentan sehr schwach
- ☐2 Die Schmerzen sind momentan mässig
- ☐3 Die Schmerzen sind momentan ziemlich stark
- ☐4 Die Schmerzen sind momentan sehr stark
- ☐5 Die Schmerzen sind momentan so schlimm wie nur vorstellbar

Abschnitt 2: Körperpflege (Waschen, Anziehen etc.)
- ☒0 Ich kann meine Körperpflege normal durchführen, ohne dass die Schmerzen dadurch stärker werden
- ☐1 Ich kann meine Körperpflege normal durchführen, aber es ist schmerzhaft
- ☐2 Meine Körperpflege durchzuführen ist schmerzhaft, und ich bin langsam und vorsichtig
- ☐3 Ich brauche bei der Körperpflege etwas Hilfe, bewältige das meiste aber selbst
- ☐4 Ich brauche täglich Hilfe bei den meisten Aspekten der Körperpflege
- ☐5 Ich kann mich nicht selbst anziehen, wasche mich mit Mühe und bleibe im Bett

Abschnitt 3: Heben
- ☐0 Ich kann schwere Gegenstände heben, ohne dass die Schmerzen dadurch stärker werden
- ☒1 Ich kann schwere Gegenstände heben, aber die Schmerzen werden dadurch stärker
- ☐2 Schmerzen hindern mich daran, schwere Gegenstände vom Boden zu heben, aber es geht, wenn sie geeignet stehen (z.B. auf einem Tisch)
- ☐3 Schmerzen hindern mich daran, schwere Gegenstände zu heben, aber ich kann leichte bis mittelschwere Gegenstände heben, wenn sie geeignet stehen
- ☐4 Ich kann nur sehr leichte Gegenstände heben
- ☐5 Ich kann überhaupt nichts heben oder tragen

Abschnitt 4: Gehen
- ☒0 Schmerzen hindern mich nicht daran, so weit zu gehen, wie ich möchte
- ☐1 Schmerzen hindern mich daran, mehr als 1-2 km zu gehen
- ☐2 Schmerzen hindern mich daran, mehr als 0.5 km zu gehen
- ☐3 Schmerzen hindern mich daran, mehr als 100 m zu gehen
- ☐4 Ich kann nur mit einem Stock oder Krücken gehen
- ☐5 Ich bin die meiste Zeit im Bett und muss mich zur Toilette schleppen

Abschnitt 5: Sitzen

☐0 Ich kann auf jedem Stuhl so lange sitzen wie ich möchte
☐1 Ich kann auf meinem Lieblingsstuhl so lange sitzen wie ich möchte
☒2 Schmerzen hindern mich daran, länger als 1 Stunde zu sitzen
☐3 Schmerzen hindern mich daran, länger als eine halbe Stunde zu sitzen
☐4 Schmerzen hindern mich daran, länger als 10 Minuten zu sitzen
☐5 Schmerzen hindern mich daran, überhaupt zu sitzen

Abschnitt 6: Stehen

☐0 Ich kann so lange stehen wie ich möchte, ohne dass die Schmerzen dadurch stärker werden
☒1 Ich kann so lange stehen wie ich möchte, aber die Schmerzen werden dadurch stärker
☐2 Schmerzen hindern mich daran, länger als 1 Stunde zu stehen
☐3 Schmerzen hindern mich daran, länger als eine halbe Stunde zu stehen
☐4 Schmerzen hindern mich daran, länger als 10 Minuten zu stehen
☐5 Schmerzen hindern mich daran, überhaupt zu stehen

Abschnitt 7: Schlafen

☒0 Mein Schlaf ist nie durch Schmerzen gestört
☐1 Mein Schlaf ist gelegentlich durch Schmerzen gestört
☐2 Ich schlafe auf Grund von Schmerzen weniger als 6 Stunden
☐3 Ich schlafe auf Grund von Schmerzen weniger als 4 Stunden
☐4 Ich schlafe auf Grund von Schmerzen weniger als 2 Stunden
☐5 Schmerzen hindern mich daran, überhaupt zu schlafen

Abschnitt 8: Sexualleben (falls zutreffend)

☒0 Mein Sexualleben ist normal, und die Schmerzen werden dadurch nicht stärker
☐1 Mein Sexualleben ist normal, aber die Schmerzen werden dadurch stärker
☐2 Mein Sexualleben ist nahezu normal, aber sehr schmerzhaft
☐3 Mein Sexualleben ist durch Schmerzen stark eingeschränkt
☐4 Ich habe auf Grund von Schmerzen fast kein Sexualleben
☐5 Schmerzen verhindern jegliches Sexualleben

Abschnitt 9: Sozialleben

☒0 Mein Sozialleben ist normal, und die Schmerzen werden dadurch nicht stärker
☐1 Mein Sozialleben ist normal, aber die Schmerzen werden dadurch stärker
☐2 Schmerzen haben keinen wesentlichen Einfluss auf mein Sozialleben, ausser dass sie meine eher aktiven Interessen, z.B. Sport einschränken
☐3 Schmerzen schränken mein Sozialleben ein, und ich gehe nicht mehr so oft aus
☐4 Schmerzen schränken mein Sozialleben auf mein Zuhause ein
☐5 Ich habe auf Grund von Schmerzen kein Sozialleben

Abschnitt 10: Reisen

☒0 Ich kann überallhin reisen, und die Schmerzen werden dadurch nicht stärker
☐1 Ich kann überallhin reisen, aber die Schmerzen werden dadurch stärker
☐2 Trotz starker Schmerzen kann ich länger als 2 Stunden unterwegs sein
☐3 Ich kann auf Grund von Schmerzen höchstens 1 Stunde unterwegs sein
☐4 Ich kann auf Grund von Schmerzen nur kurze notwendige Fahrten unter 30 Minuten machen
☐5 Schmerzen hindern mich daran, Fahrten zu machen, ausser zur medizinischen Behandlung

Appendix D: TSK-GV 11 (Tampa Scale of Kinesiophobia German Version)

FOMT
Fortbildungen für Orthopädische Medizin und Manuelle Therapie

Tampa Scale of Kinesiophobia

(validierte deutsche Version (TSK-GV, Rusu et al. 2014))

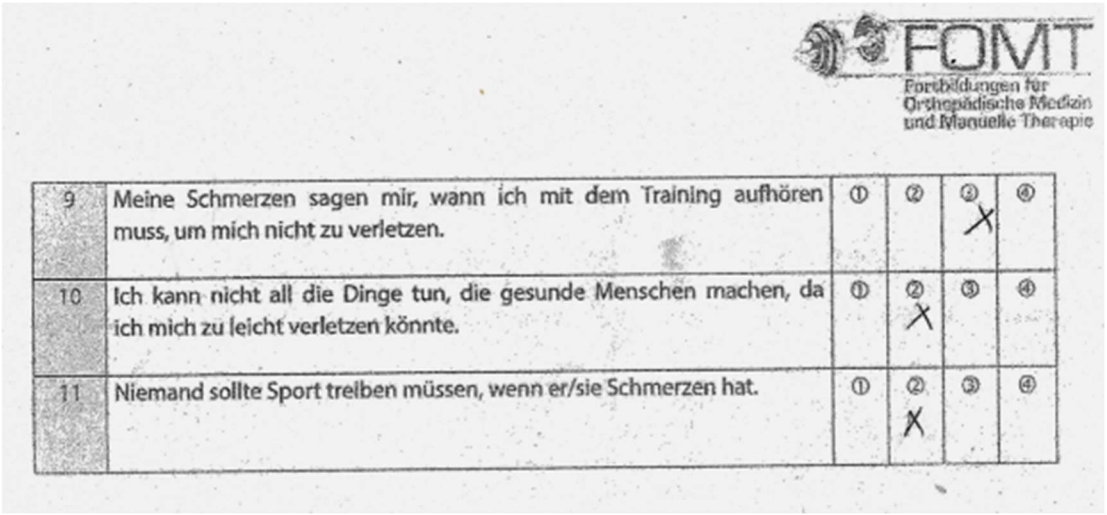
Mit den nachfolgenden Fragen möchten wir untersuchen, wie Sie selbst zu Ihren Schmerzen stehen.

Bitte geben Sie an, in welchem Maße Sie mit den vorgegebenen Aussagen einverstanden sind. Für die Durchführung benötigen Sie ca. 5 Minuten. Bitte nehmen Sie sich die Zeit für die korrekte Beantwortung der Fragen. Sie können für den weiteren Behandlungsverlauf sehr wichtig sein.

Nomenklatur:

A: überhaupt nicht einverstanden
B: mehr oder weniger nicht einverstanden
C: mehr oder weniger einverstanden
D: völlig einverstanden

Item	Charakter	A	B	C	D
1	Ich habe Angst davor, dass ich mich möglicherweise verletze, wenn ich Sport treibe.	①	②	③ X	④
2	Wenn ich versuchen würde, mich über die Schmerzen hinweg zu setzen, würden sie noch schlimmer.	①	② X	③	④
3	Mein Körper sagt mir, dass ich etwas sehr Schlimmes habe.	①	② X	③	④
4	Mein Gesundheitszustand wird von anderen nicht ernst genug genommen.	①	② X	③	④
5	Wegen des Schmerzproblems ist mein Körper für den Rest meines Lebens gefährdet.	①	② X	③	④
6	Schmerz bedeutet immer, dass ich mich verletzt habe.	① X	②	③	④
7	Die sicherste Art, zu verhindern, dass meine Schmerzen schlimmer werden, ist einfach darauf zu achten, dass ich keine unnötigen Bewegungen mache.	① X	②	③	④
8	Ich hätte nicht so viel Schmerzen, wenn nicht etwas Bedenkliches in meinem Körper vor sich ginge.	① X	②	③	④



FOMT
Fortbildungen für Orthopädische Medizin und Manuelle Therapie

9	Meine Schmerzen sagen mir, wann ich mit dem Training aufhören muss, um mich nicht zu verletzen.	①	②	③ X	④
10	Ich kann nicht all die Dinge tun, die gesunde Menschen machen, da ich mich zu leicht verletzen könnte.	①	② X	③	④
11	Niemand sollte Sport treiben müssen, wenn er/sie Schmerzen hat.	①	② X	③	④

Appendix E: DASS- 21 German Version SubScale Depression

Fragen zu Ihrem Befinden

Bearbeitungshinweis: Bitte lesen Sie jede Aussage und kreuzen Sie die Zahl 0, 1, 2 oder 3 an, die angeben soll, wie sehr die Aussage während der letzten Woche auf Sie zutraf. Es gibt keine richtigen oder falschen Antworten. Versuchen Sie, sich spontan für eine Antwort zu entscheiden.

0	Traf gar nicht auf mich zu
1	Traf bis zu einem gewissen Grad auf mich zu oder manchmal
2	Traf in beträchtlichem Maße auf mich zu oder ziemlich oft
3	Traf sehr stark auf mich zu oder die meiste Zeit

Ich konnte überhaupt keine positiven Gefühle mehr erleben	(0)	1	2	3
Es fiel mir schwer, mich dazu aufzuraffen, Dinge zu erledigen.	(0)	1	2	3
Ich hatte das Gefühl, dass ich mich auf nichts mehr freuen konnte.	(0)	1	2	3
Ich fühlte mich niedergeschlagen und traurig.	(0)	1	2	3
Ich war nicht in der Lage, mich für irgendetwas zu begeistern.	(0)	1	2	3
Ich fühlte mich als Person nicht viel wert.	(0)	1	2	3
Ich empfand das Leben als sinnlos.	(0)	1	2	3

Appendix F: Apparatus Components

Modulated head strap with smartphone holder

Smartphone holder
to connect to the bendable arm

Bendable arm "gooseneck" to connect to the tripod

Tripod