Unravelling Pain Together

Patient centered transdisciplinary pain neuroscience education

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‘It is never done, nor finished

it is never in perfection, yet perfect

just as life is’

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UNRAVELLING PAIN TOGETHER

Patient centered transdisciplinary pain neuroscience education

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1

GENERAL INTRODUCTION

Pain and chronic pain

Whether we want to or not, pain is an inevitable part of life. Whether it is a sprain, cut, headache or a heartache: without any doubt we will experience some form of pain at one point or another in our life. Chances are, we might even experience more severe and chronic pain. As on average one in every five persons worldwide experiences (severe) chronic pain in his/her life span[1-4]. Whereby, chronic pain is defined as "pain that persists beyond normal time of healing and/or pain persisting for 3–6 months or longer"[5]. This makes the prevalence of chronic pain higher than any other chronic disease, including cancer, heart disease and diabetes[6-9]. Until this date chronic pain is a leading cause of disability and human suffering[10]. Persons with chronic pain experience the highest number of years lived with disability[6] and a large negative impact of their pain on their quality of life[1,3]. Even worse, severe chronic pain decreases life expectancy[11] and increases chances of cancer and cardiovascular mortality[12]. Besides, patients with chronic pain often have comorbidities such as depression, fear and sleep problems[13-16]. On a financial level, chronic pain is associated with huge economic burdens for the patient, healthcare and the economy [3,17-21], making it a major global healthcare problem. This enormous personal and societal impact of pain is the reason why it is proposed that chronic pain should be considered a disease in its own right[22-24].

When looking at chronic pain as a disease in its own right, one should first look at the existing knowledge on the etiology of chronic pain. As unlike acute pain, often in chronic pain there is no longer bodily threat or 'damage' present. Yet, how can pain persist? Furthermore how should it be called? And what elements influence this pain and the patients' pain experience? The first part of this General Introduction covers the denomination of chronic pain and factors underlining the pain experience. As we answer these questions one can see that the last decades knowledge on pain mechanisms has changed and is still evolving. Subsequently, the treatment of patients with chronic pain has evolved. In the second part of this General Introduction preliminaries for the treatment of patients with chronic pain are discussed.

Etiology of chronic pain

In many patients with chronic pain, the etiology of their pain cannot, or not solely, be explained by the existence of somatic pathophysiological factors (nociceptive nor neuropathic, by inflammation, infections, autoimmune or metabolic)[25-30] and the main pain mechanism model is not merely nociceptive[31]. Instead, the persistence of pain can be explained by changes in the central nervous system[25,26,32-34], also known as 'central sensitization' (CS) [24,35] or in clinical presentation known as 'nociplastic pain'[36]. CS is defined as 'an increased responsiveness of nociceptive neurons in the central nervous system to their normal or subthreshold afferent input'[24,35]. In patients with CS an amplification of neural signaling elicits generalized pain hypersensitivity[25,37]. This hypersensitivity is caused by hyperexcitability of the nervous system, leading to increased responsiveness of a variety of non-harmful stimuli, such as: movement, touch, light, scents, foods and medication[29,38], eventually causing pain without (noxious) peripheral stimuli[25]. In CS several neurophysiological, endocrine and immunological processes involved in neural plasticity are overly activated[39]. Evidence exists that these patients experience prolonged pain after (potential noxious) stimulation, have pain in referred areas (widespread pain) and demonstrate symptoms as hyperesthesia, hyperalgesia and allodynia[32,33,40]. In these patients sensitization at the spinal cord level, enhanced activity of the nociceptive descending faciliatory pathways[41,42], impaired conditioned pain modulation[43] and impaired endogenous pain inhibition[38] takes place. Furthermore, the central processing of patients with CS is altered and, in contrast to acute pain, different brain areas are associated with the processing of stimuli[44-49]. In relationship to the processing of stimuli these brain areas combined are currently known as the 'dynamic pain connectome'[50]. Each individual has his/her personal 'connectome'[45,48,51,52].

What's in a name?

Yet, currently there is a debate going within the scientific community, in social media and in scientific articles, about the description and definition of CS (pain) in relation to chronic pain[36,53-56]. This discussion is based on several arguments: First, it is currently under debate that the use of the wording of CS should only be restricted to preclinical studies and not to clinical practice. This restriction is based on the following arguments: the neural response of CS is so far only measured in animals [54,56] and CS is only studied in humans in subjective pain measures[39,54,56]. This statement is correct, however, are not most conditions, like non-specific neck- and back pain, depression or anxiety, measured subjectively in clinical practice? Furthermore, some argue there is an absence of evidence demonstrating how spatial extension is spreading in the central nervous system in CS[56]. Nonetheless, on the other hand spread of pain sensitivity has been found in several human studies[25,39,55]. Additionally, many studies have demonstrated that CS is a robust phenomenon occurring when induction of central facilitation of nociceptive central pathways takes place and contributes to pain hypersensitivity[39,55].

Second, measures of CS in clinical practice are all indirect[54], for instance by phenomena such as hyperalgesia and allodynia. These measures are based on the history taking, quantitative sensory testing[57] and self-report instruments, such as the Central Sensitization Inventory (CSI) questionnaire[58,59]. It is discussed by some that, based on these indirect measures, clinically establishing a 'diagnosis' of CS is difficult[56]. In opposition, evidence exists that upregulated and central-mediated responses by a hyperexitable nervous system are present in many patients with chronic pain[39,60]. Besides, clinical signs of CS pathways can indeed be observed in patients with chronic pain[33,61,62]. Therefore, to support clinical practice an algorithm for the classification of CS has been established[59]. Furthermore, the International Association for the Study of Pain (IASP) terminology taskforce is working on clinical diagnostical criteria.

Third, it is discussed that CS is a continuum, i.e. signs of CS can exist in co-occurrence with nociceptive and neuropathic pain. However, signs of CS can also exist without input from a nociceptive or neuropathic component[29,39,63,64]. But then, not every patient with chronic pain has CS and in some chronic pain populations a subgroup presents with predominant CS [27,29,63,65-74]. It is therefore proposed to screen the patient for their (predominant) 'pain type', while keeping in mind that an overlap between these types can occur[59].

Finally, there is presently a discussion going on about the name of CS. It is currently called dominant CS pain, central sensitivity syndromes[75], nociplastic pain[36] or chronic primary pain'[76]. Nociplastic pain is the definition as used by the IASP terminology task force. Throughout this PhD dissertation the definition of CS is used, however, whenever CS is written it can also be read as nociplastic pain.

Factors underlining CS pain

We have now briefly reviewed the current evidence on the etiology of chronic pain, and how to call it (CS or nociplastic pain). Yet, what influences the continuation and amplification of the patients' pain experience? Even though it is not yet completely understood why some people develop CS and others do not, there are some indicators that premorbid and acute stage high sensory sensitivity and/or somatization predict CS[77]. Additionally, it is known that biopsychosocial factors can contribute to increased activity in the 'dynamic pain connectome'[45,50,78-81] also known as 'cognitive and emotional senzitisation'[80]. These biopsychosocial factors include, but are not limited to, maladaptive cognitions about pain, pain catastrophizing, pain related anxiety, hypervigilance, trait anxiety, trait neuroticism, kinesiophobia, depressive feelings, stress, traumatic stress disorders, adverse life events, diminished self-efficacy and inactivity/ deconditioning[78,81-99]. Hence, as not all factors play a role in each patient it is important to identify the individual's biopsychosocial factors. Subsequent, further treatment should aim to comprehend and if possible change these (modifiable) factors in a patient centered manner.

Yet, especially when it comes to identifying and treating psychosocial factors within physiotherapy: there is a crux. Research has shown that physiotherapists struggle in this area [100-106], and for instance rarely ask about the patients' cognitions on their condition. Therefore, we conducted a narrative review, as described in this dissertation, to aid in the patient centered biopsychosocial assessment for physiotherapists encountering patients with chronic pain.

Education of pain in patients with chronic pain

In any illness, explaining the etiology in lay terms of this condition to the patient is important for the individual. To appropriately self-manage it is crucial for the individual to make sense of the biology and physiology of their condition. This is no different for patients with chronic pain[107]. Therefore, education is recommended in the treatment for patients with chronic pain [108,109]. Educating patients with chronic pain in the neurophysiology of pain is called pain neuroscience education (PNE)[107,110,111]. PNE was first mentioned on the IASP Conference in Vienna, by Louis Gifford in 1999[112] and first studied in a RCT by Moseley et al. in 2002[113]. Since then the research into PNE has shown positive effects of PNE in patients with chronic pain on their knowledge of pain and pain perceptions; decreased pain and increased endogenous pain inhibition; improved mental health, physical functioning, vitality, and self-rated disability; and a diminished passive coping, kinesiophobia and catastrophizing[113-124], however, only when PNE is provided in combination with other (physiotherapy) treatment modalities [113-122]. When further exploring the reconceptualization of pain after group PNE, most patients, but not all, mentioned increased pain knowledge which they then translated to daily life[125]. Essential in this reconceptualization is the perceived relevance for the individual, complaints being addressed and being taken seriously[125,126]. Therefore, PNE should be performed in a patient centered manner.

Patient centered care in patients with chronic pain

Even though the importance of patient-centeredness in healthcare encounters was already recognized by philosophers, such as Kierkegaard in 1849: '*If one is truly to succeed in leading a person to a specific place, one must first and foremost take care to find him where he is and begin there. This is the secret in the entire art of helping*'. Consultations in healthcare are often medically focused and there is a limited inclusion of the patients' perspective in the self-care of their chronic illnesses[127]. Unlike what often happens in current practice, healthcare should be focused on the patient instead of the clinician. Reasons why we should adopt the patient centered vision, other than patient-centeredness being a moral philosophy[128], is because research has shown that improvements in patient centered care improves the therapeutic alliance, satisfaction, patient outcomes and decreases healthcare costs[127,129-132]. These studies have changed healthcare policies: patient centered care has now been recognized as of high priority within healthcare, healthcare policies[133-135] and identified by the World Health Organization (WHO) as an important goal for the future of medicine[129]. Especially in the population of patients with chronic pain these are issues that resonate. As patients are often dissatisfied, the costs are rising, patient outcomes are often limited and self-care of their condition is of utmost importance. Therefore, patient-centeredness has possibilities to further enhance the treatment, among which PNE, of patients with chronic pain. Yet, what is patient-centeredness? The theoretical models, in form of reviews, proposing patient-centeredness have thus far, to our knowledge, been studied in overall care (The Picker Institute's principles[136]), medicine [128,137] and nursing [138]. First described by Balint et al. in 1969, in an era where the doctor was often only focused on 'illness-oriented medicine', the author proposed to try to understand the whole person, as a unique human being[139]. Probably the most commonly used framework in medicine is by Mead and Bower, describing the biopsychosocial perspective, the 'patient-as-person', sharing power and responsibility, the therapeutic alliance, and the 'doctor-as-person' [137].

Even though there are definitions of patient-centeredness within care, medicine, nursing, occupational therapy and psychology, prior to the literature review described in this dissertation none was available for physiotherapy. Without a commonly accepted definition of patient-centeredness in physiotherapy the teachings of physiotherapists into the basis of a true personalized biopsychosocial treatment of patients with chronic pain, but also research into its' implementation and efficacy is stranded[140].

Transdisciplinary treatment of chronic pain

In the Netherlands, where the current dissertation and interventions took place, a stepped care principle of treatment modalities for patients with chronic pain is currently advised. In a patient-centered manner, based on the patients' preferences, nature and complexity of the complaints and effects of previous treatments, healthcare should be provided in a stepped manner[141]. In this stepped manner the therapeutic interventions of patients with chronic pain can be divided into different modalities: prevention, (often) monodisciplinary primary care, multi-, inter- or transdisciplinary secondary and tertiary care. As chronic pain is often a complex problem, effective team approaches can exceed the expertise of monodisciplinary care[142]. Within these team approaches differences can be observed between multi-, inter- and transdisciplinary teams (figure 1.).

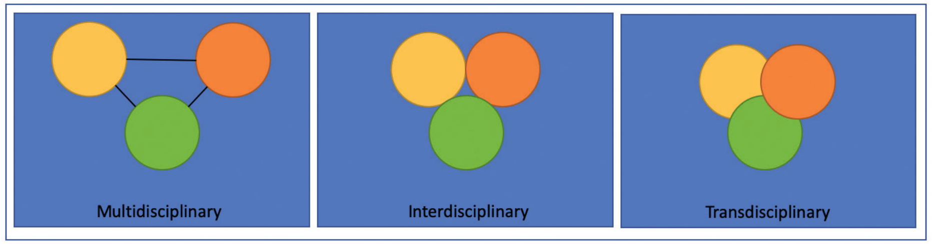

Figure 1. Theoretic scheme of the differences between working multi-, inter and transdisciplinary

According to the terminology of the IASP multidisciplinary means: 'Multimodal treatment provided by practitioners from different disciplines, all the professions working separately with their own therapeutic aim for the patient and not necessarily communicating with each other'; while interdisciplinary is defined as: 'Multimodal treatment provided by a multidisciplinary team collaborating in assessment and treatment using a shared biopsychosocial model and goals, all working closely together with regular team meetings, agreement on diagnosis, therapeutic aims and plans for treatment and review'[35]. Transdisciplinary teamwork outperforms interdisciplinary in that the healthcare professionals collaborate intensively, with shared responsibilities[143,144]. Even though every team member has his/her expertise (medicine, psychology or physiotherapy) there are flexible boundaries, roles and the team learns simultaneously in a nurturing biopsychosocial setting[143-146]. A large cross-sectional study by Quaschning et al. with 402 patients from 11 different rehabilitation clinics showed that team interaction is of key importance within the Model of Shared Decision Making (SDM) on patient satisfaction and treatment acceptance. Furthermore, team interaction serves as a predictor for treatment adherence and satisfaction with decisions within the treatment[147]. This highlights the importance of patient centered care, SDM and team interaction in rehabilitation.

So far, previous research has shown the importance of intensive collaborations, and the experiences of healthcare professionals with transdisciplinary care. However, the experience of patients with chronic pain with such an approach, nor the practice of transdisciplinary care itself has, to our knowledge, been studied. When we truly want a therapy to be patient-centered, we must first know what the patients' experiences are of that therapy (PNE). Furthermore, it is important to explore the social process of patient centered transdisciplinary PNE. When theorized which factors lead to a successful PNE, this could then be taught to other healthcare professionals working with transdisciplinary PNE.

Last, there has not yet been a study trying to comprehend the changes in outcomes following this transdisciplinary care, among which PNE, for patients with chronic pain. To comprehend under which conditions changes in outcomes of patients with chronic pain after a transdisciplinary cognitive behavioural therapy (CBT) treatment, among which PNE, might occur, a moderator analysis was performed.

Outline of the dissertation

Within this dissertation the patient centered transdisciplinary PNE and treatment for patients with chronic pain is examined. The first part of the dissertation focuses on physiotherapists. The first aim of this dissertation was to complement the existing literature of patient-centeredness, even though there are definitions of patient-centeredness within care, medicine, nursing, occupational therapy, and psychology, none was available for physiotherapy. The second aim was to aid physiotherapists, by describing a patient centered biopsychosocial assessment for physiotherapists encountering patients with chronic pain. The second part of the dissertation seeks to find an in depth understanding of the process of patient centered transdisciplinary PNE. This was done through qualitative research. Therefore, the third aim was to study and theorize the experiences of patients with chronic pain who recently received transdisciplinary PNE. The fourth aim was to comprehend the social phenomenon surrounding transdisciplinary PNE, and which factors lead to a successful transdisciplinary PNE. And the third and last part of this dissertation investigates the when and how of changes following a transdisciplinary CBT pain management treatment.

In this thesis we will therefore explore five components, each targeting one of these aims.

- Chapter 2 explores to what extent patient-centeredness is examined in physiotherapy in qualitative research and whether a theoretical framework can be constructed from this research for patient-centeredness in physiotherapy.
- Chapter 3 describes an outline of the clinical biopsychosocial assessment to be used as a practical tool by physiotherapists in the encounter of patients with chronic pain.
- Chapter 4 examines the perspectives of patients with chronic pain who recently received PNE in a transdisciplinary setting, in order to provide a theoretical model and framework of transdisciplinary PNE.
- Chapter 5 focuses on the clinical observations of transdisciplinary PNE. In order to explore, comprehend and theorize the social process between the patient, partner and healthcare professionals in the practice of transdisciplinary PNE. To answer which features and aspects contribute to the successful application of PNE.
- Chapter 6 examines whether changes in self-reported signs of CS after an individualized CBT transdisciplinary treatment program, with PNE as a treatment modality, can be explained by differences in illness perceptions and pain catastrophizing.

Chapter 7 provides a general discussion of this dissertation.

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2

To what extent is patient centeredness examined in physiotherapy and can a theoretical framework be constructed?

Patient-centeredness in physiotherapy: What does it entail? A systematic review of qualitative studies

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Abstract

Purpose

The literature review aimed at examining and summarizing themes related to patient-centeredness identified in qualitative research from the perspectives of patients and physiotherapists. Following the review, a secondary aim was to synthesize the themes to construct a proposed conceptual framework for utilization within physiotherapy.

Methods

A systematic search of qualitative studies was conducted including all articles up to September 2015. Methodological quality was examined with a checklist. The studies were examined for themes suggestive of the practice of patient-centeredness from the therapists' and/or the patients' perspective. Data were extracted using a data extraction form and analyzed following 'thematic synthesis'.

Results

14 articles were included. Methodological quality was high in five studies. Eight major descriptive themes and four subthemes (ST) were identified. The descriptive themes were: "*Individuality" (ST 'Getting to know the patient' and ST 'Individualized treatment'), "Education", "Communication" (ST 'Non-verbal communication'), "Goal setting", "Support" (ST 'Empowerment'), "Social characteristics of a patient-centered physiotherapist", "A confident physiotherapist"*, and "*Knowledge & Skills of a patient-centered physiotherapist".*

Conclusions

Patient-centeredness in physiotherapy entails the characteristics of offering an individualized treatment, continuous communication (verbal and non-verbal), education during all aspects of treatment, working with patient defined goals in a treatment in which the patient is supported and empowered with a physiotherapist having social skills, being confident and showing specific knowledge.

Introduction

Healthcare is continuously evolving globally, one reason being the increase in incidence and prevalence of patients with (multiple) chronic diseases. In response to these changes, the complexity of healthcare is continuously expanding and the delivery of healthcare, even with all the advantages, may often be complicated, uncoordinated and unsafe[1]. According to the US Institute of Medicine patient-centered care has a potential to address some of these deficits in the healthcare system. Therefore patient-centered care has a high priority in the restructuring of healthcare in the 21st century[1]. The federal government of the US has established a Patient-Centered Outcomes Research Institute which underlines their recommendations for changes in healthcare. These recommendations have been developed, however, without patient participation. As Lorig (2012) suggests, '*if a service is to be patient-centered, then both the health care system and the patient have to be involved in determining what this means. Each has its own view of meaning, and patient-centered care will never be achieved if patients are not part of the solution*' (p. 524)[2]. This highlights the importance of patient-centeredness in healthcare policymaking today.

There are many different definitions of patient-centeredness in healthcare. Patient-centeredness was first described in medicine by McWhinney as, 'the physician tries to enter the patients' world, to see the illness through the patients' eyes,'[3]. Patient-centered healthcare in hospital settings entails eight characteristics of care: respect for the patient's values, preferences, and expressed needs; coordinated and integrated care; clear, high-quality information and education for the patient and family; physical comfort, including pain management; emotional support and alleviation of fear and anxiety; involvement of family members and friends, as appropriate; continuity, including through care-site transitions; and access to care[4]. Probably the most commonly used framework of patient-centeredness in medicine is a model described by Mead and Bower with five interconnecting components: 1) biopsychosocial perspective, 2) the 'patient-as-person', 3) sharing power and responsibility, 4) the therapeutic alliance, and 5) the 'doctor-as-person' [5]. Patient-centeredness has also been described as a moral philosophy of healthcare professionals to endorse high quality health care[6].

In physiotherapy however, there is a lack of understanding surrounding the concept of patient-centeredness. Therefore, it is considered important to examine the existing literature on patient-centeredness to assist in developing a deeper understanding of the concepts and implications in physiotherapy. Mead and Bower's framework (2000) uses largely qualitative descriptive studies and it could be argued that qualitative research is the most effective way to provide an in-depth understanding of patient-centeredness perspectives.

As physiotherapists we are healthcare professionals that endorse patients' self-management in which we incorporate the biopsychosocial perspective, by combining functional training for the body and coaching[7,8]. In medicine it is known that patient-centeredness can strengthen the biopsychosocial perspective by enhancing the relationship (improving empathy, attentiveness and communication) between the healthcare professional and the patient. Furthermore patient-centered medicine shows positive effects on a range of qualitative measures relating to clarifying patients' concerns and beliefs[9].

For the reasons outlined above, a systematic review of the available qualitative research literature related to patient-centeredness in physiotherapy was conducted. The literature review aimed to 1) examine and summarize themes related to patient-centeredness identified in qualitative research and 2) provide a framework from which to develop applications to physiotherapy. The particular phenomenon of interest was the understanding of patient-centeredness from the perspectives of patients and physiotherapists.

We only included qualitative articles as they allow for seeking meaning and understanding of a phenomenon, in this case patient-centeredness. Following the review, a secondary aim was to synthesize the themes to help construct a conceptual framework describing patient-centeredness for utilization within the context of physiotherapy. Therefore, the research question of this qualitative systematic review is:

To what extent is patient-centeredness examined in physiotherapy in qualitative research and can a theoretical framework be constructed from this research for patient-centeredness in physiotherapy?

Methods

A systematic search (Appendix 1) was conducted in PubMed (MEDLINE), EMBASE, Cochrane, PsychINFO, CINAHL, PEDro and Scopus including articles from 1970 until September 15th 2015. The time span was limited as patient-centeredness was first introduced in 1970[10]. In addition, the reference lists of all selected articles were screened for relevant papers not identified through the search. The search was carried out without additional limits. The PICo was used to identify the P-Population (adult patients who received physiotherapy and physiotherapists), the I-Interest (experiences) and Co-Context (physiotherapy in all settings). Based on the PICo the following search terms were used to search each of the trial registers and databases listed above: 'patient centeredness', 'patient centred', 'patient centered', 'patient oriented', 'patient focused', 'physiotherapy', 'physical therapy', 'factors', and 'aspects'. Medical Subject Headings (MESH) terms were used for patient-centered care and physiotherapy. Search terms were combined using AND and OR. Search strategies were peer reviewed by PvW and ANB.

All articles were examined for eligibility by checking the in- and exclusion criteria. Inclusion criteria were: 1) qualitative studies; 2) studies assessing patient-centeredness or aspects of patient-centeredness (or a synonym) in physiotherapy; 3) studies involving rehabilitation mentioning physiotherapy (in that case only the parts/quotes involving physiotherapy were used for this review); 4) articles written in English, Dutch or German.

Exclusion criteria where: 1) studies that examined patient-centeredness only in other medical professions besides physiotherapy; 2) articles that examined patient satisfaction only, as patient satisfaction was considered an outcome of patient-centeredness; 3) articles that involved pediatric physiotherapy (due to the triangle-relationship with children, parents and therapist); 4) studies that examined themes suggestive of the practice of patient-centeredness from the therapists' and/or the patients' perspective. Eligibility assessment of the articles was performed by one researcher (AJW). Duplicates were removed. Retrieved records were first screened on title and abstract.

The reporting of components dealing with methodological quality was assessed by AJW and ANB. A checklist based on three different checklists was created to obtain a complete methodological overview. This checklist was based on the COREQ statement for qualitative research[11], the checklist used by Schoeb et al. [12] and the checklist of the Britisch Medical Journal (BMJ)[13]. The COREQ contained non-informative items, was dichotomized and supplemented with relevant items of the checklist by Schoeb et al. and the BMJ. The development of the checklist was done by the first researcher (AJW) and reviewed by the second researcher (ANB). The full checklist is displayed in Appendix 2. For each selected paper, all the items included in the checklist were rated as Yes (Y), No (N) or unclear (?) by summing all items scored positive (scored with a Y). According to Veerbeek et al.(2011), a study has low risk for bias when it scores ≥75% of the maximum score and at high risk for bias when it scores ≤75%[14].The methodological reviewing of the studies was done independently by AJW and ANB. Cohen's Kappa was used to assess inter-rater agreement between the two researchers assessing the study quality of the included studies[15].

Data were extracted using a data extraction form, (available upon request with the first author) prior to data analysis by one reviewer, AJW. The data extraction form was pilot tested and refined. Information was extracted from each included article on: 1) characteristics of participants; 2) type of study design; 3) findings and 4) special features. Principle summary measures were aspects that describe patient-centeredness. Data synthesis was done following the method of thematic synthesis[16], in which approaches from both meta-ethnography and grounded theory are used for analysis. Before data synthesis, articles were read several times to ensure familiarization with the study. Further to the free line-by-line coding of these studies, performed by the first author (AJW), the resulting 'free codes' were reviewed by ANB and PvW. In case of discrepancy across reviewers, consensus was derived by discussion between the reviewers.

The 'free codes' where then organized into related areas to construct 'descriptive' themes and 'analytical themes'. The development of the descriptive and analytical themes was performed by AJW and SCJMV and later reviewed by PvW, (available upon request). Lastly, a proposed conceptual framework was developed by AJW, ANB and PvW through brainstorm sessions based on the analytical themes and reviewed by all authors. The goal of the proposed conceptual framework to explain the interaction between the themes and to clearly state these connections. Empirical data saturation was reached by consensus between the reviewers.

Results

The flowchart of the study selection is displayed in figure 1. All 14 selected articles were qualitative studies and published in English.

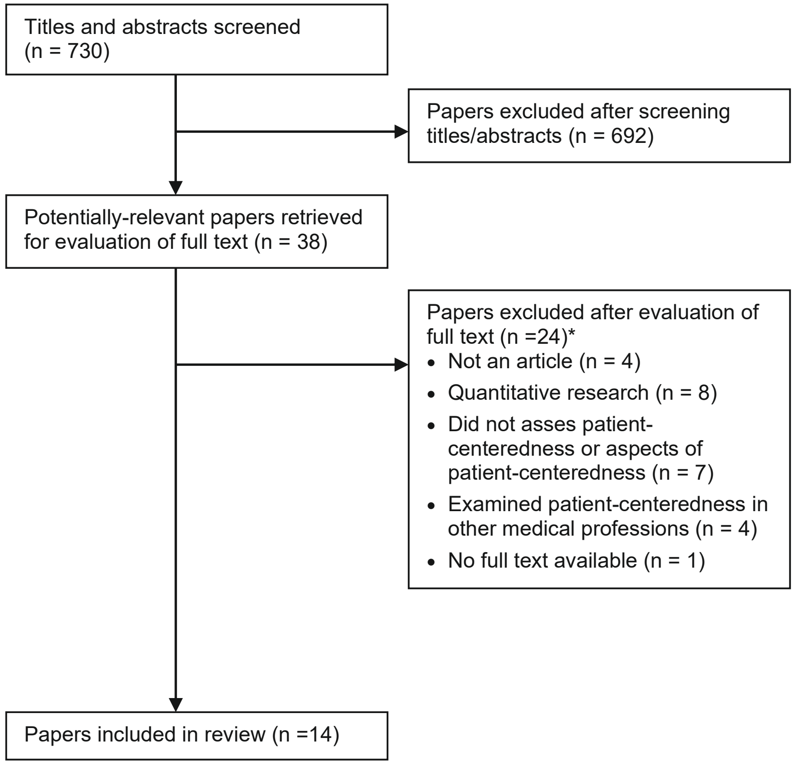

Figure 1. Flow of studies through the review.
* Papers may have been excluded for failing to meet more than one inclusion- or exclusion criteria.

Although all the included studies collected qualitative data relevant to patient-centeredness, the methodology varied. The study designs included: grounded theory[17-20], nominal group technique[21], ethnography[22,23], a descriptive qualitative approach[24], phenomenography[25], phenomenology[26,27], or no specific design[28-30].

Study quality was assessed for each study and varied from 40% up to 75% (table 2). Five studies were defined as high quality. The inter-rater agreement between the two researchers assessing the study quality of the included studies was computed and resulted in a Cohen's Kappa of 0.511, p <0.005 which is a moderate agreement[15,31].

Although the agreement moderate, after discussion the reviewers agreed on the final study ratings presented in table 2.

The combined number of participants (n=231) across the included studies were recruited through physiotherapy practices and rehabilitation centers. Some studies (N= 7) included physiotherapists, others (N=5) included patients and two studies included both[20,28] in the data collection. The participants' age ranged from 18 to 84, 4 studies did not report the participants' age[20,23,28,30]. Data collection methods varied from observations, open interviews, semi-structured interviews, emails, and semi-structured focus groups to highly structured focus groups. Study findings varied from a specific aspect of patient-centeredness to a description of patient-centeredness in physiotherapy. In table 1 an overview of study characteristics is provided.

Table 1. Detailed description of included studies

First author, year	Country	Population	Setting	Methodology	Primary aim(s)	Methods	Major themes	Perspective
A.Melander Wikman, 2006	Sweden	6 Patients rehabilitating at three different healthcare centers, 3 month or longer in rehabilitation (age 35-58, 2 male, 4 female) with neurological, circulatory and/ or orthopaedic diseases	In a room at the healthcare (4) center and at home (2)	Grounded Theory	To describe the patient's experiences of influence and participation in the rehabilitation process. Based on patient-centered care	In depth interviews	The parallel process of rehabilitation: the traditional medical model with compliance, sub ordinance and the invisible physiotherapist (at the hospital) and the individual model with being confirmed, sense of coherence, searching for information and daring to demand (within primary healthcare).	Patient's
M.O. Kidd, 2011	New Zealand	8 Musculoskeletal patients (age 20-68, 4 female and 4 male) receiving a maximum of 10 treatments	Workplace (2), home (1) or at the researchers' workplace (5)	Grounded theory	To determine patients' perspectives of components of patient-centred physiotherapy and its essential elements	Semi-structured interviews	Ability to communicate, confidence, knowledge and expertise, understanding people and an ability to relate, transparent focus on progress and outcome	Patient's
K. Cooper, 2007	Scotland, Grampian	25 Chronic low back pain patients (age 18-65, 5 male, 20 female) receiving physiotherapy in the last 6 months	At home or National Health Service hospital (not physiotherapy department)	Framework method of qualitative data analysis	To define patient-centredness, in the context of physiotherapy for CLBP, from the patient's perspective	Semi-structured interviews	Communication (most important), individual care, information sharing, the physiotherapist, decision-making, organization of care	Patient's

Table 1. (Continued)

First author, year	Country	Population	Setting	Methodology	Primary aim(s)	Methods	Major themes	Perspective
M. Potter, 2003	Australia, Western	26 Current and former patients, no common complaint (age 20-79, mean 48.8 years, 10 male, 16 female) in private practice	Not described	Nominal group technique	To explore patients' perspectives regarding the qualities of a 'good' physiotherapist and to gain insight into the characteristics of good and bad experiences in private practice physiotherapy. Based on patient-centred private sector physiotherapy	Highly structured meeting process (focus group)	Communication ability (interpersonal skills, physiotherapist's manner, teaching/education) , other attributes of the physiotherapist (professional behaviour, organizational ability), characteristics of the service provided by the physiotherapist (diagnostic and treatment expertise, the environment, convenience and accessibility)	Patient's
D. Thomson, 2008	England	5 Physiotherapists working with chronic pain patients, 3-week intensive program (age 24-45, 4 female, 1male, 2-20 years' experience) in a English National Health Service Hospital	Physiotherapists were shadowed and interviewed in an English National Health Service Hospital	Critical ethnography	To describe and interpret the interactions between therapists and their patients on a chronic pain unit in an English National Health Service (NHS) hospital from the perspectives of the therapists	Interviews and observations	Therapist-patient interactions, communication, equality of power, rehabilitation as a risk-taking negotiating process	Therapist's

Table 1. (Continued)

First author, year	Country	Population	Setting	Methodology	Primary aim(s)	Methods	Major themes	Perspective
A.B. Rindflesch, 2009	USA	9 Physiotherapists in acute care(3), inpatient (3) and outpatient rehabilitation (3) (age 28-56, 8 female, 1 male, 4-32 years' experience) in an Academic medical center	Onsite observation in an Academic medical center, where focus groups took place is not described	Grounded theory	To describe the practice of patient education in physical therapy among nine physical therapists from three practice areas	Focus groups and observations	Patient education is physical therapy, patient education is empowerment, the content of patient education is patient-centered , outcome of patient education is evaluated trough function	Therapist's
E. Pashley, 2010	Canada, Greater Toronto Area	10 Physiotherapists in outpatient orthopaedics (age 30-62, mean 44.4 years, 8 female, 2 male, 1,5-41 years' experience, mean 18,65 years)	Not described	Descriptive qualitative approach	(1) to describe the relevant factors that physiotherapists take into account in discontinuing treatment of adults in the outpatient orthopaedic setting and (2) to explore how these factors mediate the decision-making process	Key informant interviews and focus groups	Physiotherapists experience, funding source, facilitating self-management, negotiating patient goals and managing expectations, using objective findings, patient education	Therapist's

Table 1. (Continued)

First author, year	Country	Population	Setting	Methodology	Primary aim(s)	Methods	Major themes	Perspective
I. Larsson, 2010	Sweden, southern	11 Physiotherapists in different areas: orthopaedics, rheumatology, neurology, respiratory diseases and surgery (8 female, 3 male, 1-42 years' experience, median 15 years)	In a room at Health Sciences Centre at Lund University or, in 4 cases, at the respondent's workplace	Phenomenography	To describe how physiotherapists experience client participation. Based on patient-centered care	Semi-structured interviews	Collaboration as biopsychosocial client-centered client participation. Guidance as biomedical perspective of client participation, blocks client-centeredness. Expertise as well as biomedical perspective of client participation, but paternalistic and not client-centered.	Therapist's
E. Thornquist, 1991	Norway	Manual, psychomotor and home visiting physiotherapists	First encounters at normal work surroundings (physiotherapists practice) and at home	Not described	What do physiotherapists do to establish a relationship in encounters with patients? And more specifically: How do they relate to their patients through their bodies?	Observations (videos) and interviews	Greeting; note taking; gaze; bodily expression of caring and attentiveness; body position, orientation and closeness; manual therapy-practice: exchange of body messages; psychomotor practice: perception of body relationships	Therapist's

Table 1. (Continued)

First author, year	Country	Population	Setting	Methodology	Primary aim(s)	Methods	Major themes	Perspective
E. Leach, 2012	Australia, Queensland	8 Therapists (occupational, speech and physiotherapy) and 5 stroke patients (age 49-84, 1 female, 4 male) in subacute rehabilitation	Emails	Not described	To examine current clinical approaches to goal-setting through the multiple disciplines of occupational therapy, speech pathology and physiotherapy within one rehabilitation facility. Specifically, it aimed to identify the degree and quality of patient input into the goalsetting process from the perspective of the therapist and compare the therapists' goals with those perceived to be the patient's goals using the ICF framework	Semi-structured emails	Goal-setting approaches: therapist controlled, therapist led, patient focused. Goals identified by therapists versus perceived patient goals. Facilitators and barriers	Patient's and therapist's

Table 1. (Continued)

First author, year	Country	Population	Setting	Methodology	Primary aim(s)	Methods	Major themes	Perspective
F. Trede, 2000	Australia, Sydney	8 Physiotherapists and 7 patients with low back pain	Not described	Grounded Theory	What educational practices are currently applied and what educational theories could inform effective educational practice?	Semi-structured interviews	Professional power and compliance, hands-off attitude versus hands-on technique, the role of pain in education, and transformation from physiotherapist-centred to patient centred approaches	Patient's and therapist's
K. Harman, 2011	Canada, Nova Scotia and British Columbia	44 Physiotherapists from private practice (36 male, 8 female, mean 17.5 years' experience (range: 0.5-38 years)	Not described	Not described	To explore client education provided by physiotherapists in private practice who treat injured workers with subacute low back pain (SA-LBP)	Semi-structured focus groups	The critical importance of education, education: a multidimensional concept, understanding the physiotherapist-client relationship	Therapist's
S. Rutberg, 2013	Sweden	11 Patients with migraine (age 20-69 years, 9 female, 2 men, migraine diagnosis <1-59 years)	At the home or workplace of the participant (6) , or were conducted at Luleå University of Technology (5)	Phenomenology	Exploring the lived experience of physical therapy of persons with migraine	Semi-structured interviews	Meeting a physical therapist with professional tools and a personal touch. Investing time and energy to feel better, relying on the competence of the physical therapist, wanting to be treated and to become involved as an individual, being respected in a trustful relationship	Patient's

Table 1. (Continued)

First author, year	Country	Population	Setting	Methodology	Primary aim(s)	Methods	Major themes	Perspective
A. Hiller, 2015	Australia	9 physiotherapists (4 male, 5 female, 1,5-21 years' experience, musculoskeletal, sports, neurological, continence and pelvic floor) 52 patients (15 male, 37 female, age 20-70 years, with spinal pain, work related, knee, sports, peripheral, balance and neurological, women's and chest problems)	In private physiotherapy practices in Melbourne	Ethnographic	To first examine whether and how established models of healthcare communication (practioner-centered and patient -centered) are incorporated into one-on-one consultations and second to examine physiotherapists' interpretation and understanding of their clinical communication	Observations, field notes and semi-structured interviews	Observational themes: Focus on physical aspects and pain, a consistent structure, physiotherapists lead the communication, use of casual conversation, touch as communication Physiotherapist interview theme: a sense of purpose	Therapist's

Table 2. Methodological quality scores of the included studies.

No.	Checklist item	Melander Wikman 2006	Kidd 2011	Cooper 2007	Potter 2003	Thomson 2008	Rindflesch 2009	Pashley 2010	Larsson 2010	Thornquist 1991	Leach 2012	Trede 2000	Harman 2011	Rutberg 2013	Hiller 2015
1	Was the researcher experienced or trained? *	?	?	?	?	Y	?	Y	?	?	?	?	?	?	?
2	Was the research question clearly defined? $	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
3	Was the methodological orientation suitable for this research question? *	Y	Y	Y	N	Y	Y	N	Y	?	N	Y	?	Y	Y
4	Was theoretical or purposeful sampling used? *	Y	Y	Y	Y	Y	Y	Y	Y	?	Y	N	Y	Y	Y
5	Was there stated how many participants where approached? *	N	N	Y	N	N	Y	N	Y	N	N	Y	Y	Y	N

Table 2. (Continued)

No.	Checklist item	Melander Wikman 2006	Kidd 2011	Cooper 2007	Potter 2003	Thomson 2008	Rindflesch 2009	Pashley 2010	Larsson 2010	Thornquist 1991	Leach 2012	Trede 2000	Harman 2011	Rutberg 2013	Hiller 2015
6	Were the important characteristics of the sample described? *	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y
7	Does the sample produce the type of knowledge necessary to understand the structures and processes within which the individuals or situations are located? #	Y	Y	Y	?	Y	N	Y	N	Y	Y	Y	Y	Y	Y
8	Was there stated that the interview was open, semi structured or if there were focus groups? *	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 2. (Continued)

No.	Checklist item	Melander Wikman 2006	Kidd 2011	Cooper 2007	Potter 2003	Thomson 2008	Rindflesch 2009	Pashley 2010	Larsson 2010	Thornquist 1991	Leach 2012	Trede 2000	Harman 2011	Rutberg 2013	Hiller 2015
9	Were repeated interviews carried out? *	N	N	N	Y	Y	Y	?	N	?	Y	N	N	N	Y
10	Were field notes made? *	?	Y	N	N	Y	?	Y	N	?	N	?	?	?	Y
11	Was data saturation discussed/ reached? *	Y	Y	N	Y	N	N	N	N	N	N	N	N	N	Y
12	Were there two or more researchers that coded the data?*	Y	?	Y	Y	N	?	Y	N	N	Y	?	N	Y	N
13	Was software used to manage the data?*	?	Y	Y	N	Y	N	Y	N	N	Y	?	Y	?	?
14	Did themes derive from the data?*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
15	Were participant quotations presented to illustrate themes/items?*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 2. (Continued)

No.	Checklist item	Melander Wikman 2006	Kidd 2011	Cooper 2007	Potter 2003	Thomson 2008	Rindflesch 2009	Pashley 2010	Larsson 2010	Thornquist 1991	Leach 2012	Trede 2000	Harman 2011	Rutberg 2013	Hiller 2015
16	Were major themes clearly presented in the findings?*	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
17	Is the description described in sufficient detail to allow the researcher or the reader to interpret the meaning and context of what is being researched? #	Y	Y	Y	N	Y	N	Y	N	Y	N	Y	Y	Y	Y
18	Does the researcher move from description of the data, through quotations or examples, to an analysis and interpretation of their meaning and significance? #	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 2. (Continued)

No.	Checklist item	Melander Wikman 2006	Kidd 2011	Cooper 2007	Potter 2003	Thomson 2008	Rindflesch 2009	Pashley 2010	Larsson 2010	Thornquist 1991	Leach 2012	Trede 2000	Harman 2011	Rutberg 2013	Hiller 2015
19	Are claims being made for the generalizability of the findings to other bodies of knowledge? (within scientific research) #	N	Y	N	N	N	N	N	N	N	N	N	Y	Y	N
20	Are claims being made for the generalizability of the findings to other populations? #	N	N	N	N	N	N	Y	Y	N	N	N	Y	Y	Y
Overall quality in %		65	75	70	45	75	55	75	55	40	60	50	65	75	75

*= original from the COREQ statement[11], #=original from V. Schoeb et al.[12], $=original from the British Medical Journal quality checklist [13]
Y= described in the article/good quality, N=definitely not described or poor quality, ? = not clearly described in the article if it is done or not
Overall quality in %.

In the descriptive analysis 13 descriptive themes were found. During the analytical analysis phase these were gathered into 8 major descriptive themes and 4 subthemes (ST) (two subthemes were conjoined) described below and in the proposed conceptual framework (figure 2). The descriptive themes were:

1. The concept of individuality in patient-centeredness
   ST (1) 'Getting to know the patient';
   ST (2) 'Individualized treatment';
2. Continuous tailored communication in lay speech
3. ST(3) 'Non-verbal communication'
4. Education during and about all aspects of the treatment
5. Working with patient-defined goals
6. A patient-centered treatment in which the patient is supported
7. ST(4) 'Empowerment'
8. Social characteristics of a patient-centered physiotherapist
9. A confident physiotherapist
10. Knowledge and skills of a physiotherapist in patient-centeredness

Individuality:

Individuality was found in all of the articles and was both from the patient's and the therapist's perspective referred to as important. This concerned specific patient-tailored education, communication and treatment. Subthemes were 'getting to know the patient' and 'individualized treatment'.

Subtheme: Getting to know the patient

It was found that both patients and physiotherapists believed that getting to know the patient as a person was important for individualization in physiotherapy. This involved getting to know patients' history, needs, preferences, personality, beliefs, values, expectations, motivation, and circumstances[17,18,21,24-28,30] and remembering them. Patients appreciated being seen as an integration of body and soul[18] and knowing the patient as a person was an essential part of this integration.

Subtheme: Individualized treatment

Patients wanted themselves, rather than the techniques, to be in the center of concern[20]. An individualized treatment involved an individualized treatment plan so patients can learn independently[20], including exercises, advice and education that was composed in dialogue and collaboration with the patient[19,24,26,27,30]. During the treatment the therapist had to be aware of the changing needs of the patient[26].The exercises and given advice affected patient adherence[27], suggesting that patient-centeredness required the physiotherapist to ensure that the patient experienced the exercises as important and individualized[20]. Adjustments made by the physiotherapist in response to patients' feedback was experienced as important[20,27]. Not only the content of the treatment should be individualized, but the delivery of treatment as well[27].

Communication

Both therapists' and patients mentioned communication as a part of patient-centeredness in all the articles. The most important aspect of communication was the need of an ongoing dialogue with patients. Moreover, the communication style should be tailored to the individual patient in clear and lay speech[17,20,23,24,26,27]. This required openness of the therapist about themselves and the therapy, and ultimately created safety for the patient to open up[20,26]. Personal communication and communication skills were far more important than the provision of scientific facts[20]. By personal communication a bond was established and the therapy shifted from therapist to patient-centered[23].

Communicative abilities of a patient-centered physiotherapist meant being receptive to what the patient has to say, correctly interpreted and giving explanations in a way patients understand[15,20]. Purposefully changing communication styles depending on the patient[23]. Having the ability to explain in lay terms, directly speaking to the patient, listening, and asking appropriate questions was of importance[17,21,24,27].

Subtheme: Non-verbal communication

Non-verbal communication incorporated eye contact, nodding and facial expressions[23,29,30]. This indicated interest into the patient, availability for contact and made sure the patient perceives the contact as 'being seen'[29]. Furthermore, therapists' used their own body language and facial expression, as well as that of the patient, to establish a bond and reflect if it was indeed established[23,30].

Both the patients' and the therapists' experienced non-verbal communication as consisting of physiotherapists body movements. It comprised of using their hands, touch, cushions for comforting, and creating a trustful body language[23,26,29]. Furthermore non-verbal communication comprised of active listening to the patient and making sure that the patient was aware of this active listening[20,21,27,29,30].

Non-verbal communication created a sense of being respected[23,26], caring for the patient[23,29], demonstrating empathy, respect, consideration, made the patient feel at ease[17,23], and created room for emotions.

Education

All studies mentioned education as related to patient-centeredness. Education was mentioned as explanation about physical symptoms, the problem, intake, diagnosis, treatment, and treatment course. The content taught during education should be useful and focused on the patient's problems[17]. Visualizing, using metaphors and demonstrating towards the patient was found to be constructive in patient-centered education[17,21]. Education was more than simplifying in plain language: the information had to be compatible with patients' reality, perceptions and be meaningful[20].

There was an interaction of this theme with Social characteristics, Communication, Individuality and Goal setting, as the content in the education should be interactively communicated in a manner that patients understand and tailored on the patients' needs and goals[17,19,21,24,27]. Written education was not perceived as individualized and patient-centered by patients[27].

Goal setting

Goal setting was used by physiotherapists to activate and motivate patients, to determine what meaningful therapy would be for the patient and to set discharge limits[19,22,24,28]. Goal setting seemed particular of physiotherapists' interest, as patients did not spontaneously mention goal setting as important for patient-centered physiotherapy. Patient-centered physiotherapists, however, tried to allow the patients to define their own goals in collaboration[20,22,24,25]. This was done by facilitating them and guiding them, using education and dialogue to determine the patients' goals[19,20,22,25,28]. Goals were mostly created in collaboration between the physiotherapist and the patient[20,28]. However, some physiotherapists made no or little mention of patient-centered goals[24].

Support

Support from the physiotherapist consisted of a mixture of individuality, equality of responsibility, understanding, feeling important, reassuring, and empowerment[17-22,24-27,30]. Patients valued the feeling of a physiotherapist having their back, by supporting them, relating to them and seeing them as a complete person[18].

Being supportive in patient-centered physiotherapy demanded an interaction with the descriptive themes social characteristics, individualization, communication and education. As a physiotherapist could not be supportive until he knew and understood the patient (individualization). This support was established by verbal and non-verbal communication, such as touch and educating the patient. This supported and empowered the patient. This empowerment, however, could not be accomplished without the social characteristics of a patient-centered physiotherapist.

Subtheme: Empowerment

Patient-centered empowerment was mentioned as a personal feeling by the patient, where the physiotherapist tries to give responsibility and power to the patient[18,22,30]. Strengthening of the empowerment was mostly done by touch[23], education or showing improvements in symptoms and functions[17,19,20]. Furthermore, counseling (exploration of choices, support, encouragement and back-up) was an applied strategy[18,20]. Being able to make an appointment quickly made patients feel empowered and helped them with coping[26]. Physiotherapists strived for optimal patient empowerment[22].

Social characteristics of a patient-centered physiotherapist

Patients described the social characteristics of a patient-centered physiotherapist as respectful, non-judgmental, non-egotistical with an open interested attitude and mind[17,21,22,24-26]. Physiotherapists should be honest about his/her limitations and reflective of his/her own behaviour and emotions[21,30], put the patient's needs first and build a trusting relationship and rapport with the patient[17,20,22,26]. This involved being friendly, supportive, considerate, patient, genuine, polite, positive, caring for the patient, having the ability to care for the patient, taking the patient seriously, believing in the patient, recognition of the patients' emotions, making a commitment to the patient and making the best effort[17,20,22,23,26,27,30]. In essence, the therapist should understand the patient and relate to them[30].

However, perceiving the therapist as 'being nice' was not the only aspect of a patient-centered approach[27]. In addition, communicative abilities of the physiotherapist were judged as important[26]. These abilities are mentioned in the theme *"Communication"*.

Although patients appreciated getting to know the person behind the physiotherapist[26], a professional distance and professionalism should be maintained, as well as dedication to the profession[17,21,26,27]. From these examples it may be suggested that patient-centeredness is all about the role the physiotherapist adopts to place the patient at the center of the treatment.

A confident physiotherapist

Both patients and physiotherapists underlined the importance of a confident physiotherapist. Besides a confident physiotherapist it was also acknowledged that the physiotherapist should inspire confidence in the patient[17]. Confident body language and verbal communication, and confidence in explaining to the patient were described as key ingredients[17,26,27]. Feeling the confidence of the therapist in his/her treatment inspired confidence in the patient[17] and decreased worries and fears[26]. Furthermore, patients felt that the physiotherapist should feel confident enough to discuss any issues with their patients[21,30]. The underlying concepts and behaviours of a confident physiotherapist were not explained in any of the studies.

Knowledge and skills of a physiotherapist in patient-centeredness

The physiotherapist should be competent enough to deal with the patient's specific disorder[27] and this is not only achieved by keeping skills and knowledge up to date, but also by using this knowledge and expertise with good teaching skills[17,21,22,27]. Knowledge should be disease specific, contain-familiarity with body dysfunction and include the understanding of the patient's perspective. Besides, the therapist should have a very good understanding of the patient in order to tailor treatment[22,25,28].

Interestingly, physiotherapists found the greater their experience and maturity within the profession, the more they felt able to apply patient-centeredness[19,21,24]. This may be associated with increased confidence but how experience, maturity and patient-centeredness were related was not described in detail.

Patients valued the input of physiotherapist's knowledge by means of the physiotherapist being the expert[17], however did not specify this knowledge. Patients wanted to have clear explanations, but also desired the ability to make their own or shared decisions[27].

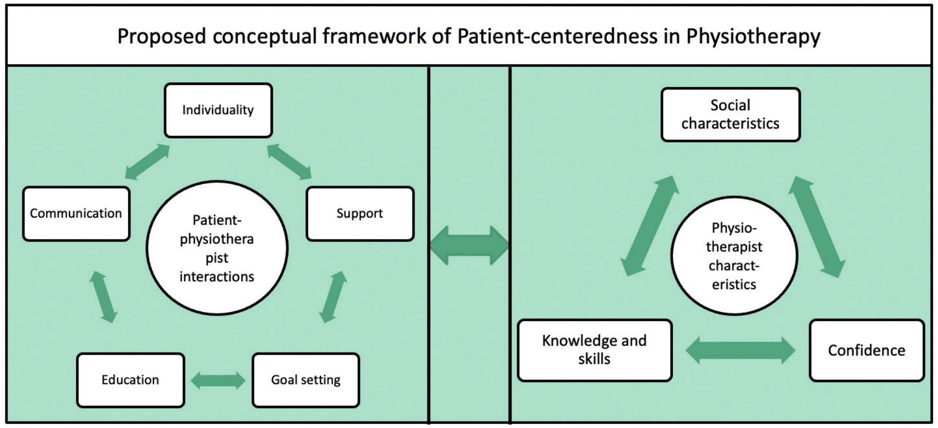

Figure 2: Proposed framework for patient-centeredness in physiotherapy

The proposed conceptual framework, figure 2, was based on brainstorm sessions and consensus with multiple authors (AJW, ANB and PvW) and reviewed by all authors. During the analysis the authors discovered that patient-centeredness in physiotherapy is a dynamic concept with closely related themes and subthemes.

The analysis and brainstorm sessions uncovered that there is a difference in the themes we found: there are themes related to the physiotherapist characteristics and there are themes related to the patient-physiotherapist interaction. Figure 2 is designed according to these two differences.

The themes related to the patient-physiotherapist interaction (Individuality, Communication, Education, Goal setting, Support) are located on the left side of the proposed conceptual framework because our writing directions is from left to right, thereby suggesting that these themes are preceding the themes related to the physiotherapist characteristics. The themes (Individuality, Communication, Education, Goal setting, Support) are all of equal importance, connected, intertwined and all have an influence on each other.

Even though the patient is the most important in patient-centeredness , the physiotherapists in itself plays an important role: he/she is the one who places the patient in the center. Furthermore, the physiotherapist and his/her behaviour (Social characteristics, Knowledge and Skills, Confidence) influences all other themes: the individuality of the therapy, communication, education, goal setting and support.

Discussion

This review identified 14 articles from qualitative studies investigating patient-centeredness in physiotherapy. From these studies a synthesis of interrelated themes (*"individuality"*, *"communication"*, *"education"*, *"goal setting"*, *"support"*, "*social characteristics of a patient-centered physiotherapist*", *"a confident physiotherapist"*, "*knowledge and skills of a physiotherapist in patient-centeredness*") with subthemes and a proposed conceptual framework (figure 2) of patient-centeredness in physiotherapy was made. All relevant articles related to patient-centeredness in physiotherapy were included. The findings from this review may be used to educate students and during the continuous education of clinicians. Whereby the proposed conceptual framework may be an indication and example of how the different themes interact and relate to each other: patient-centeredness in physiotherapy entails the characteristics of offering an individualized treatment, continuous communication (verbal and non-verbal), education during all aspects of treatment, working with patient-defined goals, a treatment in which the patient is supported and empowered and a physiotherapist with patient-centered social skills, confidence and knowledge.

"Individuality" concerns specific patient-tailored education, communication and treatment. *"Communication"* is the need for a continuous individualized dialogue with patients in clear and lay speech. When doing so patient satisfaction and therapeutic alliance improves[32]. Physiotherapist should be aware of these communication needs and require training during and after physiotherapy education[33,34]. *"Education"* primarily involves advice about the problem, diagnosis, treatment and treatment course. *"Goal setting"* is used by physiotherapists to activate and motivate patients, however, was not spontaneously mentioned by patients. *"Support"* from the physiotherapist is seen as a mixture of individuality, equality of responsibility, understanding, reassuring and empowerment. "*The social characteristics*", "*confidence*" and "*skills and knowledge*" of a patient-centered physiotherapist are personal skills and encompass for instance: being able to relate to the patient, confident body language, up to date knowledge and teaching skills. This theme can be used to create awareness among physiotherapist and offers the opportunity to physiotherapists to reflect upon their attitude and behaviour.

The concepts of this review are to some extent similar to previous frameworks constructed for patient-centeredness in overall care (The Picker Institute's principles[4]), medicine[5,6] and nursing[35]. For instance, in all reviews individuality of the patient (*i.e. the patient as a person*[5] *and respect for patients' values, preferences and expressed needs*[4]) was identified as important, which in our review was the largest theme. Furthermore, both Mead and Bower, as well as Epstein et al. included '*sharing power and responsibility'* in their framework[5,6]. This is to some extent similar to "*Support*" in our review. '*Patient participation and involvement'* and '*the relationship between the patient and the healthcare professional*' from the review of patient-centeredness in nursing[35] are also well represented in the themes identified in the present review, highlighting the importance of these two topics in both professions.

Unlike the frameworks in overall care, medicine and nursing, the setting/organization was not an important part of patient-centeredness in physiotherapy. The Picker Institute's principles mention the '*Involvement of family and friends', 'transition and continuity' and 'coordination and integration of care*'[4]. In nursing '*the context where care is delivered*' implied the environment, such as policy, equipment, lack of time and deeper philosophical issues within the nurse and team[35]. This discrepancy might be due to the different settings and hence may reflect true differences. Both, the Picker Institute and nursing frameworks are based on thorough investigations of patient-centeredness in hospitals[4,35], whereas most of the patients and physiotherapists from the original studies in this review work in a private practice and (sub-acute) rehabilitation settings.

From the above reflection of this review and prior research on patient-centeredness in overall care, nursing and medicine it can be argued that there are similarities as well as differences between the models. The variance between these models might reflect on true dissimilarities between the professions and settings, hence represent various forms of patient-centeredness. Therefore, it is proposed that there are distinct needs of patient-centeredness in physiotherapy compared to overall care, nursing and medicine due to professional differences. As a result, this review and proposed conceptual framework is an enhancement on prior research in overall care, nursing and medicine as it is specific for physiotherapy.

The findings of this review are also comparable to the findings of Edwards et al. about clinical reasoning strategies in physiotherapy[36]. Their extensive grounded theory study reveals several conceptual frameworks ('*clinical reasoning strategies, cue-based combining of reasoning strategies and interplay of reasoning strategies in different paradigms of knowledge generation*') with subcategories[36]. Even though their study was based on defining clinical reasoning strategies, their constructs overlap with ours. This indicates that patient-centeredness and clinical reasoning are closely connected.

There are also comparisons between the review and a recent qualitative review of O'Keefe et al. on patient-therapist interactions in musculoskeletal therapy[37]. Whereby they found the following themes: '*physiotherapists interpersonal and communication skills*' (listening, encouragement, confidence, being empathetic and friendly, and nonverbal communication), '*practical skills*' (expertise and level of training, although the ability to provide good education was considered as important only by patients), '*individualized patient-centered care*' (individualizing the treatment to the patient and taking patient's opinions into account), '*and organizational and environmental factors*' (i.e., time and flexibility with care and appointments). Even though their aim was based on outcomes: to investigate the factors that influence the patient-physiotherapist interactions, and the aim of this review on determinants: creating a synthesis of patient-centeredness, the themes of both reviews are comparable. Suggesting that maybe in which manner a physiotherapist works patient-centered affects the outcomes of the interactions between the patient and physiotherapist. While their search terms were different both reviews included 4 articles that are the same ([17,21,27,30]) suggesting a great deal of overlap between the different constructs. The difference to their review and the current review, besides the focus, is that they included studies focusing on satisfaction and excluded studies that focused on physiotherapy in a rehabilitation setting. Whilst this review excluded studies focusing on satisfaction because it was suggested that satisfaction is an outcome of patient-centeredness rather than a base/determinant. Furthermore, this review included all settings and by that created an overall synthesis of patient-centeredness based on all settings in physiotherapy.

Study limitations

Due to the limited number of available studies, we included several different qualitative study designs in this review. There is a debate ongoing about combining study designs in qualitative reviews. However, the use of multiple methodologies can increase the understanding of the phenomenon/process, can compensate the limitations of individual methods[38], and exclusion based on qualitative methodology diminishes insight in the research topic[39].

We included articles that either assessed patient-centeredness or aspects of patient-centeredness (or a synonym) in physiotherapy. As a result, the primary aim of the studies included were not all based on assessing patient-centeredness. However, all studies mentioned patient-centeredness in their full text. They either had aims based on patient-centered care, used patient-centeredness as an outcome of their results, or reflected on their findings in the light of previous definitions of patient-centered care.

Within qualitative research there is debate about the preferred techniques one can use to assess the methodological quality of individual studies. For example, about saturation (included as number 11 in the methodological checklist). Saturation is a technique whereby researchers stop data collecting when no new information emerges from the data that will add to the understanding of the phenomenon under study[40]). Within GT it is mentioned that data saturation is usually reached between 20-30 interviews[40]. However, other researchers suggest saturation as a method to obtain methodological quality may be inapplicable[40].

The inter-rater agreement between the two researchers assessing the study quality of the included studies was 'moderate'[14,30]. During the analysis we decided to not bring a third reviewer forward due to practical implications, however we did reach consensus on the final scoring.

One could argue that within the profession of physiotherapy many differences exist between monodisciplinary and multidisciplinary physiotherapy. Six of the 13 included articles in this review conducted research in acute or sub-acute rehabilitation, with the focus on physiotherapy. Therefore, it can be assumed that this review gives a complete overview of patient-centeredness in the different areas of physiotherapy (except for pediatric physiotherapy).

More sound qualitative research on this topic should be performed to further investigate in which manner and to what extent patient-centeredness is implemented in clinical practice. Hiller et al. were, to our knowledge, the first to investigate this with observations and interviews and found that physiotherapists' approach are more likely to be therapist-centered than patient-centered[22]. Qualitative research should further enhance our understanding about the perceptions of physiotherapists of patient-centeredness, see if there are differences between conditions (for instance between non-life-threatening conditions, chronic conditions and conditions in which the patient cannot clearly communicate) and how to implement patient-centered strategies in clinical practice. These qualitative studies should contain patient-centeredness or a well-defined synonym in the title or key words to ease the search of qualitative articles[41].

Additionally, the present overview calls for quantitative research to study the implementation and implications of working patient-centered in physiotherapy practice according to the provided description and framework. Not only does research show that patient-centered medicine has positive effects on clarifying patients' concerns and beliefs[8], patient-centered medical care also reduces costs by lowering unnecessary diagnostic tests and referrals[42]. This increased effectiveness might also occur in physiotherapy and is worth studying further.

Our findings show a better understanding of the concept patient-centeredness in adult patients. This model however cannot be generalized to all health in physiotherapy conditions, for instance in patients with acute stroke or in patients with dementia of young children. Further research may focus on potential models of patient-centered strategies in these patient groups.

Conclusion

Patient-centeredness in physiotherapy is a framework containing multiple closely related themes: "*individuality*"; "*communication*"; "*education*"; "*goal setting*" and "*support*"; "*the social characteristics*", "*confidence*" and "*skills and knowledge of a patient-centered physiotherapist*". The results presented in this review provide insights into patient-centeredness in physiotherapy. A proposed conceptual framework is constructed to help physiotherapists improve their understanding of patient-centeredness. It is hoped the proposed conceptual framework developed from these study findings will assist physiotherapists in their understanding of patient-centeredness and the implications of patient-centeredness in clinical practice. Further research is needed in order to further enhance our understanding about the clinical applicability of the proposed conceptual framework and to assess the implementation and implications.

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Appendix 1. Search strategy

Key search terms	Physiotherapy	Factors
Patient/person/client centeredness	Physical Therapy	Aspects
Patient/person/client centered care	Rehabilitation	Components
Patient/person/client centred	Remedial exercise	Features
Patient/person/client centered		Elements
Patient/person/client orientated		Parts
Patient/person/client tailored		
Patient/person/client focused		
Databases		
PubMed (MEDLINE)		
EMBASE		
Cochrane		
PsychINFO		
CINAHL		
PEDro		
Scopus		

Search Strategy PubMed (MEDLINE):
Topic: Patient-centeredness
01. (((((((((((((((((((((“Patient centeredness”) OR patient centered care[MeSH Terms]) OR “patient centered”) OR “patient centred”) OR “Patient orientated”) OR “patient oriented”) OR “Patient tailored”) OR “Patient Focused”) OR “Person centeredness”) OR “Person centered”) OR “Person centred”) OR “person orientated”) OR “person oriented”) OR “person tailored”) OR “person focused”) OR “Client centeredness”) OR “Client centered”) OR “Client centred”) OR “client orientated”) OR “client oriented”) OR “client focused”) OR “client tailored”

Topic: Physiotherapy
02. (((((((((“physical therapy”) OR physical therapist[MeSH Terms]) OR modalities, physical therapy[MeSH Terms]) OR physical therapy specialty[MeSH Terms]) OR physiotherapy) OR rehabilitation) OR rehabilitation[MeSH Terms]) OR “remedial exercise”) OR remedial AND exercise) OR physical AND therapy

Topic: Factors:
03. (((((Factors) OR aspects) OR components) OR features) OR elements) OR parts
04. ((#01) AND #02) AND #03

Search Strategy EMBASE:
01. 'physiotherapy'/exp OR (physical AND 'therapy'/exp) OR 'physical therapy'/exp
02. 'patient centred' OR 'patient orientated' OR 'patient oriented' OR 'patient tailored' OR 'patient focused' OR 'person centredness' OR 'person centred' OR 'person orientated' OR 'person oriented' OR 'person tailored' OR 'person focused' OR 'client centredness' OR 'client centred' OR 'client orientated' OR 'client oriented' OR 'client focused' OR 'client tailored' OR 'patient centredness' AND [embase]/lim
03. factors OR aspects OR components OR features OR 'elements'/exp OR parts AND [embase]/lim
04. #01 AND #02 AND #03
05. #04 AND 'qualitative research'/de(limit)

Appendix 2. Checklist methodological quality assessment

No.	Checklist item	Definition
1	Was the researcher experienced or trained?	
2	Was the research question clearly defined?	
3	Was the methodological orientation suitable for this research question?	Grounded theory, discourse analysis, ethnography, phenomenology, case study
4	Was theoretical or purposeful sampling used?	
5	Was there stated how many participants where approached?	
6	Were the important characteristics of the sample described?	Demographic data, date, where data was collected
7	Does the sample produce the type of knowledge necessary to understand the structures and processes within which the individuals or situations are located?	Choice of informants whose knowledge or experience is relevant to the substantive focus and theoretical framework of the study
8	Was there stated that the interview was open, semi structured or if there were focus groups?	
9	Were repeated interviews carried out?	Repeated interviews derive more information
10	Were field notes made?	
11	Was data saturation discussed/reached?	
12	Were there two or more researchers that coded the data?	Triangulation of coders
13	Was software used to manage the data?	
14	Did themes derive from the data?	Themes in advance or derived from the data, if themes where identified in advance the quality of data analysis is less
15	Were participant quotations presented to illustrate themes/items?	
16	Were major themes clearly presented in the findings?	
17	Is the description described in sufficient detail to allow the researcher or the reader to interpret the meaning and context of what is being researched?	Appropriate presentation of primary data and description of context
18	Does the researcher move from description of the data, through quotations or examples, to an analysis and interpretation of their meaning and significance?	Evidence of analysis and interpretation of data at conceptual and theoretical level
19	Are claims being made for the generalizability of the findings to other bodies of knowledge? (within scientific research)	Findings are related to broader theoretical concerns and/or other empirical context
20	Are claims being made for the generalizability of the findings to other populations?	Findings are related to broader theoretical concerns and/or other empirical context

3

The clinical biopsychosocial assessment in the physiotherapy encounter of patients with chronic pain

Clinical biopsychosocial physiotherapy assessment of the patient with chronic pain: The first step in pain neuroscience education

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Abstract

Purpose

Pain Neuroscience Education (PNE) is increasingly used as part of a physiotherapy treatment in patients with chronic pain. A thorough clinical biopsychosocial assessment is recommended prior to PNE to allow proper explanation of the neurophysiology of pain and the biopsychosocial interactions in an interactive and patient-centered manner. However, without clear guidelines, clinicians are left wondering how a biopsychosocial assessment should be administered.

Methods

Therefore, we provided a practical guide based on scientific research and clinical experience for the biopsychosocial assessment of patients with chronic pain in physiotherapy practice. The purpose of this paper is to describe the use of the Pain – Somatic factors – Cognitive factors – Emotional factors – Behavioural factors – Social factors – Motivation – model (PSCEBSM-model) during the intake, as well as a pain analysis sheet. This model attempts to clearly establish what the dominant pain mechanism is (predominant nociceptive, neuropathic or non-neuropathic central sensitization pain), as well as to assess the provoking and perpetuating biopsychosocial factors in the patient with chronic pain.

Conclusion

Using this approach allows the clinician to specifically classify the patient and tailor the plan of care, including PNE, to the individual patient.

Introduction

Chronic pain, also described as 'pain that persists beyond normal time of healing and/or pain persisting for 3 to 6 months or longer'[1], is a huge global issue and major health care problem [2], with a prevalence of 17 to 27% in populations all over the world [3-6]. In the US chronic pain is more prevalent than diabetes, heart disease and cancer combined [7-9]. Chronic pain is associated with increased medical costs, decreased income and huge economic burdens [10,11], and has a large negative impact on the patients' quality of life [3,10].

In the last few decades, evidence has shown that a more or less irreversible state of hyperexcitability within the central nervous system known as non-neuropathic central sensitization pain (CS), is present in patients with chronic pain [12-14]. According to Woolf and Salter (2000) CS is operationally defined as an amplification of neural signaling within the central nervous system that elicits pain hypersensitivity [15]. CS is characterized by generalized hypersensitivity of the somatosensory system [16-19], resulting in amplification of signaling and eventually even pain without nociceptive input.

It is known that in patients with pain syndromes such as: fibromyalgia [20-22]; persisting traumatic neck pain [23-27]; tension-type headache [28]; migraine [29]; subacromial impingement syndrome [30]; tennis elbow [16,17]; nonspecific arm pain [18]; low back pain [20,31,32]; pelvic pain [33,34]; chronic fatigue syndrome [35]; osteoarthritis [20,36,37]; rheumatoid arthritis [38]; and tendinopathy [19], that pain often cannot be explained (solely) by an obvious anatomic defect or tissue damage. In fibromyalgia, chronic whiplash associated disorders, chronic fatigue syndrome and irritable bowel syndrome CS is merely the predominant underlying pain mechanism [20,39,40]. In other chronic pain populations, such as low back pain and osteoarthritis, a subgroup may be present with predominant CS pain [20,28-30,36-39,41,42].

The neurophysiological changes in CS are related to changes in the pain neuromatrix, modulating pain processes by behavioural, emotional, social and cognitive factors. [43]. It is known that pain catastrophizing [44]; pain-related anxiety [44-47]; trait anxiety [47,48] (trait anxiety is the personal level of anxiety); trait neuroticism (personal level of negative affectivity) [49]; depressive feelings and stress [50-52]; diminished self-efficacy [43]; adverse life events [53]; and post-traumatic stress disorders [54-58] are present to varying degrees in patients with chronic pain. These can be a consequence of pain and/or can contribute to the transition and persistence of chronic pain. Emotions, thoughts, attention and stress can influence the pain facilitating pathways [59], thereby leading to cognitive emotional sensitization [60]. Catastrophizing, for instance, is related to activation of the pain neuromatrix, increased pain, affective distress, pain-related disability and poorer treatment outcomes [44,61]. Therefore, the initial examination should take into account both somatic (bottom-up, pathoanatomical, peripheral signals) and psycho-social factors (top down, dis-inhibition or pain facilitation).

Consequently, a thorough clinical biopsychosocial assessment is required to understand the process of CS and allows an individualized, patient-centered explanation including biopsychosocial interactions, also known as pain neuroscience education (PNE) [62-70]. However, without clear guidelines clinicians are left wondering how such biopsychosocial assessment should be done and how it allows for an interactive and patient centered PNE. Therefore, the purpose of this paper is to provide a practical guide, based on scientific research and clinical experience, for the biopsychosocial assessment of patients with chronic pain in physiotherapy practice.

Intake

To facilitate the biopsychosocial intake of patients with chronic pain we suggest the use of the PSCEBSM- model (based on the SCEBS model [71] plus pain and motivation): Pain – Somatic and medical factors – Cognitive factors – Emotional factors – Behavioural factors – Social factors – Motivation. This model starts with examining and determining the type of pain, continues with identifying the different factors associated with chronic pain and ends with determination of the stage of motivation of the patient. A flowchart of the model for use in clinical practice is offered in Figure 1. The pain analysis sheet (Figure 2) can be used to provide a clear overview of the PSCEBSM-model, guide the content of PNE and the treatment. The use of this model takes time, modifications in clinical care, and needs adequate biopsychosocial communication skills.

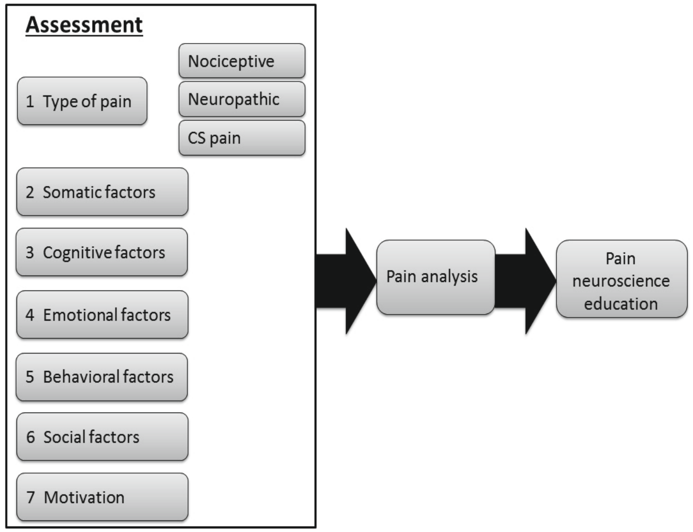
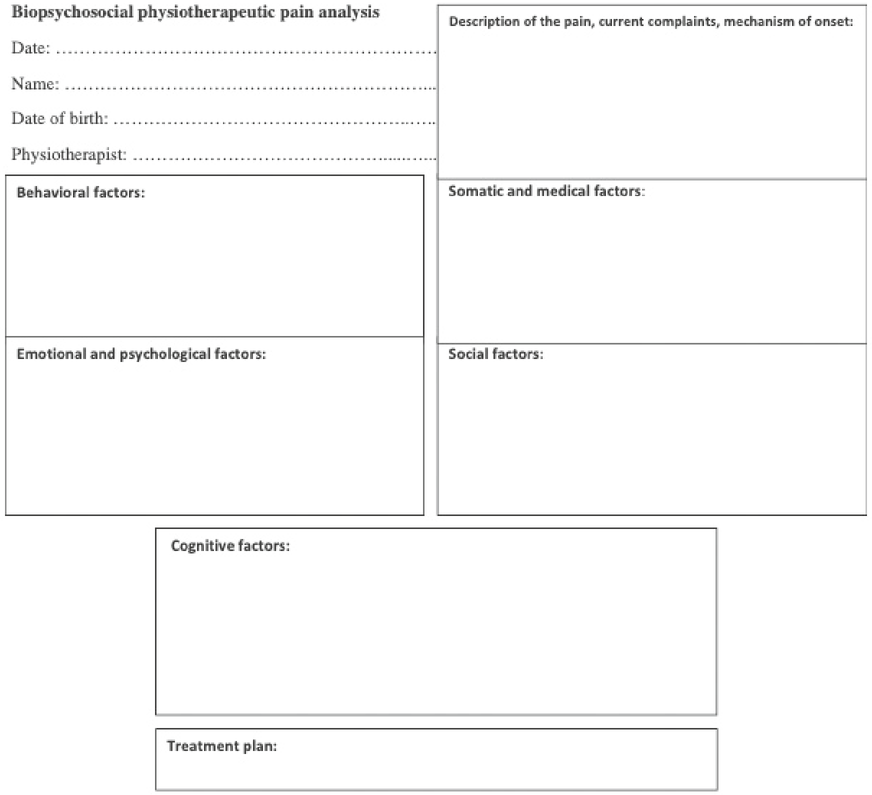


Figure 1. Flowchart of the biopsychosocial assessment of patients with chronic pain



Biopsychosocial physiotherapeutic pain analysis

Date: ……………………………………………………………

Name: ……………………………………………………………

Date of birth: ……………………………………………………

Physiotherapist: …………………………………………………

Description of the pain, current complaints, mechanism of onset:

Behavioral factors:

Somatic and medical factors:

Emotional and psychological factors:

Social factors:

Cognitive factors:

Treatment plan:

Figure 2. Pain analysis sheet

P - Type of Pain

In order to allow tailoring PNE to the underlying pain mechanisms it is important to differentiate between the 3 major pain types (nociceptive, neuropathic and CS pain) (Figure 2). An algorithm with a set of classification criteria for differentiating predominant neuropathic, nociceptive and CS pain in patients with musculoskeletal pain has been proposed by 18 pain experts from seven countries [72]. To identify the predominant pain type two steps need to be taken. The first step entails recognizing neuropathic pain as the predominant pain type. Neuropathic pain is defined as "pain arising as a direct consequence of a lesion or disease affecting the somatosensory system" [73]. Table 1, adapted from [72] shows the clinical differentiation between predominant nociceptive, non-neuropathic CS pain and neuropathic pain. In line with the diagnostic criteria for neuropathic pain (Treede et al, 2008), central neuropathic pain can be distinguished from CS pain by the lack of damage to the nervous system in the latter group.

Table 1. Criteria for the differential classification between predominant neuropathic [73-75] and central sensitization pain. Adapted from Nijs et al.[72]

Nociceptive Pain	Neuropathic Pain	Non-neuropathic CS pain
History of damage to body tissue in the previous 6-8 weeks. Pain diminishes according to the natural healing phases.	History of a lesion or disease of the nervous system, or posttraumatic/postsurgical damage to the nervous system Indications from diagnostic examinations to reveal an anomaly of the nervous system	No history of a lesion, damage or disease of the nervous system No indications from diagnostic examinations
Related to tissue damage or potential damage. An ankle sprain or almost burning a hand	Related to a medical or systemic cause such as, stroke, herpes, diabetes, or some form of neurodegenerative disease	No medical cause for the pain established
Local pain, most often with diagnostic signs such as: oedema, hematomas, skin colorations etc.	Pain and sensory dysfunction is neuroanatomical logical	Pain is neuroanatomical illogical and segmentally unrelated to the primary source of nociception Several regions of hyperalgesia at sites outside and remote to the symptomatic area (still at segmentally unrelated sites)
Pain is described as sharp, aching, or throbbing.	Pain is frequently described as burning, shooting, or pricking	Pain is most frequently described as vague and dull

The second step is to differentiate between predominant nociceptive and CS pain. The pain is more likely to be originated from CS if the perceived pain and disability are disproportionate to the nature of the injury or pathology [72] AND one of the following 2 criteria: 1) The presence of a diffuse or neuro-anatomically illogical pain distribution [72] that is not in accordance with dermatomes and myotomes. A wide spread pain index (also known as body diagram) can be used to assess the pain distribution by mapping the pain locations [76,77]. The widespread pain index, which includes 19 body regions (each region that has pain is given a point, for a range of scores from 0-19 points), can be used to aid in this process [78]. A score of 7 or greater suggests widespread pain; and 2) Hypersensitivity of senses unrelated to the musculoskeletal system [72], which can be assessed using the Central Sensitization Inventory (CSI) (Table 2). This includes hypersensitivity to light, sounds, smell, taste and a hypersensitive skin. The CSI appears to be a valid, reliable, usable and diagnostically relevant questionnaire assessing common symptoms and facilitating factors to CS in 25 items [79,80]. Based on a validation study a cutoff score of 40 points indicates the possibility that the symptoms are due to predominant CS pain [81,82]. However, the score of the CSI should be interpreted with caution and in accordance with the clinical symptoms of the patient. More detailed information regarding differentiating between predominant nociceptive and CS pain and how to apply this information in clinical practice can be found in the original paper[72]. Or, adopted for low back pain patients in a more recent paper [83].

The outcome of the mechanism-based classification of pain types can be either predominant nociceptive, neuropathic, CS, or a mixed type of pain. The next step is to identify which factors play a role in the continuation of the patient's pain. These factors can be divided according to the other domains of the PSCEBSM-model.

Table 2. Cutoff scores and implications for the questionnaires used during the biopsychosocial intake

Questionnaire	Range/ Cut off score	Implications	Psychometrics	Practical issues	Used by the authors in clinical practice
Central Sensitization Inventory (CSI) [79,81,82]	0-100/ >40 points	Symptom presentation may indicate the presence of CS pain	Test-retest reliability 0.82 Cronbach's alpha 0.88 Sensitivity 81-82,8%, Specificity 54.8-75%	Number of items: 35 Time to administer: 10 minutes	Yes
Leeds Assessment of Neuropathic Symptoms and Signs (LANSS) [84]	0-24/≥12 points	Neuropathic mechanisms are likely to contribute to the patient's pain	Cronbach's alpha of 0.74 Sensitivity 83%, Specificity 87% Good validity and reliability	Number of items: 7 Time to administer: 2-3 minutes	If necessary
Body diagram [78]	-	No cut of score exists	-	Time to administer: 5 minutes	Yes
Brief Illness Perception Questionnaire (Brief IPQ) [85,86]	-	Each item has to be viewed separately	Moderate overall test-retest reliability Good concurrent, predictive and discriminant validity	Number of items: 13 Time to administer: 5-10 minutes Available on: http://www.uib.no/ipq/index.html	Yes
Pain Catastrophizing Scale (PCS) [87,88]	≥30 points	The patient is likely to catastrophize if the score is above 30 Higher scores indicate higher catastrophizing	Cronbach's alpha 0.88-0.95 Good construct, criterion, concurrent and discriminant validity[89]	Number of items: 13 Time to administer: 5-10 minutes Subscales: Rumination: items 8, 9, 10, 11 Magnification: items 6, 7, 13 Helplessness: items 1, 2, 3, 4, 5, 12	Yes
State-Trait Anxiety Inventory (STAI) [90]	≥39–40[91] ≥54–55 for older adults[92]	2 subscales: State and Trait, range of scores per subtest 20–80 Higher scores indicate greater anxiety	Test–retest reliability 0.31-0.86 Cronbach's alpha 0.86-0.95[93] Validity S-scale limited	Number of items: 40 Time to administer: 10 minutes State Anxiety: current state of anxiety Trait Anxiety: relatively stable aspects of "anxiety proneness"	If necessary

Table 2. (Continued)

Questionnaire	Range/ Cut off score	Implications	Psychometrics	Practical issues	Used by the authors in clinical practice
Tampa-Scale of Kinesiophobia (TSK) [94]	≥37	The patient most likely has fear of movement Higher scores indicate greater fear of movement	Moderate construct, concurrent and predictive validity, good internal consistency and a moderate to good retest reliability [95,96]	Number of items: 17 Time to administer: 5-10 minutes The scoring on items 4, 8, 12, and 16 should be reversed	If necessary
Injustice Experience Questionnaire (IEQ) [97]	≥19 in WAD* [98]	Above this score perceived injustice is associated with high pain severity, not returning to work, and narcotic use Higher scores indicate more perceived injustice	Cronbach's alpha 0.92 Test retest reliability 0.90-0.98 [97,99] Good construct validity	Number of items: 12 Time to administer: 5-10 minutes Subscales: Blame/Unfairness: items 3, 7, 9, 10, 11, 12 Severity/Irreparability: items 1, 2, 4, 5, 6, 8	Yes
Psychological Inflexibility in Pain Scale (PIPS) [100]	-	No cut off score exists Higher scores indicate less psychological flexibility	Cronbach's alpha 0.90 (avoidance), 0.75 (fusion) and 0.89 (total scale) Intercorrelation between subscales 0.46 Acceptable model fit Good construct and concurrent validity	Number of items: 16 Time to administer: 5-10 minutes Subscales: Avoidance of pain: items 2, 3, 7, 8, 9, 11, 13, 14, 15, 16 Fusion with pain thoughts: items 1, 4, 5, 6, 10, 12	If necessary
Center for Epidemiologic Studies Depression scale (CES-D) [101]	≥16	Indicative of "significant" or "mild" depressive symptomatology Higher scores indicate more depressive feelings	Cronbach's alpha 0.88-0.91 Test-retest reliability ICC=0.87, individual items ICC=0.11-0.73 Poor to excellent validity Sensitivity 80.0%, Specificity 69.8% [102,103]	Number of items: 20 Time to administer: 5-10 minutes Subscales: Somatic-retarded activity: items 1, 2, 3, 5, 7, 11, 20 Depressed affect: items 6, 10, 14, 17, 18 Positive affect: items 4, 8, 12, 16 Interpersonal affect: items 15, 19	If necessary

Table 2. (Continued)

Questionnaire	Range/ Cut off score	Implications	Psychometrics	Practical issues	Used by the authors in clinical practice
Patient Health Questionnaire (PHQ-2 and PHQ-9)[104]	PHQ-9: >10	Indicative for a depressive disorder Higher scores indicate more depressive feelings	Cronbach's alpha 0.86-0.89 PHQ-9 cut off score of > 10: Sensitivity 88%, specificity 88% Good criteria validity[104,105]	PHQ-2: Number of items: 2 Time to administer: 1 minute PHQ-9: Number of items: 9 Time to administer: 5-10 minutes Patients who screen positive on the PHQ-2 should be further evaluated with the PHQ-9 to determine if they meet the criteria for a depressive disorder.	If necessary
Activity Diary	-	Cut of scores are not necessary.	-	Time to administer: 10-15 minutes	Yes

*WAD: Patients with Whiplash Associated Disorders

S - Somatic and Medical Factors

In patients with CS, somatic and medical factors that may be present include: other (past and present) illnesses that might influence CS; nonuse or disuse of body parts; changed movement patterns; exercise capacity; and strength and muscle tension/tonus during movements. Medication can have (positive/negative) side effects. Therefore, other medical issues and drug use should ideally be examined by a medical physician, however a physiotherapist's basic understanding of pathophysiology and medications interacting with the central nervous system is important when providing PNE. Physiotherapists are indeed capable of gathering this type of information. However, the prescription, administration and modification of medications should be done by a physician. Following the intake, a thorough physical examination should take place. It is important to recognize that in the presence of CS alters findings on clinical tests, such as the Straight Leg Raise, Upper Limb Neurodynamic Tests (ULNT) and assessments of movement or muscle strength. Due to the increased sensitivity to mechanical stimulations and changed patterns in the central nervous system in patients with CS, all physical examination tests (e.g. range of motion, strength, muscle tone, neurodynamic tests, and movement coordination) can evoke pain. Therefore, the aim of the physical examination is to support or refute the clinical picture of CS, assess movement quality, determine body movement if the manner in which the patient moves provokes symptoms consistent with CS (e.g. very guarded or with a lot of tone), and determine if there is fear of movement. In the case of positive findings, clinical reasoning skills are required to decide whether or not such physical factors are of clinical importance for the individual patient and whether or not it contributes in the persistence of CS pain. Positive findings could be: bracing when bending; holding his/her breath while moving; increased tonus prior to movement; verbal or non-verbal signs of fear; and inconsistent movement patterns.

The physical examination is important for both the physiotherapist and patient. By assessing complaints thoroughly, both parties can be reassured that anything dangerous/serious can be ruled out and confidence is restored that the patient's pain is taken seriously.

C - Cognition/Perceptions

As discussed previously, cognitions and perceptions are important factors that might contribute to (the maintenance of) CS pain. Besides influencing the hypersensitivity in the brain by activating the pain neuromatrix [106], they also influence the behavioural and emotional factors of patients [107]. During history taking, the patient's perceptions and cognitions should be assessed thoroughly. Most important are his/her perceptions about the physical and mental aspects of pain as well as the consequences. Furthermore the following factors should be assessed: the expectations for care (anticipated outcome, as well as the content of the treatment); expectations regarding the prognosis of their pain; the coherence (the patients' ability to comprehend their whole situation and their capacity to use available resources to deal with their pain); and emotional representation of the pain. Cognitive patterns, such as catastrophizing, perceived injustice or perceived harm are important to recognize.

In the following section several diagnostic questionnaires are suggested to support the clinician. Not all questionnaires have to be used, rather clinicians can decide which ones to use based on their perceptions and the patient's characteristics. Table 2 provides the cutoff scores, clinical implications and psychometric information for all questionnaires.

Pain Perceptions

The Brief Illness Perception Questionnaire (Brief IPQ) can be used to assess pain perceptions of the patient. The Brief IPQ consists of 13 items and is based on the Common Sense Model of Self-regulation [107] (described in *Behavioural factors*) and has a moderate overall test-retest reliability and good concurrent validity [85,86]. The questionnaire ends with a 3-item rank to list the personal causes of the illness. In addition, the Brief IPQ assesses the expectations for care (items 2 and 4) as well as self-efficacy (item 3). Items 6 and 7 refer to worrying about and understanding pain, respectively. With our clinical expertise patients scoring high (≥6) on 'worrying about their pain' and low (≤4) on 'understanding their pain' could potentially benefit from PNE in helps to decrease their worrying and improve the understanding of their condition.

Pain Catastrophizing

When pain catastrophizing is suspected, the Pain Catastrophizing Scale (PCS) can be used to assess the degree of pain catastrophizing. The PCS is a valid and reliable 13-item questionnaire (table 2) that examines the rumination, magnification, and helplessness patients have about their perceived ability to manage their pain [87,88]. In order to avoid prejudices, we propose omitting the words 'pain catastrophizing scale' from the questionnaire when handing it over to the patient. If the patient scores high (≥30) on the PCS, their feelings and cognitions on catastrophizing should be acknowledged and explored in the PNE session. The patient should also be told that catastrophizing increases the activity in the pain signature in the brain and therefore increases their pain.

E - Emotional Factors

Emotional factors are related to cognitions and perceptions and include anxiety, anger, fear, depressive feelings and post-traumatic stress. Physiotherapists can specifically ask about emotional factors related to the onset of pain, such as fear of specific movements, avoidance behaviours, a psychological traumatic onset of the pain, or psychological issues including work, family, financial, or social.

Anxiety

State anxiety (related to an event) and trait anxiety (personal level of anxiety) are important factors in chronic pain. In addition to questioning the patient about anxiety, we recommend using the State-Trait Anxiety Inventory (STAI). This questionnaire has 20 items for assessing trait anxiety and 20 for state anxiety. The STAI has a good internal consistency, is reliable and has considerable construct and concurrent validity [90]. A cutoff score of 39-40 has been suggested to detect clinically significant symptoms and a higher cut score of 54–55 has been suggested for older adults [91,92]. If the outcome of the STAI indicates that the patient has anxiety, either state or trait, the effects of this anxiety should be explored and discussed in the PNE session.

Fear of Movement

Based on previous experiences, patients can become fearful and begin to avoid potentially painful movements. The Tampa-Scale of Kinesiophobia (TSK) is a 17-item scale that measures the *somatic focus of patients (beliefs about* underlying and serious medical problems), and *activity avoidance* (beliefs about (re)injury or increased pain). The TSK has moderate construct, concurrent and predictive validity, good internal consistency and a moderate to good retest reliability [95,96]. Patients scoring high on the TSK, above 37 points, are likely to have fear of movement [94] and during the PNE session the effects of fear of movement on the pain neuromatrix in the brain (by increased activity in the hypothalamic–pituitary–adrenal axis and increased attention) should be explained.

Anger

Perceived injustice as a form of anger can be measured using the Injustice Experience Questionnaire (IEQ). Perceived injustice can have negative effects on pain, disability and treatment. For example, patients developing chronic pain following a car accident do not present with perceived injustice or anger in the acute stage, but develop it throughout the transition phase towards chronicity, with marked increased levels in the chronic stage (and not in those recovering) [108]. Therefore, we recommend the use of the IEQ on patients who are suspected of having anger/perceived injustice such as a patient who develops chronic pain following a car accident. The IEQ has a high internal consistency, a good construct validity and reliability [97]. If high scores (> 19) on this questionnaire are present this can be used to focus part of the PNE. By first acknowledging their feelings of anger and injustice and then explaining that such emotions sustain the pain signature in the brain and may present barriers to improvement.

Depressive Feelings

Physiotherapists are not trained to diagnose depression or other psychological states, but should be aware of their existence and role in patients with chronic pain. Depressive feelings can be assessed through self-report questionnaires. The two-item Patient Health Questionnaire-2 (PHQ-2) and nine-item PHQ-9 are commonly recommended for depression screening in clinical and research settings. The PHQ-2 is a quick and helpful screening tool for depression, with a sensitivity of 86% and specificity of 78 [104]. Patients who report more than 2 points or higher on the PHQ-2 should be further evaluated with the PHQ-9. A score of 10 or higher on the PHQ-9 detects depression. The PHQ-2 has a high sensitivity (86%), the PHQ-9 has higher specificity (91%) [104]. Additionally, the Center for Epidemiologic Studies Depression scale (CES-D)[101] can be used. The CES-D is a 20 item self-report measure of depressive symptomatology during the past week. Scores of 16 or greater indicate more severe symptoms. The CES-D has a high internal consistency, good reliability, convergent and divergent validity [109]. Patients scoring high on this or any other scale for measuring depressive feelings need support, acknowledgement, comfort and help, each of which can be provided in part by PNE.

There is a bidirectional relationship between depression and pain [110], however, because patients are often fearful of being labelled ('it's in your head') we suggest explaining to patients with chronic pain that depression may be a consequence rather than a cause of chronic pain. Furthermore, we suggest explaining the interplay between pain and depression in the pain neuromatrix during PNE.

Stress

Physiotherapists are suggested to screen their patients for post-traumatic stress disorder by asking the patient about prior traumatic events and whether they frequently relive the event, avoid situations that remind them of the event or have negative changes in beliefs and feelings since the event. In addition, physiotherapists should also evaluate general levels of stress and/or stress intolerance. Stress can be related to work factors, relationships, financial stress, health related stress, etc. and should be investigated during the assessment. If relevant to the individual patient, the influence of stress on the pain neuromatrix and top down inhibitory pathways should be explained during PNE.

B - Behavioural Factors

For physiotherapists it is important to assess current behaviour and adaptations made as a consequence of pain. Both conscious and non-conscious behaviour can be the product of cognitive and emotional information when perceiving and interpreting inputs or perceived threats to health and wellbeing [45,107,111,112].

Patients can be roughly divided into three subgroups: patients who demonstrate healthy behaviour (pain experience results in no/low fear, confrontation and recovery [113]), avoidance (described previously) and persistence behaviour. Persisters are patients who continue to perform painful activities until completion even though the activity is perceived as too hard [114]. In the long run, persistence behaviour can also be unhelpful and result in an extreme active-non-active pattern (also called: 'yo-yo' or 'over activity–underactivity cycling') of daily activity levels [115,116]. When assessing patients' behaviour in clinical practice, the majority of patients present with a mixed pattern: they avoid certain activities or movements, and simultaneously persist in others. This observation underscores the need for a thorough individual assessment and questioning of each patient individually. Patients should be questioned about their work, home and recreational activities to determine which are avoided or persisted. In addition, patients need to be asked when and why they chose to either persist or avoid the activities. An activity diary may aid in this process. There are different models explaining the above mentioned behaviour, such as the Common Sense Model of Self-regulation (CSMS), classical conditioning and operant conditioning [107,111,112].

The CSMS is a model that helps understand how the perceptions, experience and impact of having a disorder might influence a patient's interpretation and response [107].

Based on the perceptions a person has, he/she will present with certain behaviours in an attempt to influence the threat of a potentially painful event. After any event a person assesses whether or not the threat is diminished. If, for instance, the patient experiences lower back pain during forward bending (threat), the perceptions and emotions can change the behaviour and pattern of forward bending. The latest fear-avoidance model of Vlaeyen et al. [45,113] supports the CSMS and the role of pain catastrophizing in pain chronification. According to the CSMS the fear-avoidance behaviour of the patient, physical inactivity, disuse and consequent disability result from current or previous pain perceptions. Therefore, the physiotherapist should assess the impact of pain perceptions and behaviours on levels of function (work, recreation, daily activities). For example, when a patient expresses the avoidance of playing tennis due to potential back pain, the physiotherapist should ask about the patient's beliefs and emotions about what happens during this activity.

Unconscious behaviour and classical conditioning [111] are also important. For instance, working in a stressful situation at a desk for long periods during which the patient perceives pain, the desk may become associated with the pain. The desk is a neutral stimulus, but can become associated with the pain and, in the end, can evoke pain. In a model recently proposed by Moseley and Vlaeyen [117], they postulate that classical conditioning can eventually result in pain from non-nociceptive impulses by stimulus generalization, called the Imprecision Hypothesis [117].

Behaviour and social factors may also become related through operant conditioning (changing of behaviour by the use of reinforcement, after the desired response). Operant conditioning, as described by Skinner et al.[112], is directly applicable to pain behaviour[118]. Operant conditioning works with positive and negative reinforcers. For example, an unconsciously positive reinforcement of the pain behaviour may occur when sympathetic attention is given to the patient, which is likely to strengthen the behaviour and increase its likelihood in the future. When behaviour is followed by negative reinforcement such as criticism, that behaviour is less likely to occur in the future and behaviour to remove or avoid the consequence is likely to increase. If neither happens the behaviour is likely to go extinct[112,118]. In the assessment, physiotherapists should ask about avoided behaviours and how the social surroundings impact this response to identify potential positive and negative reinforcers.

S - Social Factors

Social and environmental factors that cause stress or a disbalance in the identified self of the patient can have a negative effect on pain. Social factors can be divided into: housing or living situation, social environment, work, relationship with the partner, and prior/other treatments. It is important to find out if there are components of the social factors that are helpful and supportive or stressful and unconsciously unhelpful. Other important social factors include prior/concurrent treatments and the attitudes and beliefs of these healthcare professionals (for instance: a former physiotherapist who has told the patient that his/her 'disk was out of line'). These prior/concurrent treatments, as well as advice and explanations about the patient's condition will influence their perceptions and current coping strategies. Therefore prior/concurrent treatments should be explored and communication between healthcare professionals is suggested.

Low levels of social support may present barriers to improvement in patients with chronic pain, can be a sustaining factor in CS and worsen the prognosis [119,120]. Unpublished results and clinical experience suggest that PNE can improve social support, especially when the therapist facilitates social support by asking the patient to bring their spouse, child or a close friend to one of the sessions. If this is not feasible, significant others can be motivated to read information about CS, such as the book 'Explain Pain'[121].

M - Motivation

Determining motivation and readiness to change is vital for further treatment. The perceptions about the cause of pain and the treatment expectations are crucial to understand in order to target and modify them during the treatment [43]. This is especially true if the proposed treatment (including PNE) might be different from what they have heard before, and more biopsychosocial focused.

The 16-item Psychology Inflexibility in Pain Scale (PIPS) can be used to assess avoidance of pain and cognitive fusion with pain where patients get intertwined with their thoughts, and thoughts are seen as a fact, for example: 'I am my pain'. The scale has good internal consistency as well as criterion and construct validity. Furthermore, it has been reported that psychological flexibility has a mediator function in the relationship between pain and kinesiophobia, pain and disability, and acceptance and catastrophizing, meaning that these relationships are largely influenced by psychological flexibility [100]. The PIPS is used to examine the patient's psychological flexibility to change. Previous research has shown that patients with chronic pain with a high degree of psychological inflexibility are likely to be non-responders in an Acceptance and Commitment Therapy (ACT) based rehabilitation [122]. Based on the assessment and a high score on one or both scales of the PIPS, the physiotherapist might decide not to initiate treatment. Alternatively, if the PIPS score is high, one could focus intensively on PNE to change cognitions and perceptions prior to initiating the remaining parts of the rehabilitation program. Once the focused PNE has been delivered, the PIPS is scored again to see if there is a difference in score that might indicate that the patient is now ready for rehabilitation. We realize the latter is a pragmatic approach and not (yet) supported by research findings.

The stage of change model is another manner to assess the motivation for treatment and education of the patient. The start of the PNE should be tailored to the stage of change the patient is in[123]. One of the goals of PNE is to transition patients in their stage of change when necessary, however, the starting point should be adjusted to the stage of change a patient is in. The physiotherapist has to determine which phase the patient is in, considering both the perception and emotional state of the patient. In the precontemplation phase the patient has no intention to change, he/she is not willing to adapt another explanation or another treatment or coping strategy. In the contemplation phase the patient is aware of the problem and starts thinking about changing, however, still has doubts, but is open to listen. The preparation phase is one step further: the patient is intending to take action in the next month and is more willing to listen to PNE and other new explanations. In the action phase, the patient modifies his/her behaviour, experiences, and environment in order to overcome the problems. In this very important phase the physiotherapist plays an important role in the inventory of existing or potential barriers for maintaining this new behaviour and changed perceptions. In the maintenance phase the action has been successful and the patient works to prevent relapse and to consolidate the goals for more than six months. The last phase, termination, is the phase in which people have changed and no longer need to work to prevent relapse [123].

Discussion

This article describes the biopsychosocial assessment of patients with non-neuropathic CS pain in physiotherapy practice and includes a combination of clinical experience and scientific evidence. Certain aspects of this approach are scientifically validated, but certain components and combinations of components have not been studied (Type of Pain + SCEBS model + Motivation). We attempted to clearly delineate what is supported by research and what is based on expert opinion.

Similar to the recommended approach outlined in this article, Dansie and Turk have previously presented a physician guide for the assessment of patients with chronic pain [124]. Their assessment is based on three main questions: 1) What is the extent of the patient's disease or injury (physical impairment)? 2) What is the magnitude of the illness? That is, to what extent is the patient suffering, disabled, and unable to enjoy usual activities? 3) Does the individual's behaviour seem appropriate to the disease or injury, or is there any evidence of symptom amplification for a variety of psychological or social reasons?[124]. Furthermore, they advise a standardized pain assessment and a brief screening interview in which the physician can screen for psychosocial problems. However, unlike the extensive description of the biopsychosocial assessment in our article they focused primarily on the assessment of pain and disability.

Diagnosis/Clinical Reasoning

For some patients with chronic pain getting a diagnosis that makes sense to them is the first step to self-management of their pain. By getting a diagnosis the pain is no longer 'in your mind', 'imagination' or 'hysteria' [125] and has become 'legal' and acknowledged by healthcare professionals. Results by Thompson et al. show that for patients with chronic pain who 'thrive' (who live well with their pain), receiving the 'chronic pain' diagnosis by a healthcare professional, even though shocking, was the first step in their self-management [126].

Identifying the primary mechanism contributing to that pain experience (nociception, neuropathic, CS, combination) is more important than classifying pain according to its duration. Identifying whether or not the patient has predominantly nociceptive, neuropathic or CS pain is a diagnosis in itself that offers potential treatment pathways (see Nijs et al. 2014)[72]. Based on this mechanism the further PNE can be provided (figure 3.)

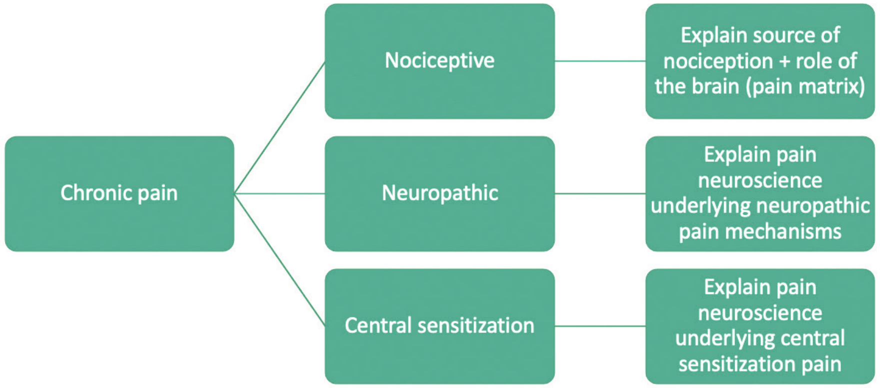


Figure 3. Pain Neuroscience Education tailored to the primary pain mechanisms of the patient

Biopsychosocial Assessment: Recommendations for Further Treatment

To assess pain as a biopsychosocial phenomenon and really comprehend the essence of a patient's pain problem takes time. Obviously, it is important to focus on the changeable biopsychosocial factors while also being aware of non-changeable aspects such as personality, neuroticism and the degree of trait anxiety, which are known to be stable to some degree over time [127-130].

Knowledge of these biopsychosocial factors is essential for steering the plan of care and identifying the potential components of PNE to be used. The (psychosocial) education of the physiotherapist, including the competence, knowledge, biopsychosocial vision, interpersonal factors and '*fingerspitzengefühl*' (instinct, intuitive flair, high situational awareness, ability to respond most appropriately and tactfully, etc.), combined with two-way communication and a patient-centered approach are important. Physiotherapists specialize in the assessment of function, physical activity, movements, muscle tension, etc. combined with strategies to treat these impairments. Even though questionnaires can help identify behavioural, cognitive and emotional factors (table 2), we must be reflective of our biopsychosocial view and knowledge of illness perceptions. Research has shown that physiotherapists struggle in this area[131-137]. It is important, as health care providers, to know and respect our limits, especially when working with patients with chronic pain. Throughout the assessment physiotherapists should be aware of their limitations and ask themselves: 'is this patient (with chronic pain) in the right place here with me or should he/she be treated in a multidisciplinary setting or referred to another provider?'.

Once indications for PNE are established, individualized therapy can be initiated by explaining the biopsychosocial diagnosis to the patient; reassuring them that their pain is real and explaining why they are in pain (CS pain, neuropathic pain, nociception). Changeable factors and the receptiveness of the patient to change further guide the content and the attitude of the physiotherapist during PNE. Based on the stages of change model [123] patients in the precontemplation phase need a more 'nurturing parent' role and can be more resistant and defensive. Patients who are in the contemplation phase may benefit from a 'Socratic teacher' who encourages patients to achieve insights into their own condition. If the patient is in the preparation stage, we recommend that the physiotherapist adopt the role of an 'experienced coach' who can provide a new game plan or can review and modify the patient's own plan. Patients in the action and maintenance phases benefit from a physiotherapist who becomes more of a 'consultant' who is available to provide expert advice and support [123]. Physiotherapists keen to learn more about this topic are referred to the cited references.

We have outlined how physiotherapists may take the first step in the successful treatment of patients with chronic pain, by motivating the patient to achieve goals and restore values and his/her identified self [126,138,139]. Chronic pain is complicated, and a thorough biopsychosocial intake, examination and interdisciplinary treatment plan are required for a successful treatment.

Conclusion

Prior to providing PNE and further treatment, an extensive biopsychosocial intake should be conducted. To our knowledge this is the first article describing the comprehensive biopsychosocial intake of patients with chronic pain in physiotherapy practice and is derived on scientific evidence as well as expert opinion. This approach needs to be investigated further in clinical trials with chronic pain patients.

We believe the biopsychosocial intake described here is necessary to clarify the primary type of chronic pain: predominant neuropathic, nociceptive or CS pain. This allows the physiotherapist to assess the biopsychosocial factors that may be contributing to the continuation of pain. 'Diagnosing' the patient as having CS pain, nociceptive pain, neuropathic pain or a combination, is the first step in tailoring a patient centered PNE that can aid the patient in his/her self-management process.

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Correspondence to the Perspective article "Clinical biopsychosocial physiotherapy assessment of patients with chronic pain: The first step in pain neuroscience education"

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We would like to thank Rob A.B. Oostendorp and his co-authors for their positive feedback on our recent article on the biopsychosocial physiotherapy assessment of patients with chronic pain [1]. In their letter to the editor Oostendorp et al. addressed important issues regarding to the familiarity of physiotherapist with the psychosocial-aspects of the biopsychosocial assessment and the usability of the Pain-Somatic-Cognitive-Emotional-Behavioural-Social-Motivation (PSCEBSM)-model. Here we take the opportunity proposed by the Editors to respond to commentary of Oostendorp et al.

First, we would like to take the opportunity to acknowledge the important contributions of Oostendorp et al. to the field of the physiotherapy assessment by their article concerning the biopsychosocial intake by manual therapists in patients with back- or neck-pain[2]. Although the biopsychosocial perspective was introduced in medicine by Engel in 1977[3], the use in clinical physiotherapy practice seems to be impaired. As well-studied by Oostendorp et al. and reviewed in our article, the abilities to perform the psychosocial aspect of the biopsychosocial intake is indeed sometimes lacking and physiotherapist mainly tend to focus on the 'Bio' aspects[4-11]. We could not agree more with Oostendorp et al. that physiotherapists primarily asses the somatic dimension. Thereby the physiotherapy practice somehow seems to cling to the Biomedical perspective, even in the treatment of chronic pain in which guidelines prescribe a biopsychosocial approach. In intend to shift this paradigm, the clinical biopsychosocial physiotherapy assessment as described in our recent article arose. This clinical biopsychosocial assessment is designed as a guideline for physiotherapists to include all aspects of the biopsychosocial perspective, and especially to not forget the psychosocial part. However, we do recognize that only reading is insufficient to allow (deep) learning and that there is a difference between learning and changing behaviour in practice. The biopsychosocial perspective is long time incorporated in multiple guidelines regarding the treatment of patients with chronic pain and in pre- and postgraduate physiotherapy courses. Yet the profession seems to struggle to merge it into their behavioural-skills in daily practice. This might be because the majority of physiotherapists have received a biomedical-focused (pre/post) graduate education.

Specific training regarding the biopsychosocial approach can facilitate physiotherapists in biopsychosocial clinical reasoning[12,13]. Furthermore, we suggest that novel ways are investigated, in cooperation with physiotherapists, to see how we can further improve the implementation of the biopsychosocial perspective. As we need to change this paradigm of biomedical-behaviour in physiotherapy practice.

We agree with Oostendorp et al. that the original Somatic-Cognitive-Behavioural-Social (SCEBS) method as described by Spaendonck and Bleijenberg[14,15] differs in content from the PSCEBSM-model described in our article. In contrast to the SCEBS-method, the PSCEBSM-model contains two additional domains useful in the biopsychosocial assessment of patient with chronic pain, namely the P (Pain) factor and M (Motivation) factor. The chapter regarding the Pain-factor, contains the differentiation between three major pain types[16]. Identifying the primary pain mechanism allows the physiotherapist to tailor the pain neuroscience education to the patients' complaints.

The Motivation-factor was added, because motivation for a specific treatment, such as PNE, is essential to recognize and is often related to the expectations and perceptions of patients. It is suggested that a higher motivation results in better outcomes in treatments[17,18]. However, 'motivation' in itself is an ambiguous concept containing several elements of the SCEGS-model and personal factors, social factors, factors related to the physiotherapist and factors related to the relationship between the patient and physiotherapist[19]. To aid physiotherapists with this ambiguous concept, we suggested adding motivation in the PSCEBSM-model. The aforementioned can be used to help investigate the treatment expectations, psychological flexibility to change and the stage of change the patient is currently in. Furthermore, physiotherapists should be aware of the influence of their own attitude towards the patient and the influence of interactive factors on the motivation of the patient.

Where the original SCEBS method focused on questions in regard to the different biopsychosocial dimensions (for instance: "Are you anxious about particular activities?" or "Are you depressed?"), the PSCEBS-model discussed in our article also includes questionnaires. The questionnaires were added for two reasons. First, to aid physiotherapists in recognizing psychosocial factors. As mentioned above physiotherapists may feel unprepared to deal with those factors and the questionnaires can be used to screen for psychosocial factors and to aid in the conversation. Second, to evaluate the treatment in an objective manner where possible.

The last focus of the commentary by Oostendorp et al. were the recommendations for further research. Our recommendation was that the (value of the) clinical biopsychosocial assessment as described in the article requires further investigation in clinical trials. Such trials can serve to explore the added value of the biopsychosocial assessment for treatment outcome, but depending on the study aims (e.g., examining the clinimetric properties of parts of the biopsychosocial assessment), a different design (e.g., test-retest observational studies) may be needed. We acknowledge that the form and content of such research was not described in our article, as it goes beyond the scope of our paper. Furthermore, we agree with Oostendorp et al. that investigating the physiotherapy assessment of patients with chronic pain in a total scope by Quality Indicators (QI's) certainly deserves attention. As described previously a behavioural change in physiotherapists is necessary. QI's, elements of practice that can be used to assess the (change in) quality of provided care [20], are appropriate evaluation measures to assess such behaviour change. Oostendorp et al. already developed a high quality and appropriate QI set in their research into the biopsychosocial history taking of manual therapists[2] that might be suitable to study change in biopsychosocial behaviour of physiotherapists when implementing the PSCEBSM-model. Improving patient care should be the main focus of innovations such as the PSCEBSM-model and it is a necessity that those innovations are thoroughly evaluated.

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Perspectives of patients with chronic pain who received transdisciplinary Pain Neuroscience Education

What is important in transdisciplinary pain neuroscience education? The experience of patients with chronic pain: A qualitative study

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Abstract

Purpose
The main focus of pain neuroscience education (PNE) is to change patients' pain perceptions. Even though PNE is extensively studied, the experiences of patients regarding the PNE process are unknown. Therefore, the aim of this study was to explore these experiences.

Methods
Fifteen patients with non-specific chronic pain from a transdisciplinary treatment centre were in-depth interviewed. Data collection and analysis were performed according to Grounded Theory.

Results
Five interacting topics emerged: 1) "*the pre-PNE phase*", involving the primary needs to provide PNE, subthemes "*a broad intake" and "the healthcare professionals*"; 2) "*a comprehensible PNE*" containing "*understandable explanation*" and "*interaction between the physiotherapist and psychologist*"; 3) "*outcomes of PNE"* including "*awareness*", "*finding peace of mind*" and "*fewer complaints*"; 4) "*scepticism*" containing "*doubt towards the diagnosis and PNE*", "*disagreement with the diagnosis and PNE*" and "*PNE can be confronting*".

Conclusion
This is the first study providing insight into the constructs contributing to the PNE experience of patients with chronic pain. The results reveal the importance of the therapeutic alliance between the patient and healthcare professional, taking time, listening, providing a clear explanation, and the possible outcomes when doing so. The findings from this study can be used to facilitate healthcare professionals in providing PNE.

Introduction

Chronic pain is a huge global issue and major healthcare problem[1]. With a prevalence of 17 to 27% worldwide,[2-4] chronic pain is associated with increased medical costs, decreased incomes, economic burdens[5] and a decreased quality of life in patients[2,5]. Chronic pain is defined as pain that persists beyond normal time of healing or pain that persists for 3 to 6 months or longer[6].

Several chronic pain syndromes cannot be explained solely by tissue damage or inflammation (nociceptive pain) nor by a lesion in the nervous system (neuropathic pain). Often patients with chronic pain present a hyper excitability within the central nervous system, known as central sensitization[7-9]. Central sensitization enlarges the neural signalling which elicits generalized pain hypersensitivity of the somatosensory system[8]. This pain hypersensitivity results in intensification of the signalling of nociceptive or neuropathic pain and even in pain without any peripheral nociceptive signals. These neurophysiologic changes are sustained by behavioural, psychological, and environmental aspects, contributing to the continuation of pain[10,11]. In fibromyalgia, chronic whiplash, chronic fatigue syndrome, and irritable bowel syndrome, central sensitization is often the predominant mechanism[12-14]. In other chronic pain populations, such as low back pain and osteoarthritis, a subgroup presents a predominant central sensitization[12,15-17].

Pain neuroscience education (PNE) provides healthcare professionals an opportunity to explain the pain mechanism of central sensitization, its neurophysiological changes and integrates at the same time behavioural, psychological and environmental aspects which contribute to the continuation of the pain[18,19]. It has been shown that PNE decreases pain and improves endogenous pain inhibition, mental health, physical functioning, vitality and self-rated disability, and diminishes passive coping, kinesiophobia and catastrophizing[20-27]. PNE addresses patients' perceptions, such as perceptions about the cause of pain, the onset of pain, or how to cope with pain[19]. PNE tries to increase the knowledge of pain and change inadequate pain perceptions, such as 'my back is weak', 'my vertebra is out of line', and 'there must be something physical wrong with me'. Therefore, it is important to recognize patients' experiences of the PNE process to provide a theoretical model and framework about PNE. Unfortunately, studies exploring the experience of patients with chronic pain related to PNE are essentially lacking. Identification of these experiences may further improve the knowledge of healthcare professionals working with PNE in daily practice. Therefore, the aim of this study was to explore the experiences of patients who recently received PNE in a transdisciplinary setting in the Netherlands in order to provide a theoretical model and framework about PNE. We undertook a qualitative research to allow the theories to emerge from the perspective of patients.

Materials and Methods

Design

Based on the methods of Grounded Theory [28], we conducted a qualitative study to comprehend and theorize how patients experienced PNE. Grounded Theory is a qualitative research methodology used to deeply analyse and develop theoretical explanations. In this study, these theoretical explanations emerged from the participants' unique perspectives related to the PNE phenomenon[29]. This PNE phenomenon was grounded in data obtained from face-to-face in-depth semi-structured interviews with patients who had partaken in PNE to expose the patients' experienced concepts of PNE. Thereafter, a focus group of PNE-healthcare professionals was performed to verify the data and optimise the input. A theoretical framework was constructed based on topics obtained from these semi-structured interviews and focus group[29]. Our study conforms to the consolidated criteria for reporting qualitative research (COREQ)[30].

Participants

Between January 2013 and June 2013, 15 participants were recruited by theoretical purposeful sampling [29] from Transcare (Harkema, The Netherlands) a transdisciplinary outpatient treatment centre of general practitioners, psychologists, and physiotherapists treating patients with non-specific chronic pain (Tables 1 and 2). Patients were eligible to participate if they: 1) were between 18 and 85 years of age, 2) were suffering from nonspecific chronic pain as defined by the International Association for the Study of Pain (IASP)[6], 3) were treated with PNE at Transcare, and 4) were sufficiently able to read, speak and understand Dutch. Patients were excluded from this study when they: 1) were diagnosed with specific medical condition (*e.g.*, M. Parkinson, Rheumatoid Arthritis, stroke), 2) had cognitive impairments, 3) had dementia, 4) or had a serious psychiatric condition according to the Symptom Checklist 90 (SCL-90)[31].

Table 1. Demographics and background characteristics

Characteristics	**Individual interviews**	**Focus group**
Men	7	3
Women	8	3
Age (years; mean, range)	47 (18–62)	47 (37–57)
Experience (years; mean, range)	-	22 (16–34)
Current relational status		
Single	4	-
Living together	3	1
Married	6	5
Divorced	5	-
Education level		
Elementary school	1	-
Junior general secondary education	1	-
Senior general secondary education	2	-
Junior secondary technical education	2	-
Intermediate vocational education	6	-
Higher professional education	2	-
Higher professional education with postgraduate qualification	-	2
University without postgraduate qualification	1	-
University with postgraduate qualification	1	2
University with postgraduate qualification and PhD	-	2
Primary income source		
Student	1	-
Job	8	6
Unemployed	2	-
Disenabled to work	4	-
Location of pain		
Neck, shoulders, arm	4	-
Back and gluteal	3	-
Abdomen	2	-
Leg, hip and knee	4	-
Widespread	2	-
Treatment		
PNE	5	-
PNE + physical therapy	3	-
PNE + psychotherapy	1	-
PNE + medication	1	-
PNE + physical therapy + psychotherapy	3	-
PNE + physical therapy + medication	1	-
PNE + physical therapy + psychotherapy + medication	1	-

Table 2. Interview respondents (n=15) and key characteristics

	Respondent[a]	Age	Job	Location of pain	Duration of pain in months	Content of treatment at Transcare
1	Scott	58	Accountant	Backpain	120	PNE and Physiotherapy
2	Alice	41	Hairdresser	Neck- and shoulderpain	18	PNE and Physiotherapy
3	Lucy	62	Disenabled to work	Backpain	264	Only PNE
4	Helen	58	Housewife	Widespread pain	60	Only PNE
5	Anna	47	Management assistant	Widespread pain	16	PNE, Physiotherapy and Psychology
6	Helga	52	Geriatric nutrition assistant	Abdominal pain	276	Only PNE
7	Finch	54	Disenabled to work	Hip and legpain	48	PNE, Physiotherapy, Psychology and medication
8	Dani	18	Student	Neck- and shoulderpain	60	PNE and Physiotherapy
9	Sam	41	Deliveryman	Buttock- and legpain	24	PNE and medication
10	Freddy	35	Carpenter	Kneepain	20	Only PNE
11	Walt	33	Trader and investment advisor	Groin- and upperlegpain	180	Only PNE
12	John	62	Metalworker	Abdominal- and ribpain	120	PNE, Physiotherapy and medication
13	Amy	49	Housekeeper	Neck-, shoulder- and armpain	6	PNE and Psychology
14	Rene	56	Unemployed	Neck-shoulder- and armpain	8	PNE, Physiotherapy and Psychology
15	Wendi	40	Tax lawyer	Neck-, back and hippain	36	PNE, Physiotherapy and Psychology

[a] Pseudonyms used throughout the text

Patients were approached after their PNE session by the treating healthcare professionals and asked if they were willing to participate in the study. When they agreed, the first author contacted the patients and appointments were made. Furthermore, written information and informed consent were sent by email or postal mail. In the written information is stated that study participation would not influence their treatment. Confidentiality was guaranteed and all materials were handled anonymously. This study was conducted in compliance with Dutch law and the principles of the Declaration of Helsinki. All participants signed informed consent.

According to Grounded Theory, a purposeful homogenous sample was used in the first seven interviews. This homogenous sample consisted of respondents who were appointed by the healthcare professionals as having a positive attitude towards PNE. After these seven interviews, eight respondents were heterogeneously selected irrespective of their attitude towards PNE in order to obtain a realistic sample[29].

Pain Neuroscience Education

Transcare is a transdisciplinary outpatient treatment centre of general practitioners, psychologists, and physiotherapists treating patients with non-specific chronic pain. Transdisciplinary means that these healthcare professionals collaborate intensively, with flexible boundaries and roles, learn simultaneously, and have a shared biopsychosocial view on chronic pain[32,33]. Transcares' aim is to provide transdisciplinary, low cost, evidence-based, patient centered PNE, and treatment for patients with chronic pain, where the initial contact with the patient is key. The treatment is focused on changing perceptions about pain and providing self-management tools to drastically reduce and minimize further medical care for chronic pain. Patients who receive treatment at Transcare first have a three-hour assessment – one hour for every discipline (general practioner, psychologist, physiotherapist). After these extensive intakes, the healthcare professionals make a biopsychosocial pain analysis with predominant pain mechanisms and contributing factors. The diagnosis of the predominant pain mechanism (i.e., nociceptive, neuropathic, central sensitization pain, or a combination of these) is based on the stepwise approach and algorithm for the classification of central sensitization pain[34]. This algorithm can guide the therapist to determine if the pain is predominantly neuropathic or not and if not by differentiating between predominantly nociceptive pain and central sensitization. After the intake the patient receives PNE comparable to Explain Pain[35], adapted to the predominant pain mechanism(s) and contributing factors, using the following mode of administration: one week after the intake, the general practitioner provides the patient information about the team's biopsychosocial diagnosis in a 10-min conversation in a one-on-one setting with the patient and partner (spouse, family member, or friend). The general practitioner gives verbal information about the predominant pain mechanism(s), supported by a booklet based on the Dutch book Pain Education: A Practical Guide for Healthcare Professionals (Pijneducatie, een praktische handleiding voor [para]medici)[36]. Two weeks after the intake, the patient and partner participate in a one-hour PNE session provided by the psychologist and physiotherapist. Once again, their pain is explained in a patient-specific manner. At first, the neuroscience explaining their pain is highlighted; secondly, the biopsychosocial factors contributing to the persistence of pain are discussed; and finally, patient centered treatment options are discussed. Treatment options after PNE can consist of the following: none (reasons: no need for further treatment, no common ground with the healthcare professionals, patient finds it too burdensome, etc.), medication, physiotherapy, psychotherapy, or a combination of the latter two. All treatments are evidence based and patient centered. Medication therapy consists of decreasing use of ineffective medication and (if necessary) increasing centrally acting medication. Physiotherapy and psychotherapy are based on the principles of Cognitive Behavioural Therapy (CBT), including graded activity, graded exposure, relaxation techniques, mindfulness, body-oriented work, interventions for depression and anxiety, Eye Movement Desensitization and Reprocessing (EMDR), etc.

Procedure

The individual face-to-face, in-depth interviews were conducted with patients who received PNE approximately a month prior. This time interval was based on the theoretic construct which provides respondents with some time to process the bulk of information they received during the PNE sessions. Before the interviews, a semi-structured interview guide was constructed and piloted tested during two test interviews to ensure the quality of the interview guide. Table 3 contains a summary of the interview guide topics.

The interviews were contained open questions according to the 'river model', in which the interview 'flows like a river' and if a topic 'runs dry' the interviewer returns to the 'mainstream of the river'[37]. To create an open character during the interviews prior to questioning rapport was established between the researcher and the respondents. Respondents were invited to tell the researcher to stop questioning certain topics if they felt uncomfortable or did not want to explain them any further.

Table 3. A summary of the themes mentioned in the interview guides

Initial interview guide	Interview guide after initial axial coding
Demographics	Demographics
Experiences related to the process *(waiting time for intake, appointments, environment, travel distance)*	-
Overall experiences of Transcare *(overall experience, experience with intake, experience first PNE with the general practitioner, multidisciplinary cooperation, medication therapy, physiotherapy, psychotherapy, change in pain intensity (if applicable), change in pain perceptions)*	**Overall experiences of Transcare** *(overall experience, experience first PNE with the general practitioner, multidisciplinary cooperation, medication therapy, physiotherapy, psychotherapy, change in pain intensity (if applicable), change in pain perceptions)*
-	**Experiences in regard to the intake day** *(How did you experience the intake)*
Specific experiences of PNE session with Physiotherapist and Psychologist *(What was your experience, what was important in that session, what could improve, communication, interaction, attitude of healthcare professionals towards the patient, language used in the PNE, comprehensibility of the PNE, metaphors/ examples used during PNE, support/ empowerment/to have the feeling of being understood by the healthcare professionals, reassurance by the message of PNE?, repetition of PNE)*	**Specific experiences of PNE session with Physiotherapist and Psychologist** *(What was your experience, what was important in that session, what could improve, begin taken seriously, feeling understood by the healthcare professionals, being yourself, feeling comfortable, personal involvement of the healthcare professionals, having a connection with the healthcare professionals, healthcare professionals were open, personal, involved, interaction between both during the PNE, Physiotherapist and Psychologist complemented each other, observations by Psychologist, drawings made, clear explanation, why was the explanation clear, to find peace and clarity, bringing those close to you to the PNE, increased awareness, understanding your symptoms, consciousness of your body, improved self-control on the symptoms, does he/she experience fewer symptoms)*
Influence of PNE on patient and daily life	Influence of PNE on patient and daily life
Anything you would like to bring in yourself?	Anything you would like to bring in yourself?

Analysis

The transcriptions of the interviews and the focus group were analysed using Grounded Theory[29]. The interviews first were transcribed verbatim with transcription software F4 (Dr Dresing & Pehl GmbH, Marburg, Germany)[38]. After this transcription, the data were analysed with open, axial, and selective coding according to Grounded Theory[29]. Coding was the interpretative process in which conceptual labels were given to the data[29].

During the analysis, the Qualitative Analysis Guide of Leuven (QUAGOL)[39] was used to guide the Grounded Theory analysis process. The QUAGOL is a practice-based guide that has two parts with five stages in which the researchers are guided in a flexible and iterative constant comparing process through the analysis of data, and it respects the different phases of coding used in GT[39]. Table 4 shows the stages we pursued during the analysis process. QSR International's NVivo 10 software (QRS International Pty Ltd., Doncaster, Australia) was used during the second stage of the QUAGOL to help shape the coding phases.

Table 4. Stages of analysis based on the QUAGOL and GT [28,39]

Stage	Action
1	The transcription was first read, whereby key phrases were underlined, and the meaning of the text was interpreted tentatively.
2	The researcher reread the transcript in order to phrase its understanding, then set aside the transcript and wrote a narrative report. This was guided by the following question: "What are the essential characteristics of the interviewee's story that may contribute to a better insight into the research topic?"
3	The researcher constructed a conceptual interview scheme to provide concepts that appeared relevant to the research topic.
4	The appropriateness was verified by rereading the interview. The third and fourth stages were iterative.
5	The interview schemes were compared within and with other schemes and data of other interviews.
6	In the sixth stage, QSR International's NVivo 10 software was used. This was the start of the actual coding process, where open codes based on the conceptual interview schemes were listed.
7	The interviews were read again, and the codes were filled with significant passes of the interviews (axial coding).
8	The codes and topics were integrated into a meaningful conceptual framework and story-line, also known as the selective coding phase in GT.
9	A conceptual framework in response to the research question was created. In the last stage, the results were described on a conceptual and theoretical level, grounded in the interview data.

The first author performed the main analysis, whereby the evolving codes were repeatedly discussed with the second, third, and last author. Interviews and analysis of the interviews were performed in Dutch until data saturation was achieved, which means that no new codes or categories emerged from the data[29]. The theory was translated into English, and an effort was made to convey the sense of the Dutch language in order to keep some perspective of context.

After the initial axial coding phase of the first seven interviews, the interview guide was adjusted based on the emerged codes (Table 3), and more detailed questions were asked to shape the next analysis phase[29]. During and after the interviews and throughout the analysis, AJW created memos related to the evolving theory and the process, which were later used in the analysis[29].

After axial coding of the first seven interviews, member checks were performed. A member check is a technique whereby the data are taken back to the interviewees and discussed and tested with a few of the interviewees from whom the data were originally obtained[40]. During these member checks, the initial theory, which evolved from the axial coding of the first seven interviews was discussed with two respondents of the seven respondents. The topics of the axial coding were read, and an in-depth discussion was held with both respondents. After these member checks, the initial codes of the first axial coding were adapted based on the feedback of the respondents. After development of the complete theory, a focus group was organized to discuss, optimize and verify the evolved theory of the axial coding. This focus group was conducted because the healthcare professionals have extensive knowledge of, and experience with, chronic pain and PNE. Their internal theoretical model of PNE is influenced by the expressed experiences of PNE from their prior patients. By presenting the results from the axial coding to the focus group a discussion emerged based on the axial coding themes found in the expressed experiences of the respondents and the internal frameworks of the healthcare professionals. This discussion enriched the analysis as some themes of the axial coding were confirmed, while others were adjusted by fusion or rearrangement of the themes. Nothing from the axial coding was removed as a result of the focus group. This focus group was led by the first author and consisted of healthcare professionals of Transcare (Table 1). All interviews and member checks were done by the first author. She received extensive interview training at Evers Research & Training, Rotterdam, the Netherlands.

Trustworthiness

The criteria of Lincoln and Guba[40] were used to clarify our efforts to ensure the quality of this research throughout the research process and output. Credibility (confidence in the "truth" of the findings) was ensured by: a pilot-tested interview guide, audio recordings and verbatim transcriptions of the interviews, an open non-judgmental atmosphere during the interviews, bracketing out during the data collection and analysis, member checks of the first analysis, and negative case analysis (the inclusion of respondents with outlying experiences), peer debriefing of axial coding and theory development by the first and last author, thickly described data, and limitations about the transferability (the findings have applicability in other contexts) are made. Dependability (the findings are consistent and could be repeated) was ensured by a description and continued monitoring of the process and product of the research by the first, third, and last author and close monitoring by the other authors. Confirmability (the extent to which the findings of a study are shaped by the respondents) was ensured by the open non-judgmental atmosphere of the interviews, bracketing out, data triangulation by semi-structured interviews and a focus group, an iterative analysis, a researcher triangulation by the first and third author, and all of the coding phases were continuously discussed between the first, third, and fourth author.

Results

Respondents

Nineteen patients were asked to participate. Four patients were not willing to participate for unknown reasons. In total, 15 patients were interviewed (seven men, eight women) until saturation was reached. The average age was 47 (18 to 62) years (Tables 1 and 2). Informed consent was obtained from all respondents. The interviews lasted 35 to 86 minutes; 14 were held at the respondents' homes and one at a physiotherapy practice. Three member checks were planned, one respondent cancelled. The two member checks lasted 26 and 23 minutes. The focus group lasted 135 minutes, with six members of Transcare: one general practitioner, two psychologists, two physiotherapists, and one researcher (three men and three women, with an average age of 46 [37 to 57] years; Table 1).

Findings

Four interacting topics emerged and are depicted in Figure 1. The first topic was "the pre-PNE phase" and involved the primary needs in order to provide PNE with the respondents. Subthemes were "a broad intake" and "the healthcare professionals". The second topic, "a comprehensible PNE", contained an "understandable explanation" and the "interaction between the physiotherapist and psychologist". The third topic involved the "outcomes of PNE", including the subthemes "awareness", "finding peace of mind", and "fewer complaints". The fourth topic, "scepticism", contained "doubt towards the diagnosis and PNE", "disagreement with diagnosis and PNE", and "PNE can be confronting". Scepticism can negatively impact the third topic.

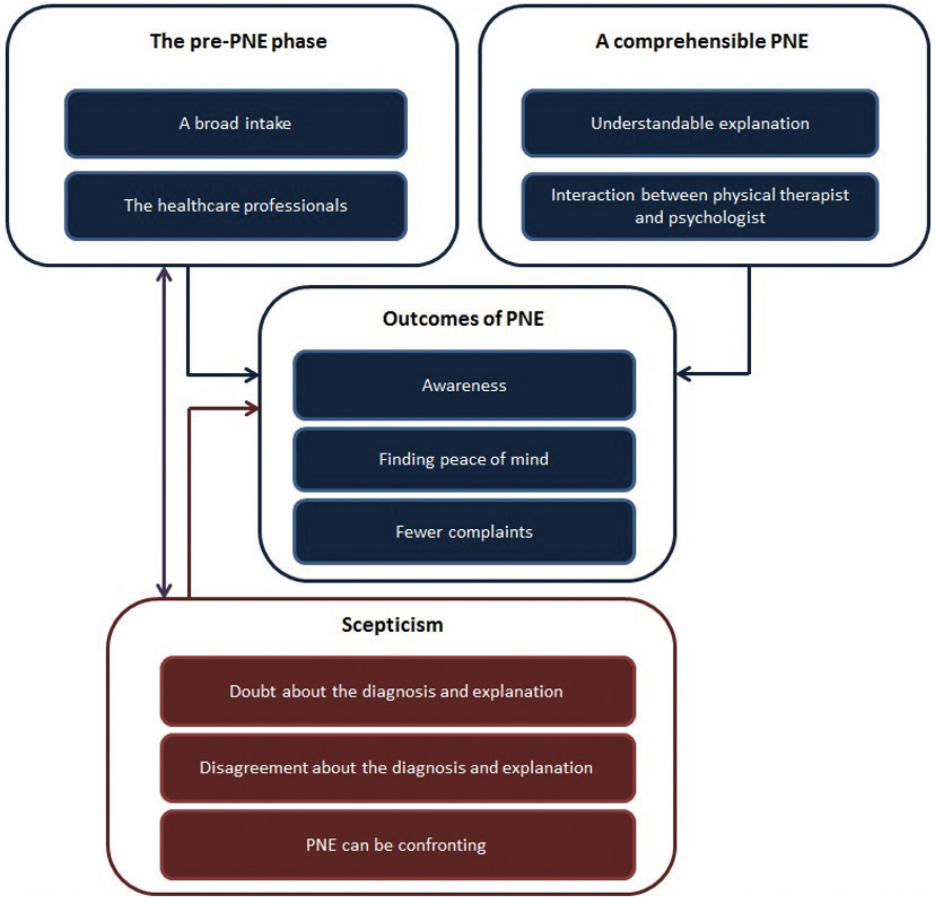

Figure 1. Conceptual model of constructs influencing the experience of PNE

The Pre-PNE Phase

A broad intake

Respondents mentioned that the intake creates conditions for PNE; it was their first encounter with and impression of the healthcare professionals. Because the intake was elaborate it made them feel that they were able to tell their complete story. Respondents also frequently stated that the intake was intense and emotionally exhausting. They were confronted with their problems, symptoms, and functional limitations for three consecutive hours. During the intake, the respondents felt the need to clarify their symptoms to both the healthcare professionals and themselves. By doing this, some already came to an increased awareness and better understanding of their complaints, symptoms, and contributing factors. Respondents sometimes took a sceptical stand towards elaborating the psychological aspects of their pain during the intake. Yet, having the intake include time with the psychologist made them more willing to accept the biopsychosocial view.

The healthcare professionals

The respondents' first impression of the healthcare professionals during the intake was crucial and mentioned as a primary condition for PNE. The healthcare professionals were perceived as empathetic, friendly, open, nice, relaxed, spontaneous, good listeners, and quickly got familiar with the respondents. The respondents experienced the healthcare professionals as interested and involved and felt that they cared for them as a person. This became apparent due to the nonverbal communication and voice tone when addressing important issues. These interpersonal aspects of the healthcare professionals made the respondents feel comfortable, at ease, connected, and understood. The interaction was perceived as pleasant, open, and honest. The interest, involvement, and concerns made the respondents feel that they were taken seriously and recognized. Therefore, they felt they could tell their story from their own perspective. They felt they were being seen rather than a bodily piece. Consequently, this increased the willingness to open up about themselves, their problems, and psychosocial factors.

> *Helen: "I was able to tell from my own perspective how something feels, because I felt heard. I felt that I was taken seriously. And when I get that feeling, the other one (healthcare professional) can get a clearer image of me".*

Respondents often felt nervous for the intake's psychological assessment and had some reservations. However, the psychologist generally made them feel at ease, and their suspicion disappeared quickly.

> *Scott: "Well, I had never been to a psychologist before, so for me it was the first time, and I must admit it was 200% positive (laughs) … I had the idea that you have to be a bit, well, crazy or very depressed to go to a psychologist. You know. And that's not true, of course. She clarified this right away and put me at ease".*

The respondents felt that the healthcare professionals were competent, experts in the field of pain and knew more about chronic pain than just the knowledge from their own

profession. For instance, the physiotherapist had knowledge about the psychological aspects of pain, and the psychologist had awareness of body functions. The respondents described the healthcare professionals as a good team that collaborated intensively, whereby the healthcare professionals complemented each other.

A comprehensible PNE

Although the neurophysiology of PNE is theoretical and for some difficult to understand, respondents found the explanation good and clear, and they would not change a thing. PNE was perceived as a quest through their pain problem together with the healthcare professionals. The respondents often saw themselves and their symptoms reflected during the PNE.

Understandable explanation

The respondents mentioned that the pain mechanisms (nociceptive, neuropathic, central sensitization pain, or a combination of these) were explained step by step in a clear manner and at an easy, steady pace. The repetition of PNE (first by the general practitioner and booklet, and then by a combined session with a physiotherapist and psychologist) was perceived as important for the respondents, as it made the PNE understandable. Respondents said the plain language, the explanation on paper and the personal explanation clarified the PNE. The drawings in the booklet, which were also used during the PNE, were illustrative. The examples used during the PNE were clear and comprehensible, taken from real life and focused on the individual. Use of the burglar/fire alarm metaphor was found to be very illustrative[19,36]. During nociceptive pain the alarm goes off because there is a burglar intruder, in central sensitization pain the alarm is so sensitive it goes off even without a burglar present. Some respondents indicated that they would not have understood the PNE without these metaphors.

> *Wendy: "They explained it very well, because at the general practitioner I got a blue booklet about chronic pain. About nerves and how it all works. That your body is actually a burglar alarm set incorrectly. That one I remember, when people ask me how I am doing and what was discovered, I tell them that. It [the metaphor] appeals to the imagination".*

Respondents felt that they were now able to explain their pain to others, thereby receiving more recognition for their problems.

All respondents were asked to bring their partner or a close friend to the combined PNE with the physiotherapist and psychologist, which was generally valued positively. It made the explanation more understandable: *"two hear more than one, two remember more"*. Furthermore, the partner or friend could share their ideas about the contributing factors, enhancing the translation of PNE into the respondents' efforts to self-management the pain during daily life. For some, however, bringing their partner was unnecessary or even regarded as if the healthcare professionals thought that the respondents would not be honest about the treatment at home.

Interaction between the physiotherapist and psychologist

It was noticed by the respondents that there was interplay between the physiotherapist and psychologist during the session. They complemented each other. Often, one provided the explanation while the other was drawing, or one was talking and the other observed the respondent. It made the respondents feel like they kept an eye on them, checked if the provided information was understood and reflected on the respondents' thoughts and emotions. Respondents mentioned that this facilitated the understanding of the PNE and enhanced the translation to the respondents' daily self-management.

Furthermore, respondents mentioned that the presence of two healthcare professionals speaking the same language confirmed that the pain mechanism (nociceptive, neuropathic, central sensitization pain, or a combination) as explained by the healthcare professionals was actually true, making it easier to accept.

> *Wendy: "They are very clear and… How do I explain that? They stand behind their opinion".*

Outcomes of PNE

Awareness

The PNE initiated a process of awareness in which the respondents' gained more insight in their symptoms and how to cope with their condition. Furthermore, respondents mentioned that they became more aware that they needed to handle their body more respectful. In addition, respondents mentioned that due to the PNE they gained more self-control.

Insight into symptoms

Respondents often came to find a cause and solution for their chronic pain. Clarifying their pain was important and often caused a change in pain perception and acknowledged the contributing factors. When this perception change occurred, respondents learned to acknowledge the balance and interaction between body and mind. Furthermore, they gained insight into the way their behaviour, emotions, and perceptions influenced their pain. Respondents mentioned that they became aware of the influence of previous events on pain, took life a bit easier, and learned to take their symptoms seriously.

For some, PNE was a confirmation of what they already knew, sometimes subconsciously without accepting it, and for others a means to freshen up on what they heard previously.

Consciousness of their body

As they gained more insight into their pain, the respondents learned to be more conscious of their body in a behavioural manner. They were less preoccupied and dealt with their pain more adequately. The respondents learned the influence of behaviour on their physical and psychological symptoms. In addition, they learned how to use their body more appropriately, being more conscious of tense postures and the positive influence of relaxation. Respondents mentioned that they learned to express their limits, even though it is difficult not to cross their boundaries. They experienced the positive influence of listening to their body and the advice they had received.

Gaining self-control

The insight into symptoms and improved consciousness of their body caused improved self-control and self-management. Most respondents gained more insight into their symptoms and subsequently perceived more control over their symptoms. They were able to handle their problems more adequately by accepting and learning to deal with their pain, being less occupied with pain and learning to put it at ease. The respondents mentioned that they dealt better with their pain, and that this was due to the practical translation of the PNE to the respondents' daily life.

> *Walt: "I think that (the education of) Transcare is good for awareness in that you don't always have to think: 'Oh, I'm in pain and I can't do anything'. It's about taking more responsibility yourself. (…) Whether physically or mentally".*

Still, not all respondents experienced more self-control. Some mentioned that it was too soon and they were in too much of a psychological conflict to experience more self-control. These respondents were searching for strategies to deal with their psychological problems and pain, trying to regain balance.

Finding peace of mind

Some respondents experienced peace of mind after PNE. The acknowledgement of their pain – *"it's not in my head", "the pain is real"* – was important. Likewise, the explanation that there was nothing damaged was valued. In addition, for some, PNE was the last piece of the puzzle in their search for the cause and treatment of their symptoms. They were able to stop searching and found peace of mind.

> *Helga: "And now I found some peace of mind. Like, well, stop searching. There is, so far, nothing more to do. (…) So, well, a bit of peace of mind. Some clarity".*

Some were not reassured by the explanation that there is no tissue damage accountable for their pain. These respondents found support in their perception that there must be something physically wrong.

> *Rene: "The reassurance is, at least that's how I interpreted it, that there is pain but no damage. And that I don't know, I don't know if there is no damage. I'm still in doubt".*

Fewer symptoms

Some respondents had fewer symptoms. They attributed this to the received tips, advice, and exercises. They felt they had made progress, were able to do more, had less pain, felt less down, and slept better. A few had changing symptoms; they experienced symptom reduction, but while stressed or when performing physical effort, they temporarily experienced more pain.

Other respondents did not experience a reduction in symptoms. Some said it was too early in the process for symptom reduction. Others did not have fewer symptoms but were better able to handle them. Two respondents had more symptoms; they were hiding their pain before and were now confronted with their pain and pain-related problems.

All respondents, except for two, hoped for recovery and less pain. These two had chronic pain for a substantial time period and were previously told by doctors that their pain was chronic. Even though they hoped it would diminish, they knew their pain was not going to change. They wanted an explanation for their pain and help in dealing with their pain. The other respondents found it important to know whether they had the ability to experience less pain.

Scepticism

Doubt towards the diagnosis and PNE

Most respondents were at first a little sceptical about their "diagnosis" of the predominant pain mechanism. According to the response of the focus group, this was normal. They are likely to have heard numerous explanations for their pain throughout their search for relief. Respondents often did not completely agree with the diagnosis. They knew they had chronic pain, but had doubts or were emotionally not ready to accept it. Some could not accept it as the predominant cause for their symptoms. Respondents described an internal struggle between accepting the diagnosis on the one hand and still feeling the urge to search for another (mostly physical) cause on the other hand. Respondents mentioned the conflict between the biopsychosocial perspectives of the PNE and previous physically focused treatments.

Some respondents who did not have any additional medical examinations found it hard to accept that there was nothing physically wrong without such examinations being performed.

> *Wendy: "Okay, so it's chronic pain. That is also reassuring in a sense that there is nothing going on. It's really double! Because neurologically there is nothing wrong, somehow you don't trust that you've not had scans made and no real medical examinations were done. On the other hand, it's comforting to hear that there is nothing serious going on".*

Others were still distrustful and afraid to be disappointed due to previous negative experiences in healthcare; i.e. they were sent to various doctors, who all provided different explanations for their pain, which made them feel that they were not taken seriously, going from "pillar to post". These respondents said that *"seeing (improvement) is believing"*.

> *John: "Look, we still have some distrust, but that's because we were sent away by several doctors in the past with the message 'Learn to live with it'. You know, Transcare says, we know what is going on, that's it. We just hope that they are right".*

Disagreement with the diagnosis and PNE
Two respondents rejected the PNE completely and did not agree with the diagnosis at all. They found PNE comprehensible but did not recognize it as applicable to themselves. They believed in a physical cause rather than a co-psychological cause for their symptoms. Their a priori expectations of Transcare were low. Nevertheless, they were satisfied with the intake, the interpersonal aspects of the healthcare professionals, the friendly environment and contact between them and the healthcare professionals, the comprehensibility of PNE, and the advice they received. They indicated that they would recommend the treatment centre to other patients with chronic pain.

One respondent missed the link between the PNE and daily activities. The respondent agreed with having central sensitization as the main pain mechanism and understood it, but for him he felt it was not helpful because he was in too much pain.

PNE can be confronting
Some respondents felt that they were rapidly marked with central sensitization as the main pain mechanism and were therefore stigmatized. They felt that the way central sensitization was explained to them was too confronting and PNE should be given more carefully. The healthcare professionals recognized that PNE can be confronting due to the nature of talking about contributing factors, which are often cognitive, behavioural, and emotional.

Discussion

In this study, we aimed to investigate the experiences of PNE in patients with chronic pain in a transdisciplinary setting. This study showed that in the process of PNE several topics and subthemes are important to patients with non-specific chronic pain.

The first identified topic was "*the pre-PNE phase*", the phase prior to the PNE in which the respondents met the healthcare professionals during a broad intake. The intake is described by the respondents as essential; the broad transdisciplinary assessment already makes them more aware of the biopsychosocial view of pain. The questions during the intake of the respondents are based on the Pain, Somatic, Cognitive, Emotional, Behavioural, Social, and Motivational aspects – model[41,42]. This model, as well as the involvement of a psychologist in the team and the pain-analysis after the intake allow the healthcare professionals to fully review all aspects of the respondent's pain problem. The questions related to this model and the involvement of the psychologist made the respondents more aware of the biopsychosocial factors related to pain. Through this assessment, the patient's perceptions and a priori expectations were already altered. Furthermore, the results showed that the patient centered, serious, interested, and friendly interpersonal approach of the healthcare professionals during the intake enhances the further treatment and the acceptance and understanding of PNE. Earlier research also showed the influence of contextual effects on health outcomes[43]. This systematic review showed that physicians who adopt a warm, friendly, and reassuring role are more effective and showed also that the working-ground of the treatment (i.e. providing patient centered care, taking time, building rapport, and building a therapeutic alliance) enhances health outcomes[44,45]. Another review[46] , reporting on the interaction between patients with chronic pain and healthcare professionals and its influence on the patient's self-management, describes that patients are more open when healthcare professionals are empathic, and that patients benefit from a biopsychosocial and patient centered approach. This also corresponds with our results within the topic "*the pre-PNE phase*".

The second identified topic, "*a comprehensible PNE*", comprised of "*understandable explanation*" and the "*interaction between the physiotherapist and psychologist*". Research has shown that receiving comprehensible information is necessary, as it improves the satisfaction with care, diminishes symptoms, and improves adherence[46]. Until recently, PNE was only studied in a monodisciplinary (physiotherapy) setting, but not in a transdisciplinary setting. In the transdisciplinary setting of Transcare the second PNE session is given by a physiotherapist together with a psychologist. During the interviews per formed in this study, the interaction between the physiotherapist and psychologist during the PNE was mentioned by the respondents as a facilitator in the understanding of PNE, and the translation to their daily self-management. Future work should explore whether this transdisciplinary PNE is superior over monodisciplinary PNE.

The third topic involved the "*outcomes of PNE*", including the subthemes "*awareness*", "*finding peace of mind*", and "*fewer symptoms*". Respondents reported to experience more awareness related to their insight into symptoms, better coping skills, and gained more self-control. The latter is similar to findings from a qualitative study of PNE provided in group sessions, which found that PNE in group sessions had the same reconceptualization of pain, thereby improving the pain management in eight out of 10 patients[47]. Furthermore, respondents in our study often found peace of mind and some experienced fewer symptoms after PNE. The reconceptualization and clarification of the pain are known to enhance endogenous pain inhibition and neurophysiological changes in patients with chronic pain by informing the patients that their pain is real, but not dangerous, thereby reducing symptoms[21,22,48]. However, there was a subgroup of respondents in the current study that did not experience fewer symptoms. This subgroup was not homogenous, for instance some respondents mentioned a better self-control of their pain, but did not experience fewer symptoms, while others were still trying to cope with the psychosocial factors contributing to their pain experience.

The fourth topic, *"scepticism"*, contained "*doubt towards the diagnosis and PNE*", "*disagreement with the diagnosis and PNE*", and "*PNE can be confronting*". Some patients had doubt and "*scepticism*" towards the diagnosis, whereby a few respondents rejected their diagnoses completely. This is in accordance with a qualitative study on group PNE[47] which found that a minority of the respondents thought that PNE was irrelevant to them. These respondents reported no benefits of the group PNE. This qualitative study suggested that these respondents probably did not perceive enough relevance and benefits out of the PNE for themselves. The respondents in our study who disagreed with the PNE believed in a physical cause rather than a co-psychological cause, and their a priori expectations were low. This is in accordance with a study that found that patients' readiness to change, an increased commitment to self-management, and initial hesitation about the treatment predicts the satisfaction and likelihood of completion of the program[49-51].

The framework presented in this article is, to our knowledge, the first theoretical framework of the PNE experiences of respondents with chronic pain. It is constructed out of the topics found during the selective coding phase, according to Grounded Theory and the Qualitative Analysis Guide of Leuven[28,39]. "*The pre-PNE phase*" is the first topic one encounters in the theoretical framework, as was identified by the respondents with the healthcare professionals and their biopsychosocial views. Then, as the respondents proceed from the intake to the PNE, the theoretical framework shows the topics associated with what the respondents viewed as "*a comprehensible PNE*". "*The pre-PNE phase*" and "*a comprehensible PNE*" both had an influence on the respondents. This influence is reflected in the connections between these topics and the topic "*outcomes of PNE*". On the lower end of the framework the last topic "*scepticism*" is displayed. The connections between this topic and "*outcomes of PNE*" display the influence of the topic "*scepticism*" on the outcomes of PNE. Furthermore, "*scepticism*"' has a two-way connection with "*the pre-PNE phase*": by the intake and the friendly healthcare professionals some scepticism might reduce, and the content of the topic "*scepticism*" can also have his influence on the intake and healthcare professionals. As is the case with qualitative research, the theoretical framework was shaped through the researchers' interpretation of the results and therefore subjected to further discussion and intensification.

Reflexivity

Even though it is a strength that the researcher performing the interviews received extensive interview training at Evers Research & Training (Rotterdam, The Netherlands), and completed a course on qualitative research and analysis during her education in physiotherapy science (Clinical Health Sciences, University Medical Center Utrecht, Utrecht, The Netherlands), she had no prior experience in interviewing and undertaking qualitative research. As the researcher plays a substantial role in the research process, his/her experience has influenced the results, even though considerable effort was made by the actions mentioned in "Trustworthiness" to diminish this influence. There are some strengths and limitations to mention. Firstly, the key strength of this research is that the research question and research design to answer the research question are both highly relevant to healthcare professions working with patients with chronic pain. Secondly, there are many different visions on validity and reliability within qualitative research; however, there are efforts that can be made by researchers to ensure the trustworthiness of their research[40.] We believe that the actions mentioned in "Trustworthiness" are strengths, as they improved the quality of our research. Nevertheless, transferability (generalizability) in qualitative research is always a delicate issue[52]. In this study, there are multiple areas that compromise the generalizability and external validity. Primarily, because the results and framework of this study are derived from one setting, instead of multiple, the generalizability and external validity is moderated. Next, the setting in itself is different from other PNE settings: there is a repetition of PNE by the general practitioner, a booklet, and combined session which is new. Furthermore, the transdisciplinary nature of the PNE, provided by a physiotherapist together with and psychologist, has not been studied before. Hence, the effectiveness of transdisciplinary treatments requires further study and does not correspond with existing data about (monodisciplinary) PNE[27]. Therefore, one should be careful in generalizing the study findings to monodisciplinary treatment settings that provide PNE. Thirdly, it is a strength and limitation that the data collection was performed in a clinical setting. This is a strength as it provides relevant and bottom-up research on how PNE is provided in clinical settings. However, there is a possibility that the further treatment some respondents have received at Transcare, influenced the experiences they reported on their PNE. To segregate these effects the interviewer specifically first asked the respondents about their overall experience, followed by questioning then about their experiences with the PNE sessions. Furthermore, there were also respondents included who only received PNE. We have indicated whether the respondents received further treatment and what kind of treatment in Table 2. Fourthly, the Qualitative Analysis Guide of Leuven[39] was used for data analysis. This relatively new tool guides the researcher through a structured data analysis[39]. The limitation is that the Qualitative Analysis Guide of Leuven strongly recommends teamwork throughout the entire analysis, applying all steps of the Qualitative Analysis Guide of Leuven together. Due to practical issues, among which were time constraints, this was not feasible.

Future research should focus on investigating the experiences of patients with chronic pain with PNE in different settings and cultures. For instance, there is no interaction between the physiotherapist and psychologist in monodisciplinary PNE, and this may have a different effect on the experiences of patients with PNE. As for cultures, it is known that each culture has different beliefs and explanations of pain and methods to cope with pain[53]. PNE in the Netherlands can have a different outcome than PNE in other countries. To develop a holistic understanding of PNE, it is also important that future research observes PNE in practice. Observation not only checks what respondents say in the interviews, it records events in clinical practice that respondents may not notice, may not discuss or may misinterpret. Furthermore, participant observational qualitative research also incorporates the ability to check for nonverbal expressions, interactions, and ways of communication[54].

Conclusion

This is the first study providing insight into the constructs contributing to the experience of transdisciplinary PNE in patients with chronic pain. The results reveal the importance of the therapeutic alliance between the patient and caregiver, taking time, listening, providing a clear explanation, and the possible outcomes when doing so. This takes time, involvement, good interpersonal factors, and a biopsychosocial view on pain, whereby a team interaction may enhance the outcomes following PNE. When doing so, the perceptual changes about pain will improve in a cognitive, behavioural manner.

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5

Clinical observations of patient and therapist interactions in transdisciplinary Pain Neuroscience Education

Exploring patient-therapist interactions for effective transdisciplinary pain neuroscience education: A qualitative constructivist grounded theory study

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Abstract

Purpose

Even though mounting evidence supports the use of Pain Neuroscience Education, the experience of receiving such education has been studied scarcely. As Pain Neuroscience Education is a 'talk-modality' many interpersonal aspects contribute to the outcome. Therefore, the aim of this study was to explore social processes in the practice of providing Pain Neuroscience Education.

Materials and methods

A heterogeneous convenience sample of eight participants with chronic pain were recruited from a transdisciplinary treatment center. Nine sessions of transdisciplinary Pain Neuroscience Education were recorded with audiovisual equipment. Data analysis was performed according to Constructive Grounded Theory.

Findings

Four connected and interactive categories were found in the process of transdisciplinary Pain Neuroscience Education: *"generating a safe and comfortable feeling, situation", "the Pain Neuroscience Education process", "process of change of the respondent"* and "*the outcome of the Pain Neuroscience Education process"*. The following overarching categories were identified: "*communicational skills*" , "*interplay between the healthcare professionals*" and "*the influence of changeability of the respondents*".

Conclusion

A variety of aspects contributing to the experience of transdisciplinary Pain Neuroscience Education were identified. Therapists should be aware to use a person-centered approach, of the importance of the therapeutic alliance, their communication skills, use a step by step introduction of the education and individualized metaphors.

Introduction

Chronic pain is defined as pain that persists beyond normal tissue healing time and/or when pain persists for 3 to 6 months or longer[1]. Recent studies show a prevalence rate of moderate to severe chronic non-cancer pain between 19%[2,3] and 27% in Europe[4]. Chronic musculoskeletal pain is associated with increased medical costs, decreased income and huge economic burdens[5,6]. Besides that, chronic pain is immensely burdensome to the individual and associated with a negative impact on quality of life[2,5,7].

In persons with chronic pain, the persistence of pain, unlike acute pain or a chronic disease, cannot usually be explained by the presence of an obvious anatomical pathology or tissue damage. There is strong evidence that in persons with chronic pain abnormal endogenous pain modulation exists and that the peripheral and central nervous system have become sensitized[8-12].This complex neurophysiological phenomenon in chronic pain is also known as central sensitization (CS)[8-11]. CS entails not only neurophysiological changes, but also differences in autonomic, motor, neuroendocrine and immune systems[12]. Recently the clinical phenomenon of CS has been renamed by the International Association for the Study of Pain into "nociplastic pain"[13]. Anywhere in this chapter where is written "CS", it can also be read as "nociplastic pain". In persons with CS the central processing of information is altered and, compared to acute pain, different brain areas become involved in the processing of stimuli[14-18]. Together, these pathways and areas are called "the pain matrix"[19] whereby every individual has his/her own personal "dynamic pain connectome"[20]. Activity in this neuromatrix is influenced by complex interplay between factors such as behavioural, psychological and environmental factors, which can contribute to the continuation and amplification of pain[12,21,22].

It is advised to use Pain Neuroscience Education (PNE) as a part of the treatment process for persons with chronic pain. In PNE, the person's understanding of the neurophysiological processes underlying chronic pain and the relevance of such pain in the lives the individual is addressed. Effectiveness of PNE in chronic pain treatment programs holds level A evidence[23,24] and it is recommended by the International Association for the Study of Pain as an important step in individual treatments for persons with chronic pain. During PNE the neurophysiological-neuroendocrine-neuroimmunology alterations of chronic pain are explained in lay language in accordance with the patient's own experiences, perspective and contributing factors, whilst integrating the important role of biopsychosocial perpetuating factors[10,25]. The goal of PNE is to establish a reconceptualization of pain, decrease the perceived threat of pain, reduce pain catastrophizing, and improve functioning and quality of life[26-28]. Several studies have examined the effects of PNE in a variety of chronic pain populations and have shown positive results, especially when added to other treatment modalities[23,24,26-35]. These positive results include: increased knowledge of pain and pain perceptions, lower pain intensity, normalized endogenous pain inhibition, improved mental health, physical functioning, vitality and self-rated disability, and diminished passive coping, kinesiophobia and pain catastrophizing[23,24,26-35]. Recent qualitative studies have underlined the importance of the relevance to the individual and individualization of PNE in order to reconceptualize pain[36-38]. Furthermore, an increasing number of healthcare professionals from various health disciplines, working with persons with chronic pain apply PNE as an integrated part of their pain management program[25,36-40].

Relevance

As little is known about the clinical application of PNE, it has been recommended to study clinical characteristics around receiving PNE and person-therapist interactions affecting the outcomes of PNE[41]. Thus far, most insights into the clinical practice of PNE have been only possible through expert opinion and perspectives by authorities in the application for PNE[42]. However, the "voices" of therapists and persons involved in the clinical practice of PNE have not been extensively heard and exploration of these is warranted. Qualitative research is often proposed for exploring clinical phenomena[43]. To our knowledge thus far four studies have explored the clinical practice of PNE, through patient interviews[36-38,40]. As PNE is a "talk-modality" interpersonal aspects[36-38,40], such as the therapeutic alliance, contribute to the effectiveness of the treatment[44]. A strong therapeutic alliance is known to increase treatment adherence, treatment satisfaction, as well as to improve treatment outcomes in patients with chronic pain[45,46].

The therapeutic alliance consists of verbal, but most importantly, nonverbal communication and often subconscious processes[44]. For instance, the key components of therapeutic alliance, as described by Rogers, are empathy, congruence and unconditional positive regard[44]. These processes can only be captured through observations of clinical practice. To further understand the process of PNE, analysis of clinical practice using video observations was considered in this study to be an appropriate way to observe social interactions, and with minimal researcher intrusion[47]. Using the video data, analyses of nonspecific factors such as interactions and nonverbal communication can be undertaken[48].

Research Aim

The primary aim of PNE is to change perceptions of pain, thereby decreasing the threat associated with pain in the individual experiencing chronic pain. Based on previous research three possible outcomes are theorized: 1) the individual agrees with the explanation and reconceptualizes his/her pain, 2) has doubts and partly reconceptualizes or 3) disagrees and does not reconceptualize[36-38,40]. Important clinical questions are; In what contexts do some individuals agree (outcome 1), while others hesitate or even disagree (outcomes 2 and 3)? We theorized that there are multiple influencing contexts and factors, such as: the patients' biopsychosocial experiences and expectations, and whether or not these internal processes are expressed by the individual. Furthermore, the healthcare professionals' characteristics, such as communication skills, knowledge and expectations may influence the PNE. And lastly, the characteristics of the PNE, the content, process, social context, and delivery may influence the outcomes. These components may all influence each other and consequently also the outcomes of PNE (figure 1). Therefore, the aim of this study is to explore the social process between the individual in chronic pain, their partner and healthcare professionals in the practice of transdisciplinary PNE, to deeply comprehend and theorize what factors lead to a successful PNE.

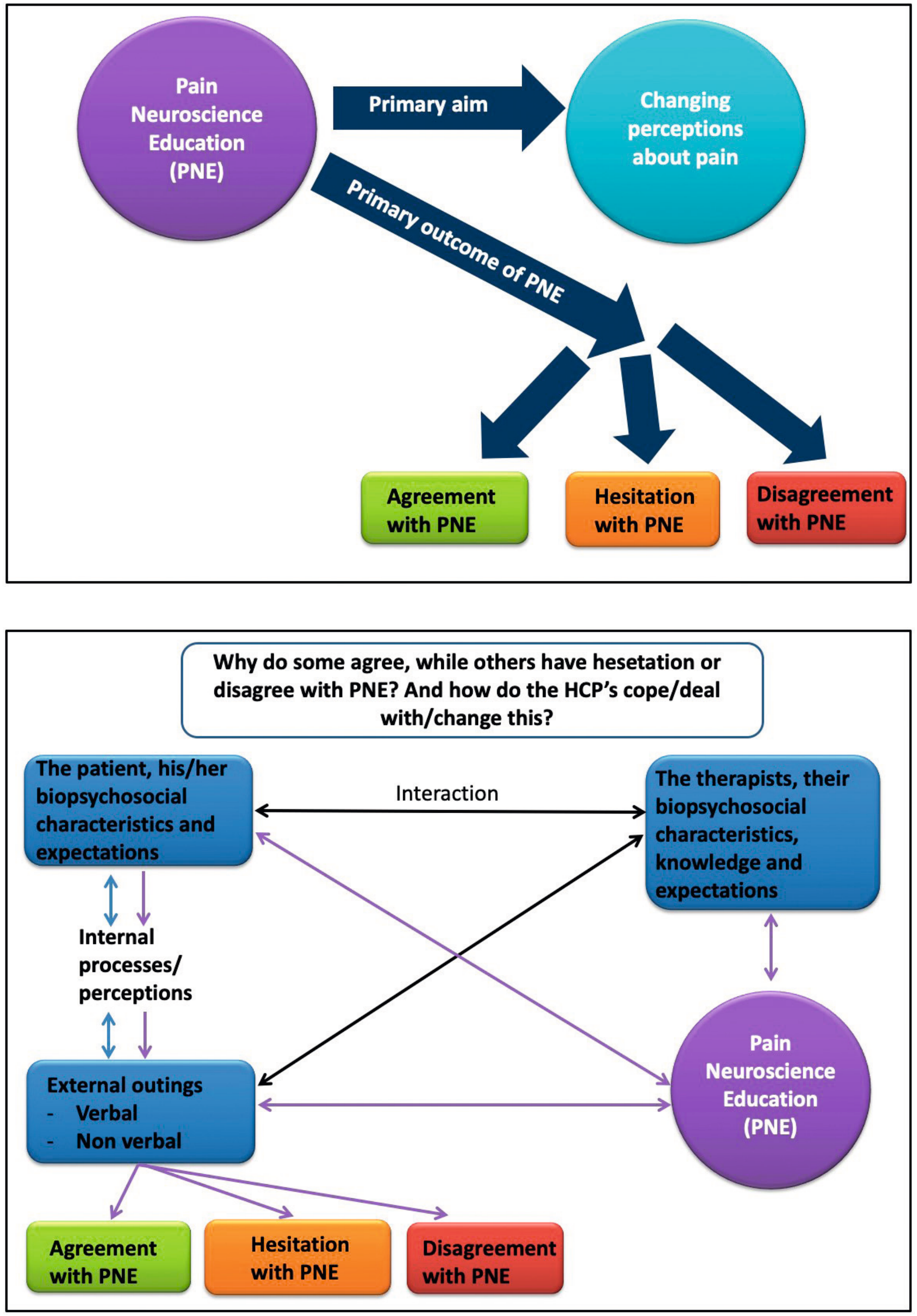

Figure 1. Primary conceptual framework
*HCP's: healthcare professionals

Methods

Design

Based on Constructivist Grounded Theory[49,50] we conducted an observational qualitative study with video observations to explore the practice of transdisciplinary PNE. In order to develop a theory describing the relationships between what is observed and the outcomes seen in practice. Qualitative research is the most suitable method for inquiry on social phenomena, as it can provide a greater depth of understanding of the phenomenon[43]. Constructivist Grounded Theory adopts the inductive, comparative, emergent, and open-ended approach of the original Grounded Theory[51], while being aware of the influence of the observer/analysist. Constructivist Grounded Theory disputes the idea of a neutral observer and acknowledges that researchers have preconceptions[49]. These preconceptions influence the construction of the theories induced through the research process and they should therefore be examined, identified and described[49].

The outcome of this study was a theoretical conceptualization of PNE practice, based on the categories induced from the observations grounded in the video data. Our study was conducted and reported where possible according to the Consolidated criteria for Reporting Qualitative research (COREQ)[52].

Study location

The current study took place in a transdisciplinary pain management center (Transcare) in the Netherlands. In this transdisciplinary center, the care for individuals with chronic pain is provided by teams of doctors, psychologists and physical therapists. Working transdisciplinary implies that the teams collaborate intensively, have flexible boundaries and roles, learn simultaneously and have a shared biopsychosocial view on chronic pain[53,54]. When needed collaboration with other medical specialists from nearby hospitals can be initiated. A complete description of the goals, focus of the transdisciplinary treatment center, treatment and transdisciplinary PNE patients received can be found in a previous article by Wijma et al.[40].

Participants

A heterogenous convenience sample of 8 respondents with various chronic musculoskeletal pain disorders were recruited from a transdisciplinary pain management center between March 2015 and December 2016. The inclusion criteria were: 1) between 18-85 years of age, 2) experiencing nonspecific chronic pain as defined by the International Association for the Study of Pain[1], and 3) sufficiently able to read, speak and understand Dutch. The exclusion criteria were: 1) identified as experiencing specific nociceptive pain, 2) mentally limited, 3) having dementia, 4) or a serious psychiatric condition according to the Symptom Checklist 90 (SCL-90)[55].

Twenty-three persons fulfilling the inclusion criteria were asked to participate in this study. For those who agreed to participate, AW contacted them by phone to provide further verbal and written information and an informed consent form. In the moments prior to the PNE session AW unobtrusively installed the camera and received the informed consent forms from the respondents. Confidentiality was guaranteed and all material was handled anonymously. The study received ethical approval from the Maasstad Hospital in Rotterdam, the Netherlands.

Healthcare professionals

The demographic information of the healthcare professionals, in every session a psychologist and physiotherapist, is described in table 1. All healthcare professionals working at the transdisciplinary treatment center were invited to participate, and all provided consent to do so.

Table 1. Demographic data of the healthcare professionals (7)

Healthcare professional	M/F	Age	Education	Occupation	Years of experience	Years of experience in working with patients with chronic pain	Years working at the trans-disciplinary team	Relevant PNE courses
1	M	49	PhD	Physiotherapist/ Psychologist	25	25	8	PNE course teacher
2	F	26	University	Psychologist	2	1	1	Courses Pain in Motion
3	F	26	Higher professional education	Physiotherapist	4	2,5	2,5	Courses Pain in Motion
4	F	43	University	Psychologist	20	10	5	Courses Pain in Motion, several psychological courses
5	F	49	University	Psychologist	21	15	5	Courses Pain in Motion, self-study
6	F	57	Higher professional education	Physiotherapist	34	15	5	Courses Pain in Motion
7	M	62	Higher professional education	Physiotherapist	37	5	5	Courses Pain in Motion

Procedure

The practice of transdisciplinary PNE was examined using data from video observations of the interactions between individuals with chronic pain (respondents), their partners and the healthcare professionals (physiotherapist and psychologist) during the second PNE session, whereby the respondents were the main focus. In the preceding session with general practitioner the respondents were asked to bring a relative, friend or partner to this session.

Both the observations and analysis were in Dutch. Observations continued until the researchers AW and TP felt confident that theoretical data saturation was achieved. At this point, there was conceptual depth of each category and it was believed that no new information emerged from the data in the analysis that added to dimensions of the categories and understanding of the phenomenon under study[49]. The theory was then translated from Dutch into English. Throughout the translation efforts were made to convey the sense of the Dutch-language by allowing enough time to carefully and critically reflect on the meaning and wording of the prime language. Furthermore, the translation, performed by AW, was reviewed by two team members (PvW, TP) of which one (TP) had been involved in the complete analysis. Prior and all the way through the analysis all researchers created memos which were later on used in the analysis[49].

Points of departure – Theoretical framework

Prior to the observations primary conceptual theoretical frameworks (figure 1) were constructed based on our previous knowledge. Furthermore sensitizing concepts (table 2) were developed based on:

- a previous study of the experiences of patients with chronic pain with transdisciplinary PNE[40];
- previous literature about the expectations of patients with chronic pain influencing treatment outcomes[56], about the importance of PNE feeling relevant to the individual[38] and stages of change[57];
- and professional and academic experiences of AW, CPvW, LV and TP.

The process of articulating this theoretical framework (figure 1) helped to shape the study theories stated in the research aims section above.

Both the theoretical frameworks and sensitizing concepts were constructed to help structure the analysis of the data according to the Constructivist Grounded Theory by Charmaz[49] and evolved during the analysis (table 2.).

Table 2. Sensitizing concepts

Primary sensitizing concepts	Sensitizing concepts after the first member check
1. How do respondents understand CS? - Did they get the message, can they explain this model, how do they explain the message? - What are the practical implications for the respondents? And how do the respondents transfer it to daily life? - What were their expectations and perceptions? How did the healthcare professionals deal with this? - How did the healthcare professionals take care of externalizing internal processes of the respondents to reveal the perceptions of the respondents based on acceptation of the model? (agreement, hesitation, disagreement)	**1. Overall:** - Does the partner play a role? If so, what kind of role? -How do they accept their pain(complaints) and the consequences of those? -Do they get advice etc. for the future/is the following treatment discussed? -How do the healthcare professionals bond with the respondents? -Which conversation techniques were used by the healthcare professionals? -Are there clumsy actions/faux pas by the healthcare professionals? -How is the PNE structured? What is being said/used?
2. What are the feelings of the respondents with the message? -Do they get emotional? - Does it reassure them? Or do they get anxious in any way? Or relieved? Or angry? - Is there resistance against the message/CS, or not? If so: which forms of resistance do they show? And how do the healthcare professionals cope? -In which manner does the resistance they have, have an effect on the outcome of the PNE session? (agreement, hesitation, disagreement) - If a respondent keeps being resistant, how do the healthcare professionals cope with that?	**2. How do respondents understand CS?** - Did they get the message? What is their knowledge? How is this expressed? - What were their expectations and perceptions? How did the Healthcare professionals deal with this? (is both 2 and 3) - How did the Healthcare professionals take care of externalizing internal processes of the respondents to reveal the perceptions of the respondents based on acceptation of the model? (agreement, hesitation, disagreement) (is both 2 and 3)

Table 2. (Continued)

Primary sensitizing concepts	Sensitizing concepts after the first member check
3. Does the message have any consequences for their behaviour? -Did the respondent already adapt? -Does the respondent have any idea how to adjust his/her behaviour? (This might be complicated to get from the PNE session) - Is there any sign of changing into another stage of change?	**3. What are the feelings of the respondents with the message?** - Do they get emotional? What kind of emotions are shown? - Is there resistance against the message/CS, or not? If so: which forms of resistance do they show? - How do the healthcare professionals cope with resistance? -In which manner does the resistance they have, have an effect on the outcome of the PNE session? - If a respondent keeps being resistant, how do the healthcare professionals cope with that? -What kind of processes can you see between the respondents and healthcare professionals when there is concern/doubt/anxiety/resistance?
4. General: - Does the partner play a role? If so, what kind of role?	**4 Does the message have any consequences for their behaviour?** - Does the respondent have any idea how to adjust his/her behaviour? (This might be complicated to get from the PNE session) - Is there any sign of changing into another stage of change?

Sensitizing concepts based on previous research, literature and professional experience where created to study three domains: cognitive, behavioural and emotional.

Prior to the analysis all researchers (AW, TP and CPvW) described their own theoretical background in a reflective paper[49], including descriptions of their knowledge, thoughts, perceptions and emotions about: the setting (Transcare), CS and PNE, the other professionals involved in the treatment and transdisciplinary collaboration. This description increases the trustworthiness of the study[58].

Analysis

The analysis was performed in an iterative process, meaning that there was constant comparison between data gathering and analysis, by AW and TP. Both are physiotherapists, respectively with a MSc., PhD-researcher with training in qualitative research and MSc.-student with training in qualitative research. The analysis started with a general impression of the recording. Then the recordings were observed in a focused manner based on the sensitizing concepts. During the third step in a selective observation the differences, contrasts, extremes and paradoxes between the observations of the set were sought. This phase was independently done by AW and TP whereby the actors, activities, jottings and broad lines of the setting where described[49].

The next step was to transcribe all observations verbatim with transcription software F4 (dr. Dresing & Pehl GmbH, Marburg, Germany)[59] by AW. Non-verbal actions that were noticed were described by AW and inserted based on consensus by both AW and TP. For example: "*5.41 min: the respondent frowned, interpretation: hesitation*".

After the transcriptions the data were analyzed according to Constructivist Grounded Theory[49]. First, AW and TP used an interpretive coding process to perform initial coding of the data by applying conceptual labels. A codebook was made in QSR International's NVivo 12 software (QRS International Pty Ltd., Doncaster, Australia). After the initial coding of three observations focused coding was performed. This iterative process was repeated after the initial coding of the subsequent observations. Finally, theoretical coding was categorized to inform construction of a theory and theoretical framework by AW and TP. This was peer reviewed and debriefed by CPvW and LV, CPvW being a psychologist and physiotherapist and LV a physiotherapist and lecturer, both academics with a background in qualitative research: this resulted in the final theoretical findings and framework.

After the focused coding of the first four observations a member check of synthesized data[60] was held with one psychologist, a participating healthcare provider whom had been observed. Another member check was conducted after the focused coding of all observations with another observed psychologist. These psychologists were chosen to reflect the transdisciplinary perspective of the phenomenon under study, as both researchers performing the initial analysis (AW and TP) are physiotherapists. During these member checks the preliminary focused coding was discussed. The member checks resulted in adaptation of the focused codings. For instance, by renaming wording in the codes, whereby ‘perceptions’ were renamed into ‘cognitions’, as it was construed as more accurate.

The sensitizing concepts (table 2) and conceptual theoretical frameworks (figure 1) were modified throughout the analysis of the observations, particularly after the first member check.

Trustworthiness
The trustworthiness criteria of Lincoln and Guba[58] were used to endorse the quality of the study.

As well as using member checks, credibility was facilitated by reaching data saturation and achieving in-depth observations. Negative case analysis was done by falsifications and a heterogeneous sample. Furthermore, anecdotalism was avoided and interpretations were agreed on by all the researchers, who were aware of their own preconceived theoretical perspectives. All data was systematically handled in NVivo. Researcher triangulation was done by two researchers throughout. The codebook and codes were discussed and peer debriefing was done by two individuals.

Transferability was pursued by writing a thick description of the population, field and data. Furthermore, the theoretical implications (patterns) were fully described in this study.

Dependability was sought by a continued monitoring of the process and product of the research by the authors. Furthermore, transparent description of the research steps and memos were made.

Confirmability is known among researchers as being potentially problematic in qualitative observational studies, however, to improve confirmability the following steps were taken: 1) NVivo was used, with complete and meticulous documentation, thereby creating a full audit trail[58]; 2) researcher triangulation was performed; 3) the researchers (AW and TP) constantly applied self-reflection by reflective field notes during the analysis. They were aware of the researchers-effect, the effect of preconceptions, faulty interpretations and familiarity with the setting on the data, recording these in a reflective paper.

Findings

Twenty-three individuals were asked to participate in the study. Twelve were not willing to participate because they felt uncomfortable with the camera or felt they would focus too much on the camera instead of the conversation. In three individuals, the data collection was not completed due to the following reasons: one individual stepped out of the program prior to the PNE, one video recording failed and one person did not arrive at the PNE appointment. Eight individuals remained who were recorded, one individual was recorded twice. While only one psychologist and one physiotherapist attended each session, this represented seven different health professionals across the nine recordings. Further demographics are described in table 3. The length of the observations varied from 30 to 83 minutes per session.

Table 3. Demographic data of the study participants (n=8)

Respondent	M/F	Age	Relational status	Occupation	Education	Location of pain/ complaints	Duration of complaints (months)	Other relevant health problems	Significant other at the PNE
1	M	64	Married	Disenabled to work	Junior secondary technical education	Headache, dizziness	36	Eye problems	-
2	F	65	Divorced	Retired	Junior secondary home economics education	Back, hips and knee	60	-	Daughter
3	F	33	Living together	Disenabled to work	Intermediate vocational education	Stomach, widespread pain	96	-	-
4	F	35	Married	Housewife	Intermediate vocational education	Fatigue, widespread pain, headache,	240	-	-
5	M	39	Married	Disenabled to work	Intermediate vocational education	Backpain towards legs and shoulders	11	-	Wife
6	F	38	Divorced	Disenabled to work	Intermediate vocational education	Backpain	38	-	-
7	F	45	Married	Nurse	Higher professional education	Widespread pain, legs, shoulders, fatigue	24	-	-
8	F	49	Divorced	Disenabled to work	Intermediate vocational education	Widespread pain, restless legs	312	-	-

Due to the thick description of findings, only the summarized results from the theoretical coding are described, the appendix provides the complete results.

The findings are presented according to the categories that emerged during the data analysis below. When the data represents aspects from the respondent, their partner as well as the healthcare professionals, the aspects from the respondent are described first, in line with patient-centeredness. Whenever is written ‘respondent’, it can be both respondent and partner, if it was just the partner this is described.

Seven connected, interactive categories emerged from the data, as can be seen in the conceptual theoretical framework (figure 2).

Four of these categories were related to the phases of the PNE session:

1) Generating a safe and comfortable feeling and situation
2) The PNE proces
3) Process of change of the respondent
4) The outcome of the PNE process

A further three categories emerged as important factors in all phases of the PNE

5) Communication skills of the healthcare professionals
6) Interplay between the healthcare professionals
7) Influence of changeability of the respondents on the process.

The categories *interplay between the healthcare professionals* (described in the appendix) and *communication skills* played a role in both *generating a safe and comfortable feeling* (1) and *the PNE process* (2). Both the communication skills of, and the interplay between the healthcare professionals made the respondents feel at ease and helped guide them through comprehending the information as presented during the PNE session.

The *influence of changeability of the respondents on the process* was more related to *the PNE process* (category 2), *the process of change* (category 3) and *the outcome of the PNE process* (category 4). Here, the changeability guided the content of PNE and influenced the process and the outcome.

Every videotaped PNE session was individualized, resulting in a broad variation of data during the session. A general overview of the content addressed in the observed sessions is summarized in Table 4, while change processes of the respondents are detailed in Table 5. Table 6 describes the individual differences in the PNE. An effort is made to convey these individual differences, as well as reflect the similarities in the following report.

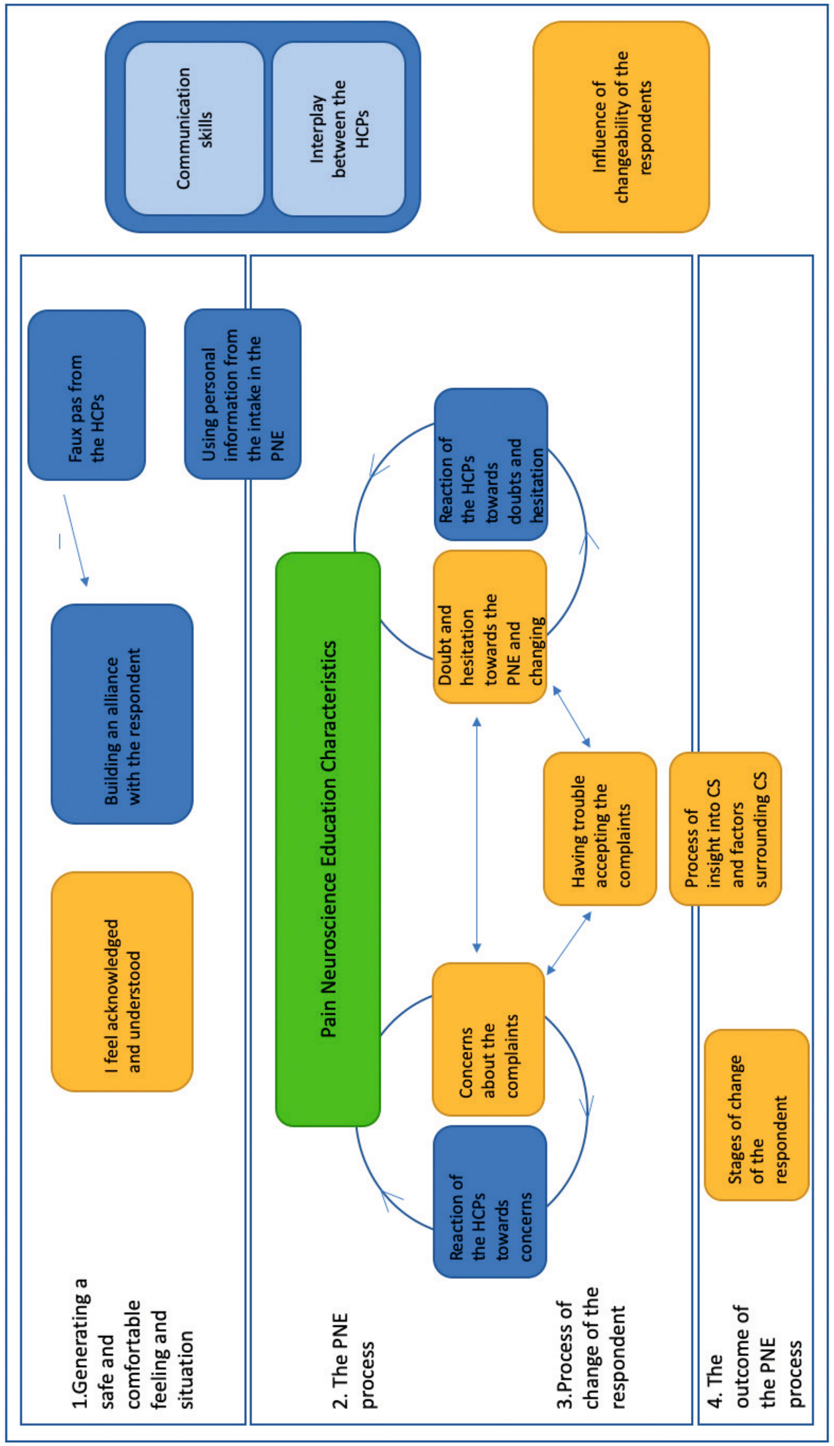

Figure 2. Definitive conceptual theoretical framework
Yellow stands for themes related to the respondent, blue for themes related to the healthcare professionals and green related to the PNE content.

Category 1: Generating a safe and comfortable feeling and situation

Everyone in the process invested in creating a warm and friendly environment. Efforts to create and keep an alliance with the respondents was seen from the healthcare professionals. These efforts resulted in the respondents showing both verbal and non-verbal signs of feeling at ease, acknowledged and understood.

> *Respondent 3: "I do feel as if you understand me"*
> *Respondent 1, Psychologist: "Because we don't feel what you feel, but we believe every word you say"*
> *Respondent 1: "Yes (nods twice)"*

Generating a safe and comfortable feeling was started during the prior intake and continued to be an active process throughout the session with all respondents. Individual differences, however, were too small to describe.

Three sub-categories were identified linked to 'generating a safe and comfortable feeling'. From both the respondents and healthcare professionals: *Making jokes to keep the conversation light* (described in the appendix). From the healthcare professionals: *Building an alliance with the respondents* and *Faux pas from the healthcare professionals.*

Sub-category: Building an alliance with the respondent

Building an alliance with the respondent consisted of multiple efforts: *Creating a safe environment*, *Recognizing and understanding personal suffering and pain* and *Using personal information from the intake in the PNE* (the latter overlapping with the next category: *The PNE Process*).

Creating a safe environment

Creating a safe environment ensured the respondents dared to express themselves. For instance, by telling them they could always ask any question, no matter what, and responding to those questions with ease and understanding. Furthermore, this save environment was created by letting them tell their story and giving the respondents time to express themselves. Expressed or non-verbal shown discomfort or awkwardness as felt by the respondents were handled with care. Discomfort was also handled by making polite jokes by the healthcare professionals, often followed by a gesture that they took them seriously.

Creating a comfortable space also meant placing the respondent in the center, asking for their preferences.

> *Physiotherapist respondent 7: "Regarding the future treatment trajectory, it is important that you say what you want .. of course, it's nice that you take our feelings into account, be aware that this process is all about you."*

Recognizing and understanding personal suffering and pain
Recognizing and understanding the respondents' pain by the healthcare professionals meant showing an overall empathy for the respondent as a person and their suffering. The healthcare professionals often recognized, emphasized and expressed the frustrations, feelings of heaviness and the hardships of dealing with chronic pain and fatigue the respondents felt.

Some of the most used sentences were: *"yes, that is hard", "I get it"* and *"we understand that it is difficult".*

The impact of the pain on the respondent's life and future was often mentioned.

> *Respondent 8, physiotherapist:" Well, it is complicated to deal, to, deal with this"*

The healthcare professionals underlined their empathy for the unfamiliarity of the respondents with CS and contributing factors, acknowledging the doubt some respondents experienced.

> *Physiotherapist: "That (hay fever) is in essence an overreaction of the nervous system. That is actually what it is about, and that signals pain, right? The pain is real; however, you can't see anything different in those people. That is often what makes you insecure, that is what often makes it incomprehensible: why am I in pain now?"*

The healthcare professionals also corroborated on the realness of the complaints. Often by saying things like: *"CS pain is a real pain and not "in your head", it is not psychological." "Whatever you feel is real."* Furthermore, they explained to the respondents that even though there is no damage, their pain is real.

For those respondents who had a biomedical question or quest the healthcare professionals understood and acknowledged this quest. If necessary, and not already performed, biomedical examination, such as bloodwork, was done. In an interactive process with the respondent outcomes of these or previous examinations were explained in the light of PNE.

Among this recognition was also the acknowledgement that the biopsychosocial contributing factors are often factors one does/feels unconsciously and are not easy to change for the respondents. However, it also implied acknowledging that when these biopsychosocial contributing factors changed, life would probably be more enjoyable.

Using personal information from the intake in the PNE
The healthcare professionals used personal, sometimes specific, information which they heard or had seen during the intake. Using this personal story was important to enhance its relevance to the individual, reinforce the explanation and made respondents feel heard. For instance, what they had seen in the physical examination, information about biopsychosocial contributing factors and emotions that where present. Or they just referred to what the respondents said by:

> *"I've heard you say this before".*
> *Respondent 2, psychologist: "You told me in the first conversation: I am not that much of a worrier, and I don't worry that much, but I do feel that the pain now dominates my life. (R: Yes, yes, yes, yes.)'*

Sub-category: Faux pas from the healthcare professionals
Faux pas from the healthcare professionals were unhelpful actions that caused small ruptures in the alliance. For instance, asking many questions in one sentence, using difficult words, introducing the contributing biopsychosocial factors too fast, giving an unclear answer to a question, etc. These were often addressed and the ruptures repaired.

> *Respondent 5, physiotherapist: "No that is true.. can you grasp what I am saying? How is that for you? .. Because it means a difference in dealing with the pain, right? And how you look at pain. Is that, is that a reassurance or not? How does it feel for you both?"*

> *Respondent 5: "... I don't know how that feels"*
> *Respondent 5, partner: "I am so glad that it isn't a herniated disc anymore, yet on the other hand he has something that isn't visible. How do we explain that to others?"*

Category 2: The PNE process

The category the PNE process consists of the characteristics of the PNE, in which the content of the PNE (*The steps of the PNE process*), *Individualization of the PNE* and *Examples and metaphors* are described. Among with the PNE there are different processes that are in action, related to the next categories *Process of change of the* respondent and *Outcome of the PNE process*.

Subcategory: The steps of the PNE process

Most often the PNE conversation would involve similar 'steps' in the process, as described in table 4. By applying this stepwise structure respondents were engaged in the explanation of their pain. However, these steps would change according to the individual respondent or preferences of the healthcare professionals (table 6).

Table 4. General lay out of the content of the observed PNE sessions

General content of the PNE session	Healthcare professional explaining (most often)	Particulars
1 a) Welcome back, give a general lay out of this session.	Psychologist	1a and 1b could be exchanged
1 b) Ask how the first session with the GP is experienced by the respondent and what the respondent remembers of the GP's explanation.	Psychologist	
1 c) Explain goals for this session; more clarification, explain their pain in more depth, some guidance in how to deal with his/her pain, and further treatment(s).	Psychologist	
2) Explain difference between acute and chronic pain.	Physiotherapist	Based on the predominant paint mechanism[61]. Respondents who first experienced acute/nociceptive pain were explained that it started with acute pain, however there is no "damage left" and the metaphors were their own (for instance falling of stairs). Respondents who had a combination (nociceptive pain and/or neuropathic and CS) were explained the combination.
3) From "damage" to CS: explaining the difference between acute and chronic pain for the individual. Based on respondents own description of pain, disabilities, prior treatments and tests.	Physiotherapist	Normalizing the pain. Important in this phase is that the healthcare professionals underlined the credibility of the pain, taking the respondent and his/her pain really serious.
4 a) Explanation that it is an overactive processing/sensitization. Drawing a schematic picture of the nervous system. Explaining neurophysiology of acute pain by an example.	Physiotherapist	
4 b) Explain neurophysiology of chronic pain/ central sensitization, while drawing the changes in the central nervous system. With examples from the individual.	Physiotherapist	
5) Bridging the PNE towards the biopsychosocial factors.	Psychologist	The variations in this "bridge" depended on the healthcare's" preferences and their estimation of the patient's preferences
6) Explain and discuss the biopsychosocial factors that contribute in the respondent's pain experience, while drawing the links in the brain. Individual contributing factors were discussed in a for the respondent non-threatening manner.	Both, however most often the psychologist	
7a) Based on the contributing biopsychosocial factors provide some advice and guidance in dealing with his/her pain.	Both	7a/b/c could be exchanged
7 b) Discuss further treatment options and goals.	Both	
7 c) Give a realistic picture and hope for the future. Give back purpose.	Both	
8) Closure of the PNE session.	Both	

A more detailed, yet general, description of the PNE session is included in the appendix

Subcategory: Individualizing the PNE

Individualizing the PNE was done in a subconscious manner and multiple ways.
First, in all sessions the healthcare professionals recalled information and questions from the respondents that were mentioned in the intake. These were answered during the session.

Additionally, they copied the words and language of the respondents, with language based on the individual. They explained in a pace adapted to the respondent, and used recognizable metaphors for the individual or their own metaphors. The treatment options were discussed in a shared decision manner, with an individualized level of involvement.

Individualizing the PNE also mentioned explaining all complaints of the individual respondent, not just the pain.

> *Respondent 1, physiotherapist: "So that is it, this is it. It's not pretention ..It's just, that system is upset, just as it is mixed up with you, and you can notice that in different aspects, it can just be pain, but with you we see a combination of pain, sound, light.."*

Further individual differences during the PNE are described in table 5 and 6.

Table 5. Change processes of the respondents during the PNE

Respondent	Start PNE	During/end PNE	Resistance*	Stage of change prior PNE	Stage of change after PNE
1	Feels urge to explain complaints, didn't quite remember the message of the first PNE.	Unknown whether he truly understands PNE and contributing factors	No obvious resistance against PNE, unknown comprehension, finds it hard to accept his complaints	Precontemplation	Precontemplation
2	Understood the prior PNE, fire alarm, happy with the diagnosis and explanation. Wanted to know the cause of the fire alarm going off.	Understands PNE, agrees with it. Did have questions on whether her pain was an inflammation, reassured when explained why not and why CS. Has already changes in mind (yoga, relaxation)	No resistance against PNE, reasonable comprehension and acceptation	Contemplation	Contemplation
3	Doubt and hesitation: found the first explanation woolly. Understood it, however, can't cope with her pain.	Understands PNE, agrees with it, understands the contributing factors.	No resistance against PNE, accepted it, however, finds it hard to accept her complaints, resistance towards changing, lesser psychological flexibility	Contemplation	Contemplation
4	Resistance against prior PNE, felt there weren't enough biomedical examinations done, wanted an easy solution.	Quickly shifted from resistance to agreement when "no results from bloodwork" in relation to complaints and CS as underpinning chronic pain was explained. Thinking along with contributing factors and how to deal with those.	First resistance against PNE, quickly changed, acceptance and good comprehension at the end.	Contemplation	Contemplation
5	Unknown whether he really comprehended the previous PNE, partner did. Acceptance idem.	Both go along with the PNE. Ps and Pht (#) frequently try to get him involved. When asked they agree with the PNE, contributing factors and treatment plan	Large role partner, he has little expressions and involvement. No obvious resistance against PNE, probably acceptance, unknown comprehension	Precontemplation	Precontemplation

Table 5. (Continued)

Respondent	Start PNE	During/end PNE	Resistance*	Stage of change prior PNE	Stage of change after PNE
6a	No resistance against CS, first part previous PNE, however resistance against "being afraid to move" as told by doctor being a part of her problem	Reasonable understanding of PNE, acceptation PNE, only fear of movement as contributing factor explained due to lack of time	Started with resistance against "being afraid to move" as factor in her problem, changed into agreement with it being a factor. No resistance against PNE, reasonable comprehension	Contemplation	Contemplation
6b	Grasped the essence of the previous PNE, accepted it	Agrees with the message of the PNE. Questions whether her crooked pelvis is of influence, understands explanation of Pht that it is not crooked however she has a tensed and stiff movement pattern. Finds it hard to change her behavioural patterns	Reasonable to well comprehension. No resistance against PNE and contributing factors, however finds it hard to accept her complaints, deal with them and change behaviour	Contemplation	Contemplation
7	Found the first PNE pleasant and enlightening, understands quite a bit already. Already changed behaviour after the PNE. Came with some questions written down.	Understands the PNE, agrees with it, comes with contributing factors, comes with ideas on how to proceed	No resistance against PNE, good comprehension and acceptation	Action	Action
8	Slight hesitation, wants to agree with the previous PNNE/CS, however thinks: "what if there is something else?" Looked up information on Moseley, already insight in receptors and role stress	During the complete PNE: keeps on changing directions from: agreement, acceptance knowing and open towards change, to: "but what if it is..", "yes, but..", and back to agreement	Hesitation and agreement with PNE alternate, same with comprehension vs. biomedical thinking. However, is accepting the PNE and open towards contributing factors and treatment.	Contemplation/ Preparation/ Action	Contemplation/ Preparation/ Action

*Resistance against the complete PNE, or a part of PNE, # Ps = psychologist, Pht = physiotherapist

Table 6. Individual differences during the PNE

Respondent	Manners in which the PNE was individualized
1	Simple vocabulary. Start with his accident as nociception and explain how it got to CS. Let him speak about his complaints and based on that explain PNE, explain faulty cognitions and why not moving his head increases the problem, as well as taking him seriously and showing understanding; following his rhythm. Only discuss other contributing factors (such as acceptance stress) in limited detail. Urge him and explain why not to pursue biomedical solutions. Further treatment: physiotherapy, graded activity and exposure.
2	Daughter is present, yet not really involved. Respondent mentions burglar alarm in the beginning of the PNE: at her job (now retired) the burglary alarm would go off unexplained. Use example walking from the intake. Use different metaphors: burglar, hot pain, hay fever, load/capacity, diminished physical condition, whiplash as example CS, asthma, headaches, stomachache, phantom pain. Explain limited role arthritis. Explain physical and emotional tensions, and their relationship, and with CS. Talk about role social surroundings; feels taken seriously, feels supported, they have read about CS. Explain her questions on: whether CS is hereditary, why it is just one part of her body, whether she should fitness or do yoga. Only physiotherapy based on relaxation and increasing physical fitness, door is open to psychologist if necessary.
3	Ask if bloodwork was done; yes, no specialties. Explain CS based on hypersensitiveness of sitting on a chair, twice, then based on hay fever. Followed by explanation pain control system and how this system can get repressed by several factors. (total about 20 minutes) Then go into detail about negative emotions, fatigue, pushing boundaries, early life events, caring for oneself; respondent find this part difficult: agrees with it, brings it up herself, then avoids it; this is a dance between the respondent and the healthcare professionals. Advice to start psychotherapy, will think about it, second PNE planned to review and discuss next therapy.
4	Start with discussion bloodwork and X-rays, respondent mentions not being content about results; no abnormalities. Healthcare professionals take her seriously, name her frustration, ask what she would have wanted: an explanation for her complaints, they call it fibromyalgia and then start explaining CS. Respondent has had previous therapy on pain, this PNE focus on both pain and fatigue. Take the burden of pain and fatigue on her very seriously. During the PNE deviate from the neurophysiology when she mentions examples of her disabilities and then go back. First part PNE about 18 minutes, then on to contributing factors. Struggling and difficulties in dealing with different aspects of life, diminished feeling of fulfillment of life, life not being easy and setting the bar high. A lot of reflective questions. Physiotherapy and psychology: graded activity, relaxation overall and in anger, dealing with life.

Table 6. (Continued)

Respondent	Manners in which the PNE was individualized
5	More plain vocabulary, only mention of sensitive nervous system and not CS. Start with hernia as acute onset, then towards hernia is gone, still in pain: CS. Explanation why biomedical therapies such as bloodsuckers won't work in this (CS) system. Explain previous well-functioning pain control system (container on hand) and his current pain. Trying to involve him in the PNE with questions, sits huddled, little expressions (difference from at home). Partner is really involved and understands explanation. How to explain this to the social surroundings. Example bronchitis, going on and on with an ankle sprain; body also needs time to heal. Lesser mentioning of emotions (stress boss, finances, how he used to be a different man), more on normalizing, relaxation in movement, trust in the body and steadily going back to work. Goals for further treatment: physiotherapy.
6	Had two sessions. In the first session first focus on removing resistance surrounding "afraid to move" via understanding, moving along with her, explaining neurophysiology, explanation moving tensed and influence on pain and then towards naming it "being afraid to move". Second session more focus on stress factors, such as: start pain and trauma surrounding fall of stairs, divorce, setting the bar high, behavioural influences such as: always being busy, not taking rest and sawtooth pattern of daily activities. Goals further treatment: both physiotherapy and psychology, one of the goals: normalizing work.
7	Already understood a great deal of PNE based on the prior session and information leaflet. Brings her own questions to the PNE session. Shorter neurophysiology during the PNE, more focus on contributing factors. A great deal of influence and input from the respondent. Together towards shared decision making for further treatment, based on the question: "what do you need?". During the last phase the respondent indicates that she prefers another, older psychologist.
8	Respondent is offered a stool, because she can't sit in a chair. One mayor question at the beginning of the respondent is whether she should continue other pelvic physiotherapy; she explains her arguments pro/con, based on questions and advice she decides to stop this therapy. Throughout the PNE session the respondent asks questions, comes up with her own examples (walking, singing, burn out, adrenaline) and the PNE is partly based on these questions and examples. The respondent "flutters" between understanding and acceptance, coming up with examples to support this, then hesitation and contradicts herself. The healthcare professionals try to balance the PNE conversation by letting her talk, then questioning, reflective questioning and examples. Further treatment: psychologist and physiotherapist.

Subcategory: Metaphors and examples

Metaphors and examples were based on the individual person, in plain language, based on the expected health literacy of the respondent. Often the respondents would react in agreement, this could be seen by the non-verbal communication (listening seriously and nodding), or in a verbal manner by "*yes*", "*hmhm*" (often in combination with non-verbal communication), or by responding to a metaphor with their own metaphor/example.

> *Respondent 7, physiotherapist: 'It is, no, these are none painful signals that go up (points from spine upwards to the brain), they, they come into a network which immediately says: POING, pain! Because you sense pain in your brain, not in your foot'*

A complete list of the metaphors used is presented in the appendix.

Category 3: Process of change of the respondent

Understanding, agreeing with and implicating the PNE on his/herself and daily life was a process for the respondent. This change process is a personal iterative process with multiple steps, as displayed in figure 3. Not all steps could be seen in all videos, these individual differences can be seen in table 5, describing the individual differences of the PNE session and table 6 describing the change process of the respondent.

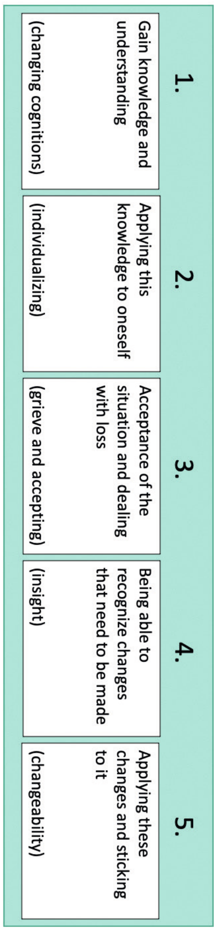

Figure 3. Change process surrounding PNE

Within this change process respondents had several struggles which emerged as the sub-categories: *Concerns about the complaints they experienced, Reaction of the healthcare professionals towards concerns, Having trouble accepting their complaints* and *Doubts and resistance towards the PNE and change and Reaction of the healthcare professionals towards doubts and hesitation*. Throughout these struggles, a *Process of insight in CS and the factors surrounding the experienced complaints* also started and in some even changes for daily life were made or planned.

Sub-category: Concerns about the complaints they experienced

All respondents expressed concerns surrounding their complaints. These concerns were often expressed at the start of the PNE. Followed by a cyclical process in the PNE between the explanation for these complaints (CS) and other concerns the respondents perceived. Most often throughout the PNE these concerns decreased or diminished completely, apart from respondent 1 and 8 (table 5,6). These concerns often surrounded the etiology of their complaints: how it could be that they were now experienced chronic pain but not prior, why their complaints were increasing, and how to deal with their pain.

> *Respondent 8: "and when I get up I get this shooting pain in my foot…then I'm like, well!, just by lying! I'm thinking I'm giving my body a bit of rest and then when I get up the pain is even worse. That's when I'm concerned, I'm like: What is it? What is it?"*

Furthermore, some respondents expressed concerns on how people in their social network reacted or would react to their complaints. Concerns surrounding how their social environment reacts to their complaints where often either about their pain not being understood or taken seriously in the past ("*chronic pain is not a visible problem like breaking a leg*"), or about novelty of CS ("*central sensitization is not known in our social environment", and "how do we explain this to our environment?"*).

Sub-category: Reaction of the healthcare professionals towards concerns

The healthcare professionals dealt with the concerns first by asking the respondents about their concerns, in order to allow them to express their concerns. Subsequently, the healthcare professionals took great care in taking the respondents' concerns seriously. Often, by these actions the concerns would then be gone, or less important.

> *Respondent 1, physiotherapist: "You say your symptoms have increased, is that something you worry about? Say, what if it continues like this, what then? Or isn't that on your mind?"*
> *Respondent 1: "Well that is something I have been thinking about. What if I have to live like this? It continues and gets worse? (looks sad). That's why I'm here"*

If these concerns were driven by inadequate cognitions, they questioned these misconceptions and then proceeded by (re)explaining the PNE in further detail. This cycle was repeated if necessary.

By letting the respondents express their concerns and addressing these, both the therapeutic alliance was reinforced as well as a deepened understanding of the respondents about their pain was achieved.

Sub-category: Having trouble accepting the complaints

Dealing with the complaints and the consequences of them in daily life was hard for the respondents. All respondents expressed that they often felt frustrated, sad, angry, stressed, restricted in life and activities, and often mentioned having trouble accepting their pain and other complaints (fatigue, dizziness, etc.).

> *Respondent 4: "Eh well, I would like to walk more, I would pretty much like to walk more, however my feet hurt so much when I do so"*

There were, however, also some signs from respondents that they did accept the pain and had found ways to deal with the complaints. For instance, by mentioning that they tried to live mindful and expressing that accepting the complaints is a stepwise process they had to go through.

Sub-category: Doubt and hesitation towards the PNE and changing

Doubts and hesitation could be seen in multiple manners, most often by small concealed resistance, such as: *Yes, but…..", "I get it, however …."* and non-verbal manners. As can be seen in table 5 and 6, some of the respondents started with some hesitation towards message of PNE from the previous session. Doubts and hesitation could also be related to the contributing factors. As can be seen in table 5 and 6, some respondents found it difficult to face the biopsychosocial factors that appeared to contribute to the persistence of their pain.

There could also be hesitation or resistance about how the healthcare professionals would frame or use certain words and explanations.

> *Respondent 5, physiotherapist: "It is also about how you deal with your own body, ehm, stress, tension, right? Partner respondent 5: "He is not a stressed person at all. He is, he can be super relaxed about almost everything. He is not somebody who worries easily"*

During the start of the PNE session, all respondents had some doubts, hesitation or resistance about the explanation. These diminished as the healthcare professionals further explained what they were doubtful about, for instance specific somatic perceptions. Most often during the PNE session respondents shifted their aim away from searching for a simple biomedical solution towards a biopsychosocial understanding of their complaints. Apart from respondent one, who found it difficult to comprehend the message that there was no specific biomedical cause, and respondent eight, who alternated between hesitation and agreeing with the PNE throughout the session. Furthermore, there was also resistance associated with behavioural change necessary to deal with pain in the long term in some respondents (especially in respondents three and eight, in smaller manner in respondent six). For instance, respondent three did agree with CS, the PNE and contributing factors, however found it hard to change her behaviour in the future (see table 5 and 6). Doubt and resistance towards change was harder to address and often persisted in those who experienced it. This form of hesitation linked to the category of C*hangeability of the respondent*. There was no obvious resistance to be seen against the healthcare professionals and no major ruptures in the alliance were observed. Based on these video observations it was not possible to tell which actions from the healthcare professionals might have led to a decrease in doubt and hesitations of the respondents, or if other actions would have led to other outcomes. Furthermore, based on these video observations it is only partly possible to tell whether the amount of doubt and resistance had influence on the final outcomes of the PNE session, as we could only observe the doubt and resistance during this session and not what happened during the subsequent treatment.

Sub-category: Reaction of the healthcare professionals towards doubts and hesitation

The healthcare professionals would react in different manners towards doubt and hesitation. First, by asking them how the previous session of PNE with the GP went, they addressed doubts and hesitation surrounding this session in the beginning of the current PNE.

Most and foremost they would listen, acknowledge the respondent, take them seriously, acknowledge that living with these complaints is hard, recognizing what is important for the respondents and that behaviour change is difficult. Sometimes by listening and giving the respondents time to express themselves the resistance diminished. If the respondents didn't express these doubts and hesitations but they were noticeably there (because the nonverbal communication would show a closed posture, frowning, retreating in the chair), the healthcare professionals would ask them about the resistance they saw or mention them themselves. When they were out in the open, they would then discuss them. Explaining the goals of the session also diminished some doubts and hesitations. Furthermore, a part of the PNE was to explain origin of the complaints the respondents experienced, which also dealt with doubt and resistance. When a word or sentence would cause resistance, they would reframe it and use other words. The same accounted for the examples they used.

> *Respondent 1, physiotherapist: ".... There are things that can enhance the signal, for instance stress. Such a conversation is a form of stress" Respondent 1: "Well not for me, I am not easily stressed"..*
> *Psychologist: "Effort, maybe we should call it effort" Respondent 1: "Yeah that I realize"*

Every now and then they cleared the air by using (appropriate) jokes. To further deal with resistance they also used positive reinforcement of the changes the respondents already made. Furthermore, they would try to bring insight to the respondent by asking in depth questions, having silences, summaries, reflective questions and sometimes more confronting questions, and giving the respondents time to express themselves. Or they would try to let the respondent look at his/her life from a distance. Giving hope for the future was also a way to diminish resistance of the respondents:

> *Respondent 8: ".. I used to walk so much, where, where is that all that investment? .. I'm so, I find that frustrating." Physiotherapist: "Well maybe that it is still somewhere?" Respondent 8: "[frustration laugh] Yes I hope so, because if it all just gets worse, well then I feel like there's nothing left. [shakes head] That's when I get those thoughts: this is never going to be over and just let it go.." Physiotherapist: "So yes, we should break that cycle"*

Category 4: Outcome of the PNE process

Two sub-categories emerged in relation to the outcome of the PNE process: Process of insight into CS and factors surrounding CS and *Stages of change of the respondent* (table 5).

The process of insight into CS involves two components: the first is gaining knowledge, the second is applying this knowledge to yourself and possibly others. This process is interactive with the previous categories (e.g. *Process of change of the respondent*) and the category *Influence of changeability of the respondents.*

> *Respondent 1, psychologist: "And how can that (conversation) increase your complaints?" Respondent 1: "Yeah, well, it's probably because I turn my head a lot, I think"*
> *Psychologist: "That is the explanation?"*
> *Respondent 1: " Yes, I think so" Physiotherapist: "But in a such a conversation you're facing the other right? So, then it isn't the head (turning)"*
> *Respondent 1: "Yes, that's true"*

All respondents showed signs of trying to convey the message and understand what is being said. However, in some respondents it was more difficult to align the individuals' beliefs with the healthcare professionals views regarding the underlying pain mechanisms and contributing factors. As mentioned in table 5 and 6 all respondents gained different levels of knowledge about CS, the contributing factors and applied these differently to themselves. Signs of increased awareness, knowledge and understanding could be seen in the videos (a larger description is in the appendix) and would for instance be:

> *Respondent 6, session 2: "So you have to work here (points to head, smiles) as it were, to decrease the pain there (points to hip)"*

Category 5: Communication skills

Several different communication skills were used and every healthcare professional had his/her own preferences. For example, some of the psychologists" used more "reflective summarizing", where the physiotherapist videotaped in the PNE session of respondent 7 used a lot of silences. Furthermore, the communication style was modified in a patient centered manner to the respondent in front of them. For instance, in persons with less formal education less difficult language was used.

> *Respondent 2, physiotherapist: "It is actually too strong of a response from the nervous system. What do you think?"*

Communication skills and strategies included: encouraging, verbalizing non-verbal communication, parroting, positive reinforcements, silences, asking interactive questions, (reflective) summarizing, reflective and provocative questions and comments. A detailed description with examples can be found in the appendix.

Category 6: Interplay between the healthcare professionals

Throughout the PNE session there was an interplay between the healthcare professionals. For instance, one of the two would confirm the others explanation, deepen the explanation or check the cognitions and emotions of the respondent about that explanation. This interplay was also characterized by the synchronicity and fluidity between the healthcare professionals in the conversations.

Category 7: The influence of changeability of the respondents

As can be seen in figure 2 and 3, throughout the PNE a change process is initiated. The changeability, or psychological/cognitive flexibility, of the respondent, as seen in these videos during this process, encompasses a few steps:

1) the ability to exert reciprocity in interpersonal contact and openness;
2) the comprehension of the neurophysiology of the PNE and change in cognitions;
3) the self-reflectivity about the contributing factors;
4) the ability to stop fighting against their complaints and in some way accept these complaints;
5) the ability to modify behaviour or accept help regarding this.

Whilst not all respondents were able to progress through all steps, all of the videos mapped onto the steps. For instance, most understood the neurophysiology, however some found it hard to comprehend (the depth of this comprehension remains unknown from these videos). Some respondents found it difficult to be reflective about their contributing factors, while others found it hard to accept their complaints and stop fighting. Last, some found it hard to modify or alter their behaviour in the future (described in table 5 and 6), especially respondent 3, 6 and 8:

> *Respondent 3: "yes, yeah.. it is about going on and on.. I'm a hard worker so that is what I do. And I know that I have more physical complaints afterwards. It is just... How can I change that? I'm like: yes, on the one hand I want to change because I want to get rid of the pain, however, on the other hand I want to live my life like I do now"*

From these videos the changeability of a respondent was seen as something that corresponds with expected health literacy rather than intelligence, as both respondents with a respectively expected higher or lower intelligence (based on education) could be proactive/cooperative or be resistant towards change.

Discussion

In this study we studied the second PNE session for patients with chronic pain in a transdisciplinary setting. The aim of this study was to explore the social process between the patient, partner and healthcare professionals in the practice of transdisciplinary PNE, in order to try to comprehend and theorize what contexts and influences may lead to effective PNE outcomes.

Several key findings in the process of PNE emerged: Underlying the PNE was the therapeutic alliance, as found in "*Generating a safe and comfortable feeling, situation*". The video observations showed that effort was put in to achieve and maintain a positive relationship. Important in this category, and overlapping with the "*PNE process*", was incorporating personal information from the intake in the PNE. These results are in concordance with a previous study highlighting the importance of a good patient-therapist interaction in pain rehabilitation[62]. The patient-therapist interaction is also known as the therapeutic alliance [44], with a strong therapeutic alliance able to improve treatment outcome in patients having chronic pain[45,46]. In correspondence with existing literature regarding the therapeutic "ruptures and repairs" were seen throughout the video observations[63,64]. Ruptures are part of the therapeutic process and when healthcare professionals are attentive to ruptures, explore the negative feelings of the patient, and respond to those feelings in an open and non-defensive way, ruptures can strengthen the therapeutic relationship[63,65,66]. Attending to ruptures, as seen during the observations, by the healthcare professionals through "communicational skills", as well as taking the patient seriously, is not only important, it can also contribute to positive patient outcomes[63]. However, the therapeutic alliance grasps more than the healthcare professionals being caring, sensitive, a personal bond and positive feelings, it also comprehends agreement on tasks and goals and the perception of the patient that the offered interventions have potential[67-69]. In alignment with the therapeutic alliance, based on the video observations, PNE was used as a steppingstone to reach agreement for the following intervention. When respondents were not yet ready for these future interventions, a next session was scheduled to give the respondent time to think about it and further explore how to proceed.

Secondly, the step by step explanation of the PNE, the metaphors that were used and the individualization of PNE to the respondent, also known as "*The PNE process*", helped the respondents change their way of thinking ("*The process of change of the respondent*") from searching for a biomedical, somatic, cause into a more biopsychosocial understanding in which pain does not represent physical harm. The current is in concordance with a previous study, in which the respondents mentioned the education as being comprehensible, especially by the repetition, examples and individualized metaphors[40]. The PNE process sparked a "*Process of change of the respondents*". This process involved the interactions between the respondents and healthcare professionals on topics such as: concerns about the complaints, trouble with accepting and dealing with the complaints, doubt and resistance towards the new information (most often at the beginning of the session). In most respondents the interaction and message of PNE positively influenced the topics mentioned above. Even though some nuances must be introduced: several respondents did still have some biomedical beliefs and questions at the end of the PNE, for instance: *"Are you sure it is not an inflammation?*". These questions can be seen as doubts towards the provided explanation. Previous studies have shown that it is "normal for patients to feel this way": most often the patients have heard numerous theories about pain and reconceptualizing and adopting a new one takes time[36-38,40]. From these studies, as well as other studies, it is known that patients often had various tests, treatments and diagnosis' and in order to re-engage trust, as well as following a biopsychosocial route requires time and an optimal therapeutic alliance[42]. Furthermore, it is important to keep in mind that relevance to the individual is important and PNE will not suit all patients[38], some patients will not agree with the neurophysiological explanation of pain[40,62]. The PNE process activated the "*Outcome of the change process"* of the respondents, in which most respondents gained improved understanding of their pain and factors contributing to their pain experience. This is consistent with both previous qualitative research[38], an implementation survey[41] and reviews on quantitative studies of PNE, which have shown increased pain knowledge, changed attitudes towards pain, improved coping, decreased kinesiophobia and pain catastrophizing in patients with chronic pain[24,34]. However, in line with the current observations previous studies also mentioned that follow up during further treatment is needed to further deepen the reconceptualization and enhance these aspects[33,34,37].

Some of the respondents did understand the PNE, however found it hard to envision changes in their pain related behaviour, whilst others had already changed their daily practice based on the first PNE session. The "*Influence of changeability of the respondents"* on the PNE and outcomes, even though present, was a difficult concept to grasp. There was no distinct profile noticed from the video observations, nor characteristics of a “responder” or “non-responder” to the PNE. This is in line with previous studies on the implementation of PNE, which also found that even though there are patients who respond better to PNE defining characteristics of these patients and patients who do not respond so positively continues to be difficult[37,38,41].

Limitations

There are several factors to mention with regards to limitations in this study. First, as there were only observations there was no data triangulation. This may have resulted in limited richness of the data as the experiences of the respondents surrounding their PNE have not been investigated. Furthermore, the observations only included the second PNE session. As the intake, first session with the GP and further treatments were not taken into account, the trajectory of the respondents surrounding the understanding and reconceptualization of their pain was not visible. It can be debated to what extent true changes and reconceptualization can be explored in the video recording of one session. The generalizability of the current study is limited to the transdisciplinary context of the observed PNE in which a psychologist and physiotherapist collaborate. Most PNE however, is delivered in practice in a monodisciplinary (physiotherapy) setting. It is known that physiotherapists often struggle with the psychosocial part of the treatment[70-73]. However, when they are trained in combining physiotherapy with psychology treatment it improves outcomes[74,75]. In the current study the physiotherapists were trained in these psychosocial parts and had extensive clinical expertise in chronic pain and (bio)psychosocial treatments. This training might have influenced the categories that were found in this study. Another limitation concerns the translation of the theory. Even though efforts were made to convey the essence of the Dutch-language and the translation was reviewed by two team members, there are some considerations to mention. First, procedures to assure the trustworthiness of the translation, such as for instance forward and backward translation, were not performed. Second, it is previously proposed that any translation of language is problematic, as: ’no one can be sure of which concepts or words differ in meaning across languages and which do not, or if it matters in the context of the translation’[76]. However, whilst critically challenging the translation, as mentioned in the method-section, some actions were made to enhance the validity of the translation. And last, the reflexivity of the researchers analyzing the data is a source of limitation[77]. Both researchers performing the initial analysis have experience with providing PNE (one in a private clinical practice, the other both in clinical practice, education and science, as well as in a transdisciplinary team) and believe PNE is an important part of the intervention of patients with (long term) pain. Furthermore, all other authors are in line with this view and in some form contribute to the field of PNE either in clinical practice, education or science. To ensure that the researchers were not overly involved a reflective paper was written and a neutral stance was sought throughout the analysis.

Implications for science

This study contributes to the research topic of PNE for patients with chronic pain. Future research should indicate, for instance by treatment trajectory studies[78], how the acceptance of the PNE could influence reconceptualization of cognitions, and how changes in outcomes following PNE unfold in a transdisciplinary setting. Furthermore, it would be interesting to investigate whether there is a difference in outcomes in comparison to similar PNE within monodisciplinary settings.

Implications for practice

It has been suggested previously to study clinical characteristics that may increase the effectiveness of PNE[41]. Even though qualitative research has a limited transferability[43], with some caution based on the current study several implications for practice can be mentioned that may help clinicians. First, of large importance: clinicians should be aware and invest in the therapeutic alliance between the patient and healthcare professional(s) prior, during and after the PNE. For instance, by taking the patient and his/her problems seriously, using the aforementioned communicational skills and by using personal information from the intake in the PNE session. Second, individualizing PNE to the patient and the variety of the metaphors by which the healthcare professional can choose individual examples is of importance. And last, introducing the biopsychosocial perspective early on in treatment, whenever possible in an inter- or transdisciplinary setting, might enhance the patients’ comprehension of the biopsychosocial aspects of their complaints. This forms a foundation and rationale for the patient to address these in a biopsychosocial-viewed pain management treatment.

Conclusion

In conclusion a variety of factors related to and influencing the practice of PNE emerged in relation to effective PNE outcomes. These included the underlying therapeutic alliance in "*Generating a safe and comfortable feeling*", situation, the steps, individualization and metaphors used during the PNE session in *The PNE process,* the *"Process of change of the respondent"* and the interactions of the healthcare professionals influencing this process. This leads to an increased knowledge about CS and biopsychosocial factors contributing to the pain experience in "*The outcome of the PNE process*". Further inter-linking findings were "*Communication skills, The interplay between health care professionals*" and *"The influence of changeability of the respondents"*. Due to limitations in the design the transferability of the study findings is limited to the second session of PNE in a transdisciplinary setting. These findings provide the groundwork to inform further research into what is required for effective delivery of PNE services.

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Appendix 1: Comprehensive results

The findings that are presented here are the comprehensive results from the theoretical coding of the research subject: *"Exploring patient-therapist interactions for effective Transdisciplinary Pain Neuroscience Education: A qualitative Constructivist Grounded Theory study".* The tables and figures mentioned in the appendix correspond with the tables and figures mentioned in the findings of the research subject.

Category 1: Generating a safe and comfortable feeling and situation

Everyone in the process invested in creating a warm and friendly environment. Efforts to create and keep an alliance with the respondents was often seen from the healthcare professionals. These efforts resulted in the respondents showing both verbal and non-verbal signs of feeling at ease, acknowledged and understood. Signs in non-verbal communication were such as 'sighs', 'relaxing the shoulders', often 'nodding', 'gentle smiles' and getting emotional. It was also seen in verbal communications such as '*yes that is it!*', '*exactly*' or for instance finishing the sentence of the healthcare professional.

> *Respondent 3: "I do feel as if you understand me"*
> *Respondent 1, Psychologist: "Because we don't feel what you feel, but we believe every word you say" Respondent 1: "Yes (nods twice)"*

Generating a safe and comfortable feeling was started during the prior intake and continued to be an active process throughout the session with all respondents. Even though there were small individual differences, they were too small to describe as differences between respondents.

Three subcategories were identified. From both the respondents and healthcare professionals: *Making jokes to keep the conversation light* . From the healthcare professionals: *Building an alliance with the respondents* and *Faux pas from the healthcare professionals*.

Making jokes to keep the conversation light

Making jokes was used by everyone to keep a light atmosphere. Whenever respondents felt a bit tensed or a bit awkward, any one of them would 'laugh it off' or joke. This could be when the respondent didn't really understand something or when a difficult topic was addressed by anyone of them, when they felt less comfortable talking about themselves.

> *Respondent 6: 'yeah, that sawthooth pattern (in daily activities) (laughing)'*

Building an alliance with the respondent

Building an alliance with the respondent consists of multiple efforts: *Creating a safe environment*, in which the healthcare professionals *Showed understanding, recognition and empathy*, and *acknowledged the authenticity of pain*.

Creating a safe environment

Creating a safe environment ensured the respondents dared to express themselves. This environment was created non-verbal by for instance offering a comfortable chair and creating a comfortable space. Verbally it was done telling them they could always ask any question, no matter what for question or how critical, during the session or in later treatment and responding to those questions with ease and understanding. Furthermore, this save environment was created by letting them tell their story and giving the respondents time to express themselves. Expressed or non-verbal shown discomfort or awkwardness as felt by the respondents were handled with care. For instance, respondents would be joking, or telling something that was hard for them:

> *Respondent 6: 'I have just browsed through it (booklet), because I have to concentrate very hard when I am reading. I am a bit dyslexic and I often have something like: 'what is written there?' And I read everything wrong again' Psychologist: 'You have to take the time for it.'*

Discomfort was also handled by making polite jokes by the healthcare professionals, often followed by a sentence or gesture to reassure the respondent they took them seriously.

> *Respondent 1: (mentions that he had a lot of pain after the movement assessment of the intake) Psychologist to physiotherapist: (jokes) 'What did you do? Did you pull?' Respondent 1: ' No, I had to do this and this (turns head slowly, moves arms slowly), and well' Physiotherapist: 'That does sound like a funny movement' Psychologist: 'I think I'll quit our collaboration (all laugh) .. But (serious) the physio made a movement with your neck you don't usually make'*

Creating a comfortable space meant placing the respondent in the center. For instance by first asking them if it was ok to contact other healthcare professionals related to the treatment and what kind of information the respondent wanted to be shared. It was also done by asking the respondent for his/her preferences:

> *Physiotherapist respondent 7: ' Regarding, the future treatment trajectory, it is important that you say what you want .. of course, it's nice that you take our feelings into account, be aware that the process is all about you.'*

Recognizing and understanding personal suffering and pain

Recognizing and understanding the respondents' pain by the healthcare professionals meant showing an overall empathy for the respondent as a person and their suffering. The healthcare professionals often recognized, emphasized and expressed the frustrations, feelings of heaviness and the hardships of dealing with chronic pain and fatigue the respondents felt.

For instance, by being caring, wanting to gain an in-depth knowledge of the complaints and emotions, acknowledging mixed emotions, underlining emotions, renaming emotions and giving the respondents time to deal with their emotions.

> *Respondent 3: 'Now I'm getting emotional again ..' Psychologist: 'That really touches you, right?'*

As well as expressing what these emotions did to them as healthcare professionals.

> *Respondent 4, physiotherapist: 'Could it also be eehm .. your story is so moving, .. euhm sorry. A very moving story, yes, it keeps you busy, kids, they keep you busy'*

Some of the most used sentences were: *'yes, that is hard'*, *'I get it'* and *'we understand that it is difficult'*.

The impact of the pain on the respondent's life and future was often mentioned.

Besides an overall empathy, the healthcare underlined their empathy for the unfamiliarity of the respondents with CS and contributing factors. They recognized that is not easy to understand and that it is normal to not know all that information. Thereby they acknowledged the doubt some respondents had towards the PNE.

> *Respondent 2, physiotherapist: 'Well, the hard thing is, you can't see anything right? Someone with hay fever has tears in her eyes and know it's hay fever' Respondent 2: 'Yes, tears and snotty, she gets a cold, she has red eyes and that (hay fever) is why, right?' Physiotherapist: 'That is in essence an overreaction of the nervous system. That is actually what it is about and now about pain signals pain. The pain is real; however, you can't see anything different in those people. That is often what makes you insecure, that is what often makes it incomprehensible: why am I in pain now?' Respondent 2: 'Yes, yes' (nods twice)*

Furthermore, the healthcare professionals showed an understanding, recognition and empathy for the suffering of the respondents.

> *Respondent 5, physiotherapist towards partner: 'So he's a completely different man you say'*

The healthcare professionals often expressed the frustrations, feelings of heaviness and the hardships of dealing with chronic pain and fatigue the respondents felt. They recognized that pain costs a lot of energy, is frustrating, feels uncontrollable, disappointing, often endures, demands attention, and is difficult to deal with.

> *Respondent 8, physiotherapist:' Well, it is complicated to deal, to, deal with this'*

The impact of the pain on the respondent's life and future was often mentioned, for instance how activities were limited, normal activities where now full of effort and pain and weighed upon them.

Besides acknowledging the emotional impact of pain on a person, the healthcare professionals also corroborated on the realness of the complaints. By explaining to the respondents that: *'CS isn't something you do to yourself', 'it is a process that happens within your body and outside someone's will'. 'Just because you can't see it on the outside, doesn't mean it is not real'. 'Pain is not something someone imagines', 'nor is someone a wimp for having CS pain'. 'CS pain is a real pain and not 'in your head'', 'it is not psychological', 'whatever you feel is real'.*

For those respondents (respondents 1, 2, 4 and 8) who had a biomedical question or quest the healthcare professionals understood and acknowledged this quest and that for them biomedical explanations needed to be excluded. If necessary, and not already performed, biomedical examination, such as bloodwork, was done. In an interactive process with the patient outcomes of these or previous examinations were explained in the light of PNE.

They also understood that respondents find it hard to differentiate between 'nociceptive' and 'CS' pain and it is hard to deal with chronic pain:

> *Respondent 3, physiotherapist: 'If only I would give my arm some rest and it would become less painful, however, that is not the case (in your situation)'*

One of the ways in which they acknowledged the realness of the complaints is by explaining to the respondents that around 20% of the population experiences chronic pain. Furthermore, they explained to the respondents that even though there is no damage, their pain is real.

Among this category was also the acknowledgement that the contributing factors, such as frustration, negative feelings towards pain, tension, avoidance, are often factors one changes/does/feels unconsciously and not are easy to change. However, also acknowledging that when these contributing factors were changed, life would be more enjoyable.

> *Respondent 1, physiotherapist: 'Exactly, however, hurt, or screeching sounds scream for attention, because it is just very annoying and often your thoughts go straight to those feelings.. however, that is also a factor which maintains the problem. So try distraction, that's easy to say, huh, from the distraction, but (...) it's a given. If you manage to find distractions, for example with music, which makes you distract from the sound, it eventually gives you peace.'*

Using personal information from the intake in the PNE

The healthcare professionals used personal sometimes specific information which they heard or had seen during the intake. Using this personal story was important to enhance its relevance to the individual, reinforce the explanation and made respondents feel heard. For instance, the healthcare professionals would explain what they had seen in the physical examination (moving tensed, being tensed), repeat information from the intake (trauma/memories surrounding trauma, always pushing yourself, struggling, trying everything to control the pain, working nightshifts, going beyond ones limits, finding it hard to be relaxed) and/or emotions that where present during the intake. Or they just referred to what the respondents said by: '*I've heard you say that before*'.

> *Respondent 2, psychologist: 'You told me in the first conversation: I am not that much of a worrier, and I don't worry that much, but I do feel that the pain now dominates my life. (R: Yes, yes, yes, yes.) And that is a very frightening thought.*
> *Respondent 2: Yes. Well that is the case at this moment'*

Faux pas from the healthcare professionals
Faux pas from the healthcare professionals were unhelpful actions that caused small ruptures in the therapeutic alliance. On a communicational level these were for instance asking many questions in one sentence and using difficult words.

> *Respondent 5, physiotherapist: 'No that is true.. can you grasp what I am saying? How is that for you? .. Because it means a difference in dealing with the pain, right? And how you look at pain. Is that, is that a reassurance or not? How does it feel for you both?'*
> *Respondent 5: '... I don't know how that feels'*
> *Respondent 5, partner: 'I am so glad that it isn't a herniated disc anymore, yet on the other hand he has something that isn't visible. How do we explain that to others?'*

Furthermore, faux pas would be when the healthcare professional quickly went through the contributing biopsychosocial factors:

> *Respondent 7, physiotherapist: 'Again, raising the bar high, right? (Yes) and constantly over asking your body (Yes) that is not something you can always control (No) not within your family, within your work (No, no) the nightshifts you work (Yes) Yes, the irregular work shifts (business) Yes'*
> *Respondent: 'Yes, well it is..'*
> *Physiotherapist: 'It is quite a lot'*
> *Respondent: 'Yes, well in terms of work, it is kind of a lot'*
> *Physiotherapist:' Well, (pointing to the board) and thoughts also go with the anger it evokes'*

Sometimes there would be an unclear answer to a question or topics and questions mentioned by the respondent or partner were not readdressed.

Furthermore, faux pas also happened when the healthcare professional was not at his/her best game explaining the neurophysiology of PNE, had a misapprehension on a source of stress of the respondent, or mentioned arthritis all of the sudden somewhere in between the PNE.

Some other faux pas were: bridging the contributing factors in the PNE was explained in a inartful manner, a metaphor was used that the respondent didn't understand, and in one of the respondents two appointments were scheduled wrong.

These faux pas were often addressed and the ruptures repaired.

Category 2: The PNE process
The category the PNE process consists of the sub-category '*characteristics of the PNE*, in which the content of the PNE, individualization of the PNE and examples and metaphors are described. Among with the PNE there are different processes that are in action, related to the next categories *'Process of change of the* respondent' and *'Outcome of the PNE process'*.

The steps of the PNE process
Most often the PNE conversation would involve similar steps in the process, as described in table 4 and in the table below (supplementary table 1). By this stepwise structure respondents were engaged in the explanation of their pain/complaints.

Supplementary table 1. Detailed description of the general lay out of the PNE session

General content of the PNE session	Healthcare professional explaining (most often)	Particulars
1 a) Welcome back, general lay out of this session	Psychologist	1a and 1b could be exchanged
1 b) Ask how the first session with the GP is experienced by the respondent and what the respondent remembers of the GP's explanation.	Psychologist	
1 c) Explain goals for this session; more clarification, explain their pain in more depth, some guidance in how to deal with his/her pain, and further treatment(s).	Psychologist	Reaction of the respondents on the goals were expectations and questions: which treatment trajectory, why am I in pain/what is the cause of CS, the desire to have more energy, more tools to deal with pain, desire to get rid of the pain
2) Explain difference between acute and chronic pain; 20% of the population experiences chronic pain, examples. There is a difference in cause, duration, progression, efficacy of NSAIDs, often increased pain. Both are alarming, however in acute pain there is harm, in chronic not. There is an overactive processing of (danger) signals, fire alarm metaphor.	Physiotherapist	Respondents who first experienced acute pain were explained that it started with acute pain, however there is no 'damage left' and the metaphors were their own (for instance falling of stairs) Based on the classification of pain[61].
3) From 'damage' to CS: explaining the difference between acute and chronic pain for the individual. No damage, however: the pain signal is real, credible. Biomedical cause are ruled out, or not enough to explain the pain (arthrosis), and/or: it started with acute pain or neuropathic pain, however there is now an overactive processing system. Based on patients' own description of pain, disabilities, prior treatments and tests.	Physiotherapist	Normalizing the pain. Important in this phase was that the healthcare professionals underlined the credibility of the pain, taking the respondent and his/her pain really serious.
4 a) Explanation that it is an overactive processing/sensitization. By drawing a schematic picture of the nervous system: brain, spinal cord, and peripheral nerves. Explaining neurophysiology of acute pain by an example (for instance a cut, individual example), while drawing ascending and descending pathways, in order to normalize acute pain (helpful).	Physiotherapist	
4 b) Explain neurophysiology of chronic pain/central sensitization, while drawing the changes in the central nervous system: ascending and descending overactive interpretations of sensory input, decreased filter for sensory input in the spinal cord and brain, whilst using individual examples (for instance hyperalgesia, pain when sitting).	Physiotherapist	
5) Bridging the PNE towards the biopsychosocial factors in various ways, for instance: now we are going to see what might induce this system to get overactive, you have previously said … Do you think this could influence this system? Do you have an idea what could influence this? Or via predisposition, or naming the first contributing factor.	Psychologist	The variations in this 'bridge' depended on the healthcare's' preferences and their estimation of the patients' preferences
6) Explain and discussing the biopsychosocial factors that contribute in the respondent's pain experience, while drawing the links in the brain. Individual contributing factors were discussed in a for the respondent non-threatening manner, such as: previous operations, continuing searching for the cause/solution, questions about their pain, maladaptive cognitions, not accepting pain/fighting, emotions surrounding pain (frustration, anger, sadness, compulsiveness, fear, fear of movement), emotions surrounding other aspects of life (traumas, family, work, etc), not ventilating emotions, stress, physical tensions, changed behavioral patterns (small: not lifting, larger: doing a lot one day and nothing the other), avoidance, sleep, irregular working schedules, not taking care of oneself, putting the bar high, trouble dealing with life, life's purpose/fulfillment, financial problems, pressure to go back to work.	Both, however most often the psychologist	
7a) Based on the contributing biopsychosocial factors some individual advice and guidance in dealing with his/her pain was provided. Such as: this needs a different kind of handling than acute pain, stop looking for the fire, stop looking for a magic pill, take the pain into account but not too much, don't do all or nothing/ try to minimize sawtooth patterns in activities, regain structure, seek distraction, you can influence your pain; it's not easy but you can, simple therapies won't work in this system and will disappoint you, allow yourself time to grow, it's a learning process, taking care of yourself is important, dealing with stress and tension, relaxation (overall, and when in pain) is important, it's important to break this spiral, it is important to enhance movement/activities, smooth reintegration to work is important, accepting the pain vs. fighting it, create your own vision on how to deal with chronic pain.	Both	7a/b/c could be exchanged

Supplementary table 1. (Continued)

Supplementary table 1. (Continued)

General content of the PNE session	Healthcare professional explaining (most often)	Particulars
7 b) Further treatment options and goals were discussed. Individual treatment options were considered in a respondent centered shared decision making manner that enhanced the inhibitory system and made the patients regain control. Shared decision making meant that patients were asked: how can we help you?, patients had time to reflect on what they needed, treatment options were discussed with them, patients were advised to think about the treatment options and their preferences, there was a respondent centered planning of the sessions, the treatment was communicated with other healthcare professionals that were involved if the respondent preferred this and patients were advised to discuss the treatment options at home. The respondent centered treatment options were: physiotherapy, psychology, psychotherapy, or a combination. Patients were advised that 'simple' therapies won't work, or that hands on therapy has no long-term effect. Goals for treatment (transdisciplinary, both physiotherapy and psychology): steadily enhancing activities, regaining physical fitness, improving strength and vitality, regaining control over life, becoming emotionally more balanced, becoming more resilient, decreasing the bar, learning to care for yourself, learning to be proud, recognizing stress- and other signals from the body telling you your boundaries, learning to relax (overall), learning to relax the body, relearning movement strategies and becoming less stiff, being able to react less tense in life, dealing with/accepting pain and fatigue, dealing with emotions and cognitions about yourself/pain, creating awareness (about how you deal with life, things happening in life), learning other behavioral/coping strategies (about pain, decreasing the saw-thooth pattern of daily activities and/or week schedules), increasing confidence in the body and/or reintegrating towards work.	Both	

Supplementary table 1. (Continued)

General content of the PNE session	Healthcare professional explaining (most often)	Particulars
7 c) Give a realistic picture and hope for the future. Thereby giving back purpose: These complaints are not something that will disappear in an instant. This situation (CS) is reversible or partly reversible, but we don't know where we'll end up or how long it will take. We are aiming to decrease pain in the long term. It's not about being completely pain free. The pain itself is hard to treat, however by treating the factors surrounding it, the pain-system might get calmer. This all depends on the person, complaint, history, factors surrounding it. We are aiming to give back control. The better one deals with pain/life, the better it is to bare, the more energized we feel, the more satisfied we are with life, the more the pain is manageable and sometimes fades away. It's not easy, but possible. Individual responses: 'You have already changed some factors (work, psychological treatment), those surrounding things are what makes it better.' 'Your body is strong, that is important to remember, the pain signal might stay but that is a writing error, maybe it is about giving life meaning even though you are in pain.'	Both	
8) Closure of the PNE session: There is a lot we have talked about today. These factors, treating those is what we aim to focus on. Are there any questions? Is everything clear? Sometimes: shortly explain what is going to happen in the next sessions. Advice to write down any thoughts and questions for the next sessions.	Both	

In most occasions these steps would change according to the individual respondent or preferences of the healthcare professionals. As described in the next category.

Individualizing the PNE

As can be seen in table 5 and 6 every PNE session was individualized according to the respondent. Individualizing the PNE was done in a subconscious manner and multiple ways. First, in all sessions the healthcare professionals recalled information and questions from the respondents that were mentioned in the intake. Furthermore, if the respondent had mentioned questions or expectations during the intake or PNE session, these were answered during the session. The individual contributing biopsychosocial factors were explained during the second part of the PNE. Additionally, the healthcare professionals copied the words and language of the respondents, with language based on the individual. They explained in a pace adapted to the respondent and used recognizable metaphors for the respondents. The treatment options were discussed in a shared decision manner, with an individualized level of involvement.

Individualizing the PNE also meant keeping it interactive by asking questions to the respondent, checking whether the respondent understood the previous information.

> *Respondent 8, psychologist: 'Could you think of something? What could also be a factor is the thoughts you have about the pain … could you give an example of that?'*

Furthermore, in the beginning of the PNE the healthcare professionals would often ask them what their knowledge about (chronic) pain was or mentioned that the respondent might already know some things about (chronic) pain from previous treatments/sessions. Based on their answers they would then proceed. Sometimes reducing the amount of neurophysiology because the respondent already knew a fair deal about it. In some PNE sessions the neurophysiology part was decreased and less complicated vocabulary, in respondent five without even calling it 'sensitization', to keep it understandable. If a respondent mentioned their own metaphors for the explanation the healthcare professionals would incorporate these in the further explanation.

Individualizing the PNE also mentioned explaining all complaints of the individual respondent, the pain, but also fatigue, dizziness, (physical and mental) tension, seeing flashes, hearing sounds and trouble sleeping.

> *Respondent 1, physiotherapist: 'So that is it, this is it. It's not affectation.. It's just, that system is upset, just as it is mixed up, with you, and you can notice that in different aspects, it can just be pain, but with you we see a combination of pain, sound, light..'*

Metaphors and examples

Metaphors and examples were based on the individual person, in plain language, based on the expected health literacy of the respondent. Often the respondents would react in agreement, this could be seen by the non-verbal communication (listening seriously and nodding), or in a verbal manner by 'yes', 'hmhm' (often in combination with non-verbal communication) or by responding to a metaphor with their own metaphor/example.

> *Respondent 7, physiotherapist: 'It is, no, these are none painful signals that go up (points from spine upwards to the brain), they, they come into a network which immediately says: POING, pain! Because you sense pain in your brain, not in your foot'*

Metaphors and examples related to the neurophysiology were: examples of acute pain (falling on your knee, spraining an ankle); our body has no difference between acute pain and chronic pain; alarm bell going off; a burglary/fire alarm that goes off for nothing/wind/a fly, which is not necessary; fire alarm is too sensitive; hay fever as an example of amplified reactions; there is pain however no damage; when in pain one searches for the fire but it is not there; you are put on the wrong foot (by own cognitions of the pain: bone fragment, something being loose in the skull); the problem is real, however there is no physical cause, the problem is the alarm system; the problem is not the fire; the system is the problem; the system is over excited; the system is under pressure; the filter doesn't filter signals enough; a volume button that is set open; amplified signals; sensitizing of the body and processing system; everything that enters that system is interpreted as pain, while there is none there is no damage; brain is on the wrong track; misinterpretation; example of how he sees light flashes in the dark as an example of how the nerves are overstimulated, same as for pain and sounds, it's something he sees/hears yet is not there, overactive nervous system that makes own sounds and light, started with blow to the head, now overactive; the stimuli from her legs are interpreted as pain, there is nothing wrong with the legs it is the system behind it that interprets the stimuli as painful, that is where you feel pain; it's the signals that are coming up, enter the network, which 'poing' marks pain, you feel pain in your brain not in your foot; examples on how normal daily activities (sitting, using the stairs, etc.) are painful due to amplified signals; example of how cutting yourself doesn't hurt when your children are crying, because then the filter does work and the brain prioritizes; example of browsing through vacation photo's vs not seeing them for a while; the pain system is wired, however not a solid thing. Metaphors and examples related to the contributing factors were: pain as an unwelcome guest; how stress negatively affects to your cognitive functioning; examples how their pain control system used to be effective; how persistence in survival mode negatively affects pain; examples on how continuing to persevere with bronchitis or a sprained ankle is not useful; it is a bucket with water that is overflowing (always trying to please others); how 'normal fatigue' is concurred in a few weeks of holiday, however hers' continues and is therefore not just a wrought-up phase; a lid that opens up every time (traumas); operations are often part of the problem, because they are such heavy input, that's why they often stop after 2-3 surgeries; operations can be useful however, are also detrimental for this system; your brain keeps on going (thinking, worrying), and is linked to all sorts of connections in your body, so 'pfieuw' there goes the signal again, it is all connected; asthma as a physical condition which is affected by stress; how not taking care of yourself increases the system; physical and psychological taking care of oneself is the same thing.

Metaphors linking the neurophysiology and contributing factors and further treatment were: about this alarm system, if it's a little clearer, more understandable, you can take advantage of it, it's not something that doesn't change, you are not crazy, this is the explanation for your complaints; the cause is in the system, not in that something is damaged, this other interpretation of your complaints could be the first step; it's about quieting down this system; the more relaxed it is up there, the better the filter works, that's how the system works; lyrica (medication) tries to ignite the filter, which helps in some people; when your emotions calm down a bit you might notice that you're functioning improves.

Category 3: Process of change of the respondent

Understanding, agreeing with and implicating the PNE on his/herself and daily life was a process for the respondent. This change process is a personal iterative process with multiple steps, as displayed in figure 3.

Not all steps could be seen in all videos: some respondents found it more difficult to comprehend the information, others found it hard to accept their situation, or found it hard to change, whereas others already understood the knowledge, had no trouble accepting, or already made some differences in their lives. These individual differences can be seen in table 6, describing the individual differences of the PNE session and table 5, describing the outcome of the PNE process.

Within this change process respondents had several struggles, which emerged as the sub-categories, as can be seen in the theoretical framework. These struggles surrounded '*concerns about the complaints they experienced', 'having trouble accepting the complaints'* and *'doubts and resistance towards the PNE and change'*. Throughout these struggles, a '*process of insight in CS and the factors surrounding the experienced complaints'* also started and in some even changes for daily life were made or planned for in the future.

Concerns about the complaints they experienced and how the healthcare professionals react to this

There was a cyclical process between the concerns about the complaints the respondents perceived and the explanation for this (CS) during the PNE. All respondents expressed concerns surrounding their complaints, however respondents 3,4,6 and 8 more often. Furthermore, some respondents expressed concerns surrounding how their environment reacts to their complaints, either by themselves or because the healthcare professionals asked them. The healthcare professionals would often react to these concerns with conversational skills.

Concerns about the complaints

Respondents expressed their concerns about their complaints often in the start of the PNE. Most often throughout the PNE this decreased or diminished completely, apart from respondent one and eight (table 5 and 6). These concerns surrounded the etiology of their complaints: how it could be that they were now experienced chronic pain but not prior, why their complaints were increasing, and how to deal with their pain.

> *Respondent 8: 'and when I get up I get this shooting pain in my foot...then I'm like, well!, just by lying! I'm thinking I'm giving my body a bit of rest and then when I get up the pain is even worse. That's when I'm concerned, I'm like: What is it? What is it?'*

Furthermore, they expressed concerns surrounding how their social environment reacts to their complaints. Either about their complaints in the past: problems with employers that didn't show understanding, some experienced incomprehension and not being taken seriously by their social environment/family/friends (others did experience being understood by their surroundings), some said they felt their social environment thought '*it's in your head*' and '*chronic pain is not a visible problem like breaking a leg*'. And in the present: '*central sensitization is not known by our social environment'*, and *'how do we explain this to our environment?'*

> *Respondent 2, psychologist: 'Miss told me that she practiced the word 'sensitization' quite a lot at home (all laugh) and she noticed that in her environment it is a new thing'*
> *Respondent 2: Yes, I hadn't heard of it before, nobody, nobody I talked to had heard of it before'*

> *Respondent 4, partner: 'I'm really glad that it is not a hernia.. however, now he has something that is not visible .. how do you explain that? .. towards another?'*

Reaction of the healthcare professionals towards concerns
The healthcare professionals dealt with the concerns first by asking the respondents about their concerns, so they would out them. Subsequently, healthcare professionals took great care in taking the respondents and their concerns seriously. Often, by these actions the concerns would then be gone, or less important.

> *Respondent 1, physiotherapist: 'You say your symptoms have increased, is that something you worry about? Say, what if it continues like this what then? Or isn't that on your mind?'*
> *Respondent 1: 'Well that is something I have been thinking about. What if I have to live like this? It continues and gets worse? (looks sad). That's why I'm here'*

If these concerns were driven by inadequate cognitions, they questioned these misconceptions and proceeded by (re)explaining the PNE in further detail. This cycle was repeated if necessary. By letting the respondents express their concerns and addressing these both the therapeutic alliance was reinforced as well as a deepened understanding of the respondents about their pain was achieved.

Having trouble accepting the complaints
Dealing with the complaints and the consequences of these complaints in daily life was hard for the respondents. All respondents expressed that they often felt frustrated, sad, angry, stressed, restricted in life and activities, and often mentioned having trouble accepting their pain and other complaints (fatigue, dizziness, etc.).

> *Respondent 4: 'Eh well, I would like to walk more, I would pretty much like to walk more, however my feet hurt so much when I do so'*

The complaints also had consequences which they found hard to deal with, such as a loss of income, financial problems, struggles with bosses and being less involved in life.

Furthermore, respondents often mentioned having trouble accepting the complaints they perceived. In this they expressed a desire to experience less complaints, be able to do more, hope for an easy solution and hope for less pain.

> *Respondent 6: '.. Yeah, that's what I said earlier, even if I have to be crippled for the rest of my life, I don't care, as long as I get rid of the pain'*

Having trouble accepting the complaints often let to internal struggles. For instance, between wanting to do more and then perceiving pain, or having the household done in a fast pace and feeling less energetic, having to accept help from others, knowing that in order to be able to deal better with the pain certain internal changes had to be made.

There were, however, also some sings from respondents that they did accept the pain and had found ways to deal with the complaints. For instance, by mentioning that they tried to live mindful, expressed that accepting the complaints is a stepwise process they had to go through, had ideas on what could help them deal with their complaints, or because they already made some changes and had a positive reaction on those changes.

Doubt and resistance towards the PNE and changing
There was no obvious resistance to be seen against the healthcare professionals. Based on these video observations no major ruptures in the alliance was observed, nor increase in doubt and hesitation towards the healthcare professionals. If respondents had doubt and resistance towards the message of the PNE it often diminished throughout the PNE session. Meaning that respondents hadn't already changed their mind, then most often during the PNE session they went from searching for a simple biomedical solution towards a biopsychosocial understanding of their complaints. Apart from respondent one, who found it difficult to comprehend the message that there was nothing biomedically wrong. Doubt and resistance towards change was harder to address and as can be read in table 5, often persisted in those who experienced it. This form of hesitation linked to the category of *'changeability of the respondent'*.

Based on these video observations it was not possible to tell which actions from the healthcare professionals might have led to a decrease in doubt and hesitations of the respondents. Or if other actions would have led to other outcomes. Based on these video observations it is only partly possible to tell whether the amount of doubt and resistance had influence on the final outcomes of the PNE session, as we could only observe the doubt and resistance towards the during this session and not what happened during the subsequent treatment. Therefore, it was not possible to tell which doubts and hesitations might have risen after this session and brought back to the healthcare professionals in the next treatment session. Furthermore, as PNE is at the beginning of the treatment and not a stand-alone treatment modality it is unsure which other treatments influence these doubts and hesitations later on.

Doubts and hesitation from the respondents

Doubts and hesitation could be seen in multiple manners. Most often by small concealed resistance, for instance in the form of: *'Yes, but.....', 'I get it, however ....'*. By increasing the pitch and loudness of their voice, or by non-verbal manners: swallowing words, getting a bit restless, sitting with a closed attitude and by sitting back and creating more space between them and the healthcare professionals.

As can be seen in table 5 and 6 some of the respondents started with some hesitation towards message of PNE from the previous session. Respondent two, for instance, did agree with her pain being an alarm signal going off without a burglar present, however had some resistance as to whether she caused the alarm going off. Once it was neurophysiological explained that she did not the hesitation was gone. Respondent three had some resistance because there was no biomedical cause, which, once taken seriously and explained was gone. Respondent four kind of understood the previous session, however found it *'a bit wooly'*, didn't really grasp it and once it was explained that there is something neurophysiological changed had less resistance towards the message. However, her resistance against changing behaviours in order to deal with pain stayed. Respondent six had some resistance towards the message that she was 'afraid to move', during the PNE this resistance disappeared. Respondent eight had some hesitation, '*what if there is something else going on?*' and switched in this hesitation throughout the PNE.

During the PNE session, all respondents who first had some doubt, hesitation or resistance about the PNE diminished in this as the healthcare professionals explained the part they were doubtful of. Besides respondent eight, who alternated between hesitation and agreeing with the PNE throughout the session. Doubts could come from: finding the first explanation a bit wooly; disappointment that there was no biomedical cause; doubts about the diagnosis: isn't there something damaged/a biomedical explanation; hope for an easy solution; I'm not the cause of this (the alarm going off) right?; previous operations being iatrogenic; why do I feel this now?.

Doubts and hesitation could also be related to the contributing factors. As can be seen in table 5 and 6, some found facing their biopsychosocial contributing factors difficult. There could also be hesitation or resistance about how the healthcare professionals would frame or use certain words and explanations: stress, life being heavy: '*yes, but I don't experience life as being heavy, to me it (feeling distant to herself in conversations) is strange'*, your back is strong and not crooked, there is nothing wrong/damaged.

> *Respondent 5, physiotherapist: 'It is also about how you deal with your own body, ehm, stress, tension, right?*
> *Partner respondent 5: 'He is not a stressed person at all. He is, he can be super relaxed about almost everything. He is not somebody who worries easily'*

Or hesitation surrounding the cause of the complaints being traumatic (fall from the stairs), being worried about their complaints (dizziness, fatigue, pain, etc) and/or how they dealt with their complaints (avoidance, finding it hard to accept their pain, keeping on searching for a cause of the pain, the importance of regulating emotions). Last, there was also resistance associated with behavioural change necessary to deal with pain in the long term in some respondents (especially in respondents 3 and 8, in smaller manner in respondent 6).Either in behavioural change that already happened, however did not diminish the complaints, or even though they understood that behavioural change was important yet finding it hard to change. For instance, respondent three did agree with CS, the PNE and contributing factors, however found it hard to change her behaviour in the future.
Doubt and hesitations were linked to the *'influence of changeability of the respondents'.*

Reaction of the healthcare professionals towards doubts and hesitation

The healthcare professionals would react in different manners towards doubt and hesitation. First, by asking them how the previous session of PNE with the GP went, they addressed doubts and hesitation surrounding this session in the beginning of the current PNE.

> *Respondent 6, physiotherapist:' Could she (doctor) explain what she was thinking about as cause for your complaints, did she tell you that?'*
> *Respondent 6: 'Euh, well, no. I told her in my previous rehabilitation treatment they also said that euh, I had to learn to deal with the pain. They already told me that I am scared to move. Well, I said: that's not completely correct, because if that would be true, then I would have used the crutches all the time and wouldn't have used my right foot.' Physiotherapist: 'Yes, so you don't recognize yourself in that description?'*
> *Respondent: 'No, because I walk about 20 minutes every day, preferably without crutches.. because I feel like, you need to get some movement otherwise you get stiff'*
> *Physiotherapist: 'Yes, that is really good of you to do that' .. continues about not being afraid to move ..*
> *Physiotherapist: 'You feel like doesn't cover it (psychologist: No) (Respondent: No, no [shakes head]). I get that.'*
> *Psychologist: 'It's really just a part of the story actually, a part of the bigger picture, so it is important that we explain the bigger picture to you, so this part can fall into place, but we have to talk about it together, right?' Respondent: 'Yes' [nods, non-verbal no resistance]*

Most and foremost they would acknowledge the respondent, take them seriously, acknowledge that living with these complaints is hard, it is not something someone chooses, that these contributing factors are not thoughts/emotions/behaviours/ experiences someone has or does on purpose, acknowledging what is important for the respondents and that it is not easy to change. Sometimes by listening and giving the respondents time to express themselves the resistance diminished in itself. If the respondents didn't express these doubts and hesitations but they were noticeably there (because the nonverbal communication would show a closed posture, frowning, retreating in the chair), the healthcare professionals would ask or mention about the resistance they saw themselves. When they were out in the open, they would then talk these over with the respondents. Explaining the goals of the session also diminished some doubts and hesitations. A part of the PNE was to explain origin of the complaints the respondents experienced, which also dealt with doubt and resistance. For instance, why it was not an inflammation, why it was only one spot, why they believed it was CS pain, why it got worse, why sitting was painful, why physical tension and moving stiff increases pain, and why they believed the respondent was feeling tired. Sometimes when a word or sentence, such a 'stress', would cause resistance they would reframe it and use other words. The same accounted for the examples they used, they would use examples and check by verbal and non-verbal signs that the respondents could understand them, if not, they would use different examples.

> *Respondent 1, physiotherapist: '.... There are things that can enhance the signal, for instance stress. Such a conversation is some sort of stress' Respondent 1: 'Well not for me, I am not easily stressed'.. Psychologist: 'Effort, maybe we should call it effort' Respondent 1: 'Yeah that I realize'*

Every now and then they cleared the air by using (appropriate) jokes. They also used positive reinforcement of the changes the respondents already made to deal with resistance. Furthermore, they would try to bring insight to the respondent by asking in depth questions, having silences, summarizations, reflective questions and sometimes more confronting questions, and giving the respondents then time to express themselves. Or they would try to let the respondent look at her life from a distance, as if it was someone else's' life, to recognize that the way the respondent was dealing with things only made it harder. Giving hope for the future was also a way to help respondents deal with the hardships surrounding the complaints, contributing factors and having to change.

> *Respondent 8: '.. I used to walk so much, where, where is that all that investment? .. I'm so, I find that frustrating.' Physiotherapist: 'Well maybe that's still somewhere?' Respondent 8: '[frustration laugh] Yes I hope so, because if it all just gets worse, well then I feel like there's nothing left. [shakes head] That's when I get those thoughts: this is never going to be over and just let it go..' Physiotherapist: 'So yes, we should break that cycle'*

Giving them hope that by changing their behaviour, often not extremely but in some amount, they could regain some perspective for the future.

Category 4: Outcome of the PNE process

Two sub-categories emerged in relation to the outcome of the PNE process: "Process of insight into CS and factors surrounding CS" and *"stages of change of the respondent"* (table 5).

Process of insight into CS and factors surrounding CS

The process of insight into CS involves two components: the first is gaining knowledge, the second is applying this knowledge to oneself and possible others. This process is interactive with the previous sub-categories *'concerns about the complaints', 'doubt and hesitation'*, and the reaction of the healthcare professionals towards this*, 'having trouble accepting the complaints*' and the category '*influence of changeability of the respondents*'.

> *Respondent 1, psychologist: 'And how can that (conversation) increase your complaints?' Respondent 1: 'Yeah, well, it's probably because I turn my head a lot, I think' Psychologist: 'That is the explanation?' Respondent 1: ' Yes, I think so' Physiotherapist: 'But in a such a conversation your facing the other right? So, then it isn't the head (turning)' Respondent 1: 'Yes, that's true'*

In some respondents it was more difficult to align the respondents' beliefs with the healthcare professionals views regarding the underlying pain mechanisms and contributing factors. In respondent five it was harder to notice as he had minimal non-verbal expressions, however, he and all other respondents showed signs of trying to convey the message and understand what is being said. These expressions could be noticed by showing signs of actively and seriously listening and thinking.

As is mentioned in table 5 and 6, all respondents gained different levels of knowledge about CS, the surrounding factors and applied these differently to themselves. Most of them would have some doubts, biomedical ideas or uncertainties at the beginning of the session and steadily progressed towards an increased knowledge, understanding of CS. As well as in applying it to themselves. Concerning the factors surrounding CS, by the explanation most understood why and how these factors influenced their pain experience. However, as previously explained some found it hard to deal with changing their behaviour/themselves in order to cope with these factors.

Signs of increased awareness, knowledge and understanding would for instance be: explaining acute and CS pain in his/her own terms, asking questions about the explanations/metaphors, acknowledging his/her own contributing factors, agreeing with/acknowledging that the explanation they are receiving is 'their pain', coming up with treatment options or agreeing with the proposed treatment options, seeing changes for the future, coming up with own examples:

> *Respondent 5, partner: ' So then, everything you feel is in stereo?'*
> *Respondent 6, session 2: 'So you have to work here (points to head, smiles) as it were, to decrease the pain there (points to hip)'*

> *Respondent 7: 'Yes, absolutely, that's what I mean by focus. That is, if I'm, if it (the pain) is there, then, then, yes, I increase it by frustrating myself over it'*

Category 5: Communication skills

Several different communication skills were used. Whereby every healthcare professional had his/her own preferences. As an example, some of the psychologists' used more 'reflective summarizing', whereas the physiotherapist videotaped in the PNE session of respondent 7 used a lot of silences. Furthermore, the communication style was modified in a patient centered manner to the respondent in front of them. For instance, in persons with less formal education less difficult language was used.

The healthcare professionals used the following communication techniques:

Encouraging

Using words and expressions such as: *'hmhm', 'yes', 'exactly', 'no', 'that's correct', 'precisely', 'yes I agree with that', 'ha', 'good'*, as well as nodding and putting question marks at the end of these short expressions showed understanding and encouraged respondents to talk.

Verbalizing non-verbal communication

Non-verbal communication, often sighs, were checked or interpreted.

> *Respondent 3: 'And also over time, that it just takes so long, (PS: Yes) that's why I got so emotionally flattened. (PS: Yes, yes.) I'm just .. [looks down to the right, sighs, mouth corners down, eyes hanging lightly]' Psychologist: 'Sigh, downhearted'.*

Parroting the respondent

Parroting what the respondent just said in the wording of the respondent was used to encourage the respondent to keep on talking/explaining.

Positive reinforcements

Positive reinforcements of gained insight, changed knowledge and behavioural change that respondents have in mind or already happened was used to increase the alliance.

> *Respondent 7, physiotherapist: 'And that is important, that you (see something has to change). That's why we try to map it all out, even though you already know a lot … and you already know a big deal (about her triggers)'*

Silences

Silence was used to give the respondents time to think, reflect, and express themselves.

Asking (interactive) questions about cognitions, knowledge, understanding, emotions and behaviour

One of the reasons these questions were asked was to verify and increase the understanding and knowledge of the respondents with the previous and current PNE. They often checked whether the given information changed the knowledge and understanding of the respondents about their pain.

> *Respondent 2, physiotherapist: 'It is actually a too strong of a response from the nervous system. What do you think? Do you think, well I understand that? Or not at all?'*

By asking these questions, they became more aware of the knowledge the respondents gained, but also how they incorporated this knowledge and whether there was resistance or doubt and hesitation about the explanation. They also often used this technique to question faulty cognitions such as *'my vertebrae is out of line'*, *'my SI joint is crooked'* or the cognition that *'there is a bone fragment in my brain'*. Furthermore, they asked questions about the emotions and linked behaviours of the respondents. Asking them and their partners about their lived experience with pain, so they felt understood as well as letting them gain insight in how these emotions and behaviours can increase pain. For instance, about how the pain affected them, irritations, fear, the ability to feel relaxed, emotions surrounding reintegration of work and how they handled their pain. At the end of the PNE the questions were more directed to how they could help the respondents deal with their pain. One important aspect they questioned was the emotions surrounding the PNE explanation and further treatment. Besides getting to know hesitation by asking for the knowledge of the respondents they often asked questions surrounding doubt and hesitation:

> *Respondent 6, psychologist: 'How did the explanation of the doctor seem to you?'*

One of the most used communication strategies was asking clarifying questions. Either open- or closed ended, with a non-judgmental character. For instance:

> *Psychologist: 'So it is not as if you do a little less today then you would feel better tomorrow?' Respondent 6: 'Well really, yes [laughs]. It makes me feel like: hé, I feel a little better-' Psychologist: 'And then, what are you going to do?' Respondent 6: 'Well then, I will do some "heavier" work. ' Psychologist: 'Exactly' Respondent 6: 'Well, and then I have to pay for it the next day.'*

There was a slight difference in asking questions and interactive questions and comments, because interactive questions and comments requires more of an action in the form of thinking and response of the respondent. Furthermore, interactive questions were often asked to involve the respondent into the neurophysiology of the PNE. For instance:

> *Respondent 7, physiotherapist: 'Are there other topics (contributing factors) we didn't mention, but you think hé that is important?'*

Summarizing

Summarizing was used by the healthcare professionals to build rapport, check whether they understood the respondent correctly and take the next step in the PNE.

Reflective summarizations

Reflective summarizations are more influential than normal summarizations. Besides giving the respondent a feeling of being understood, they aim to give insight to the respondent, are more metaphorically and often contain emotions. For instance:

> *Respondent 7, physiotherapist: 'Again, it is about putting the bar high, right? (R: yes). And constantly over asking yourself .. family, work, nightshifts, irregularity. it's quite a lot'*
> *Respondent 4, psychologist: 'For you beauty is very important, right?, insight and out. And you find it difficult to accept, let's say, to accede that not all is beauty, that its' not all perfect and beautiful. How beautiful you show it to be on the outside, yet on the inside you are in pain. That doesn't match at all, they have no idea how you feel in the inside, how much effort it costs you.'*

Reflective and provocative questions and comments

The healthcare professionals often used reflective and provocative questions and comments. These are shorter than the summaries and invite the respondent to reflection and can be somewhat provocative. They were often used to let respondents gain insight in their behaviour, cognitions, emotions and how this negatively impacts their pain. These questions and comments were often accompanied by 'soothing words', such as: *'it is not criticism', 'we understand why you would think/do/feel that way'*, in order to not disrupt the rapport.

Some examples:

> *Respondent 6, physiotherapist: 'You recognize the struggle?'*
> *Respondent 6, psychologist: 'So you are often under time pressure?'*
> *Respondent 3, psychologist: 'It quite heavy, your load ... so you are continuously balancing'*
> *Respondent 5, psychologist: 'Well, it's not going that well because the gas bill is not being paid!'*
> *Respondent 8, psychologist: 'Yes, so you start to question yourself a little more do you mean?'*

Category 6: Interplay between the healthcare professionals

Throughout the PNE session there was an interplay between the healthcare professionals and sometimes afterwards they reflected on the PNE together. For instance, the physiotherapist would ask the psychologist if he/she missed anything. Or one of the two would confirm the others explanation, deepen the explanation or check the cognitions and emotions of the respondent about that explanation. This interplay was also characterized by the synchronicity and fluidity between the healthcare professionals in the conversations. Often the physiotherapist would explain the neurophysiology and the psychologist would have an observing role and check how the PNE landed.

Category 7: Influence of the changeability of the respondents

As can be seen in figure 2 and 3, throughout the PNE a change process is started. The changeability, or psychological/cognitive flexibility, of the respondent as seen in these videos during this process encompasses a few steps:

1) the ability to have interpersonal contact with the healthcare professionals and be open;
2) the manner in which the respondent was able to understand and embody the knowledge of the PNE and change his/her cognitions about the complaints they experienced;
3) the self-reflectivity about his/her contributing factors, such as emotions, cognitions, stress and behaviour;
4) the ability to stop fighting against his/her complaints and their influence on his/her daily life, and in some way accept these complaints;
5) the ability to modify or alter his/her behaviour towards behaviour that would be more helpful or accept help regarding this

Whilst not all respondents were able to progress through all steps, all of the videos mapped onto the steps. For instance: respondent five had little interpersonal contact with the healthcare professionals (however did partake in step 4 and 5). Or that most understood the neurophysiology, however some found it hard to embody the knowledge. Furthermore, the depth of this comprehension remains unknown as that can only be seen in future sessions. Some respondents found it difficult to be reflective about their contributing factors, while others found it hard to accept their complaints and stop fighting. Last, some found it hard to envision how to, and/or to modify their behaviour in the future.

Most often, those respondents who found it hard to modify their behaviour, respectively respondent 3, 6 and 8, somewhere already knew that in order to deal with their complaints they had to change, however found it really difficult.

> *Respondent 3: 'yes, yeah.. it is about going on and on.. I'm a hard worker so that is what I do. And I know that I have more complaints afterwards. It is just... How can I change that? I'm like: yes, on one hand I want to change because I want to get rid of the pain, however, on the other hand I want to live my life like I do now'*

From these video's the changeability of a respondent was seen as something that corresponds with health knowledge rather than intelligence, as both respondents with a respectively expected higher or lower intelligence (based on education) could be proactive/cooperative or be resistant towards change.

6

Moderators of change in self-reported signs of central sensitization following an individualized transdisciplinary pain management program

The moderating effects of pain catastrophizing on the relationship between changes in illness perceptions and self-reported sings of central sensitization in patients with chronic pain

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Abstract

Purpose
Two factors related to the continuation of chronic pain are pain catastrophizing and illness perceptions. Pain neuroscience education is known to positively influence both in patients with chronic pain. As the integration of pain neuroscience education monodisciplinary physiotherapy treatments is effective, integrating in transdisciplinary cognitive behavioural treatments seems recommendable. When doing so, the moderating effect of pain catastrophizing and perceptions on treatment results has to be examined, as these provide valuable information under what conditions treatment works.

Methods
A bottom up retrospective observational study evaluated the changes in clinical outcomes, and relationships between clinical outcomes and cognitive and emotional factors in patients with chronic pain. Multiple regression analysis, PROCESS macro, explored the moderating effects of pain catastrophizing on the relationship between illness perceptions and self-reported symptoms of central sensitization.

Results
In total 78 patients were included in the study. A correlation between pretreatment scores and change-scores in illness perceptions and self-reported symptoms of central sensitization following treatment were found (resp. *R-sq .407, F(10,99) = .638, p=.000, R-sq .361, F(5, 54) = .609, p=.000* and *R-sq .314, F(4,55) = .560, p=.00)*. However, moderation of pain catastrophizing scores on these correlations were not found.

Conclusions
Even though a correlation between changes in pain catastrophizing and illness perceptions in patients with chronic pain was found, the direction or strength between the changes in illness perceptions and changes self-reported symptoms of central sensitization was not influenced by pretreatment scores of pain catastrophizing.

Introduction

'Pain is a mutually recognizable somatic experience that reflects a person's apprehension of threat to their bodily or existential integrity'[1]. This new definition of the International Association for the study of Pain (IASP) emphasizes the complex nature of pain: pain and the intensity of pain is a subjective experience of threat, rather than an objective measure of tissue damage. Pain that perseveres beyond the normal time for tissue healing and/or longer than 3-6 months is defined as chronic pain[2].-

Two factors that negatively influence chronic pain are pain catastrophizing and maladaptive illness perceptions[3-7]. Pain catastrophizing is characterized by cognitive and emotional processes surrounding irrational negative thoughts, magnified threat value of pain and experienced helplessness in the context of pain[8]. These three factors have been operationalized as magnification *('I wonder whether something serious might happen'*), rumination ('*I keep thinking about how much it hurts'*) and helplessness ('*I feel I can't stand it anymore'*)[8,9]. Pain catastrophizing is associated with, or predicts the degree of pain and disability[10-13] and delayed recovery[12] in various musculoskeletal pain problems. In addition, pain catastrophizing has been linked to activation of brain areas involved in pain processing, pain perception, modulation, attention to pain, and affective components of pain, leading to reduced top-down inhibition[8,13,14].

Important in any health behaviour are the beliefs a person holds on their 'illness or condition'[15]. These illness perceptions will influence the perceived threat, used coping strategies and outcomes of a patients' illness[15]. In patients with chronic pain, illness perceptions account for a large amount of depressive and anxiety symptoms[16-18]. As a consequence of maladaptive illness perceptions, the cognitive and emotional representation of these illness perceptions represent threat and fear. Which then amplify the neural signaling, thereby intensifying the experienced pain[19].

One way to deal with these maladaptive illness perceptions and pain catastrophizing is by educating patients. Also known as pain neuroscience education (PNE), the neurophysiological explanation of pain is well studied and has a high level of evidence when combined with other treatment modalities in the treatment of patients with chronic pain[20-23]. A recent review has shown that PNE produces clinically significant reductions in pain catastrophizing in patients with chronic pain.[22]. Furthermore, PNE improves most patients' knowledge on pain and reconceptualizes illness perceptions about their chronic pain[24,25]. However, PNE should be considered as a steppingstone and should be integrated in further treatment[22].

The effect of pain catastrophizing on treatment outcomes is increasingly studied. This effect can be studied from multiple perspectives: In a predictive manner: high pain catastrophizing scores are associated with more pain and disability at follow up in patients with low back pain[10]. From a mediator perspective: a decrease in pain catastrophizing is associated with better outcomes in daily activity, pain control, disability and pain in patients with low back pain[10]. Furthermore, evidence from cognitive behavioural therapy (CBT) for patients with chronic pain, including addressing maladaptive cognitions, shows that decreased pain catastrophizing is, amongst other things, linked to decreased activity in the dynamic pain connectome[26-28]. These findings suggest that CBT-induced brain changes relate to a reduction of CS in patients with chronic pain.

From a moderator perspective: higher pain catastrophizing scores significantly moderate the association between pain and secondary hyperalgesia in healthy indiviuals[29]. Furthermore, PNE combined with cognition-targeted exercise therapy is more effective in decreasing self-reported symptoms of CS in patients with high levels of pain catastrophizing[30]. Both show the connection between these cognitive-emotional factors and symptoms of CS. However, a review on treatment of low back pain concluded that the assessment of moderating effects was inconclusive[10].

Moderator analyses provide valuable information on for whom and under what conditions treatment works[31]. Therefore, it is suggested to further investigate the role of pain catastrophizing as a moderator for the outcomes of treatments of patients with chronic pain[10]. Understanding for whom and how changes in outcomes following transdisciplinary CBT treatment, including PNE, might achieve its effects is of importance for both current practice and future science.

Aim

The aim of this observational study is to explore whether the relationship between changes in illness perceptions and changes in self-reported symptoms of CS following transdisciplinary CBT treatment, among which PNE, is moderated by pain catastrophizing in patients with chronic pain.

The following hypotheses were stated prior to the analysis:

- Pretreatment levels of pain catastrophizing moderate the relationship between pretreatment levels of illness perceptions and pretreatment levels of self-reported signs of central sensitization in patients with chronic pain;
- Pretreatment levels of pain catastrophizing moderate the relationship between changes in illness perceptions and changes in self-reported signs of central sensitization in patients with chronic pain undergoing transdisciplinary CBT treatment;
- Changed of levels of pain catastrophizing moderate the relationship between changes in illness perceptions and changes in self-reported signs of central sensitization in patients with chronic pain undergoing transdisciplinary CBT treatment.

Methods

A bottom up retrospective observational study evaluated the changes in clinical outcomes, relationships between clinical outcomes and illness perceptions and pain catastrophizing, and moderating effect of pain catastrophizing scores following treatment.

Patients

Patient data were gathered and retrospectively analyzed from an individual outpatient CBT treatment program at Transcare pain management center. Prior to the intake and post treatment, patients filled out a battery of questionnaires which is part of standard care. Data were gathered from 112 patients pre-treatment and 78 post-treatment. 34 patients dropped out either because they did not continue treatment, did not want to complete the post treatment questionnaires or because questionnaires were not submitted.

Patients were eligible to participate if they: 1) were between 18 and 85 years of age, 2) were suffering from nonspecific chronic pain as defined by the International Association for the Study of Pain (IASP) [2], and 3) were sufficiently able to read, speak and understand Dutch. Patients were excluded from this study when they: 1) were diagnosed with a specific medical condition (e.g., Parkinson's disease, rheumatoid arthritis, stroke), 2) had cognitive impairments, 3) had dementia, 4) or had a serious psychiatric condition as identified through the Symptom Checklist 90 (SCL-90) [32]. All patients signed an informed consent form on which they agreed to the collection of their data. Confidentiality was guaranteed and all materials were handled anonymously. This study was conducted in compliance with the principles of the Declaration of Helsinki. Based on Dutch laws, ethics committee approval was considered unnecessary due to the nature of this study.

Intervention

All patients followed a transdisciplinary CBT treatment, as described in a previous study[25]. This treatment starts with a three-hour assessment – one hour with a medical doctor, a psychologist and physiotherapist. After this extensive intake, the healthcare professionals discuss the patient analysis containing the pre-dominant pain mechanism and biopsychosocial contributing factors. About a week later the medical doctor explains the pre-dominant pain mechanism and contributing factors to the patient, the first PNE session, in about 20-30 minutes. Often the patient is accompanied by their partner/spouse. After this session all patients receive written PNE information. In a second session, about a week later, the psychologist and physiotherapist elaborate in a second PNE session. During this session treatment goals are discussed based on shared decision making. The intervention consists of a patient centered CBT. Meaning that components of CBT, the content and duration of the therapy is adjusted to the patient and his/her needs. The CBT, without assessment, consisted of on average four psychology sessions and five to six physiotherapy sessions. The CBT, without assessment, consisted of on average four psychology sessions and five to six physiotherapy sessions.

Measures

Sociodemographic data Sociodemographic data were collected with a standardized questionnaire on age, gender, educational level, relationship status, profession and employment status.

Pain characteristics and intensity

The following characteristics were gathered: duration, intensity and location. Patients were asked to rate their average pain on a Numeric Rating Scale (NRS), ranging from 1 (no pain) to 10 (severe pain). The psychometric properties of the NRS are good[33,34].

The number of painful body regions was measured with the Widespread Pain Index (WPI). Which is a well-known measure for the distribution of pain. The score from none (0) to the complete body, including the head (20). In this study patients described where the pain is located on an illustration of the human body[35]. The WPI was then summed up and analyzed as a categorical variable. The WPI has good psychometric properties in juveniles with pain[36].

Central sensitization

Symptoms of central sensitization were measured using the Dutch version of the Central Sensitization Inventory (CSI). The CSI appears to be a valid, reliable, usable, and diagnostically relevant questionnaire assessing common symptoms and facilitating factors to CS[37-40]. A cutoff score of 40 points indicates the symptoms are due to predominant CS pain[41,42]. Only total CS scores should be used[43]. Furthermore, scores on the CSI merely reflect general distress rather than a direct measure of CS[44].

Pain catastrophizing

Pain catastrophizing was measured using the Dutch version of the Pain Catastrophizing Scale (PCS). The PCS is a self-reported questionnaire with 13 items on a 0 (not at all) to 4 (all the time) scale, n which patients are asked to report what they feel and think when they are in pain. The three subscales consist of rumination, magnification and helplessness. Higher scores relate to more pain catastrophizing, with a cut off score of 24[45] and a score of 21.6 serves as the reference value from the Dutch Dataset Pain Rehabilitation[46]. The PCS has adequate to excellent internal consistency, good concurrent validity and good responsiveness[47,48].

Illness perceptions

Illness perceptions were measured with the Dutch version of the Brief Illness Perception Questionnaire (IPQ-B). The IPQ-B is developed to assess the cognitive representations of illnesses[49] based on the Common Sense Model of Self-regulation by Leventhal. The first eight items, as used in this study, are scored on a 0 to 10 scale and represent five scales that consist of identity, cause, timeline, consequences and cure-control. Retest reliability and internal consistency is good, except for the causal item. It has a good construct validity, sound discriminant and predictive validity, but the factor structure is unstable in patients with musculoskeletal pain[50]. In the current study a total score of the IPQ-B was used. An overall score can be computed by reversing items 3, 4, and

7 and then summing all items. A higher score reflects a more threatening view of the illness.

Disability

Disability was measured using the Dutch version of the Disability Rating Index (DRI). The DRI is 12-item questionnaire measuring limitations in daily physical functioning in patients with pain, scored on a visual analogue scale from 0 to 10 (total score 0-120). It's internal consistency is good, with good reliability, good content validity, reasonable construct validity and good responsivity[34,51,52].

Health related quality of life

The Dutch version of the RAND-36 was used to measure health related quality of life (HrQoL). A higher score indicates a perceived better HrQoL. The generic questionnaire RAND-36 is almost identical to the Short-Form-36 (SF-36). Because calculating the total score of the RAND-36 for HrQoL is under discussion only the subscales were used[53]. These consist of scales for physical functioning, social functioning, and limitations due to physical and emotional problems, mental health, energy, pain and overall health perception . The RAND-36 has a high convergent validity, however low discriminant validity in an overall Dutch population[54].In three chronic diseases reliability showed strong unidimensional hierarchical scales[55].

Data analysis

For all statistical analyses SPSS version 24 statistical software was used (IBM SPSS Statistics for Mac, version 24, IBM Corp., Armonk, N.Y., USA).

Demographic variables and outcome measures were described using descriptive statistics.

Educational levels were classified according to the International Classification Education (ISCED) system, 2011. Due to the small amount (N=3) of post-treatment WPI results, the WPI was only used for baseline.

Normality was checked with Kolmogorov-Smirnov tests. Because the data were not normally distributed non-parametric tests were used. To assess pre- and post-treatment changes Wilcoxon's Signed Rank Tests were performed. For all analyses $p <$ 0.05 was considered significant. Complete case analysis was performed.

Based on an a-priori sample size calculation, calculated using G*Power[56] for multiple linear regression analysis, random model, based on a 0.05 alpha error probability, and a proposed tentative effect size for moderation analysis set on ƒ2=0,15, with a (1-ß) power of 0,80 and number of tested moderators 3, a sample size of 69 deemed sufficient.

Prior to the moderator analysis data were checked for, and the assumption of homoscedasticy was met. Residuals were normally distributed. Associations were tested using Spearman Rank Correlations. Variance inflation factor was used to check for multicollinearity, which was not found.

The PROCESS-macro v. 3.4 was used for moderation analysis (model 1)[57]. All variables were centered to the mean and the Johnson-Neyman-technique was used. Only complete data were taken into account.

Key co-variates were pretreatment and changes in pain intensity, age, sex, education, employment status, widespread pain index and duration of the complaints. As only the widespread pain index and changes in pain intensity were significant contributors in the primary model they were kept.

Results

In total 78 patients with chronic pain were included in the study. Sociodemographic characteristics are described in table 1. The majority of the sample was female (51.3%) with a mean age of 48.75 (SD=15.61). The duration of complaints was on average 91.91 months (SD=113.18), with an average pain intensity of 6.61 (SD=1.85) and 5.66 (SD=4.27) pain reported sites. The average score of self-reported symptoms of central sensitization was 33.93 (SD=15.34), which is below the cut off score of 40; 30.1% of the patients scored above the cut off score (≥40) on the CSI[41]. The average score on the pain catastrophizing (PCS) was 19.31 (SD=10.47), 44.53% scored above the Dutch reference value of 21.6[45].

Table 1. Sociodemographic and pain characteristics of the studied patients with chronic pain (n=78)

Characteristic	
Age *(mean ± SD)*	48.75 ± 15.61
Gender *(m/f, %)*	38/40 (48.7/51.3)
Relationship status (N,%)	
Single	16 (20.5)
Married	40 (51.3)
Cohabiting	13 (16.7)
Divorced	6 (7.7)
Widowed	3 (3.8)
Education (N,%)	
Primary school or less	3 (3.8)
Lower secondary education	26 (33.3)
Higher secondary education	28 (35.9)
Post-secondary non tertiary education	8 (10.3)
Tertiary education bachelor	10 (12.8)
Tertiary education master	2 (2.6)
Missing	1 (1.3)
Employment status (N,%)	
Employed	40 (51.3)
Unemployed	8 (10.3)
Studying	3 (3.8)
Welfare or social assistance	21 (26.9)
Retired	6 (7.7)
Duration of complaints in months *(mean ± SD)*	91.91±113.18
Pain intensity last week *(mean ± SD)*	6.61±1.85
WPI *(mean ± SD)*	5.66 ± 4.27

Educational levels were classified according to the International Classification Education (ISCED) system, 2011. Due to the small amount (N=3) of post-treatment WPI results, the WPI was only used for baseline. WPI: Widespread pain index

Pre-post treatment changes

On average pre- and posttreatment measures were taken 193 days (SD 110) apart from each other.

Pre- and posttreatment differences as analyzed with Wilxocon's Signed Rank Tests are depicted in table 2.

Results suggest significant changed levels of pain, NRS scores and in the RAND subscale pain, (both moderate effect size), in health (RAND subscale health change and vitality, both moderate effect size) and a significant decrease in CSI (small effect size). Besides, reported disabilities improved significantly (DRI), RAND subscales physical functioning, Role limitations physical functioning, social functioning (all small effect sizes) after treatment.

PCS decreased significantly after treatment by 28.18%, and after treatment 19.23% of the patients scored above the Dutch reference value[45].

The total score in Illness perceptions (IPQ-B) improved significantly. Illness perceptions about consequences, personal control, treatment control, identity, concerns, coherence and emotional representation significantly changed and became less negative.

There were no significant differences after treatment on the RAND subscales role limitations emotional problems, mental health, general health perception and item 2 of the IPQ-B on duration of pain.

Table 2. Outcomes of pre-post measures

Characteristic	**N**[§]	**Pre (M±SD)***	**Post (M±SD)***	**T**[¤]	**Z**[¥]	**p**	**r**[#]
NRS	77	6.61±1.85	4.86±2.37	225.50	-5.50	0.000	-0.44
CSI	71	33.93±15.34	28.99±13.85	554.50	-3.91	0.000	-0.33
DRI	73	52.53±25.37	45.40±28.29	735	-2.83	0.005	-0.23
PCS							
Total	77	19.32±10.47	14.04±12.04	691.50	-3.63	0.000	-0.29
Rumination	77	7.51±4.18	5.59±4.65	642	-3.39	0.001	-0.27
Magnification	77	2.22±1.98	1.71±2.10	443	-2.08	0.037	-0.17
Helplessness	77	9.58±5.61	6.74±6.47	596	-3.66	0.000	-0.29
IPQ-B							
Total	73	47.97±9.85	40.12±15.51	430	-4.76	0.000	-0.39
Consequences	78	6.64±1.99	5.15±2.46	270	-4.99	0.000	-0.40
Timeline	77	7.24±2.07	6.68±2.94	584	-1.76	0.078	
Personal control	77	4.24±2.36	5.09±2.54	1412	-2.506	0.012	-0.20
Treatment control	75	3.99±1.89	5.19±2.85	1706	-2.46	0.014	-0.20
Identity	78	6.68±1,72	5.15±2.36	184	-5.32	0.000	-0.43
Illness concern	78	6.00±2,15	4.26±2.93	265	-5.22	0.000	-0.42
Coherence	77	5.31±2,38	6.04±2.71	1426	-2.06	0.040	-0.17
Emotional representation	77	6.06±2,83	4.82±2.76	383.50	-3.68	0.000	-0.30
RAND							
Physical functioning	78	57.37±23.25	64.23±25.09	1579.50	-3.33	0.001	-0.27
Social functioning	75	60.23±25.30	71.38±28.05	1414	-4.05	0.000	-0.33
Role limitations physical functioning	77	26.92±35.98	50.65±42.53	1023	-4.13	0.000	-0.33
Role limitations emotional functioning	77	70.13±41.03	76.07±38.33	379	-1.07	0.284	

Table 2. (Continued)

Characteristic	N§	Pre (M±SD)*	Post (M±SD)*	T ¤	Z¥	p	r #
Mental health	77	71.85±15.53	73.71±17.09	1495	-1.02	0.308	
Vitality	76	46.22±18.90	52.63±18.47	1282.50	-2.71	0.007	-0.22
Pain	75	39.36±18.84	58.51±20.46	1751.50	-6.18	0.000	-0.50
General health perception	76	58.27±20.38	61.12±21.61	1407	-1.69	0.092	-0.14
Health change	78	34.92±24.47	60.58±25,33	185.50	-5.31	0.000	-0.43

*All values are presented as mean ± standard deviation two sided, as continuous non-normal distributed data. §N = number of patients, ¤ T = sum of positive ranks, ¥Z = Z-value, # r = effect size, £ HQoL = Health related Quality of Life, CSI = Dutch version of the Central Sensitization Inventory, DRI= Dutch version of the Disability Rating Index, PCS = Dutch version of the Pain Catastrophizing Scale, RAND = Dutch version of the RAND36, a higher score reflects a better outcome, IPQ-B = Dutch version of the Illness Perception Questionnaire Brief

Correlations

As can be seen in Table 3, there were significant associations between the three baseline scores of pain catastrophizing, illness perceptions and symptoms of central sensitization (PCS and IPQ-B (*r*=.582, *p*=.000), PCS and CSI (*r*=.261, *p*=0.027), IPQ-B and CSI (*r*=.266, *p*=.0.023)).

Pretreatment scores and change-scores always strongly correlate and were therefore excluded from the analyses. There were no associations between pretreatment measures and the change-scores. Within change-scores there were significant associations between all measures (changes in PCS and changes in IPQ-B (*r*=.453, *p*=.000), changes PCS score and CSI score (*r*=.337, *p*=.005), changes IPQ-B and changes CSI score (*r*=.387, *p*=0.02)).

Table 3. Correlations at baseline and changes scores

		IPQ-B baseline	CSI baseline	CSI changes	PCS changes	IPQ-B changes
PCS baseline	Correlation Coefficient	,582**	,261*	-,184		,050
	Sig. (2-tailed)	,000	,027	,133		,676
	N	77	72	68		71
IPQ-B baseline	Correlation Coefficient		,266*	-,078	-,019	
	Sig. (2-tailed)		,023	,525	,872	
	N		73	69	76	
CSI baseline	Correlation Coefficient				-,022	,022
	Sig. (2-tailed)				,853	,856
	N				72	68
CSI changes	Correlation Coefficient				,337**	,387**
	Sig. (2-tailed)				,005	,002
	N				68	64
PCS changes	Correlation Coefficient					,453**
	Sig. (2-tailed)					,000
	N					70

As pretreatment and change scores of the same measures are always correlated these were not taken into account. * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed), CSI = Dutch version of the Central Sensitization Inventory, PCS = Dutch version of the Pain Catastrophizing Scale, IPQ-B = Dutch version of the Illness Perception Questionnaire Brief

Moderation analysis

The first hypothesis, *i.e.* moderation of pretreatment levels of PCS on the relationship between pretreatment IPQ and pretreatment CSI scores (table 4) was not supported. There was a significant association between change in CSI and change in IPQ-B. The variance was significantly explained in the model, *R-sq .407, F(10,99) = .638, p=.000.* However, both pretreatment scores of PCS and IPQ-B were no predictors for pretreatment scores on CSI. The association between pretreatment IPQ-B and pretreatment PCS scores was not significant and did not add to the model, *R-sq 0.009, F(1,64)=.962, p=0.33.*

The second hypothesis, *i.e.* moderation of pretreatment levels of PCS on the relationship between changes in IPQ-B and changes in CSI (table 5) was not supported. There was a significant association between change in CSI and change in IPQ-B. The variance was significantly explained in the model, *R-sq .361, F(5, 54) = .609, p=.000*. However, pretreatment PCS and the change in IPQ-B were no predictors for change in CSI. Furthermore, the association between changes in IPQ-B score and pretreatment

PCS scores was not significant and did not add to the model, *R-sq 0.002, F(1, 54)=.187, p=0.70.*

The third hypothesis, *i.e.* moderation of changes in PCS on the relationship between changes in IPQ and changes in CSI (table 6) was not supported. There was a significant association between change in CSI and change in IPQ-B. The variance was significantly explained in the model, *R-sq .314, F(4,55) = .560, p=.00.* However, only change in IPQ-B was a predictor for change in CSI. Furthermore, the association between changes in IPQ-B score and changes in PCS scores was not significant and did not add to the model, *R-sq 0.00, F(1, 55)=.0.07, p=0.79.*

Table 4. Hypothesis 1: Linear model of predictors of pretreatment CSI, N=60

	b	SE B	T	p
Constant	23.941 [18.088, 29.073]	2.569	9.318	.000
Baseline score IPQ-B (centered)	.055 [-.315, .425]	.185	.297	.766
PCS baseline score (centered)	.294 [-.048, .636]	.171	1.718	.091
Baseline score IPQ-B x PCS baseline score	-.015 [-.045, .015]	.015	-.981	.331
WPI	2.02 [1.328, 2.719]	.348	5.812	.000*

*significant at the level of p <0.05
R^2=.36, CSI = Dutch version of the Central Sensitization Inventory, PCS = Dutch version of the Pain Catastrophizing Scale, IPQ-B = Dutch version of the Illness Perception Questionnaire Brief, WPI= Dutch version of the Widespread Pain Index

Table 5. Hypothesis 2: Linear model of predictors of changes in CSI, N=60

	b	SE B	T	p
Constant	-.299 [-3.87, 3.268]	1.779	-.168	.867
Changes in IPQ-B (centered)	.133 [-.057, 0.323]	.095	1.398	.168
PCS baseline score (centered)	-.085 [-.268, .098]	.091	-.929	.357
Changes in IPQ-B x PCS baseline score	.003 [-.268, .098]	.008	.433	.667
WPI	-.636 [-1.104, -.171]	.232	-2,742	.008*
Changes in NRS score	-1.185 [-2.261, -.108]	.537	-2.206	0.03*

*significant at the level of p <0.05
R^2=.36, CSI = Dutch version of the Central Sensitization Inventory, PCS = Dutch version of the Pain Catastrophizing Scale, IPQ-B = Dutch version of the Illness Perception Questionnaire Brief, WPI= Dutch version of the Widespread Pain Index, NRS = Dutch version of the Numeric Rating Scale

Table 6. Hypothesis 3: Linear model of predictors of changes in CSI, N=60

	b	SE B	T	p
Constant	-2.076 [-5.344, 1.193]	11.631	-.1273	.208
Changes in IPQ-B (centered)	.199 [.006, 0.393]	.096	2.063	.044
Changes in PCS (centered)	-.152 [-.059, .343]	.101	1.411	.164
Changes in IPQ-B x Changes in PCS	-.001 [-.012, .09]	.005	-2.684	.791
WPI	-.634 [-1.107, -.161]	.236	0.009	.009*

*significant at the level of p <0.05 R^2=.36, CSI = Dutch version of the Central Sensitization Inventory, PCS = Dutch version of the Pain Catastrophizing Scale, IPQ-B = Dutch version of the Illness Perception Questionnaire Brief, NRS = Dutch version of the Numeric Rating Scale

Discussion

This study retrospectively examined a sample of patients with chronic pain who received patient centered transdisciplinary CBT, containing PNE. The results show improvements of patients with chronic pain in self-reported pain severity, self-reported symptoms of central sensitization, disability and pain catastrophizing, as well as improved illness perceptions after receiving transdisciplinary CBT including PNE. There was an association between changes in pain catastrophizing and illness perceptions, however, moderation of baseline pain catastrophizing on the relationship between changes in illness perceptions and changes in self-reported symptoms of central sensitization was not found.

We found moderate associations between pretreatment scores of pain catastrophizing and illness perceptions, suggesting a bilateral relationship between catastrophic thinking and negative illness perceptions in patients with persistent pain. Additionally, within those measures reflecting change-scores there were moderate associations between all measures (pain catastrophizing, illness perceptions and self-reported symptoms of sensitization). These associations are in agreement with previous reviews, which have shown that PNE for patients with chronic pain improve illness perceptions, decrease pain catastrophizing, pain and disability in patients with chronic pain[20,23,58]. As well as with results from CBT treatments, which show improved pain, disability and health-related quality of life and decreased depression in patients with chronic pain[59].

Furthermore, decrease in the self-reported symptoms of central sensitization following CBT treatment is in line with current research on cognitive-emotional sensitization[19]. It is known that CBT decreases pain catastrophizing, which is linked to positive neuroplastic alterations in the dynamic pain connectome[26-28]. This effect is most present in the connectivity between the anterior default mode network and the amygdala, the 'threat-center' of the brain[28].

The results indicate that even though there is an association between changes in illness perceptions and self-reported symptoms of central sensitization in patients with chronic pain, the direction nor strength between of the relationship between these two was influenced by pain catastrophizing. Low pain catastrophizing scores at baseline (19.55, 44.54% above the Dutch reference value) and small changes (14.04, 19.23% above the Dutch reference value) might explain non-moderating findings[10]. Reason for these low initial PCS scores, and subsequently lesser changes, could be the communal aspects of pain catastrophizing[60]. Higher pain catastrophizing scores are associated with more submissive interpersonal interactions and high levels of dependency[61]. Geographical interpersonal culture has an influence on how we experience and deal with pain. The Netherlands, where the current study took place (e.g. the province of Friesland), is known for its interpersonal culture surrounding being independent and 'acting strong and sturdy'. This could have played a role in the low scores on pain catastrophizing.

Several limitations of this study can be distinguished. First, as the design was only a pre-post treatment design instead of a randomized clinical trial design, no assumptions can be made regarding the effectiveness of the treatment, nor that the content of the intervention influenced illness perceptions and pain catastrophizing. Besides, as this intervention was a patient-tailored approach some patients only received PNE while others also received CBT containing both physiotherapy and psychology. Therefore, not only the intervention differed, but the measurement points (T0 and T1) also differed between patients. As the current design of this study introduces the possibility of selection bias and limits the generalizability of the data we suggest viewing the current as a scoping study. Additionally, there was a limited amount of posttreatment data as 34 were lost to follow up. From the 78 patients with post treatment data, some questionnaires had missing values, affecting the number of patients in the moderator analysis (n=60). It is previously suggested that moderator analysis should include enough patients, as any moderating effect could be missed with too few patients to detect a moderating effect[10]. The current amount of data in the moderator analysis was below the a priori estimated power calculation (n=69), which could have contributed to not finding a difference. Currently, the handling and imputation of missing data in moderation analysis is in its first steps and, with caution, Bayesian Estimates are recommended for imputation of missing data[62]. However, when distributions are non-parametric, such as in our study, Bayesian Estimates methods have a big change to mis-specify. Therefore, before we can use it to impute missing data, more robust Bayesian Estimates methods are needed[62,63].

Scientific implications

Due to the current limitations of this study no conclusions can be drawn on the effectiveness of the treatment. However, the results do indicate changes within these patients and we suggest to further evaluate the effectiveness of transdisciplinary pain management treatment for patients having chronic pain. As suggested previously, the role of pain catastrophizing as a moderator for the outcomes of treatments[10] should be further investigated. For instance, by studying the influence of pain catastrophizing as a moderator in disability and other treatment outcomes[10]. When doing so, one has to keep in mind that in patients with chronic pain there is an interplay of many factors, both positive and negative, that influencing the patients' pain experience. Other, more evolved approaches, for instance network analysis, might be more suitable for to further investigate these complex interplaying factors[64].

Clinical implications

As the design of the current study limits generalizations, clinical implications are scarce. However, some can be mentioned. First, based on the results from this study changes were observed in pain, disability, self-reported symptoms of central sensitization, pain catastrophizing and illness perceptions for patients with chronic pain. In accordance with previous literature, when providing a patient centered transdisciplinary CBT treatment program with PNE, these patients can indeed improve on these outcome measures. And second, in accordance with previous research, this study shows that changes in illness perceptions are associated with changes in pain catastrophizing in patients having chronic pain. As PNE addresses both illness perceptions and pain catastrophizing, physiotherapists should be aware of the importance of providing PNE in the treatment of patients with chronic pain.[20-22,65]

Conclusion

This is, to our knowledge, the first study investigating the within treatment changes of patients with chronic pain who received a patient centered transdisciplinary CBT, among which PNE. There was an association between changes in pain catastrophizing and illness perceptions, suggesting that both were influenced by the treatment. However, the results indicate that even though there is an association between pretreatment and change scores in illness perceptions and self-reported symptoms of central sensitization in patients with chronic pain, neither the direction nor strength of the relationship between these two was influenced by pain catastrophizing. In future research the analysis of the data should incorporate the multi-faceted and complex aspect of chronic pain, for instance by complex network analysis.

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7

GENERAL DISCUSSION

General discussion

In the last decades there has been an improved understanding of the biopsychosocial mechanisms underlying chronic pain. Based on this increased knowledge we can now say that in patients with chronic pain centrally mediated mechanisms, also known as central sensitization (CS)[1-5], play an important role. Furthermore, as we are humans: body and mind cannot be separated. Therefore, bio, psycho as well as social factors influence the experience and continuation of pain[6-10]. Consequently, the treatment of patients with chronic pain has evolved. In this treatment, the explanation of CS and contributing biopsychosocial factors to patients, also known as PNE, has a level A evidence[11,12] and has become a key element in the treatment.

In the current dissertation transdisciplinary PNE was studied to further improve our understanding of the processes surrounding patient-centeredness and PNE. The first part of the dissertation focused on patient centered care and assessments performed by physiotherapists in patients with chronic pain. The second part of the dissertation consisted of qualitative studies focusing on understanding the processes involved in PNE. The last part investigated the when and how of changes in outcomes following a transdisciplinary cognitive behavioural pain management program.

The following research questions were addressed in the thesis:

- To what extent is patient-centeredness examined in physiotherapy in qualitative research and can a theoretical framework be constructed for patient-centeredness in physiotherapy?
- What could be an outline of the clinical biopsychosocial physiotherapy assessment of patients with chronic pain?
- What are the experiences of patients with chronic pain who recently received PNE in a transdisciplinary setting?
- What are the clinical observations of transdisciplinary PNE? With the purpose to comprehend and theorize the social process of transdisciplinary PNE.
- What are the changes after patient centered transdisciplinary CBT, among which PNE, and is the relationship between illness perceptions and self-reported signs of CS moderated by pain catastrophizing?

In this chapter we will discuss the outcomes of these questions by deliberating on the outcomes of the studies included in this dissertation, followed by reflecting on these results in a broader context of healthcare practice, teaching and future research.

Main findings

A theoretical framework of patient-centeredness in physiotherapy

Besides being a moral philosophy of healthcare professionals[13], the utilization of patient centered care is promising as it has shown to improve the therapeutic alliance, patient satisfaction and patient outcomes[14-17]. We conducted a qualitative literature review[18], in which the phenomenon of patient-centeredness in physiotherapy was studied from the perspective of both patients and physiotherapists. The results from these studies indicate a synthesis of interrelated themes with subthemes and a proposed conceptual framework. The themes we found were: either related to the patient-therapist interaction in forms of "*individuality*", "*communication*", "*education*", "*goal setting*", "*support*" or related to the physiotherapists' ability to practice patient-centeredness in forms of the "*social characteristics of a patient-centered physiotherapist*", "*a confident physiotherapist*", and "*knowledge and skills of a physiotherapist in patient-centeredness*".

The concepts of this review are quite similar to previous frameworks, with small variations between the current model and patient-centeredness in overall care (The Picker Institute's principles[19]), medicine [13,20] and nursing[21]. For instance, in contrast to overall care, medicine and nursing in the articles in the review environmental aspects were not an important part of patient-centeredness in physiotherapy[19,21]. One reason for this could be that in contrast to our review aspects like transitions, policy, coordination of care, social involvement, etc. are more important in hospital settings[19,21]. However, in a recent study on the patients' view on patient-centeredness in physiotherapy some environmental aspects, such as having privacy, were important[22]. Additionally, contextual factors, in forms of the healthcare setting and rituals of the therapists, are known to influence clinical outcomes[23]. Therefore, it can be assumed that environmental aspects are most certainly of importance in patient-centeredness in physiotherapy. Our review sought to describe the phenomenon of patient-centeredness in physiotherapy, however, as a limitation it did only describe facilitators, not the barriers. Yet, knowing what is perceived as not being patient centered by patients is also important. Barriers such as having a negative attitude, lack of self-confidence, inappropriate (non-verbal) communication, lack of biopsychosocial sensitivity, environmental factors (over crowdedness, lack of privacy) have a negative effect on patient centered physiotherapy[22]. Furthermore, recent research shows that in clinical practice the use of patient centeredness is to say the least lacking[22,24-26]. Therefore, to improve patient-centeredness in physiotherapy, critical reflections on the professional practice and communication skills of physiotherapists should be increasingly taught. As well as teaching physiotherapists in these skills, barriers of patient-centeredness should also be addressed, thereby improving their patient centered skills. The current can be taught, for instance, during undergraduate education and, for those already working as physiotherapists, by coaching of professional organizational societies. By doing so the knowledge and skills necessary for patient-centeredness in physiotherapy can be improved.

When teaching physiotherapists about patient-centeredness one should keep in mind that the proposed synthesis of patient centeredness in physiotherapy in this dissertation has not been researched on its efficacy and use in clinical practice. Therefore, future studies should examine 1) to what extent teaching physiotherapists about patient-centeredness improves their knowledge and skills; 2) whether this improved knowledge and skills increases the use of patient-centeredness in practice; 3) improves clinical outcomes, 4) increases patient satisfaction and 5) decreases health care costs in patients received patient centered care.

A practical tool for the clinical biopsychosocial physiotherapy assessment in patients with chronic pain

In patient centered physiotherapy it is important to gain a complete picture of the patients' problem in a biopsychosocial way. However, physiotherapists struggle with identifying and treating psychosocial factors[27-35], and for instance rarely question the patients' beliefs about their health care problem[33]. Biopsychosocial factors contribute to an amplified pain experience by increasing activity in the 'dynamic pain connectome'[6-10,36]. Therefore, a thorough assessment of these factors is required to understand the individuals' pain, provoking and perpetuating factors. Furthermore, this assessment allows for an individualized patient centered PNE. To aid physiotherapists in this biopsychosocial physiotherapy assessment we conducted a narrative review in which we proposed a model to investigate these biopsychosocial factors. Based on this review the PSCEBSM-model emerged, which comprises the following factors: predominant Pain mechanism, Somatic, Cognitive, Emotional, Behavioural, Social and Motivational factors. First, the predominant type of pain is established, followed by identifying the different factors associated with chronic pain and ending with the stage of motivation of the patient. Together with this model a pain analysis sheet is provided to help the clinician gain a clear overview of the PSCEBSM factors of the individual with chronic pain and guide the further treatment. As described in our 'Response Letter to the Editor'[37] (chapter 3), based on the correspondence with Oostendorp et al.[38], the layout of our current PSCEBSM-model somewhat originated from the SCEBS method as described by Spaendonck and Bleijenberg[39,40]. However, there are two main differences. First, the PSCEBSM-model contains two extra factors to asses, the Pain- and Motivation-factors. Identifying the primary pain mechanism allows the physiotherapist to tailor the PNE to the patients' problem. Furthermore, Motivation is added to examine the patients' treatment expectations, psychological flexibility to change and stage of behavioural change. Second, the SCEBS method focused on providing healthcare professionals with questions for biopsychosocial history taking (for instance: "can you move your neck/back?" or "what do you think when you experience pain?"), whereas the current PSCEBS-model also includes questionnaires. The questionnaires were added to aid physiotherapists in recognizing psychosocial factors.

There are some limitations to mention. Chronic pain is a complex phenomenon in which research studying factors influencing pain is continuously evolving. Therefore, the practical guides for healthcare professionals in the assessment of patients should evolve. In our PSCEBSM-model we did not assess all factors, such as sleep, diet or coping. In recent years the importance and reciprocal relationship of sleep on pain has become increasingly acknowledged.[41] The contribution of sleep in patients with chronic pain has been described in the key-set as developed by the American Pain Society (APS) Pain Taxonomy (AAPT) by Turk et al.[42]. When combining the key-set by Turk et al[42] and the PSCEBSM-model, keeping in mind practicality, a more overarching tool for healthcare professionals, among which physiotherapists, could be made. Furthermore, there are no studies performed into practical application and the effectiveness of this model, the SCEBS-model[43], and the overviews provided by Turk et al.[42,44]. Future research needs to investigate the appropriateness and possible effects on patient outcomes of these assessments.

Perspectives of patients with chronic pain who recently received Pain Neuroscience Education in a transdisciplinary setting

PNE has been recognized as an important element in the treatment of patients with chronic pain[11,12]. However, as chronic pain is complex, its treatment is preferred to be multimodal. In this treatment of patients with chronic pain effective team approaches can exceed the expertise of monodisciplinary care[45]. In recent years transdisciplinary teamwork has emerged. Transdisciplinary teamwork meaning, among other aspects, that there is an intensive collaboration, with shared responsibilities[46,47] and flexible boundaries[46-49].

It is important to recognize patients' experiences of the transdisciplinary Pain Neuroscience Education process. Therefore, based on the methods of Grounded Theory[50], we conducted a qualitative study to comprehend and theorize how patients with chronic pain experienced transdisciplinary PNE.

The first topic that emerged was "*the pre-PNE phase*", the phase prior to the PNE in which the respondents met the healthcare professionals during a broad biopsychosocial intake session. The second found topic "*a comprehensible PNE*", which contained an "*understandable explanation*" and the "*interaction between the physiotherapist and psychologist*". The third topic involved the "*outcomes of PNE*", including the subthemes "*awareness*", "*finding peace of mind*", and "*fewer complaints*". The fourth topic, "*scepticism*", contained "*doubt towards the diagnosis and PNE*", "*disagreement with diagnosis and PNE*", and "*PNE can be confronting*".

Even though qualitative research is limited in generalization, the results reveal the importance of the therapeutic alliance between the patient with chronic pain and healthcare professionals. A broad biopsychosocial intake, with empathic healthcare professionals, who take time to listen, is known to enhance the therapeutic alliance[51,52] and of importance in the rehabilitation of patients with chronic pain[53]. The biopsychosocial view on pain by the transdisciplinary team, their active involvement, and interpersonal skills are crucial to the outcomes of the PNE. Furthermore, the patient centered aspect of the treatment (*i.e.,* providing patient-centred care, taking time, building rapport and building a therapeutic alliance)[51,54,55], helps to tailor the comprehensible PNE to the individual, thus enhancing the perceived relevance. However, even with this perceived relevance, some patients with chronic pain did not or partly reconceptualized their pain. As King et al. mentioned before: pain-related beliefs of respondents prior to the PNE can be barriers for the PNE[56]. Furthermore, patients' readiness to change, an increased commitment to self-management, and initial hesitation about the treatment predicts the satisfaction and likelihood of completion of a pain management program[57-59].

However, most respondents with chronic pain in our study did mention perceptual changes about pain in a cognitive, emotional and behavioural manner. From previous research it is known that those patients with chronic pain who reconceptualized their pain mention an increased coping with their condition and improved physical activity levels[60]. The latter is similar to our study, in which most respondents mentioned increased coping, as well as mentioning to have an elicited biopsychosocial awareness. For instance, respondents mentioned to take better care of themselves.

Generalizing study results is always a delicate issue in qualitative research[61]. Generalizability in this study is an concern as there was an individualized transdisciplinary intake, the repetition of PNE by the general practitioner, booklet, and combined physiotherapist/ psychologist session which are not common for clinical practice, nor has been studied. Therefore, even though the current design is promising, one should be careful in generalizing the study findings to other settings. Furthermore, in the current study a classical Grounded Theory approach was used[50]. Grounded Theory is a qualitative research methodology used to deeply analyse and develop theoretical explanations emerging from the participants' unique perspectives[62]. Within Grounded Theory there is a distinctive difference between classical Grounded Theory and constructive Grounded Theory, especially concerning the role of the researcher. Whereby in classical Grounded Theory the researcher tries to take a neutral, objective, more distance stance towards the data and their preconceptions[50,62]. Starting in 2013, this study was, to our knowledge, the first study exploring the experiences of patients with chronic pain with PNE. Therefore, the choice for classical Grounded Theory was based on the following arguments: 1) no previous closely related literature was available on the subject, 2) an open stance in which any experience of the patients with chronic pain was analysed and theorized was preferred, and 3) the patients with chronic pain voices needed to be adequately reflected in the theory. However, as all researchers were working academically and/or clinically with PNE the neutral, an objective stance can be doubted and in retrospect a Constructive Grounded Theory approach might have been more appropriate.

Clinical observations of patient and therapist interactions of Pain Neuroscience Education in a transdisciplinary setting

Because PNE is a "talk-modality" many interpersonal aspects, such as the therapeutic alliance, contribute to the treatment effect. These social processes can best be captured through qualitative observational studies. Therefore, based on Constructive

Grounded Theory[63,64] we conducted an observational qualitative study to comprehend and theorize the practice of transdisciplinary PNE. The outcome was a theoretical construct and framework of transdisciplinary PNE sessions, grounded in the data of the observations. Four connected and interactive themes where found to be of importance for transdisciplinary PNE, with three overarching themes. The first theme we found was "*generating a safe and comfortable feeling, situation*" as a prerequisite. Important in this theme and overlapping with the second theme the "*PNE process*", was incorporating personal information from the intake in the PNE. Individualizations, as well as the step by step explanation and the used metaphors, sparked *"the process of change of the respondent*" (third theme) thereby leading to the fourth theme: "*outcome of the change process*", meaning that most respondents gained improved biopsychosocial understanding of their pain, whereby some had a partial reconceptualization. One of the overarching themes, the "*influence of changeability of the respondents"* on the PNE and outcomes, even though obviously present, was a difficult concept to grasp. There was no distinct profile detected from the video observations of those who would "respond" fully, partially or were "non-responders". Two other overarching themes were: "*interplay between the healthcare professionals*" and "*communication skills*" of the healthcare professionals.

The results of this study are comparable to studies highlighting the importance of a good patient-therapist interaction in pain rehabilitation[53,65], in the form of a good therapeutic alliance (TA)[66]. Attending to, and healing ruptures in the TA[67,68], as seen during the observations, can strengthen the therapeutic relationship[67,69,70] and contribute to positive patient outcomes[67.]

Whereas the TA is a basis for the PNE, reconceptualizing their pain based on PNE is sometimes difficult for patients with chronic pain: adopting a new concept on pain takes time[56,71,72]. In line with the current study, reconceptualization is often partial and follow up during further treatment is needed to further deepen the reconceptualization[56.] Therefore, it is necessary to keep in mind the patient centered nature of PNE[73]: one size will not fit all. Furthermore, even though reconceptualization is the first step, nonetheless dealing with the biopsychosocial factors that influence the pain experience is the next[74]. In the current study some of the patients with chronic pain did understand the PNE, but found it hard to envision changes in their pain related behaviour. Whilst others had already changed their daily practice based on the first PNE session. It is

important to keep in mind that PNE is an important part of the treatment of patients with chronic pain, it is not a stand-alone intervention[12,60,75].

A few limitations can be mentioned from this study: First, the observations only included the second PNE session of the respondents. Hence, the trajectory of the respondents' reconceptualization and further implications in an emotional, cognitive and behavioural manner could not be investigated. However, as the reconceptualization was only a part of the research question and we wanted to deeply understand the social aspects surrounding those who had doubt/resistance, the current format was more suitable.

Second, as previously mentioned generalizability in qualitative research is always a delicate issue[61]. The generalizability of this study is limited to the transdisciplinary context of the observed PNE in which a psychologist and physiotherapist collaborate. Whereas the evidence of the effectiveness of PNE however, comes from studies based on a monodisciplinary (physiotherapy) setting. And third, the reflexivity of the researchers analyzing the data is a source of limitation[76]. All authors in some form contribute to the field of PNE either in clinical practice, education or science. Based on the epistemology of constructive Grounded Theory the idea of being a completely neutral observer without preconceptions was chucked. Instead, these conceptions construct the research and they were therefore examined, identified and described[63].

Moderators of change of self-reported signs of central sensitization following an individualized transdisciplinary pain management program

As the integration of PNE in monodisciplinary physiotherapy is effective[11,12], integrating it and studying this integration in multi- or transdisciplinary care for patients with chronic pain seems recommendable. Hence, a scoping evaluation by means of a retrospective observational study of current practice of a patient centered transdisciplinary pain management program for patients with chronic pain, including PNE, was performed. Subsequently, it is important to comprehend which factors moderate the changes in outcomes following this program. The relationships between these clinical outcomes and cognitive and emotional factors and changes in these outcomes following treatment were analyzed. Multiple regression analysis, by the PROCESS macro[77] explored the moderating effects of pain catastrophizing on the relationship between illness perceptions and self-reported signs of CS in patients with chronic pain.

We found a moderate association between pretreatment scores of pain catastrophizing and illness perceptions in patients with chronic pain, suggesting a bilateral relationship between catastrophic thinking and negative illness perceptions. Additionally, there were significant, however moderate, correlations between pain catastrophizing, illness perceptions and self-reported symptoms of sensitization in the change-scores of patients with chronic pain following a patient centered CBT.

However, contrary to our hypothesizes, the results from our moderation analyses indicate that the direction or strength between the baseline scores and change scores of illness perceptions and self-reported symptoms of CS in patients with chronic pain was not influenced by baseline, nor change scores in pain catastrophizing. One reason could be that patients with chronic pain had low pain catastrophizing at baseline and only small changes[78].

Important to mention as a limitation is that the current design was a pre-post treatment design instead of an RCT design. Therefore, no hard assumptions can be made regarding the effectiveness of the treatment, nor a part of the treatment (PNE) can be made. Besides, as this intervention was a patient-tailored approach not all patients with chronic pain received the same treatment and measurement points (T0 and T1) differed between patients. In an ideal world a double blind RCT design, with prior intentions for effect moderation analysis, would have been performed. Furthermore, there was a significant amount of data lost to follow-up: 34 patients dropped out and a further 18 patients did not complete all questionnaire items. The data collection was allocated to a secretary, without knowledge of data collection nor was it his/her core business, and post-intervention data collection was performed by mailing these questionnaires. Even though patients were called and asked to fill in these questionnaires, some patients found it too burdensome to complete them, whilst others did not return them. In future this task should be structurally embedded within routine clinical practice, for instance by using online questionnaires in a system that allows state-of-the-art data protection and data management. Due to these dropouts and missing data the current number of data in the moderator analysis was below the number obtained through the a priori conducted power calculation. As suggested previously by Wertli et al.[78] moderator analyses should include enough patients with chronic pain, as any moderating effects could be missed with too few patients to detect a difference. The actual number of participants one should include under debate. For instance, a review on moderators in response to treatment in low back pain by Gurung et al. included, based on a priori sample size calculation, only trials with a minimum dataset of 503 participants[79]. However, they did use an effect size of 0.5 in the sample size calculation, which is large. Furthermore, they included studies whom performed multiple moderator analyses with multiple moderators, thus requiring more participants. And last, within the statistical community a sample size calculation, as we performed, indicating the number of participants needed is deemed sufficient and post-hoc power analysis not recommended[80].

Finally, as the data were not normally distributed, non-parametric testing was used for the analysis of pre- versus post-treatment differences and correlations. For the moderation analysis, however, it is advised to use the parametric regression analysis PROCESS-macro, by Hayes[77], which we have used. It is uncommon to use this combination of statistic testing. This choice was made because of the following arguments: 1) non-parametric moderation analysis is fairly new[81] and was not available at the time of the analysis, 2) transformation of data is currently under debate, and 3) there was no skewness of the data. The PROCESS macro bootstrapping does not require normal distribution if the sample size is adequate and skewness is small[82].

And now what? Philosophizing the PNE/physiotherapy future

Overthinking

Based on the current dissertation some implications are formulated. However, prior to reading these implications one should realize that these studies are mostly qualitative in nature. Therefore, the reader is encouraged to be cautious with generalizing this information towards clinical practice. One should rather consider the information and then reflect on his/her own practice and what it might mean to them.

Furthermore, the findings from the qualitative studies should be interpret with caution and reflexivity is warranted. First, even though all studies were teamwork with different team-members in each study, I was the main researcher. The chronological sequence of the studies (systematic literature review on patient centeredness in physiotherapy, GT study on the perspectives of patients on transdisciplinary PNE, and then the CGT with clinical observations of transdisciplinary PNE), could have influenced the successive studies. Nevertheless, we applied the trustworthiness criteria of Lincoln and Guba[83] in these studies to reduce such influences. Furthermore, according to the used methodologies we tried to bracket out our perspectives as much as possible in the (first) GT-study. In the (second) CGT-study the perspectives of the authors influenced the theory, as is usual in CGT. Therefore, these perspectives were written down in a reflective paper, member checking was performed and a neutral stance was sought and debated within the research-team. Second, throughout the years of my early research career, my professional career also changed: from working in private practice and hardly using PNE, to working in both private practice, using PNE, working at the transdisciplinary pain management center and teaching other healthcare professionals in PNE/working with patients with chronic pain. Following the chronological sequence of the above-mentioned studies, I started working at the transdisciplinary pain management center between the GT and CGT-study, therefore my professional career could have influenced the outcomes of this study. To enhance open-mindedness we performed researcher-triangulation, with the second researcher not being involved in the treatment, as well as write a reflective paper, perform peer debriefing and other aspects of the trustworthiness criteria.

Considering this reflexivity, to broaden it: we now have all these findings, compared to known research, yet what does it mean in the grand scheme of our profession(s)? Of PNE? So, to take it one step further: can we helicopter these findings?

As we have seen throughout this dissertation, communication skills are vital in the delivery of PNE. As PNE is currently under debate, especially in social media, I find it important to reflect on this part of PNE. First, PNE is under debate as the latest reviews have only shown small improvements in outcomes when providing PNE. One could ask: why? The first RCTs showed promising results. If I remember correctly, my first encounter with PNE was by a video of Lorimer Moseley, one of the authors of the first RCTs on PNE. Besides his fascination for neurophysiology of pain he encompasses great skills in communicating. His enthusiasm and 'plain language', as well as engagement with persons, might be one of the factors of the success reported in these first RCTs. As especially in a talk-modality, the person delivering the PNE is of major importance. Second, reviews on the effect of providing only PNE show limited effects. Pain, particularly chronic pain, is often a complex phenomenon. Therefore, the treatment of patients with chronic pain should consist of multiple treatment modalities and not just PNE. There are few patients with chronic pain who are helped with only PNE, however, most will need more than that. In my opinion PNE can be used as psychologists use psychoeducation: an evidence based neurophysiological explanation of their condition and contributing factors, which serves as a 'coat rack' (figure 1) to 'hang' the patient centered evidence-based treatment modalities on. For instance, to use as a steppingstone for Graded Exposure, in which the patient with chronic pain is encouraged to reengage in fearful activities which they have previously believed to cause damage to them and/or were fearful of.

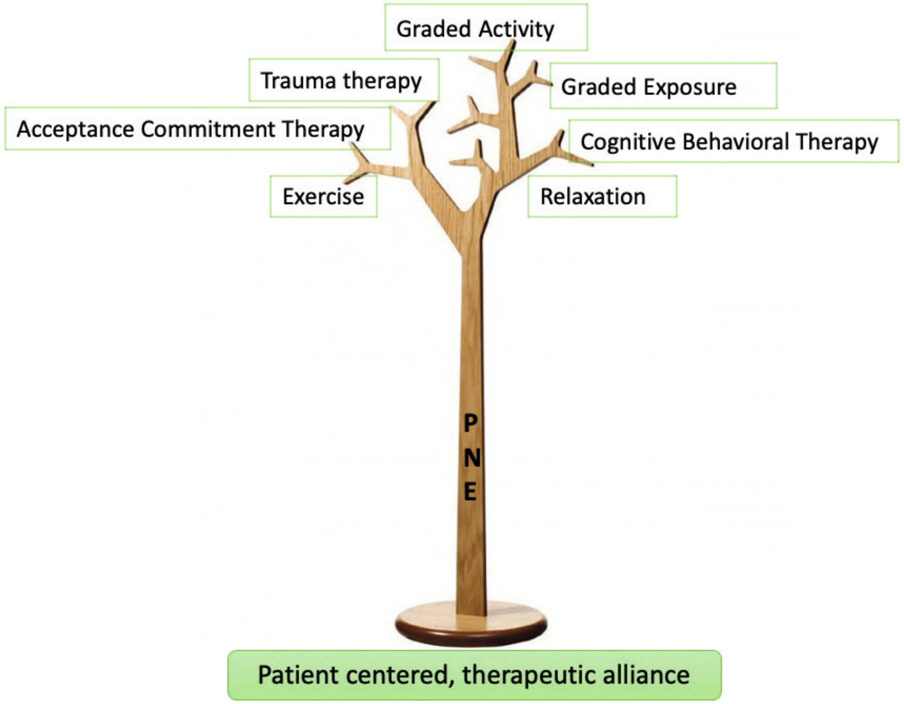

Figure 1. PNE as a 'coat-rack' to explain and use other treatment modalities (not all modalities are mentioned)

Furthermore, it provides patients with chronic pain with an explanation for why they are in pain. Which brings us to the third concern: some (clinicians, researchers) question whether we can accurately enough explain the neurophysiological processes concerning pain to patients with chronic pain without oversimplifying it, whether PNE is not too positivistic. On which I humbly disagree. Of course, we should always be reflective on how we verbalize psychoeducation. The term Pain Neuroscience Education might imply to much of a focus on the neurophysiology-part. So clinicians might only educate patients on neurophysiological changes related to CS. Whereas in a truly patient centered psychoeducation the neurophysiology is adapted on the person, and the most important part of the education is the explanation of the (changeable) biopsychosocial factors involved in the continuation of CS and (chronic) pain. Therefore, Pain Education might reflect a more inclusive terminology of this psychoeducation. Additionally, I agree with the critics that any metaphor used will never truly reflect the complex neuro-endocrine-immunological and perceptual processes involved when one is in (chronic) pain. As well as that the therapist should be careful not to 'medicalize' these processes. However, as we are human beings, our brains desire for 'logical' explanations of what is happening and what we experience. De-educating patients' maladaptive cognitions of these painful experiences ('my pain means my back muscles tear when I bend') is an important first step. Yet, we still have to explain to them why they are still in pain. Otherwise their brain will want to provide them another 'logical explanation'. By PNE we can help patients with chronic pain reconceptualize these explanations towards less threatening ones ('my back is sensitive, but not damaged, bending is a healthy step towards recovery'). Furthermore, as pain is a complex and individual experience, the narrative of the patient with chronic pain preferably constructs the PNE. The wording and experiences of the patient with chronic pain should be used during the PNE, allowing the metaphors to be patient centered and dynamical. Furthermore, the metaphors used should be thoughtfully and carefully selected. One might even discuss that therefore PNE or PE is constructivist in manner…

The latter brings us to the last reflective point of the current dissertation: chronic pain is often a complex phenomenon. Therefore, what are our professional boundaries as physiotherapists when seeing a patient with chronic pain? Is monodisciplinary physiotherapy care enough? Or should every patient with chronic pain be seen by an inter-/transdisciplinary team? These are difficult questions to answer. On a practical level one could say: no, our healthcare system is not equipped enough, nor does every patient with chronic pain need to be seen in an inter-/transdisciplinary setting. However, it is difficult to answer what the grades of complexity are and at which grade the patient with chronic pain needs to be referred from mono- to inter-/transdisciplinary. Even though a stepped care principle is recommended in the Netherlands, the levels of complexity for mono/inter/transdisciplinary have not been described. It is a dilemma, we, as scientists, professionals and patients with chronic pain, need to discuss and philosophize about to further improve the care for patients with chronic pain.

Implications for practice – based on the overthinking

Let us bring it back to the practical implications of this dissertation. First, an increasing bulk of evidence keeps on showing what philosophers have told us all along: the relationship between healthcare professional (physiotherapist) and patient is the

most important pre-requisite for the treatment of any patient. Especially in patients with chronic pain who have often had other (negative) experiences. Or as mentioned by the founding father of the TA, Carl Rogers: '*Before every session I take some time to remember my humanity*'. To further improve this relationship, the themes mentioned in our qualitative study defining patient-centeredness in physiotherapy can be used. However, this does require a self-reflective communicationally skilled physiotherapist. Second, this relationship is nurtured during the initial biopsychosocial assessment of the patient with chronic pain. During this assessment the PSCEBSM-model can be used to assess the individuals' predominant-pain mechanism, somatic, cognitive, emotional, behavioural, social and motivational factors. Furthermore, sleep and diet should be taken into account. The individuals' contributing factors can then be filled in in the provided pain-analysis form, to have a clear overview of the individuals' problems. Third, PNE should preferably be the next step in the treatment. Explaining the predominant pain-mechanism, pain neurophysiology, and contributing/provoking biopsychosocial factors in a patient centered, step-by-step manner, with lay terms adjusted to the individual. Throughout the (if possible transdisciplinary) PNE the therapist is advised to be aware of his/her communicational skills in order to provide a safe and comfortable environment and engage the patient with chronic pain to the PNE. When doing so patients with chronic pain mention to experience being seen, taken seriously and cognitions on the biopsychosocial nature of pain can improve. Most patients with chronic pain, however, not all, reconceptualize their pain from 'damage' into 'an overprotective state'. Reconceptualization and changes in outcomes are enhanced not only during the PNE session, but also in the period and treatment after the PNE. Therefore, the repetition of the PNE during the further treatment is important, for instance, as an explanation of why relaxation exercises or CBT are of importance.

And last, throughout the PNE and further treatment some doubt and scepticism about whether 'there isn't something damaged' are normal. When this occurs therapists should be aware of these so called 'ruptures' and carefully re-explain PNE whilst restoring the TA.

Implications for future research – based on the overthinking

As known, when performing research, the answers we get always lead to more questions. Therefore, some recommendations for further research are suggested. By now there are quite some 'communication-aspects' known that surround patient care, such as patient centeredness and the therapeutic alliance as outlined in this dissertation, but also Shared Decision Making, the working alliance, narrative medicine and Socratic dialogue. These constructs show considerable overlap and can be quite confusing for healthcare professionals. Especially when these healthcare professionals, such as physiotherapists, find these communication-aspects difficult. As research should be practical, it is important to help healthcare professionals see the maze of these constructs. Therefore, one could suggest studying the overarching construct of these communication aspects and provide a clinical framework, which then should be investigated for effectiveness, to help healthcare professionals further improve the most important aspect of the treatment. Furthermore, the biopsychosocial physiotherapy assessment for patients with chronic pain as suggested in this dissertation has not been investigated on its efficacy. However, prior to investigating its efficacy it is important to further supplement the assessment with factors known from more recent studies to influence the pain experience. Such as, but not exclusively, sleep and diet. Investigating the efficacy of the biopsychosocial assessment could be done in multiple manners. First, the psychometric properties of the biopsychosocial assessment could be studied by test-retest observational studies. Second, as most physiotherapists find it hard to implement psychosocial factors in the biopsychosocial assessment, behavioural change of physiotherapists after training should be assessed. This could be done by Quality Indicators (QI's), as previously used by Oostendorp et al.[84] QI's evaluate the implementation and change in quality of provided care and measure the behavioural change of physiotherapists. And third, the added value of the biopsychosocial assessment on healthcare outcomes could be studied in clinical trials. Preferably in mixed methods designs whereby the evaluation of patients with chronic pain on the assessment is taken into account.

The current dissertation outlined patient centered transdisciplinary PNE and treatment, by experiences, observations and moderators. However, to date, most healthcare professionals treating patients with chronic pain are working in a monodisciplinary setting. In the Netherlands, where the current dissertation took place, patients with chronic pain who do not respond to monodisciplinary treatment are often referred to multi- or interdisciplinary treatment centers. As outlined in the General Introduction, there are distinct differences between multi-/interdisciplinary treatment programs and transdisciplinary treatment programs. Thus, generalizing the outcomes of this dissertation to other (mono-, multi- or interdisciplinary) settings is difficult. Therefore, two implications for future research can be listed: It would be interesting to investigate

the effectiveness of working transdisciplinary, for instance by comparison to multi- or interdisciplinary settings. Throughout these studies a mixed methods design can be implemented. For instance, by including qualitative observations of not only the second session of PNE (as with ours) but also the intake, first session, and further treatment. To further theorize how reconceptualization of pain takes place, how healthcare professionals help reconceptualize pain by PNE whilst also maintaining the TA, and what the implications of these reconceptualizations are in terms of changes in cognitions, emotions, behaviour, coping, acceptance, etc. Furthermore, as patients with chronic pain are, and will be continued to, be treated in a monodisciplinary setting: further studying the implementation and effect of PNE in clinical practice is important. By means of qualitative and quantitative research methods several topics could be investigated: 1) the current implementation of PNE in monodisciplinary practice (qualitatively, quantitatively), 2) the experiences of patients with chronic pain with PNE in a monodisciplinary setting, and 3) how and when changes occur in patients with chronic pain receiving PNE in practice (for instance by investigating latent changes trajectories by latent grow curves and growth mixture modeling analysis), 4) as well as studying how we can help guide physiotherapists with this population.

To conclude

Treating patients with chronic pain with patient centered PNE entails much more than 'the talk'. It is about patient centered-working, the therapeutic alliance, a broad intake based on the PSCEBSM-model and an interactive education within a (transdisciplinary) treatment setting. As academics we have multiple obligations, and not only to our patients with chronic pain. It is not solely to study interventions, but also to support our fellow healthcare professionals. To help them implement these treatments. As they are the ones delivering the care for the patients with chronic pain. With this dissertation I hope to have unraveled some of the aspects surrounding PNE and further spark the treatment of patients with chronic pain: for them and for our fellow healthcare professionals.

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SUMMARY

Summary

Whether we want to or not, pain is an inevitable part of life. As on average twenty percent of the population suffers from chronic pain, chances are we might even experience chronic pain in our lifetime ourselves. When one is in chronic pain centrally mediated mechanisms, also known as central sensitization, play an important role in the pain experience. Central sensitization related pain, or recently called nociplastic pain by the International Association for the study of Pain, is characterized by hyperexcitability of the central nervous system. Leading to increased responsiveness and eventually causing pain without noxious peripheral stimuli. Especially in chronic pain it is known that biopsychosocial factors provoke and contribute to the pain one experiences. Whilst we are humans, body and mind cannot be separated. As a result, the treatment of patients with chronic pain has evolved and multifactorial cognitive behavioural treatments are advised. In the current dissertation an outline of such a treatment for patients with chronic pain, by means of patient centered transdisciplinary Pain Neuroscience Education as integration in the cognitive behavioural treatment for patients with chronic pain is explored.

A theoretical framework of patient centeredness in physiotherapy

Research has shown that improvements in patient centered healthcare improves the therapeutic alliance, satisfaction of patients, patient outcomes and decreases healthcare costs. Patient-centeredness has possibilities to further enhance the treatment of patients with chronic pain. Previous qualitative studies have shown that for instance 'relevance for the individual', which is a central part of patient-centeredness, is of importance during Pain Neuroscience Education. Pain Neuroscience Education is an important aspect in the treatment of patients with chronic pain. Within the healthcare system, Pain Neuroscience Education is most often delivered by physiotherapists. However, to our knowledge, theoretical models proposing patient centeredness have thus far been studied in overall care (The Picker Institute's principles), medicine and nursing. Without a commonly accepted definition of patient-centeredness in physiotherapy, research into its implementation and outcomes is stranded. Therefore, we conducted a systematic qualitative literature review in which the phenomenon of patient-centeredness in physiotherapy was studied from both the perspective of patients and physiotherapists. From these studies a synthesis of interrelated themes (*"individuality", "communication", "education", "goal setting", "support", "social characteristics of a patient-centered physiotherapist", "a confident physiotherapist", "knowledge and skills of a physiotherapist in patient-centeredness"*) with subthemes and a proposed conceptual framework of patient-centeredness in physiotherapy was constructed. Patient-centeredness in physiotherapy entails the characteristics of offering an individualized treatment, continuous communication (verbal and non-verbal), education during all aspects of treatment, working with patient defined goals, a treatment in which the patient is supported and empowered and a physiotherapist with patient centered social skills, confidence and knowledge.

A practical tool for the clinical biopsychosocial physiotherapy assessment of patients with chronic pain

To individualize the Pain Neuroscience Education prior to the education the physiotherapist should perform a thorough patient centered assessment of the patient with chronic pain and his/her complaints. Besides the 'usual physiotherapy intake' psychosocial factors ought to be examined during this intake, for instance factors such as cognitions, pain catastrophizing and emotional problems. However, research shows that physiotherapists find it difficult to investigate and deal with psychosocial problems, especially when they did not receive additional post graduate training in it. Therefore, to aid physiotherapists we conducted a narrative review in which an outline of the clinical biopsychosocial assessment to be used by physiotherapists in the encounter of patients with chronic pain was delineated. During this assessment the PSCEBSM-model can be used by physiotherapists, containing: Pain mechanism, Somatic, Cognitive, Emotional, Behavioural, Social and Motivational factors. First the dominant pain mechanism (predominant nociceptive, neuropathic or non-neuropathic central sensitization pain) is established according to the classification algorithm. Followed by an evaluation of the perpetuating biopsychosocial factors. The patient' specific pain mechanism and perpetuating factors can be filled pain analysis sheet, to be used in the following individualized Pain Neuroscience Education session.

Perspectives of patients with chronic pain who recently received Pain Neuroscience Education in a transdisciplinary setting

As chronic pain is often a complex problem effective team approaches frequently exceed the expertise of monodisciplinary care. More team collaboration, for instance by working transdisciplinary, has the potential for better outcomes of the treatment of patients with chronic pain. Transdisciplinary teamwork outperforms multi- and interdisciplinary in that professionals collaborate intensively, with shared responsibilities. Even though every team member has his/her expertise, there are flexible boundaries and roles, and team members learn simultaneously. It is important to comprehend the experiences of patients with these new approaches and interventions, such as transdisciplinary Pain Neuroscience Education. Therefore, to study the clinical application of this transdisciplinary teamwork and patient centered Pain Neuroscience Education, the experiences of patients with chronic pain were examined by a qualitative classical Grounded Theory study. Following Grounded Theory, 15 patients with chronic pain were interviewed and the data was analysed, of which four interacting topics emerged: The first topic was "*the pre-Pain Neuroscience Education phase*", the phase prior to the Pain Neuroscience Education, which comprised *"a broad intake"* and *"the healthcare professionals"*. The second found topic *"a comprehensible Pain Neuroscience Education"* contained an "*understandable explanation*" and the "*interaction between the physiotherapist and psychologist*". The third topic involved the "*outcomes of Pain Neuroscience Education*", including the subthemes "*awareness*", "*finding peace of mind*", and "*fewer complaints*". The fourth topic, "*scepticism*", contained "*doubt towards the diagnosis and Pain Neuroscience Education*", "*disagreement with diagnosis and Pain Neuroscience Education*", and "*Pain Neuroscience Education can be confronting*".

The results reveal the importance of the therapeutic alliance between the patient and healthcare professional, taking time, listening, providing a clear explanation and valuable team interaction. When doing so, most of the respondents with chronic pain reported improved cognitions about their pain and pain related behaviour.

Clinical observations of patient and therapist interactions in transdisciplinary Pain Neuroscience Education

It has been suggested to study clinical characteristics that may increase the effectiveness of PNE. As little is known about the clinical application of Pain Neuroscience Education. Because Pain Neuroscience Education is a "talk-modality" interpersonal aspects, such as the therapeutic alliance contribute to the treatment. The important aspects of social processes, such as the therapeutic alliance in clinical practice, can best be captured through qualitative studies in the form of observations. Therefore, based on Constructive Grounded Theory we conducted an observational qualitative study to try to grasp the practice of transdisciplinary Pain Neuroscience Education. With the aim of the study to explore the social processes between the patient with chronic pain, partner and healthcare professionals in the practice of transdisciplinary Pain Neuroscience Education. The outcome was a theoretic construct, grounded in the data of the observations. Nine Pain Neuroscience Education sessions from eight participants with chronic pain who were treated in a transdisciplinary treatment center were recorded with audiovisual equipment. These sessions were provided by one psychologist and physiotherapist per session. Four connected and interactive themes were found to be of importance for transdisciplinary PNE, with three overarching themes. The first theme we found was "*generating a safe and comfortable feeling, situation*" as a prerequisite. The second theme was the "*PNE process*". The third theme emerged as *"the process of change of the respondent*", leading to the fourth theme: "*outcome of the change process*". With overarching themes: the "*influence of changeability of the respondents", "interplay between the healthcare professionals"* and "*communication skills"* of the healthcare professionals.

Therapists should be aware of the importance of using a patient centered approach, in which they continuously monitor the therapeutic alliance and of their communicational skills. Furthermore, a step by step introduction of the Pain Neuroscience Education is suggested. And last, individualized metaphors are of importance to provide a patient centered Pain Neuroscience Education.

Moderators of change of self-reported signs of central sensitization following an individualized transdisciplinary pain management program

Two factors that greatly influence chronic pain and the activity in the dynamic pain connectome are pain catastrophizing and illness perceptions. Both influence each other and contribute to what is known as 'cognitive emotional sensitization'. Pain Neuroscience Education is known to improve the knowledge on pain of patients with chronic pain, as well as improve their illness perceptions. Thereby decreasing the threat of pain and pain catastrophizing. As the integration of Pain Neuroscience Education in monodisciplinary physiotherapy is effective, integrating it in multi- or transdisciplinary care seems recommendable, yet has not been studied before. Subsequently, it is important to comprehend which factors moderate these changes following a transdisciplinary cognitive behavioural therapy treatment for patients with chronic pain. A bottom up retrospective quantitative observational study evaluated the differences in clinical outcomes, among which pain catastrophizing, illness perceptions and self-reported signs of central sensitization. Furthermore, the relationship between these variables and the moderating effects of pain catastrophizing on the relationship between illness perceptions and self-reported signs of central sensitization in patients with chronic pain following a transdisciplinary cognitive behavioural therapy treatment were investigated. We found a moderate association between pretreatment scores of pain catastrophizing and illness perceptions, suggesting a bilateral relationship between catastrophic thinking and illness perceptions. Furthermore, there were significant, yet moderate, associations between change scores of pain catastrophizing, illness perceptions and self-reported symptoms of central sensitization. However, the results indicate that even though there is an association between pretreatment and change scores in illness perceptions and self-reported symptoms of central sensitization in patients with chronic pain, neither the direction nor strength of the relationship between these two was influenced by both pretreatment or change scores of pain catastrophizing. Due to the design of the study no hard conclusions can be drawn. As pain, and patients with chronic pain are multi-faceted, multifaceted everchanging factors influence their pain experience. Therefore, in future research the interplay of these factors should be studied by evolved approaches such as network analysis.

SAMENVATTING

Samenvatting

Of we het willen of niet, pijn is een onvermijdelijk onderdeel van het leven. Gemiddeld lijdt twintig procent van de bevolking aan chronische pijn, dus is er zelfs een kans dat wij in ons leven chronische pijn ervaren. Wanneer iemand chronische pijn ervaart spelen centraal mediërende mechanismen, ook wel bekend als centrale sensitisatie, een belangrijke rol in de pijnervaring. Centrale sensitisatie gerelateerde pijn, of recent door de International Association for the Study of Pain nociplastische pijn genoemd, wordt gekenmerkt door hyperexcitabiliteit van het centrale zenuwstelsel. Dit zorgt voor een verhoogde responsiviteit, leidend tot pijn zonder dat er sprake is van schadelijke perifere stimuli. Omdat bij de mens lichaam en geest niet aparte entiteiten zijn is het bekend dat biopsychosociale factoren de ervaring en voortzetting van pijn beïnvloeden. Als gevolg hiervan is de behandeling van patiënten met chronische pijn geëvolueerd en een multifactoriële cognitief gedragsmatige behandeling is geadviseerd. In deze dissertatie is een synopsis van de behandeling voor patiënten met chronische pijn, in de vorm van patiënt gecentreerde intake, transdisciplinaire pijneducatie en interventie van patiënten met chronische pijn, onderzocht.

Een theoretisch kader van patiënt gecentreerde fysiotherapie

Onderzoek heeft aangetoond dat positieve veranderingen in patiënt gecentreerde zorg de therapeutische alliantie, de patiënt tevredenheid en de patiënt gerelateerde uitkomsten verbetert en daarnaast de zorgkosten verlaagt. Tevens hebben eerdere kwalitatieve onderzoeken aangetoond dat bijvoorbeeld ‘relevantie voor het individu’, een centraal onderdeel van patiënt gecentreerde zorg, belangrijk is in de uitleg over pijn aan patiënten met chronische pijn (Pijneducatie). Pijneducatie is een belangrijk onderdeel van de behandeling van patiënten met chronische pijn. In de huidige gezondheidszorg wordt Pijneducatie meestal uitgevoerd door fysiotherapeuten. Echter, het onderzoek naar de theoretische modellen van patiënt gecentreerde zorg is tot dus ver, voor zover onze kennis strekt, alleen bestudeerd in de algehele zorg (de principes van het Picker Institute), de geneeskunde en de verpleging. Zonder een algemeen aanvaarde definitie van patiënt gecentreerde fysiotherapie kan het onderzoek naar de implementatie en effecten van patiënt gecentreerde fysiotherapie zich niet verder ontwikkelen. Daarom hebben wij een systematisch kwalitatief literatuuronderzoek uitgevoerd waarin het fenomeen van patiënt gecentreerde fysiotherapie is bestudeerd. In het onderzoek is zowel het perspectief van patiënten, als het perspectief van fysiotherapeuten meegenomen. Uit deze studie kwamen verschillende onderling samenhangende thema’s naar voren, namelijk: *“individualiteit”, “communicatie”, “educatie”, “doelen stellen”, “ondersteuning”, “sociale kenmerken van een patiënt gecentreerde fysiotherapeut”, “een zelfverzekerde fysiotherapeut”, “kennis en vaardigheden van een patiënt gecentreerde fysiotherapeut”*. Daarnaast zijn de verbanden in de vorm van een conceptueel framework van patiënt gecentreerde fysiotherapie weergegeven. Patiënt gecentreerde fysiotherapie omvat een geïndividualiseerde behandeling, continue communicatie (verbaal en non-verbaal), educatie tijdens alle aspecten van de behandeling, werken met door de patiënt gedefinieerde doelen, een behandeling waarbij de patiënt wordt ondersteund en bekrachtigd door een fysiotherapeut met patiënt gecentreerde sociale vaardigheden, zelfvertrouwen en kennis.

Een raamwerk voor de biopsychosociale intake van patiënten met chronische pijn binnen de fysiotherapie

Om pijneducatie geïndividualiseerd te kunnen geven is het van belang dat de fysiotherapeut voorafgaand aan de educatie een grondige patiënt gecentreerde intake van de patiënt met chronische pijn uitvoert. Naast de ‘gebruikelijke fysiotherapeutische intake’ is het belangrijk dat psychosociale factoren worden onderzocht, zoals cognities, pijn catastroferen en emotionele problemen. Uit onderzoek blijkt echter dat fysiotherapeuten het moeilijk vinden om met psychosociale problemen om te gaan, vooral als ze hier geen aanvullende opleiding in hebben gevolgd. Om fysiotherapeuten te helpen is er een narratief review uitgevoerd, waarin een opzet van de klinische biopsychosociale intake van patiënten met chronische pijn is beschreven voor de fysiotherapeutische praktijk.

Tijdens deze intake kan het PSCEGSM-model worden gebruikt door fysiotherapeuten, bestaande uit: predominant Pijn mechanisme, Somatische, Cognitieve, Emotionele, Gedragsmatige, Sociale en Motivationele factoren. Als eerste wordt hierin het predominante pijnmechanisme (overheersend nociceptieve, neuropatische of niet-neuropatische centrale sensitisatie pijn) vastgesteld volgens het classificatie-algoritme. Gevolgd door een evaluatie van de onderhoudende en beïnvloedende biopsychosociale factoren. Het specifieke pijnmechanisme van de patiënt met chronische pijn en de beïnvloedende factoren kunnen vervolgens worden ingevuld in een pijnanalyse formulier. Deze kan gebruikt worden in de daarop volgende geïndividualiseerde patiënt gecentreerde Pijneducatie-sessie.

De ervaring van patiënten met chronische pijn die recent transdisciplinaire Pijneducatie hebben gehad

Omdat chronische pijn een complex probleem is, overtreffen teambenaderingen vaak de expertise van monodisciplinaire zorg. Hoe intensiever de samenwerking, bijvoorbeeld door transdisciplinair werken, des te groter zijn de mogelijke effecten van de behandeling van patiënten met chronische pijn. Transdisciplinair teamwerk overtreft hierin multi- en interdisciplinair teamwerk, doordat professionals intensief samenwerken met gedeelde verantwoordelijkheden en hoewel elk teamlid zijn/haar expertise heeft zijn er flexibele grenzen en rollen en leren teamleden tegelijkertijd. Het is echter van belang om de ervaringen van patiënten over deze intensievere samenwerkingen te onderzoeken.

Om de klinische toepassing van dit transdisciplinaire teamwerk en patiënt gecentreerde transdisciplinaire Pijneducatie te bestuderen, werden de ervaringen van patiënten met chronische pijn over transdisciplinaire pijneducatie onderzocht middels een kwalitatieve klassieke Grounded Theory studie.

15 patiënten werden geïnterviewd en deze data zijn geanalyseerd, hieruit kwamen vier interacterende topics naar voren: Het eerste topic was "*de fase voor de pijneducatie*", waarin de basis gelegd werd voor de PE, met sub thema's "*een brede intake*" en "*de zorgprofessionals*". Het tweede topic was "*een begrijpelijke pijneducatie*" met "*begrijpelijke verklaring*" en "*interactie tussen de fysiotherapeut en psycholoog*". Het derde topic bevatte de "*uitkomsten van de pijneducatie*" inclusief "*bewustwording*", "*gemoedsrust vinden*" en "*minder klachten*". En het laatste topic bevatte "*scepsis*" met "*twijfel over de diagnose en pijneducatie*", "*niet eens zijn met de diagnose en pijneducatie*" en "*pijneducatie kan confronterend zijn*".

Uit de resultaten blijkt het belang van de therapeutische alliantie tussen de patiënt en de zorgprofessionals, zoals de tijd nemen voor de patiënt, luisteren naar de patiënt, een duidelijke uitleg geven aan de patiënt en goede teaminteractie. Indien dit gebeurt, noemden de meeste respondenten met chronische pijn positief veranderde cognities over hun pijn en verbeterd pijn gerelateerd gedrag.

Klinische observaties van de patiënt en therapeut interacties van transdisciplinaire Pijneducatie

Er is tot heden weinig bekend over de klinische toepassing van Pijnedcuatie. Daarom is voorgesteld om de klinische karakteristieken die de toepassing van Pijneducatie mogelijk verbeteren, te onderzoeken. Omdat Pijneducatie een 'praatmodaliteit' is, dragen verschillende interpersoonlijke aspecten, zoals de therapeutische alliantie bij aan de behandeling. De belangrijke aspecten van sociale processen, zoals de therapeutische alliantie, kunnen het best geanalyseerd worden in kwalitatief onderzoek door middel van observaties. Daarom is er een kwalitatief observatief onderzoek uitgevoerd, op basis van Constructive Grounded Theory, waarin de getracht werd de praktische toepassing van transdisciplinaire Pijneducatie te doorgronden. Met als doel om de sociale processen tussen patiënt, partner en zorgprofessionals te onderzoeken en theoretiseren. De uitkomst was een theoretisch construct, gegrond in de data van de observaties.

Negen Pijneducatie-sessies van acht respondenten met chronische pijn die werden behandeld in een transdisciplinair behandelcentrum werden opgenomen middels audiovisuele apparatuur. Deze sessies werden gegeven door één een psycholoog en een fysiotherapeut per sessie.

Vier samenhangende en interactieve thema's kwamen naar voren. Het eerste thema was "*het genereren van een veilig en comfortabel gevoel en situatie*". Het tweede thema dat naar voren kwam was "*het Pijneducatie-proces*". Het derde thema was het "*veranderingsproces van de respondent*", waaruit voort vloeide het vierde thema: "*de uitkomst van het Pijneducatie-proces"*. De volgende overkoepelende thema's werden geïdentificeerd: "*de invloed van de veranderbaarheid van de respondenten*", het "*samenspel tussen de zorgprofessionals*" en "*communicatieve vaardigheden*".

Het is van belang dat therapeuten een patiënt gecentreerde benadering gebruiken, waarbij ze de therapeutische alliantie bewaken en hun communicatieve vaardigheden onderkennen. Daarnaast is een stapsgewijze opbouw van de Pijneducatie aan te bevelen. Ten slotte zijn geïndividualiseerde metaforen van belang om een patiënt gecentreerde Pijneducatie te geven.

Moderatoren van verandering van zelf-gerapporteerde symptomen van centrale sensitisatie na een geïndividualiseerd transdisciplinair pijn management programma

Twee factoren die chronische pijn sterk beïnvloeden door een verhoogde activiteit in het pijn-connectoom zijn pijncatastrofering en ziektepercepties. Beide factoren hebben invloed op elkaar en dragen bij aan wat bekend staat als 'cognitieve emotionele sensitisatie'. Het is bekend dat Pijneducatie de kennis van patiënten met chronische pijn over pijn verbetert, ziektepercepties verandert, waardoor de dreiging van pijn en pijn catastroferen als gevolg van de Pijneducatie mogelijk afneemt. Omdat de integratie van Pijneducatie in monodisciplinaire fysiotherapie effectief is lijkt integratie in multi- of transdisciplinaire zorg aan te bevelen. Dit is echter nog niet eerder onderzocht. Daarbij is het belangrijk om het modererende effect van pijn catastroferen op behandelingsresultaten te onderzoeken.

Een bottom-up retrospectief kwantitatief observationeel onderzoek is uitgevoerd om de klinische resultaten te evalueren van onder andere pijn catastroferen, ziektepercepties en zelf-gerapporteerde symptomen van centrale sensitisatie. Tevens is onderzocht wat relaties tussen en de modererende effecten van pijn catastroferen op de relatie tussen ziektepercepties en zelf gerapporteerde symptomen van centrale sensitisatie zijn.

We vonden een gematigde associatie tussen voormetingen van pijn catastroferen en ziektepercepties. Dit wijst op een bilaterale relatie tussen catastrofaal denken en ziektepercepties. Verder waren er significante, maar gematigde, associaties tussen de verander-scores van pijn catastroferen, ziektepercepties en zelf gerapporteerde symptomen van centrale sensitisatie.

Als laatste, hoewel er een associatie was tussen baseline scores en scores in veranderingen in ziektepercepties en zelf gerapporteerde symptomen van centrale sensitisatie, werd deze niet gemodereerd door zowel baseline scores als scores in verandering van pijn catastroferen. Dit kan mogelijk verklaard worden door het feit dat de beginscores van de patiënten met chronische pijn op pijn catastroferen lager waren dan de cut off score voor pijn catastroferen en er slechts kleine veranderingen aanwezig waren.

Vanwege het design van de studie kunnen geen harde conclusies getrokken worden. Omdat pijn en patiënten met chronische pijn multidimensionaal zijn, beïnvloeden interactieve complexe factoren de pijnervaring. In toekomstig onderzoek is het daarom van belang om het samenspel van meerdere factoren, in plaats van alleen pijn catastroferen, te bestuderen door bijvoorbeeld netwerkanalyses.

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ABOUT THE AUTHOR

About the author

Amarins Jelly Wijma was born on February 17th 1987 in Bakkeveen, the Netherlands. She joined the bachelor program Physiotherapy at the Hanze University of Applied Sciences, Groningen, from 2004-2008. During her final years of the bachelor program and first year of working in clinical private practice her interest in the 'when' and 'how' of physiotherapy was sparked. Therefore, she decided to further enhance her scientific knowledge by enrolling the pre-master and master program Clinical Health Sciences, Physiotherapy Science, at the Utrecht University Medical Center (2010-2013). During the Master program she met Paul van Wilgen and 'thus the science journey began'. This journey started with a systematic qualitative literature review on patient centeredness in physiotherapy, the foundation for her PhD dissertation. During the last phase of her master's degree a qualitative Grounded Theory study was conducted, with the subject-matter 'The experiences of patients with transdisciplinary PNE', the next chapter of her PhD dissertation. In March 2014 she started her PhD at The Vrije Universiteit Brussel, Brussels, Belgium. Throughout her PhD trajectory, with the mentorship of Paul van Wilgen, Jo Nijs, Doeke Keizer and Lennard Voogt she further developed her qualitative research skills, writing (inter)national scientific publications, book chapters, blogs, teaching - and project-management skills. As can be read throughout the thesis, she finds it important to perform 'bottom up research', in which patients' voices are expressed to translate and improve clinical care for patients with chronic pain.

She is a member of the Pain in Motion research group. She has co-authored several chapters in (inter) national books. Furthermore, she has authored 8 vSCI-indexed full-text papers of which she published 5 as first author.

Besides her PhD she has continued to work in clinical practice, both in private practice and in a secondary outpatient treatment center for patients with chronic pain. Furthermore, she has taught, and continues to teach clinicians working with patients with long-term pain about PNE and other aspects involving the management of long-term pain throughout Europe. In the future she hopes to be able to continue her clinical work in combination with research and teaching.

LIST OF PUBLICATIONS

List of publications

List of publications in journals with peer review (chronological)

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