A Protocol for Pain Neuroscience Education

Case study: applying the model to a patient with chronic low back pain

Deborah Guthmann, SPT

University of North Carolina at Chapel Hill

Doctorate of Physical Therapy Program

December 4, 2018

# Background

## What is pain?

Former theories described the mechanization of pain like a telephone wire communicating onset, duration, location, and quality of noxious stimuli directly to areas of the brain which bring awareness of painful sensations.1 This model determined that pain and illness are because of anatomical pathophysiology. When proponents of this model could not find physical pathology corresponding  with the patient’s presentation, pain became ‘non-organic’ or an illness of the mind.1 This model has failed to help patients, which is evident by the continued rise in chronic pain and unsuccessful treatments. Though the literature varies widely in estimates of chronic pain, estimates range from 15-64%, with some studies citing that 25.3 million adults in the US experience chronic pain daily.2,3

In recent years, this “telephone wire” theory has been replaced with a biopsychosocial model of pain. This model understands that the human experience is modulated by biological, social, and psychosocial domains. Context heavily impacts the output of the central nervous system. Pain occurs when the brain perceives a threat, which is impacted by context, and determines that action is needed. Pain is not merely something a tissue experiences and informs the brain, rather it is a “multiple system output activated by the brain based on perceived threat.”4 Many areas of the brain are involved with processing and are unique to every individual, thus necessitating that treatment of patients be highly variable and personalized.

Acute pain, therefore, is a protective output from the central nervous system (CNS) to prevent use of potentially injured structures and to bring awareness to cause(s) of threat. It can be termed nociceptive pain and it is understood to have proportionate and clear aggravating and easing factors.4

Chronic pain is pain that lasts beyond normal tissue healing times; now often termed nociplastic pain. This pain is disproportionate and often incorporates both peripheral and central sensitivity.4 Smaller and fewer inputs activate the peripheral pathways and less nociceptive messages from the peripheral system are enough to activate CNS output of pain.4 As Louw would describe it, where before a patient could run five miles without soreness, now standing up is painful.5 This widespread hypersensitivity is characteristic of nociplastic pain and involves impaired descending inhibition and overactive descending and ascending pain pathways.

## Nociplastic Pain and the Orthopedic Clinician

Chronic musculoskeletal pain often begins with a traumatic injury. Typically, an area is sensitive during and after tissue healing in order to protect the site of former damage. It has been noted that in one in four people, this threshold does not return to normal levels and nociplastic pain occurs. It is important to note that nociplastic pain includes both central and peripheral sensitizations. Musculoskeletal changes or degeneration, such as in osteoarthritic damage to articular cartilage, can sustain central sensitization because the continuous nociceptive messages increase the CNS’ heightened awareness and therefore sensitivity.6

Hypersensitivity is believed to play a large role in osteoarthritic discomfort. While defects in articular cartilage are present, the amount of damage found on imaging does not predict or correlate with the degree of pain experienced.7 Therefore, while there may also be corresponding tissue changes, identifying chronicity as well as other signs of central and peripheral sensitization will lead to the most appropriate treatment addressing both central and peripheral components.

## Rehabilitation:

With this is mind, rehabilitation of prolonged pain becomes more about addressing nerve sensitivity than tissue damage. Proven methods are structured around delivery of pain neuroscience? education in an effort to decrease the threat associated with pain by increasing a patient’s understanding of physiology.2 It explains both “biological and physiological processes” of the pain experience and deemphasizes anatomical structures.2 Such education, when deeply learned and combined with movement therapy, decreases pain and disability, while improving function and quality of life.8 Research shows that face-to-face, individual education sessions are more effective than delivery through groups or written material alone.6 However, written material in addition to in-person education is preferred and ‘appreciated.’ PNE should accompany pain reduction techniques (i.e. modalities, manual therapy) as well as other interventions to address all biopsychosocial factors contributing to chronicity. (see table 2)

## PNE Protocol

Applying this knowledge to an independent clinical experience in physical therapy school, this writer wishes to create a protocol for pain education of the chronic low back pain population. As a template for the patient interaction, the protocol will guide the reader through identification, delivery of education, and initiation of treatment. The outline first attempts to change the maladaptive belief of pain as a threat and then initiate treatment with improved motivation and compliance. The following practice guidelines were adapted from Jo Nijs’s model as outlined in his article, “How to explain central sensitization to patients with unexplained chronic musculoskeletal pain: a practice guideline.”6

### Step 1: Identifying the patient appropriate for pain physiology education

Before seeing a patient, the chart evaluation can typically hint at the diagnosis of central sensitivity. Typically, patients have seen multiple providers and attempted other conservative evaluations and treatment measures before entering the clinic. Therefore, the exam should incorporate musculoskeletal assessment that clears red flags, observes general movements, and focuses on widespread nerve sensitivity through neurodynamic testing rather than specific orthopedic tests. A patient with central sensitization will present with hyper-responsiveness to movement and sensitivity to touch.9 They will have generalized decreases in pressure pain thresholds which is detected with pressure algometers or manual palpation. Subjective description of symptoms often include “burning” sensations.9 Pain is diffuse and spreading, not following dermatome or myotome patterns.9,10 The patient’s pain does not have clear mechanical provocative or easing factors, and may increase with temperature, stress, emotions, or without known cause. Typically, sleep is impacted and patients will complain of fatigue and aches upon awakening. Patients may express difficulty with memory or concentration and mood swings. Nociplastic pain is often accompanied or preceded by mental health illnesses such as depression and anxiety.9

The patient will also present with maladaptive pain cognition, often with hypervigilance and altered perceptions. Outcome measures can identify psychosocial problems which contribute to the development and maintenance of chronic pain.11 The fear and avoidance questionnaire (FABQ), Oswestry Disability Index (ODI), and the Roland Morris Disability Questionnaire are frequently used to screen for fear-avoidance and impairments. High scores on these tests have been linked to poor outcomes and chronic pain.11

### Step 2: Education begins

Once the physical therapist has identified nociplastic origins of symptoms, the patient should receive an explanation of the results which indicate appropriateness for a type of treatment that includes education on pain neurophysiology (treatment rationale). Pain neuroscience education (PNE) should take place over at least two sessions, face-to-face, with content based on “Explain Pain” and supplemented material from this writer’s own research. 1 Education will last 30-60 minutes per session, as proposed by Nijs and Louw.6,12 An outline of education and information provided can be found in the attached document. In general, education should cover nervous system physiology with an emphasis on pain system physiology. Acute and chronic pain definitions should be introduced as well as the central nervous system’s role in the production of pain. Discussion of contributors to central sensitivity should be included as well as methods to reduce sensitivity.

### Step 3: Reinforcement via homework

Only deep learning of pain neuroscience education will impact the pain experience.8 The patient should be provided with written educational information about neurophysiology and review concepts discussed with the therapist at home, between sessions. The source used by this writer was, “Recovery Strategies: a pain guidebook,” by Dr. Greg Lehman.

### Step 4: Correcting, reconceptualization, and application

Once information is delivered, it is imperative to identify misunderstandings and correct beliefs in later sessions. “De-education” seeks to correct misbeliefs which limit patient outcomes.2 This step will allow patients to ask questions and make the concepts personal as the therapist discusses sensitization and contributing factors in the perspective of the patient’s unique life experiences. Tools such as the neurophysiology of pain quiz may guide this dialogue.13 Patients should then set specific, measurable, achievable, relevant, and timely functional goals from the biopsychosocial understanding of pain under the guidance of the PT. Broad examples involve reducing stress, increasing physical activity, and improving sleep in order to de-sensitize nociceptors.

### Step 5: Applying pain knowledge during treatment

After learning about the biopsychosocial model of pain and pain physiology, the patient would benefit from reinforcement of concepts while being actively treated for nociplastic pain. Research has found that the pain experience is most impacted when PNE is combined with another treatment.8 Suggested interventions for central and peripheral sensitivity involve top-down and bottom-up treatments; treatments should address central sensitivity as well as peripheral components that sustain hypersensitivity. This writer emphasized pain neuroscience education, aerobic exercise, sleep, hygiene, and goal setting. Secondary interventions include 18 interventions that address all components of the pain experience.1 (see table 2)

In this consolidatory step, it is important to continually reinforce PNE concepts in communication with the patient, explaining how each treatment relates to the pain model and addresses neuropathic processes.

# Case Description: Subject Description, History, and Systems Review

## History

### Ms. Camp is a 37-year-old female with a 17-year history of back pain. She works full time at the Veterans Association Hospital in respiratory care. She is a single mom with two kids, describing them as “abnormally easy” and stress-relieving components of her life. She lives with her children and dog and has a supportive family network in the area. She experienced a recent exacerbation with reports of radiating pain into her right leg and right buttock. At the time of her physical therapy evaluation, she was finishing a two-week leave of absence due to intense, disabling pain in her low back and right leg.

### Specific to her chief complaint, she sustained a traumatic injury 17 years ago when someone fell on her during a training exercise in the military. She describes pain since that occurrence, but imaging was negative for significant soft tissue or bony damage. She cycled through three physical therapists, multiple acupuncture trials, and a chiropractor with no sustaining relief. Her medical history is significant for depression, amenorrhea, polyarthralgia, chronic pain, anxiety, and degenerative arthritis of spine. She is currently on medication for anxiety and depression and takes pain medication and muscle relaxers intermittently. These comorbidities are known to impact patient outcomes and contribute to the diagnosis of central sensitization.14

### Imagery of her spine in 2015 showed normal impressions without sclerosis, erosion, lytic or blastic lesions ruling out “red flag” conditions such as radiculopathy, myelopathy, or spondylolisthesis. Though she reported falls and intermittent numbness and tingling in her legs, she denied symptoms of radiculopathy, myelopathy, cancer, systemic infection, or cardiovascular issues.

### Ms. Camp was chosen for this case study because her history and subjective reports are consistent with nociplastic or chronic pain with central sensitization. She also expressed motivation and willingness to comply with therapy indicating that she would not be lost to follow up. Ms. Camp verbalizes that she wants to be able to work without pain, go on road trips with her kids, be able to redecorate her home, and take her dog on walks without significant pain.

In addition to patient identified goals, the writer created short- and long-term objectives based on patient needs and the education session. Goals can be found in attached document. (Table 3)

# Case Description: examination, evaluation, diagnosis, and prognosis

## Outline of procedures generally

A subjective interview was conducted first followed by gait and functional movement observations. Active ranges of motion, strength testing, and passive ranges of motion were conducted in various positions necessary for technique (see table 4). Sensation and neurodynamic testing were conducted next with palpation of nerve paths performed in sitting. Special tests were done in supine following passive ranges of motion. The last component was prone palpations of the lumbar spine as the therapist suspected it would elicit the most discomfort. Outcome measures were filled out following completion of the physical exam.

## Rationalization of exam components:

A large portion of the patient-therapist interaction was spent on the subjective portion of the exam. Central sensitization and chronic pain is often revealed in the beliefs and daily experiences of the patient.14 Because Ms. Camp has seen several clinicians, received imaging, and been cleared of red flag pathologies, her reports on function and dysfunction will likely reveal more than objective information.14 Additionally, subjective interviewing is important for developing a therapeutic relationship with the patient. It is essential to know what a patient is doing, his/her perceptions, how pain impacts life, and how life impacts pain. Subjective interviewing also facilitates a team approach with the patient and clinician working together to make decisions.15

Musculoskeletal tests used were typical of orthopedic exams and used to clear patient of both nociceptive and peripheral neurogenic sources of symptoms. While central sensitization was suspected to be the core issue, ongoing input into the nociceptic pathways contributes to prolonged pain and sensitivity.4,16 Active and passive ROM of upper and lower quarters with emphasis to hips and lumbar movements as well as strength assessments of the lower quarter were used to observe deficits and pain patterns. Special tests for the hips were used to clear instability, impingements, and malalignments as well as quantitatively assess Camp’s sensitivity to touch and movement. Functional movements were observed as well to assess limitations in daily routine and get a better picture of how impairments manifest in dysfunction.

Outcome measures selected were Roland Morris Disability Questionnaire (RMDQ), Fear and Avoidance Beliefs Questionnaire (FABQ), pain intensity scale, and body diagram. All the measures selected are commonly used in assessing a patient with suspected central sensitization.1,14,17 Quantitative assessment of the characteristics of central sensitization such as hypersensitivity, fear of movement, impact of pain on function, and the patterns of pain guide diagnosis as well as measure change throughout treatment process. The measures selected have excellent reliability and validity with normative data specific to chronic low back pain (see table 1).

## Results of subjective exam:

Ms. Camp notes that her low back pain radiates upwards towards her scapula and trapezius muscles bilaterally and down her right thigh and across buttock to left gluteus. She describes pain as dull with occasional shooting “lightning” down her right leg. She occasionally has pain in shoulders, headaches, and pain in her feet without knowing what initiated symptoms. She experiences a dull ache which never leaves but fluctuates in intensity. Though pain can occur spontaneously, she reports that typically repetitive motions including lifting, bending, pushing, and pulling increase her pain while physical therapy, occasional prescription pain medication, stretching, and complete rest alleviate it. She also expressed hypersensitivity to temperature, noises, and lights, verbalizing that it can bring on headaches and body aches. She expresses difficulty sleeping due to discomfort and often wakes up unrefreshed. Notably, Camp reports an average of three falls per month because her “right foot doesn’t touch the ground right” and gives out regularly. Camp says her pain is very limiting and knows that it has caused or is tied to her mental health struggles. She has withdrawn from activities she loves such as road trips, running, and interacting with her children. While she does yoga once per week typically, when her pain gets worse she withdraws from all physical activity. She believes that work makes her back pain worse and has contributed to dysfunction.

## Results of objective exam:

Ms. Camp was pleasant, well-groomed, cheerful, and joking throughout her evaluation. Even when movements elicited symptoms, she maintained a smile. Gait observation revealed non-antalgic pattern at self-selected pace with externally rotated lower extremities and increased q-angle noted. When prompted to walk faster, she began to limp with shortened stance phase on right lower extremity due to reported instability and ache in her right low back and buttock.

Camp was generally within normal limits for all active ranges of motion in shoulders, cervical, hips, lumbar spine, and soft tissue length of major muscle groups. She had some compensation with lumbar flexion and extension, using hip flexion and extension during movements. She maintained a lordotic posture throughout the exam, describing discomfort in lumbar extension as “tightness.” In supine, passive ROM revealed full motion with mild pain in her right low back at the end of hip ranges in her right lower extremity (LE). Strength testing revealed intact upper quarter strength and decreased strength in bilateral LE with non-fatiguing but weakened holds. She did not report pain with muscle testing. Special tests for hip pathology were negative though mild, concordant pain in her right low back and across glutes were reported with testing of left hip. Thomas test for hip flexor and quadricep tightness was positive on the right with lumbar extensions used as compensation for apparent deficits in hip flexor length.

With the slump neurodynamic test, the patient denied pain or symptoms with either LE testing. In supine, Single Leg Raise (SLR) was positive for sensitivity at 45 degrees with a neutral bias. Palpations revealed general sensitivity across her back with grade 1-2 mobilization of thoracic and lumbar spine (posterior to anterior intervertebral mobilizations). Some hypomobility was noted with significant muscle guarding with gentle palpations making motion of the spine difficult to assess. Sensation was intact to light touch with increased sensitivity bilaterally in the common fibularis, both superficial and deep branches,

Outcome measures revealed increased fear and avoidance, significant disability, and spreading pain. (see Table 5) Imaging impressions of neck and cervical spine were normal (2014) and a 2015 MRI showed normal sacral iliac joint and lumbar spine without sclerosis, erosions, or lesions.

## Diagnosis Rationale

### Exam Components Rationale

Because Ms. Camp has had physical therapy and other conservative evaluations and treatments without success, a purely musculoskeletal evaluation is not helpful or appropriate. Chronic pain patients are fear avoidant and guarded, making extensive palpation and hands-on tests difficulty. Results of typical tests will not likely have true positives or negatives. Because pain is no longer purely biomechanical in nature, nociplastic pain patterns need to be assessed. Specifically, neurodynamic testing, sensitivity to touch, and functional movements identify nerve sensitivity.

### Diagnosis:

Camp’s examination was mostly inconclusive from a purely musculoskeletal system perspective. Her subjective reports of pain with inconsistent aggravating and easing factors as well as a largely non-irritating exam did not indicate a specific tissue pathology. This is consistent with central sensitization or nociplastic pain. Her outcome measures indicated fear and movement avoidance, diffuse area of pain with spontaneous causes, and significant disability associated with symptoms (See table 5). She verbalized that pain was associated with an emotional disturbance, and she has a history of failed treatments. Combined with pain that does not follow a dermatomic or myotomic pattern and comorbid conditions of depression and anxiety, her pain is likely to be the result of nerve sensitivity rather than tissue damage. Pain is a complex neurophysiological process marked by hyper-excitable central nervous system to input. (Butler, Woolf 2007)

# Case Description: Intervention

## Intervention Rationale

Due to clinical diagnosis of nociplastic pain, pain neuroscience protocol is the most appropriate initial treatment for Ms. Camp. Pain neuroscience education is the intervention cornerstone as it has been shown to have a positive effect on pain, disability, catastrophization, and physical performance. 8 Further benefits of education for the chronic pain patient include reduction of psychosocial factors and improvement of movement.8 Because Camp has a history of failed treatment, solely focusing on orthopedic specific treatments would be nonproductive. She had tried and not improved with manual therapy and modalitites. Instead, interventions were centered on de-sensitizing the nervous system from the top-down, by addressing beliefs and central processing of threats and calming nerves. Using PNE in combination with other therapies provides superior results. Louw et al suggests 22 interventions that address deficits common with nociplastic pain. Every intervention is implemented from the lens of nerve sensitivity initiating pain rather than tissue pathology. Each intervention chosen was specific to Ms. Camp’s needs and identified areas of continued nerve sensitivity.

### Exam and Treatment rationale: Step 1. 09/05/2018

At the conclusion of Camp’s evaluation, she was introduced to the definition of pain, the concept of nociplastic pain, and treatment rationale. Based on her evaluation, the writer believed that she would benefit from treatments of PNE, goal setting, physical activity, graded imagery to reduce fear and avoidance, sleep hygiene because of reported difficulties, and manual therapy and modalities to reduce pain within a session.

The writer used eight stories, proposed by pain science researchers, to guide the patient through neurophysiology. A script and outline of each education point is found in the appendix. (Table 6) The first, introduction session incorporated “pain as an alarm,” the role of the CNS in facilitating and inhibiting messages from the periphery, and the prevalence of prolonged sensitivity as well as ways to ways to “calm nerves” through education, habituation, and physical activity. At the end of the session, Camp was given a workbook that reinforced taught material and introduced concepts to be reviewed at the next session. The writer also instructed Camp to perform physical activity for at least ten minutes per day to improve blood flow and oxygen to tissues, thus making them “happier and healthier” because aerobic activity flushes out chemicals such as adrenaline and cortisol which lend to nerve sensitivity.

The patient was receptive to the treatment rationale and hopeful because PT in the past has only temporarily impacted her pain experience. She verbalized that she would be compliant with the treatment regimen and home program. Of note, the therapist emphasized patient-therapist interaction throughout the exam and neuro re-education. Listening, encouraging, and motivational interviewing techniques were used to build a therapeutic relationship. Goals for Ms. Camp were created as outlined previously (table 3). A second session was scheduled for the following week.

### Session two: Protocol Step 2 09/26/2018

Due to a tropical storm, the original session two was rescheduled to a later date. Though the writer attempted to schedule earlier, Ms. Camp did not respond to calls or emails for a week. The earliest possible appointment was made for September 26, over three weeks after first session. This session focused on review of previously taught education and introduction of new concepts. Therapeutic exercise and heart rate monitoring occurred to delineate MET necessary for aerobic exercise benefits. Sleep hygiene was discussed and stress reduction techniques outlined. Outcome measures were not retaken as the writer will perform measures four to six weeks sequentially.

Ms. Camp reported noncompliance with treatment. She did not review the material given nor was she consistent with aerobic exercise. Of note, she fell down several stairs because her foot “just went wrong.” On further exam, no musculoskeletal or neuromuscular issues were identified. Since the last session she returned to work and described it as “okay.” She described her sleeping routine and noted unhelpful behaviors such as watching TV to go to sleep. She reported using appropriate stress coping methods such as removing stressors, coping with gentle yoga, walking, and sometimes eating. Her pain intensity and frequency had not changed since evaluation.

The interventions focused on neuro re-education through PNE topics with 30 minutes spent on education, ten discussing sleep hygiene, ten using heat to calm nerves, and ten minutes of therapeutic exercise for a total of 60-minute session. The writer used further stories to introduce topics of ion channel adaption, nerve sensor types and adaption, spreading pain, and calming nerves. The therapist reinforced the message that Ms. Camp’s symptoms arose from tissue sensitivity rather than continued damage. The writer and patient discussed contributors to pain such as stress and sleep deprivation and gave Ms. Camp a sleep hygiene checklist. She was able to teach back concepts correctly and was acceptable to information heard. To show the patient appropriate intensity for eliciting endogenous opioid and analgesic effects of exercise, the writer and Ms. Camp walked in the hallways for ten minutes with a target heart rate of 100-110 bpm which was measured through the radial pulse. This time and intensity are proposed to be sufficient for benefits of aerobic activity and stress reduction.1

A home exercise program (HEP) was given and included further reading in the workbook, 20 minutes of daily physical activity with ten at an intensity of 100-110 bpm, and incorporation of one sleep hygiene suggestion per night. Ms Camp verbalized that she would think of specific goals for treatment to be discussed at next session which was scheduled for the following week (10/05).

### Session 3: Protocol Step 4 10/10/2018

 Ms. Camp was a no-show at her scheduled appointment and rescheduled for October 10. This session was spent delineating goals, discussion of graded activity, reviewing PNE, introducing brain mapping concept with corresponding graded imagery treatment, assessment of discrimination and localization, and progression of her HEP.

 Ms. Camp reported compliance with the HEP given at the last session. However, she continued to experience impaired sleep despite using sleep hygiene concepts. Of note, she tied in pain neuroscience concepts with her discomfort felt, verbalizing that these symptoms, according to the educational material, are more about sensitivity than damage of her tissues. She reported improvement in pain (average intensity 3/10 on NRS scale improving from average of 6/10). She verbalizes that she “doesn’t feel limited by her pain now that she understands it doesn’t mean she’s injuring herself.” She expressed her goals revolved around returning to previously held activities. She would like to go on a road trip with her children and participate in a Breast Cancer Awareness 5K with her mother.

The concept of graded activity was introduced and instructions in breaking goals into parts with a gradual increase to promote habituation of nerve sensitivity. The writer and Ms Camp made the goals specific with time frames and steps to reach each goal and broke the goals into manageable components. She wanted to drive to Atlanta, October 27th, stopping every hour to stretch and move in order to calm sensitivity. She would like to walk the 5K with her mother in December, with intermediary goals of initially walking a half mile with increased distance per week. She would like to rearrange her furniture for a family get together November 5th with intermediary goal of moving furniture over several days in five minute increments (time she believes she can do without over doing it).

Upon reviewing the nerve physiology questionnaire, Ms. Camp was able to answer every question correctly, indicating improved knowledge. Further PNE was given using the stories of brain map, lion in the room, healing tissues, and emotions influence on pain experience. Topics were chosen due to patient verbalization that stress increased her pain (lion in the room), that her symptoms have spread from low back to all over, and feeling like her feet are not “hers.”

Due to patient complaints, the writer incorporated graded imagery techniques into session to improve brain mapping. It is well established that chronic pain leads to deficits in neural mapping and ‘smudging’ of homunculus.18–20 This difficulty in discrimination and localization of input can lead to prolonged pain. Those with chronic pain will have difficulty knowing where sensory input is coming from and patients will have often have globally impaired localization and two-point discrimination. To address the blurred brain map specifically, graded motor imagery has been shown to reduce pain and restore localization and discrimination abilities in comparison to typical physiotherapy.21 Using two point discrimination on Ms Camp’s feet, the writer found that she was unable to distinguish between two pin-points that were less than an inch apart in her right foot. Her left foot discrimination was less than half an inch apart. Additionally, the writer graphed Ms. Camp’s back, showing the patient an image of a back with six segments and asking her to identify which segment was being touched without looking. She was unable to identify the correct segment 50% of the time.

Therefore, the writer added to her HEP with instructions for right/left discrimination using the Orientate App, a free software that uses images of feet and hands to challenge discrimination ability, as well as stereognosis on her back. The app was to be used for five minutes daily and her children were to write various alphabet letters for identification on her back five minutes daily to improve brain mapping.

### Session four: Protocol Step five 10/30/18

Ms. Camp did not show up for appointment on 10/17. She called and rescheduled and upon arrival, reported she felt much better. She had successfully gone on a road trip with her children and rearranged furniture for her family get together. She had started going to the gym and working with a personal trainer. She had completed the pain workbook and had begun recognizing faulty thinking about pain and its causes. She reported compliance with her HEP, using the right/left discrimination app consistently as well as incorporating some sleep hygiene practices into her life. Ms. Camp admits that her sleep has not improved, and that she frequently wakes up “uncomfortable.”

Heat modalities were used to warm low back followed by ten minutes of stationary bike during which she reviewed PNE concepts with the writer. She progressed with motor imagery, searching magazines for right and left lumbar lateral flexion for five minutes daily. The session ended with Grade 2 mobilizations and soft tissue mobilization of quadratus lumborum and hamstrings. The mobilizations were performed on her lumbar spine in prone, creating passive intervertebral accessory motion for pain relief and desensitization. The soft tissue stretches were given to create space for nerves, increase blood flow and habituate Ms Camp to movement.

 The writer advanced her HEP with instructions to continue specific movement identification by analyzing pictures of herself for right or left side bending. Because she is physically active through personal training, specific exercises were not given. Neurodynamic flossing of bilateral sciatic nerve was prescribed to improve space and desensitize area.

 Ms. Camp is improving, recognizing nerve sensitivity as principle issue rather than tissue damage. She has accomplished several goals and is increasing physical activity. Her average pain intensity has decreased and, as evidenced by her outcome measures, fear and avoidance and disability are decreasing. She was scheduled for a follow-up the next week.

###  Session 5: Step 5 continued 11/29/18

Ms. Camp did not show up for her original appointment, but was able to be reached and rescheduled for November 29. Because she had not been seen in a month, the session retook outcome measures and objective testing and reviewed PNE concepts previously discussed.

 Ms. Camp reported that she had multiple family deaths and had been driving back and forth from Illinois for several weeks. She denied aggravation of symptoms and has remained consistent with daily physical activity, movement, graded imagery, and sleep hygiene techniques. She also reports using the stress coping skills she learned in physical therapy such as breathing and journaling.

 The writer repeated measures of R/L discrimination, segment identification on her back, graphesthesia, SLR, and slump and Ms. Camp did not have any impairments. Lumbar and hip range of motion was typical and did not aggravate symptoms. The FABQ, RMDQ, and Global Perception of Improvement were retaken and improved significantly, with outcomes indicating she had low levels of avoidance and disability, improving the probability of full return to work and activities. Notably, she reports that her average pain, a 2/10, was significantly lower than previously and she now had periods of no pain (0/10). (see table 5)

 To review PNE concepts and determine Ms Camp’s current retention, the writer investigated her current beliefs regarding pain. She verbalized that the pain occurred “when I do repetitive movements when I don’t move for awhile because my muscles cramp and spasm.” She noted that some pain is fake and some is real. Because she still believed tissue damage is ‘real’ pain and contributes to her symptoms, the writer reviewed several pain stories including pain physiology, spreading pain, nerve sensors and changes to ion channels with chronic pain, stress as a lion, and the brain as a boardroom.1 (see table 6) Throughout the session, the writer used the teach-back method to encourage deep learning of reviewed concepts.1

 Her home exercise program included the quadratus lumborum supine stretch, sciatic nerve flossing, and supine transverse abdominus marching. They were given with the explanation that the activities were not addressing impairments like poor ROM or strength but rather to encourage movement and desensitization. Her HEP also outlined continuation of physical activity (walking and yoga), creation of a mantra (throbs not threat), continuation of identifying side-bending in photo albums to progress graded imagery, and review of PNE concepts using the Pain Strategy Workbook. Due to the resolution of impairments and indication that Ms Camp was making positive changes in her pain experience, the writer rescheduled Ms Camp for a 30-minute follow-up with another chronic pain physical therapist who had been following her case. The follow-up would correct pain neurophysiology concepts and conclude physical therapy treatment for Ms Camp.

## Outcomes:

Functional outcome measures were collected monthly, with Numerical Rating Scale (NRS), FABQ, global impression of change and RMDQ measures taken at initial exam, second measures taken at Session Four, and third measures at session five. From baseline to session four, her FABQ improved more than 25%, indicating a clinically meaningful change in fear and avoidance. RMDQ improved seven points from baseline to session four showing a significant reduction in disability. (see table)

Objective measures for right and left discrimination were found using Orientate App. The app is designed to present flashcards of limbs in various positions and subject is to indicate whether the limb is right or left. At baseline (session 3) Ms Camp was able to identify an average of 24 right in 66 seconds indicating 2.75 seconds needed to identify the position of a limb. On second collection, discrimination ability improved to 2.1 seconds per image. This is within the normal range of identification speed (2.0 +/- 0.5 sec) as proposed by Moselely et al.21

Ms. Camp also reached all goals she made in therapy. The first was to complete a long-distance car trip with her children. She incorporated graded activity strategies, breaking the drive into one-hour increments but reported that she did not have functionally limiting pain afterward. The second goal was to rearrange furniture which Ms Camp was able to do by breaking the activity into smaller amounts. As for the goals set forth by the writer, Ms. Camp met all though not in the proposed time frames. (see table)

# Discussion

## Impact on patient

Throughout her treatment, Ms Camp gradually returned to activities she had been avoiding for years. While she did not have complete elimination of pain, she verbalized that her pain “didn’t mean as much” because she recognized that it was due to a hypersensitive nervous system. In the time frame she was being seen, Ms Camp did not miss a day of work due to pain, nor did she take prescription pain relievers as was her habit. As evidenced by changes in her outcome measures, she improved in function and ability. Of note, the writer suspects a large portion of improvement was related to the patient’s positive outlook. Consistent with the literature, her ability to reframe negative experiences and belief that she could change likely contributed considerably to her progress.12,17 By the end of her time in therapy, Ms Camp had met her goals and had no limitations due to her previous pain.

The patient had difficulty keeping appointments and there were lengthy intervals between sessions and had corresponding difficulty with retaining concepts. Suggested frequency of PT sessions for low back pain is weekly.6,12 As time stretches out, patients are less likely to retain information, maintain a credible relationship with the therapist, and are less likely to return to the clinic.12 It is unknown how much inconsistency of sessions impacted her outcomes or the length of therapy course.

The protocol had strengths and limitations. It was easily adaptable to the patient’s needs. It guided the writer in implanting PNE concepts with appropriate review, reconceptualization, and transition into treatment. It provided a broad framework for applying therapeutic education into an orthopedic setting and was easily implemented into the clinical setting. However, there was a large deviation from the suggested two, thirty-minute sessions. Partially because of the time between sessions and the inexperience of the writer, PNE sessions lasted far longer than the proposed time in order to communicate concepts and correct beliefs. Furthermore, though the protocol called for one session to correct misbeliefs, the writer incorporated review and correction into every session because the patient had difficulty grasping concepts. Using a home exercise program to provide educational material is not ideal. Because it was not possible to see the patient with sufficient frequency for education dissemination, her homework became a necessary evil. Because compliance is often an issue in the chronic pain population, education would preferably be performed one-on-one. From the writer’s experience, PNE sessions should take place every session, introducing small amounts of information which allows for processing and deep learning. Many patients describe long education sessions as a ‘fire-hydrant’ approach and they become overwhelmed. Splitting topics into small portions and spreading it over multiple weeks seems to be a more reasonable and effective approach to PNE.

Retrospectively, the writer would have used a weekly email reminder to confirm appointments with the patient as well as provide accountability and potentially send review of PNE concepts. Additionally, the patient specific goals should have been created at the first session to improve her motivation. To assess how Ms Camp believed she was improving, the Global Impression of Change measure could have been regularly used to track changes between sessions.

# Reflection:

I have been fascinated with chronic pain since my first year of physical therapy school. Neurophysiology and the process of nociception versus nociplastic pain captured my attention. In many of my clinical rotations, therapists would complain about getting a chronic pain patient, trying to hand them off to other PTs and frequently recounting interactions as “war” stories. The health care system has failed these patients. However, one clinical instructor mentored me and introduced me to current pain neuroscience. She also exemplified compassion and care, creating incredible therapeutic relationships with her patients. Given an opportunity to incorporate the latest pain neuroscience research into treating this population, I was able to practice what had been demonstrated and present an effective means of modifying the pain experience. Because many people with prolonged pain are without hope for recovery, it was a privilege to use an independent study to learn and apply effective treatment methods.

Several things went better than expected. I found it natural to develop relationships with my patients. Attempting to form a therapeutic alliance like my mentor’s, I worked on communication skills and incorporated motivational interviewing techniques into patient interactions. It seemed natural to see them as people first, rather than merely as patients. Rather than setting goals and home exercise programs myself, I discussed options with the patient, sharing power and responsibility. For example, “Steve” was noncompliant after weeks of treatment though we had adjusted his HEP many times and I’d reduced it to the bare-minimum. After brainstorming together, we created a schedule and alternated days of activity because he previously felt overwhelmed and therefore did nothing. We also wrote his goals on a big sheet of paper which he taped to his bathroom wall as a reminder. This type of cooperative relationship is shown to improve outcomes in reducing pain intensity and hypersensitivity.22

I also found that I was able to communicate difficult concepts of pain neuroscience to patients. Due to the abundant resources and an excellent mentorship, I learned how to present the information as well as use clinical judgement to determine if a patient was understanding, engaging, or disagreeing.

In retrospect, I wish I had been better organized. Because every session felt rushed and was filled with treatment, I frequently forgot components of the protocol. There were many times a patient left and I remembered I had not asked their goals, done a specific neurodynamic test, given an outcome measure, or provided a particular educational topic. In the future, I will create a template for the evaluation and treatment sessions to encourage orderliness.

I didn’t expect patient retention and compliance to be as difficult as it was. After two to three sessions, patients would not return to clinic nor respond to calls or emails. Initially, I began with a ten-patient case-load. Over the course of five months, all but two were lost to follow up. Of note, during my last weeks, several called wishing to continue with treatment but I was unable to see them because the semester ended. These characteristics are common to chronic pain patients in general and the VA in particular.8 Patients drive long distances to go to the Durham VA, and the orthopedic PT clinic maintains a trend of patients lost to follow up. Typically, therapist refer patients to clinics closer to their homes. However, there are not many PTs specializing in chronic pain and referral was not preferred for my patients.

Overall, applying a protocol for PNE in the chronic pain population was a richly rewarding experience. I learned the necessity of establishing relationships yet letting the patient take responsibility for their own treatment. I learned the need for grey thinking, maintaining flexibility with the protocol, adjusting the steps and interventions per the patient’s needs. I vastly grew in my knowledge of chronic pain, central sensitization, nociplastic pain, and the current literature in treatment. Rather than becoming bored or burned out from hours upon hours of research and writing and treating, I am more determined to seek out the most effective and helpful treatment for chronic pain patients and will continue this passion into my professional career.

# References

1. Louw A, Puenteduera E. Therapeutic neuroscience education: teaching patients about pain. International Spine and Pain Institute; 2013.

2. Louw A, Nijs J, Puentedura EJ. A clinical perspective on a pain neuroscience education approach to manual therapy. *J Man Manip Ther* 2017;25(3):160-168. doi:10.1080/10669817.2017.1323699.

3. Johannes CB, Le TK, Zhou X, Johnston JA, Dworkin RH. The prevalence of chronic pain in United States adults: results of an internet-based survey. *J. Pain* 2010;11(11):1230-1239. doi:10.1016/j.jpain.2010.07.002.

4. Moseley GL. A pain neuromatrix approach to patients with chronic pain. *Man. Ther.* 2003;8(3):130-140. doi:10.1016/S1356-689X(03)00051-1.

5. Louw A, Puentedura EJ. Therapeutic neuroscience education, pain, physiotherapy and the pain neuromatrix. *IJHS* 2014;2(3). doi:10.15640/ijhs.v2n3a4.

6. Nijs J, Paul van Wilgen C, Van Oosterwijck J, van Ittersum M, Meeus M. How to explain central sensitization to patients with “unexplained” chronic musculoskeletal pain: practice guidelines. *Man. Ther.* 2011;16(5):413-418. doi:10.1016/j.math.2011.04.005.

7. Culvenor AG, Øiestad BE, Hart HF, Stefanik JJ, Guermazi A, Crossley KM. Prevalence of knee osteoarthritis features on magnetic resonance imaging in asymptomatic uninjured adults: a systematic review and meta-analysis. *Br. J. Sports Med.* 2018. doi:10.1136/bjsports-2018-099257.

8. Louw A, Zimney K, Puentedura EJ, Diener I. The efficacy of pain neuroscience education on musculoskeletal pain: A systematic review of the literature. *Physiother Theory Pract* 2016;32(5):332-355. doi:10.1080/09593985.2016.1194646.

9. Woolf CJ. Central sensitization: implications for the diagnosis and treatment of pain. *Pain* 2011;152(3 Suppl):S2-15. doi:10.1016/j.pain.2010.09.030.

10. Campbell JN, Meyer RA. Mechanisms of neuropathic pain. *Neuron* 2006;52(1):77-92. doi:10.1016/j.neuron.2006.09.021.

11. Chung EJ, Hur Y-G, Lee B-H. A study of the relationship among fear-avoidance beliefs, pain and disability index in patients with low back pain. *J Exerc Rehabil* 2013;9(6):532-535. doi:10.12965/jer.130079.

12. Louw A, Puentedura EL, Mintken P. Use of an abbreviated neuroscience education approach in the treatment of chronic low back pain: a case report. *Physiother Theory Pract* 2012;28(1):50-62. doi:10.3109/09593985.2011.562602.

13. Vaughan B, Mulcahy J, Fitzgerald K, Austin P. Evaluating patient’s understanding of pain neurophysiology: rasch analysis of the neurophysiology of pain questionnaire. *Clin. J. Pain* 2018. doi:10.1097/AJP.0000000000000658.

14. Nijs J, Van Houdenhove B, Oostendorp RAB. Recognition of central sensitization in patients with musculoskeletal pain: Application of pain neurophysiology in manual therapy practice. *Man. Ther.* 2010;15(2):135-141. doi:10.1016/j.math.2009.12.001.

15. Diener I, Kargela M, Louw A. Listening is therapy: Patient interviewing from a pain science perspective. *Physiother Theory Pract* 2016;32(5):356-367. doi:10.1080/09593985.2016.1194648.

16. Courtney CA, Fernández-de-Las-Peñas C, Bond S. Mechanisms of chronic pain - key considerations for appropriate physical therapy management. *J Man Manip Ther* 2017;25(3):118-127. doi:10.1080/10669817.2017.1300397.

17. Nijs J, Roussel N, Paul van Wilgen C, Köke A, Smeets R. Thinking beyond muscles and joints: therapists’ and patients’ attitudes and beliefs regarding chronic musculoskeletal pain are key to applying effective treatment. *Man. Ther.* 2013;18(2):96-102. doi:10.1016/j.math.2012.11.001.

18. Willems T, Witvrouw E, Verstuyft J, Vaes P, De Clercq D. Proprioception and muscle strength in subjects with a history of ankle sprains and chronic instability. *J. Athl. Train.* 2002;37(4):487-493.

19. Bowering KJ, Butler DS, Fulton IJ, Moseley GL. Motor imagery in people with a history of back pain, current back pain, both, or neither. *Clin. J. Pain* 2014;30(12):1070-1075. doi:10.1097/AJP.0000000000000066.

20. Moseley GL, Butler DS, Beames TB, Giles TJ. The graded motor imagery handbook. Noigroup Publications; 2012.

21. Moseley GL. Graded motor imagery for pathologic pain: a randomized controlled trial. *Neurology* 2006;67(12):2129-2134. doi:10.1212/01.wnl.0000249112.56935.32.

22. Fuentes J, Armijo-Olivo S, Funabashi M, et al. Enhanced therapeutic alliance modulates pain intensity and muscle pain sensitivity in patients with chronic low back pain: an experimental controlled study. *Phys. Ther.* 2014;94(4):477-489. doi:10.2522/ptj.20130118.