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THE MECHANISMS OF TENSION MYO- NEURAL SYNDROME AND APPLIED TREATMENT AND CARE TECHNIQUES

Faculty of Biomedical Sciences and Engineering

Master of Science Thesis

August 2019

ABSTRACT

IIDA KYRRÖNEN: The mechanisms of tension myoneural syndrome and applied treatment and care techniques

Master of Science Thesis, 91 pages, 15 Appendix pages

August 2019

Master's Degree Programme in Biomedical Engineering

Major: Tissue Engineering

Examiners: Professor Minna Kellomäki and Senior Research Fellow Hannu Nieminen

Keywords: Tension Myoneural Syndrome, The Mindbody Syndrome, Psychophysiological Pain Disorder, TMS, chronic pain, mindbody connection, psychosomatic, repressed emotions, emotional awareness, self-care treatment materials

Tension Myoneural Syndrome (TMS) as a diagnosis was developed in the late 1970s by John Sarno (MD). He discovered that often back pain and later other chronic pain conditions are psychosomatic in nature. The main objectives of this Master's Thesis was to provide a comprehensive literature research on the origin, symptoms and treatment of TMS and to develop an online diagnostic TMS questionnaire tool.

The literature research revealed that the area of psychosomatic pain conditions is scarcely studied. However, the growing scientific and empirical evidence supports the role of emotions in the development of chronic pain and in some other related chronic conditions. By the currently unknown reason the brain may presume the powerful emotions, like anger, shame and grief, too overwhelming. So instead of actually *feeling* these emotions the TMS patients' brain creates physical symptoms to distract the patient. This happens in the unconscious mind without the awareness of the patient.

The role of the brain in the creation of TMS symptoms is undeniable. With the help of modern imaging technology, it is possible to study what is happening in the brain during chronic pain. Remarkably pain and especially chronic pain would seem often involve the same brain areas that are responsible of social pain and emotional processing. However, more research is needed in this area. Because of the widespread symptoms and variety of conditions that are thought to be TMS equivalents the role of immune and endocrine system involvement in TMS should also be considered.

There are a lot of different treatment programs and options to TMS. All of them rely on the same basic principles: education about the syndrome, overcoming the fear of physical activity and emotional awareness through psychotherapy or journaling. Why this kind of treatment works is most likely due to changes in the brain and nervous system related to these interventions.

The biggest problem in TMS treatment is the lack of educated medical professionals. Many doctors do not understand the importance of the mindbody connection in relation to illness and disease. Thus, misdiagnosis is common, and the patients cannot receive the treatment they would actually need and benefit from. The biggest difference between traditional treatment of chronic pain and TMS treatment is that while traditional treatment is about *pain management* and mainly symptomatic treatment, TMS treatment aims to *full recovery* and treats the root causes of the symptoms.

TIIVISTELMÄ

IIDA KYRRÖNEN: TMS-oireyhtymän mekanismit ja hoito tekniikat

Diplomityö, 91 sivua, 15 liitesivua

Elokuu 2019

Biotekniikan diplomi-insinöörin tutkinto-ohjelma

Pääaine: Kudosteknologia

Tarkastajat: professori Minna Kellomäki ja yliopistotutkija Hannu Nieminen

Avainsanat: TMS-oireyhtymä, krooninen kipu, keho-mieli yhteys, psykosomaattinen, torjutut tunteet, tunteiden tiedostaminen, itsehoito materiaalit

TMS-oireyhtymä diagnoosina on syntynyt 1970-luvun lopulla. Lääkäri John Sarno huomasi, että usein selkäkivut ovat luonteeltaan psykosomaattisia, ja myöhemmin myös muunlaiset krooniset kivut voivat johtua osittain tai kokonaan psykologisista syistä. Tämän diplomityön päätarkoituksena oli tehdä kattava kirjallisuuskatsaus TMS-oireyhtymästä perehtyen sen alkuperään, oireisiin ja hoitoon. Lisäksi tavoitteena oli kehittää verkossa toimiva versio kyselystä, jota on käytetty apuna TMS:n diagnosoinnissa.

Kirjallisuuskatsaus paljasti, että psykosomaattisia kipuoireita on tutkittu suhteellisen vähän. Kuitenkin kasvava tieteellinen ja empiirinen todistusaineisto viittaa siihen, että tunteet ovat tärkeässä osassa kroonisen kivun sekä muidenkin kroonisten sairauksien kehittymisessä. Vielä toistaiseksi tuntemattomasta syystä aivot voivat kokea vahvat tunteet, kuten vihan, häpeän tai surun liian voimakkaiksi. Tällöin itse tunteen *tuntemisen* sijaan TMS-potilaan aivot luovat fyysisiä oireita kääntääkseen potilaan huomion pois tunteista. Tämä prosessi tapahtuu täysin potilaan tiedostamatta.

Aivot ovat suuressa osassa TMS:n oireiden kehittymisessä. Nykyiset kuvantamistekniikat voivat paljastaa, miten krooninen kipu vaikuttaa aivoihin. Yllättäen kipu, erityisesti krooninen kipu, näyttäisi liittyvän samoihin aivoalueisiin, jotka ovat vastuussa sosiaalisen kivun ja tunteiden prosessoinnista. Kuitenkin lisätutkimuksia tältä alueelta tarvitaan. Vaihteleavan oireenkuvan ja laaja-alaisten oireiden vuoksi, joiden uskotaan olevan niin kutsuttuja TMS-ekvivalentteja, myös immuuni- ja umpieritysjärjestelmä saattavat olla osallisina TMS:ssä.

TMS:n hoitoon on olemassa useita erilaisia ohjelmia ja vaihtoehtoja. Kaikki hoitovaihtoehdot nojautuvat samoihin periaatteisiin: koulutukseen ja informaatioon TMS:stä, fyysiseen aktiivisuuteen liittyvien pelkojen voittamiseen sekä tunteiden tiedostamiseen psykoterapian tai tunteista kirjoittamisen avulla. Hoidon tehon arvellaan perustuvan aivoissa ja hermostossa tapahtuviin muutoksiin.

Suurin ongelma TMS:n hoidossa on koulutettujen lääketieteen ammattilaisten puute. Monet lääkärit eivät ymmärrä keho-mieliyhteyden läheistä suhdetta sairauksiin riittävän hyvin. Sen vuoksi väärät diagnoosit ovat yleisiä ja siitä johtuen potilaat eivät saa sitä hoitoa, josta he parhaiten hyötyisivät. Suurin ero perinteisen kroonisen kivun hoidon ja TMS hoidon välillä on, että perinteinen hoito pyrkii symptomaattiseen hoitoon ja *kivun hoitamiseen*, TMS hoidon tavoitteena on oireiden syyn hoitaminen ja *täysi paraneminen*.

PREFACE

This Master's Thesis has been done in Tampere University of Technology in Tampere in the faculty of Medicine and Health Technology during the autumn 2018 and spring 2019. The topic of research is Tension Myoneural Syndrome, it's possible mechanisms and treatment.

I would like to thank my examiners Professor Minna Kellomäki and the Senior Research Fellow Hannu Nieminen for their help, advice and support with my thesis. They trusted me to work independently and did not question my topic and I am very grateful for that.

I would like to thank my supervisor Dr. David Schechter for his excellent advice, feedback and support.

I would like to thank Tampereen teknillisen yliopiston tukisäätiö for financially supporting my thesis process. In addition, I would like to thank the people working around TMS for their support with my thesis.

I would like to acknowledge the work of John Sarno (MD) whose discoveries in the field of TMS has already helped thousands of people and will help millions in the future. I admire him and his courage to go with what he saw was the truth. He is my source of inspiration.

I would also like to thank my family and friends for their love, advice and support.

Especially I would like to thank Nicole Sachs. Thank you for everything. I truly hope you keep on with the good work you are doing.

Iida Kyyrönen

In Tampere, 22.7.2019

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LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviations

ACC	Anterior Cingulate Cortex
ACE	Adverse Childhood Experiences
ACT	Acceptance and commitment therapy
ACTH	Adrenocorticotrophic hormone
AI	Anterior insula
CAM	Complementary and alternative medicine (or therapies)
CBT	Cognitive behavior therapy
CFS	Chronic Fatigue Syndrome
CNS	Central nervous system
CRH	Corticotrophin-releasing hormone
CTS	Carpal tunnel syndrome
CV	Cardiovascular
dACC	Dorsal Anterior Cingulate Cortex
DLPFC	Dorsolateral prefrontal cortex
DPS	Distraction Pain Syndrome
EAET	Emotional awareness and expression therapy
EMG	Electromyography
GH	Growth hormone
GI	Gastrointestinal
GU	Genitourinary
GSR	Galvanic skin response
IBS	Irritable bowel syndrome
ICD	International Classification of Diseases
IL-1 β	Interleukin 1- β
IL-6	Interlukin-6
ISTDP	Intensive short-term dynamic psychotherapy
MBS	The Mindbody Syndrome
MMS	Musculoskeletal mind-body syndrome
NSAID	Non-steroidal anti-inflammatory drug
PAG	Periaqueductal gray
PI	Posterior insula
PMP	Pain management program
PNI	Psychoneuroimmunoendocrine system
PNPS	Psychogenic Neural Pain Syndrome
PNS	Peripheral nervous system
PPD	Psychophysiological Pain Disorder
PPDA	Psychophysiologic Disorder Association
PSNS	Parasympathetic nervous system
PTSD	Post-traumatic stress disorder
RVPFC	Right Ventral Prefrontal Cortex
SAM	Sympathetic-adrenal-medullary axis
STDP	Short-Term Dynamic Psychotherapy
S1	Somatosensory cortice
S2	Somatosensory cortice
TMJ	Temporomandibular Joint Syndrome
TMS	Tension Myoneural Syndrome

TNF- α	Tumor necrosis factor- α
TPS	Tension Psychoneural Syndrome
VAS	Visual Analog Scale (used for pain measurement)

Definitions

Analgesia	Pain relief
Alexithymia	A condition where the patient is unable to identify and process feelings
Hyperalgesia	Increased sensitivity to pain
Pathogen	Usually viruses or other micro-organisms or anything that can cause disease
Psychogenic	Having a psychological origin or cause rather than a physical one
Psychosomatic	A physical illness or another physical symptom that is caused or aggravated by a mental factor

1. INTRODUCTION

Today there is an epidemic of chronic pain in the society. Besides, about half of the out-patient visits can be connected to somatic disorders that many times cannot be adequately explained. (A. Abbass et al. 2009) Despite the development of modern medicine and the development of new medical, pharmacological, technological and surgical treatments *no purely technological solution has yet appeared* to solve the problem of chronic pain. (T. Ojala 2018, p. 38; D. Schechter 2014, p. 39) Mindbody approach to chronic pain treatment has been observed to be efficient in practice (N. Sachs 2016; J. Sarno 1982; J. Sarno 1991; J. Sarno 1998; J. Sarno 2006; D. Schechter 2014; H. Schubiner 2010; N. Selfridge et al. 2001; F. Sommer Anderson et al. 2013; M. Sopher 2003). It would be worth to consider the treatment option for chronic pain presented in this thesis. It is clear, that other strategies for treating chronic pain are not solving the problem.

Since René Descartes (1596-1650) the Western medicine and the view of the world has been dualistic: we have divided the human into mind and body (E. Davey 2016; T. Ojala 2015, p. 20). In recent times Western medicine has started to realize that this division into mind and body is not working and the roots of all disease and healing, i.e. people reporting complete healing from chronic pain or spontaneous remission from cancer, cannot be explained adequately by applying only the physical model of the human body (E. Davey 2016). It is time to recognize that the mind cannot be separated from the body – it affects the body such as the body affects the mind (C. Pert 2003).

This literature review is about how emotions, illnesses and wellness are related. The focus of this thesis is on physical symptoms that are initiated by emotional phenomena. The underlining assumption is that unconscious repressed emotions initiate physical illness (A. Abbass et al. 2009; J. Sarno 1998). In order to fully understand this connection of emotions and illness, it is crucial to examine the most complicated and least understood organ of the human body – the brain. The human body is much more easily understood by the traditional biomechanical model; single organs and cell types can be engineered and transplanted. However, engineering and even understanding the human brain is not that simple. Little is understood how the brain and the body work as a harmonic unity orchestrating the bodily functions and maintaining homeostasis and balance.

It is widely accepted that stress influences physical health and development of disease. According to recent studies the developmental environment of the child and emotions experienced in childhood affects health later in life (S. Mann 2000; N. Sachs-Ericsson et al. 2017; J. Schofferman 1992). Chronic stress and adverse childhood experiences (ACEs) like childhood abuse, parental psychopathology and early parental loss possibly by

dysregulation of the hypothalamic-pituitary-axis (HPA) and the autoimmune system lead to increased probability for anxiety and mood disorders and pain-related medical conditions (N. Sachs-Ericsson et al. 2017; D. You et al. 2018). Patients who have suffered an early social and physical trauma are more prone to physical pain in adulthood (R. Brown et al. 2005; A. Landa et al. 2012). The latest studies also suggest that social and physical pain may overlap and share similar mechanisms (N. Eisenberger 2015).

Foundation for mindbody healing is based on Sigmund Freuds (1856-1939) theories about repressed and unconscious feelings, motivation, ego and id that dominated the field of psychology until 1950s (D. Schechter 2014, p. 97-98). In the lack of the tools like MRI imaging to study the mind and the brain at the time, Freuds theories were based on patient observations.

Tension Myoneural Syndrome (TMS) was first time described by John Sarno, MD, a physiatrist and clinical rehabilitation specialist at the New York University's Rusk Institute in the late 1970s. He discovered that conventional treatment methods to heal back pain often failed. The structural reasons (i.e. bulging discs, minor curvatures and degenerative discs) did not adequately explain the pain that the patients were experiencing. Thus, he started to treat back pain as a psychosomatic condition with good results, which led to the development of the concept of TMS.

The concept of TMS has since evolved to include a variety of conditions though the description of the concept is still evolving. Because of the lack of scientific evidence there are differing opinions which conditions are purely TMS and which are not. Future studies in this field will hopefully clarify this.

Like Freuds theories also Sarnos theories for chronic pain were based on patient observations, positive treatment results and Freudian psychology. The new brain imaging tools that scientists have today have made it possible to investigate the human brain and observe its functions much more closely and accurately. Now we have the chance to understand TMS even better – if the scientific community is willing to accept the concept of mindbody connection.

In the context of this thesis I would like to remind the reader that TMS is very new and largely unstudied syndrome and it is not (yet) included into the International Classification of Diseases (ICD) (ICD10Data). Thus, there was limited amount of reliable scientific literature directly related to TMS available for this thesis. Also, most literature and research related to TMS is empirical data or experiences described by doctors and other health care professionals. Even though the source materials for this thesis were carefully selected and the authors backgrounds were evaluated before including their work this thesis can be critiqued because of this shortcoming which the author is aware. In addition, it is notable that John Sarno, the father of TMS, developed the concept of TMS by observing his patients instead of scientific studies though many of his theories about TMS

are scientifically validated and supported by later studies. However, it was seen important to include empirical observations made by TMS physicians that have not yet been proven right or wrong in clinical studies so that the correctness of these claims could be tested and evaluated in the future. Also, the purpose of this thesis was to gather together what is known about the syndrome so that scientific and more accurate studies about TMS could be done in the future.

By now no profound research about the biological processes behind TMS symptoms has been made. There are mainly studies on observing patients' recovery with mindbody treatment programs. Because of this the mechanisms for the TMS symptoms induction proposed in this thesis are mainly hypothetical and mostly based on the observed symptoms, successful treatment results and other observations.

It is also notable that the field of study of psychosomatic disorders and TMS is large and it combines many fields such as psychology, medicine and biology. This thesis concentrates mainly on chronic pain because of a) the available scientific research in this area b) the symptoms and disorders which are considered to be TMS are not clearly agreed except for chronic pain.

There are good treatment options for TMS that seem very promising compared to conventional treatment for chronic pain. Correct diagnosis and awareness of TMS is crucial for patients' recovery. For this reason, an already existing TMS diagnosis questionnaire was developed into an online questionnaire.

One of the biggest problems with TMS treatment is the lack of educated TMS practitioners. Another problem with treatment and research is lacking awareness of mindbody disorders. Hopefully this thesis can do some good in that area.

2. MINDBODY DISORDERS

TMS connects many fields of science, especially biology and psychology. To understand the nature of chronic pain the mindbody connection needs to be understood. For simplicity the most important aspects of the body and the mind related to TMS are presented separately in the next few chapters. Besides this division it is important to understand that TMS can be explained only by looking the human as a whole.

2.1 Chronic pain

Traditional definition of pain is that it is an unpleasant *sensory* and *emotional* experience that is associated with *real* or *potential* tissue damage. (E. Davey 2016; E. Haug et al. 2009, p. 151) Chronic pain differs from acute pain and it may not involve any, or at least in modern imaging technique, detectable tissue damage or altered pathology. (E. Davey 2016)

Pain can be categorized by the duration of the pain. Acute pain is usually related to burns, trauma and other injuries and has lasted maximum six weeks. Sub-acute pain, related to severe burns, pulled muscles and some fractures, is pain that has lasted from six weeks to 3 months. Pain that has lasted longer than that is categorized as chronic pain. (M. Lumley et al. 2011; D. Schechter 2014, p. 21)

Pain can also be divided by the type of pain into nociceptive and neurogenic pain. Nociceptive pain is usually related to acute injury and usually fades away when the affected body part heals. (E. Haug et al. 2009, p. 151) Neurogenic pain is pain related to injury or dysfunction of the nervous system. Neurogenic pain develops differently from nociceptive pain and acute injury may not be involved.

Sensory pain processing

Pain itself is a feeling or perception of the sensation arising from a part of the body, nociception is the sensory process that includes the signals that trigger the pain (M. Bear et al. 2006, p. 408). Human body contains specialized sensor cells called nociceptors that detect possible threats and inform the brain about the possible or existing injury. These sensory nerve fibers are branched as free nerve endings that are not surrounded by external structures. The impulse rate in these nerve fibers is slow because they are demyelinated, or the myelin sheath is inadequately developed. (M. Bear et al. 2006, p. 409; E. Haug et al. 2009, p. 152)

Usually these nerve fibers react to extreme temperatures, oxygen deprivation and to strong chemical or mechanical stimulation. Some of the nerve fibers are specified to certain types of stimulation. Tissue damage can directly activate these nerve fibers but also prostaglandins, histamine and bradykinin that is released from damaged tissue can indirectly activate these neurons. As other sensory neurons adapt to stimulation the pain detecting nerve fibers do not adapt – they work the opposite way and become more sensitive to stimulation. The purpose of this sensitization to pain called hyperalgesia is to prevent further tissue damage to already damaged tissue. (M. Bear et al. 2006, p. 408-410; E. Haug et al. 2009, p. 152)

The somas of pain detecting nerve fibers are in the spinal ganglions of the dorsal horn of the spinal cord. There they form excitatory synapses with the nerves that transmit the nerve impulse to the brain. In the brain the axons of these cells end either to brain stem or thalamus and many have synapses with the reticular formation. From thalamus the pain signal is transmitted to cerebral cortex where the feeling of pain comes into consciousness. (E. Haug et al. 2009, p. 152)

According to situation the feeling of pain may vary even though the stimulus that causes pain is of the same magnitude. Other neurons can affect the synapses that transport the pain signal to the brain in the dorsal horn of the spinal cord. These inhibitory neurons release inhibitory neurotransmitters that prevent the pain signal passing forward to the neurons located in the spinal ganglions of the dorsal horn of the spinal cord that transmit the pain signal further to the brain. These inhibitory neurons release inhibitory neurotransmitter enkephalin that is an opiate. The effect of many opiates is related to the opiate receptors in the nerve cells related to pain signal transport in the dorsal horn of the spinal cord or in the brain. (E. Haug et al. 2009, p. 152-153) Even though nociceptor activation is important in the sensory pain processing it is notable (and possibly very important in chronic pain) that the nociceptor activation is not necessary or may be completely missing even in the presence of agonizing pain: the brain is capable of controlling the cognitive qualities of nociception (M. Bear et al. 2006, p. 8).

Pain experience and processing

Pain experience is created in the brain but cannot be connected into any specific part of the brain, it is merely a complex network of connected structures that are related to pain stimulus. (S. Boll et al. 2018) Pain experience can be divided into three components: sensory and affective component and the cognitive evaluation of the pain. The sensory component is involved in localizing the pain as well as in evaluating its quality and intensity. The affective component is involved in evaluating the unpleasantness of the pain and the feelings and emotions related to the pain. (D. Price et al. 1987; H. Schubiner et

al. 2012, p. 27) The third component of pain includes the cognitive evaluation of the pain: the possible meaning and consequences of an injury or pain (M. Lumley et al. 2011).

Neural systems related to the first two components are separate but parallel. The sensory component is related to lateral pain system. The axons of this system ascend laterally in the spinothalamic tract of the spinal cord, then synapse within lateral nuclei of the thalamus and finally continue to the primary somatosensory cortex. The affective component is related to medial pain system: the axons project medially within the spinothalamic tract of the spinal cord and brainstem, then synapse within medial thalamic nuclei and finally project to various brain regions such as cingulate cortex, amygdala, hypothalamus, periaqueductal gray (PAG) and other parts of the limbic system. (M. Lumley et al. 2011)

These components correlate much with each other, but there are some brain areas whose activation is more connected with affective and sensory components. Dorsal anterior cingulate cortex (dACC) is shown to be more correlated with the affective component as well as anterior insula (AI). Lesions in the dACC or in the insula can alter the unpleasantness experience of the pain: the pain can still be felt but the pain does not bother the patient. Posterior insula (PI), primary and somatosensory cortices (S1 and S2) are more related to sensory processing. Similarly lesions in S1, S2 or PI have been observed to disrupt the sensory processing of the pain without altering the affective component. (N. Eisenberger 2015; M. Lumley et al. 2011) Neuroimaging studies support these findings. (R. Hofbauer et al. 2001; P. Rainville et al. 1997; T. Tölle et al. 1999) The affective, not the sensory component has been hypothesized to overlap with social pain. (N. Eisenberger 2015)

Neuropeptides can affect the experience of pain. The endogenous opiates (endorphins) and narcotics like opium, morphine, codeine and heroin can greatly affect the pain experience. Endorphins and endorphin receptors are concentrated into areas that are related to processing of nociceptive information. Analgesia can be produced when small amounts of endorphins or morphine are injected to PAG, the raphe nuclei or the dorsal horn of spinal cord. (M. Bear et al. 2006, p. 417-418) Lesions or morphine injections to rats amygdala is related to suppressed emotional responses to pain (P. Nandigama et al. 2003). Other neuropeptides may affect the pain experience as well: i.e. the central oxytocin system has an important neuromodulatory effect on emotion, stress and anxiety which greatly influence pain experience (S. Boll et al. 2018).

Chronic pain

Chronic pain means pain that has lasted 3 months or more (Kipu 2017) or that the disease that causes pain is continuing (P. Paakkari 2017). Chronic pain may be due to tissue damage or a damage in the nervous system. Sometimes the type and source of the pain is impossible to recognize (P. Paakkari 2017) and when there is no detectable reason or

explanation for the pain it is called idiopathic or non-specific pain. This thesis concentrates on chronic pain that is primarily centralized: the pain is idiopathic or the physiological explanations as a cause of chronic pain are questionable. This thesis does not consider primarily peripheral pain that is nociceptive, neuropathic or inflammatory in nature like rheumatoid arthritis, sickle cell disease, inflammatory bowel disease or cancer related pain. (M. Lumley et al. 2019a)

According to M. Racine (2018) chronic pain affects approximately 1 person out of 5 worldwide (M. Racine 2018). 19 % of adults in Europe suffer from pain that has lasted more than 6 months, in Finland 35 % of adults have experienced pain that has lasted more than 3 months and 14 % of adult population suffers from daily chronic pain. (Kipu 2017) According to I. Rashbaum et al. (2003) this number is up to approximately 30 % in the economically developed countries. (I. Rashbaum et al. 2003) Chronic pain is also a major risk factor for suicide, and chronic pain patients are 2-3 times more likely to end up commit suicide than people without chronic pain (M. Racine 2018). According to a study performed in Northern Finland from 1988 to 2007 there was a 14.3 times higher risk for suicide among patients with hospital-treated musculoskeletal disorder compared to general population (Löfman et al. 2011).

Most of the pain is related to human musculoskeletal system. 75 % of adults aged over 30 in Finland have experienced at least one back pain episode in their lifetime, 50 % have had more than 5 back pain episodes and 33 % have had back pain during the last month. Sciatica pain disturbs nearly 40 % of adults. Neuropathic pain affects 6-8 % of population. (Kipu 2017). Fibromyalgia sufferers make 2-5 % of population (Kipu 2017; A. Rosso 2016).

Pain and chronic pain are unfavorable and expensive for the society. In Finland 40 % of visits in the doctors' office are due to pain. (Kipu 2017) It is estimated that about half of the outpatient medical visits is due to somatic symptoms and in many cases a physical reason for these symptoms and pain is not found. (A. Abbass et al. 2009) Chronic pain patients load the health care system a lot: from European adults 60 % of chronic pain patients have seen a doctor 2-9 times during last 6 months. In the USA about one third of adults is estimated to suffer from chronic pain (M. Lumley et al. 2019a). The main costs related to pain are undirect like sick leave and decreased ability to cope with daily tasks: back pain alone caused 2 million and fibromyalgia caused 79 400 sickness allowance days in 2013 in Finland. With arthritis the same number was 1 million. (Kipu 2017) Other adverse effects of chronic pain are disability, opioid dependence and in worse cases death (M. Lumley et al. 2019a; T. Ojala 2015, p. 56, 67). In addition, chronic pain patients more often have economic problems, worse mental health, poorer life quality and are limited in their physical activity. (M. Lumley et al. 2011; M. Lumley et al. 2019a; M. Racine 2018)

Why does pain become chronic?

It is believed that even though there are nerves sending signals from the body to the brain and nerves that send signals back to the body, the most important factor in chronic pain is the brain where the nerve signals from the body are processed. (H. Schubiner et al. 2012, p. 3-4)

Conventionally the amount of pain experienced is related to the magnitude and severity of the tissue damage. This is not the case with chronic pain. Psychological and social factors contribute to the development of chronic pain and it may not be related to tissue damage at all. (S. Meints et al. 2018)

This thesis focuses on chronic pain that is not due to a physical trauma. However, it is notable that the onset of TMS pain might occur in a way that the person may presume that they have injured themselves, sometimes called as an acute attack (S. Ozanich 2014 p. 19; I. Rashbaum et al. 2003; J. Sarno 1981; J. Sarno 1991; D. Schechter 2014, p. 18). During the development into chronic pain the acute pain becomes first sub-acute and then chronic. This process is called the chronification of pain. (D. Schechter 2014, p. 24) During this process of chronification there are neurobiological, psychological and social changes that occur and can maintain the pain (M. Lumley et al. 2011). According to H. Schubiner et al. (2012) the nerves become sensitized which means that the nerves are activated by lesser tissue activation than normal (H. Schubiner 2012, p. 26, 32). Chronic pain is much about learned nerve pathways but luckily these nerve pathways can also be unlearned. (H. Schubiner et al. 2012, p. 3-4)

J. Hashmi et al. (2013) showed that during the chronification process of the pain the brain areas that process the pain change. In the chronification of pain the activity of acute pain processing brain regions diminishes and shifts more to emotion related-circuitry. (A. Apkarian et al. 2011; J. Hashmi et al. 2013) According to H. Schubiner et al. (2012) the nerve sensitization is behind the chronification process (H. Schubiner et al. 2012, p. 26).

It is thought that chronic pain is closely related to neural changes, especially in the medial pain system. There are long-term changes in neurochemistry, morphology and gene-expression in the ACC related to persistent pain. (H. Cao et al. 2009; M. Lumley et al. 2011) The ACC functions as a "neural alarm system". From there the pain signals are sent further to higher regions. One of them is the right ventral prefrontal cortex (RVPFC) that is believed to play a role in dampening the emotional distress that is caused by the pain. (N. Eisenberger et al. 2004) Also changes in the neurons projecting from the basolateral amygdala to the ventromedial hypothalamus are associated with persistent pain (M. Lumley et al. 2011). S. Debyshire et al. (2004) notice that the pain experience is not necessarily dependent on the pathology of peripheral tissue: it is possible that the pain experience can originate exclusively within the patients mind or brain. (S. Debyshire et al. 2004) In fact

the psychosocial and social experiences are generated and organized in the brain in a way that greatly affects persistent pain (M. Lumley et al. 2011).

If a so thought "injury" or trauma does not heal in a proper time frame it is good to consider whether psychological reasons are behind the onset and the prolonged duration of the pain. The patients' anxiety and catastrophizing over the pain often leads the way into pain chronification. (D. Schechter 2014, p. 25) Injuries or "imagined" injuries are more likely to develop into chronic pain if the life situation is stressful (H. Schubiner et al. 2012, p. 26). I. Rashbaum et al. (2003) refer to studies that propose strong correlation between psychological factors and stressors in life and chronic back pain and forearm pain (repetitive strain injury, RSI) (I. Rashbaum et al. 2003). Also, low back pain seems to be much better predicted by psychosocial variables than structural variables (E. Carra-gee et al. 2005). J. Katz et al. (1995) note that patients with low back pain that has continued more than a month should be evaluated for possible psychological factors that prevent recovery. (J. Katz et al. 1995)

Mood disorders and chronic pain

The psychosocial model shifts the focus from the pathophysiology into the patients psychological, emotional and cognitive state and into learned and conditioned behavior in nociception and one's pain experience. (S. Meints et al. 2018) The commonly observed psychological factors among patients with chronic pain are usually depression, anxiety, emotional distress, some negative emotions, thoughts and behavior (S. Meints et al. 2018; T. Ojala 2015). There is a clear bidirectional link between persistent pain and mood disorders: patients who suffer from depressive and anxiety disorders have 2- to 3-fold increase in their distressing somatic symptoms (A. Abbass et al. 2009; S. Meints et al. 2018). For example, when predicting whether acute pain will transit into chronic pain depression, distress and anxiety are the most robust psychosocial variables. There are studies supporting that psychological dysfunction increases the risk of chronic pain such as musculoskeletal pain and functional pain disorders. Also, persistent chronic pain condition increases the probability for mood disorders (S. Meints et al. 2018). Chronic pain can cause depression and depression can also heighten pain. The connection between pain and depression is noticed in the medical treatment of chronic pain: chronic pain can be alleviated by small doses of tricyclic antidepressants. Some drugs that work on serotonin and norepinephrine and also venlafaxine that are mood regulating neurotransmitters can alleviate chronic pain. (A. Abbass et al. 2009; B. Vastag 2003)

The amount of postsurgical pain, analgesic use, disability and impairment is also associated with the amount of pre-surgical emotional distress. (Jackson et al. 2016) L. Carroll et al. (2004) studied if depression is a risk factor for neck and back pain. They discovered that depression is a strong and independent predictor for the onset of a troublesome neck and low back pain. According to Parker et al. (2015) the functional outcome of the lumbar fusion for patients with degenerative spondylolisthesis was strongly dependent on the

extent of preoperative depression and the depression was also an independent predictor of time to return to work. The study also concluded that great depression will delay or completely prohibit patients' ability to return to work after transforaminal lumbar interbody fusion. (Parker et al. 2015)

Correlation of symptom intensity and pathology

J. Sarno (2007, p. 137) concludes that in most cases the structural abnormalities cannot be the true cause of symptoms because there is no clear correlation between the structural aberrations and the location of the pain or muscle weakness. (J. Sarno 2007, p. 137; Schechter et al. 2007). Findings in spinal imaging studies suggest that the spinal abnormalities like scoliosis, bulging disc and degenerative disc disease are equally prevalent in people with no back pain and back pain patients. (M. Jensen et al. 1994; R. Savage et al. 1997) MRI findings of the spine are not predictive when assessing the risk to develop back pain or the duration of it (D. Borenstein et al. 2001). Back pain correlates more accurately with psychosocial factors than with structural abnormalities (A. Burton et al. 1995; C. Dionne 2005; E. Hurwitz et al. 2003; I. Rashbaum et al. 2003; J. Sarno 1991) and the correlation is weak between the symptoms and imaging results (I. Rashbaum et al. 2003; J. Sarno 1991). According to J. Bedson et al. (2008) the imaging results observed on x-rays that show osteoarthritis of the knee do not adequately correlate with the existence of pain and disability (J. Bedson et al. 2008). Another study by N. Boos et al. (1995) questions the accuracy of MRI findings in diagnosing the causes of pain. They compared patients who had pain related to disc herniations with asymptomatic volunteers. Interestingly the MRI revealed that 76% of the asymptomatic volunteers had disc herniations as well. (N. Boos et al. 1995) These findings suggest that the findings done with current imaging techniques, even though many times helpful, may not be understood well enough: a physical change, detected by the imaging, that is actually a part of the normal aging process can be misinterpreted as a cause of the pain (J. Sarno 1991).

It has been evaluated by White et al. (1982) that 85% of back pain is idiopathic and D. Schechter et al. (2005) present more arguments supporting this view:

- psychosocial factors correlate with the incidences of lower back pain better than structural problems discovered by imaging diagnostics
- the most common structural diagnoses for back pain (i.e. minor curvatures, herniations and disc degeneration) are equally prevalent in the general population as among back pain patients
- pain moves many times from one place to another which is atypical and inexplicable for structurally caused pain
- back pain incidences peak in midlife and is more rarely prevalent among the children, young adults and elder people and back pain also does not get progressively worse with age

- there are less back pain incidences in underdeveloped countries even though in those countries hard labor and risk for serious back injuries is higher than in developed countries (D. Schechter et al. 2005)

Conventional treatment of chronic pain

Conventional treatment for chronic pain includes medication, physical therapy, ultrasound, nerve blocks, acupuncture, transcutaneous electric nerve stimulation, trigger point injections and surgery (J. Sarno 1991). Conventional treatment is not the main focus of this thesis, but it is shortly discussed here so that the reader can get an overview of current methods and their limitations compared to TMS treatment.

Pain medication is often effective in acute pain situations but is rarely a successful way to treat chronic pain. Chronic pain is most commonly treated by:

- *non-steroidal anti-inflammatory drugs* (NSAIDs) i.e. ibuprofen, aspirin, diclofenac and indomethacin
- *opioids*, i.e. morphine, codeine, fentanyl and heroine
- *antidepressants*, i.e. trazodone, imipramine, doxepin, nortriptyline and amitriptyline
- *sedatives/tranquillizers/relaxants*, i.e. orphenadrine, diazepam, cyclobenzaprine and chlormezanone

Even though antidepressants and epilepsy drugs have been found to be effective in the treatment of chronic pain even the most powerful drugs can eliminate only up to 35 % of the pain for half of the patients. (T. Ojala 2018, p. 32-33)

Physiotherapy aims to help the chronic pain patient. There are different kind of physiotherapy interventions that include active involvement of the patient like exercise therapy. This kind of therapy is supposed to help the patient to function in daily life and prevent the adverse effects of chronic pain (like immobility and restrictions in movements). Some more passive forms of therapy include thermic treatments (heat or cold), mechanical treatments (i.e. massage), traction and electro therapy but the effectiveness of these interventions are not clear. (T. Ojala 2018, p. 34-38)

Pain management programs (PMPs) are based on psychological interventions (A. Burger et al. 2016; E. Davey 2016). However, the goal of these programs is pain *management* not *complete cure* as it is with TMS treatment approach. PMPs include for example group and individual psychotherapy and work on acceptance and commitment therapy (ACT) that includes acceptance, defusion, present-focused attention, values, self as an observer and committed actions (E. Davey 2016). Cognitive-Behavioral Therapy (CBT) that is also a part of PMPs and it approaches chronic pain as a chronic health condition that can be managed by changing behavior, emotions and cognitions related to pain (M. Lumley et al. 2019a; T. Ojala 2018, p. 38-39). Even though CBT and ACT have been observed to

be effective in treatment of chronic pain the magnitude of the improvement in pain, disability and mood is often rather modest. CBT and ACT can be good options for patients' whose chronic pain is peripheral but for centralized chronic pain that is caused by the brain the TMS treatment model can be much more effective and possibly eliminate the pain completely. (M. Lumley et al. 2019a).

According to S. Meints et al. (2018) the treatment of chronic pain should include psychosocial and behavior factors in addition to the traditional biomechanical model (S. Meints et al. 2018). Indeed, the treatment should include a multi-professional team with doctors, physiotherapists and psychologists. The patient would work together actively with this team and the treatment should concentrate on treating the *patient* not only the pain. (Mainstream assumption is that chronic pain cannot be cured but the patient can learn to live with it.) Unfortunately, the involvement of a multi-professional team for the treatment of a chronic pain patient is rare. Also, a "ping-pong game", where the patients' treatment is diffused between various clinics and no professionals take profound responsibility of the treatment of a chronic pain patient, is not uncommon. (T. Ojala 2015)

More information about the conventional treatment of chronic pain patients can be found in T. Ojala 2015 and T. Ojala 2018.

Complementary and alternative medicine

While the conventional treatments for chronic pain are many times unsuccessful, and many have possible adverse effects, some patients seek help from other options like alternative medicine (M. Lumley et al. 2019a; T. Ojala 2015; I. Rashbaum et al. 2003). It is estimated that 25 % - 33 % of patients in primary care have medically unexplained symptoms, bodily distress syndrome or chronic functional syndromes (D. Clarke 2016). When conventional treatment fails to eliminate, relieve or even explain the pain the patient may seek relieve from outside of conventional medicine (P. Barnes et al. 2004; E. Rosenberg et al. 2008), even though there is no scientific guarantee that alternative medicine is going to help the patient (A. Furlan et al. 2010; S. Rubinstein et al. 2010). Complementary and alternative medicine or therapies (CAM) usually refer to treatments and healthcare practices that are not widely used or taught in hospitals and medical schools (J. Deutsch et al. 2008, p. 1). However, many patients seek for these CAMs instead of relying on conventional medicine (S. Ozanich 2014, p. 161). CAMs are different medical and health care systems, practices and products that are not (at least currently) considered as conventional medicine that is usually practiced by medical doctors or other health care professionals such as nurses, physiotherapists and psychologists. The difference between alternative and complementary therapies is that alternative therapies are still provided by

the traditional health care centers, but complementary therapies are out of their field. (J. Deutsch et al. 2008, p. 1-2).

CAM therapies can be divided into four different categories: mindbody therapies, biologically based therapies, energy therapies and body-based therapies. (J. Deutsch et al. 2008, p. 3) These treatment forms usually approach human as a whole and values the mindbody connection, acknowledges the role of emotions and persons own power for healing. More information about CAM therapies can be found in J. Deutsch et al. 2008.

2.2 PNI system, stress, biochemical network and pain

Because in mindbody disorders the human is treated as a whole it is important to understand the relationships between different systems in the body. Everything in human body is connected. Traditionally science just tends to treat different parts of the body separately and divide it into nervous system, brains, immune organs, immune cells and endocrine glands, when in fact all these parts of the body are connected and cannot be examined separately without losing some value. The biological and physical components are inseparable from each other – they do not work independently. In fact, they could be considered as parts of the same system, psychoneuroimmunoendocrine (PNI) system. The science that combines immunology, endocrinology, psychology and neuroscience and studies the connections between psychological, endocrine, neurological and immune systems is called *psychoneuroimmunology*. Because the field is relatively new sometimes the term *psychoneuroimmunoendocrinology* is used as well. (J. Deutsch et al. 2008, p. 88, G. Mate 2003; C. Pert 2003)

The PNI system is responsible for development, survival and reproduction of an organism. Because the components of the PNI system are interconnected it can recognize potential threats from within or without. It also enables suitable responses to these threats in the form of behavior and biochemical changes coordinated to maximize safety at minimal cost. (G. Mate 2003; F. McMillan 1999)

Conceptually the endocrine and nervous system resemble each other a lot. The released peptides from brain and endocrine glands are acting in far distant from the origin which can be described as” action at a distance” just like the nervous system has an origin of a signal and the effect of the signal in other location. Also, immune system can be considered as a part of this network between nervous system and endocrine system. (C. Pert 2003, p. 181)

Endocrine system

Let’s first study endocrine, immune and neural systems separately. The endocrine system produces hormones and hormonally active substances that usually enter the circulatory system for transportation to target organs (so no excretory ducts are present). Endocrine

system is composed of endocrine glands and organs containing hormone secreting cells. The major endocrine glands are hypothalamus, pituitary gland, pineal gland, thyroid gland, adrenal glands, placenta, ovaries (female) and testes (male). In major endocrine glands the hormone secreting cells are the major cell type. Other organs that contain hormone secreting cells are thymus, lungs, heart, liver, stomach, pancreas, kidney, small intestine, adipose tissue, skin, seminal vesicles (male) and prostate (male) and they are part of the neuroendocrine system. There are more than 100 hormones and hormonally active substances that are either: 1) peptides, 2) amino acids and arachidonic acid analogs 3) steroids. (M. Ross et al. 2016, p. 742-789)

Nervous system

The nervous system has two main parts: central nervous system (CNS) and peripheral nervous system (PNS). CNS consist of brain and the spinal cord, PNS includes the nerves located outside CNS that still are connected to CNS (for example sensory nerve fibers, somatic nerve fibers and nerve fibers in autonomic nervous system). (Hanschel et al. 2009, p. 271; Haugh et al. 2009, p. 102)

Nerve cells are responsible of the electric impulse transmission. Nerve cells contain a cell body, dendrites that bring signals from other cells to the cell body and axons that transmit signals forward, for example to muscles or organs. (Hanschel et al. 2009, p. 271-292; E. Haugh et al. 2009, p. 103-104)

Part of the nervous system that functions without the voluntary control is called the autonomic nervous system (ANS). ANS can be further divided into parasympathetic nervous system (PSNS) and sympathetic nervous system (SNS). PSNS is mostly responsible for “rest and repair” functions and SNS kicks in in the “fight or flight” situations where the body is in stress and increased physical performance is required. (E. Haugh et al. 2009, p. 134)

Immune system

The main function of the immune system is to protect an organism from disease. An adequately functioning immune system must be able to detect foreign tissue, pathogens and defected cells from healthy cells and tissues. The immune system consists of various processes and biological structures. The main parts of immune system are considered to be the spleen, the lymph nodes, the bone marrow and a variety of white blood cells (some of which circulate in the blood and some of which reside in special tissues. (E. Haug et al. 2009, p. 323-338; C. Pert 2003, p. 181) The immune system utilizes peptide-based messengers to communicate with brain and the nervous system (C. Pert 2003, p. 172). Dysfunction of the immune system can lead to cancer, autoimmune diseases or other inflammatory diseases and allergies.

Stress response

Stress is an important factor in the origin of many illnesses, including chronic pain and TMS. Thus, it is important to consider one of the most important endocrine glands, hypothalamus and the pituitary gland in more detail. The hypothalamus secretes many regulatory hormones that control the hormone secretion of the pituitary gland.

In a stress response the body utilizes two systems to prepare the body for either fight or flight. These systems are the hypothalamic-pituitary-adrenal axis (HPA-axis) and sympathetic-adrenal-medullary (SAM) axis. (J. Deutsch et al. 2008, p. 87)

As body's immune system gets alarmed by pathogens or physical trauma, the HPA-axis activation is to protect us from external threats by creating emotions. For example, if a friendly person approaches you, you will most probably greet and hug him, but if a stranger would approach you the same way the limbic system is activated, and emotions of fear and uncertainty are created to get the person away from this possibly threatening situation. In a stressful situation the hypothalamus excretes corticotrophin-releasing hormone (CRH) that in turn travels to pituitary gland that secretes adrenocorticotrophic hormone (ACTH). ACTH then travels through circulation to the adrenal cortex where cortisol is released. Cortisol is a stress hormone and it utilizes the body's energy storages, directs blood flow from the viscera to muscles and brains and increases body's sensitivity to other stress hormones. In a stress response the sympathetic nervous system is also activated. The autonomic nerves activate the adrenal medulla cells to release epinephrine and also other stress hormones and peptide levels rise such as norepinephrine, renin, calcitonin, thyroxine, substance P, neuropeptide Y, insulin and parathyroid hormone. (J. Deutsch et al. 2008, p. 87)

In a fight or flight situation this stress response and activation of sympathetic nervous system is crucial for survival. However, the problems arise in long term chronic stress situations because the system is designed only to function for a short period of time. Cells require also a state of growth which is not possible simultaneously with a stress response. In a modern society people live in a more stressful world than before: possible stresses are present everywhere and human is not adapted to this stressful environment. (J. Deutsch et al. 2008, p. 87, B. Lipton 2015, S. Ozanich 2014; H. Schubiner et al. 2012, p. 21) People are also being predisposed to fear many things (nocebo, see more p. 67) (S. Ozanich 2014) which affects the feeling of certainty and safety in people's lives. There is a positive correlation between economic stress and physical pain and decrease in pain tolerance as well as the usage of pain medication (E. Chou et al. 2016). Chronic stress increases the cortisol (ANS hormone) production and abnormalities in cortisol production is related to increased risk of chronic pain (H. Schubiner et al. 2012, p. 25). To return the mindbody into a calmer homeostatic state, reactivation of the parasympathetic nervous system is needed (J. Deutsch et al. 2008, p. 87, S. Ozanich 2014, p. 41-42).

The stressful situations that trigger and contribute to the development of chronic pain *do not need to be current events*. Childhood stressful events like emotional, physical or sexual abuse increases the risk for chronic pain in adulthood. (H. Schubiner et al. 2012, p. 25) The childhood emotional experiences and the degree of anxiety, stressful life events and abuse probably correlate with the pain responding later in life (M. Lumley et al. 2011).

Limbic system, physical and social pain overlap

Limbic system consists of four basic structures that are thalamus, amygdala, hypothalamus and hippocampus. Limbic system is important in emotional processing. Especially amygdala is thought to be important in TMS: its activation is usually correlated with emotions like fear, anxiety and anger and it is responsible for emotional processing and expression.

Detecting both, physical threats and social threats (i.e. separation), that would be harmful is essential to survival. There is evidence suggesting that social pain, pain experience related to social relationships, social exclusion and loss, and physical pain may share some neural circuitry and neurobiological substrates. (N. Eisenberger et al. 2004; N. Eisenberger et al. 2007; N. Eisenberger 2015; B. Vastag 2003) A study performed by E. Kross et al. (2011) where brain scans were taken from young adults showed activation of the brain areas related to physical injury (mild pain) when experiencing emotional injury (showing a picture of ex-lover) (E. Kross et al. 2011).

S. Bantick et al. (2002) showed that when study subjects were distracted during painful stimulation there is increase activity in areas associated with affective division of ACC and orbitofrontal regions, when at the same time thalamus, insula and the cognitive division of ACC that are part of the pain matrix showed reduced activation - distraction led to reduced pain perception. (S. Bantick et al. 2002)

Anterior cingulate cortex (ACC) and especially the dorsal subdivision of ACC (dACC) are thought to be involved in the affectively distressing components of physical and social pain. (N. Eisenberger et al. 2004; N. Eisenberger 2015) An example of the activation of ACC is when the patients' doctor does not have an answer why the patient has pain: the patient gets worried and frustrated and these emotional reactions activate ACC. ACC activation is also connected to increased pain and turning off the dorsolateral prefrontal cortex (DLPFC) that usually decreases the pain. (H. Schubiner et al. 2012, p. 24)

Opioid system is known to be involved in pain processing. There is evidence suggesting that opioid system may have been co-opted to facilitate social bonding processes: the social bonding may alter the endogenous opioid activity. Pleasant feelings and connection are related to increases in endogenous opioids and reduction in endogenous opioids is related to social separation. (Panksepp et al. 1978; N. Eisenberger 2015)

If this overlap of the social and physical pain suggested exists and relies on the same neural substrates, it could mean that people who are more sensitive to one kind of pain are also more sensitive to other kind of pain (N. Eiseberger 2015). There is evidence that people who are more sensitive to social pain report more psychosomatic symptoms (A. Ehnvall et al. 2009; P. Ciechanowski et al. 2002) and pain and chronic pain patients are more sensitive to social pain (G. Asmundson et al. 1996). Another consequence of this overlap would be that factors that influence the sensitivity to social or physical pain then cause a parallel effect on the other type of pain (N. Eiseberger 2015).

Emotions and neuropeptides

It has been suggested that peptides and other informational substances are the biochemicals responsible for emotion (C. Pert et al. 1985; C. Pert 2003, p. 141). Peptides and neuropeptides are in essential role in regulating emotions, mood, pain and pleasure. For example, endorphins produce opioid kind of pleasure response. Besides the name of neuropeptides these chemicals and their receptors can be found throughout the PNI system: they are present in nervous, endocrine and immune systems as well, so all over the body and affect all the systems they are in contact with (J. Deutsch et al. 2008, p. 88; F. McMillan 1999; C. Pert et al. 1985). These systems communicate constantly via hormones, neurotransmitters, cytokines and neurotransmitters. For example, corticotropin releasing hormone (CRH) coordinates body's response to stress, such as physiological and behavioral changes and insulin like growth factor (IGF-1) has been reported in high levels to be correlated with incidences of cancer and depression. Melatonin might also play a role in cancer and depression. (J. Deutsch et al. 2008, p. 88) It is possible that the malfunctioning of the descending serotonin and noradrenergic pathways are responsible for pain experience and processing (B. Vastag 2003). In fibromyalgia patients several neuroendocrine axes that coordinate the co-operation of brain and the body have been observed to be dysfunctional (L. Crofford 1998). Certain cytokines that are related to chronic stress affect the cells and nerve endings in a way that they are more sensitive to pain: chronic stress increases the sensitivity to pain in the brain, spinal cord and nerves (H. Schubiner et al. 2012, p. 24).

2.3 Psychology of mindbody disorders

Tension Myoneural Syndrome (TMS) is a syndrome that was first discussed to be responsible for back pain and other unexplained chronic pain conditions (J. Sarno 1998). Several different terms have been used in the literature:

- Tension Myoneural Syndrome
- Tension Myositis Syndrome
- The Mindbody Syndrome (MBS) (S. Ozanich 2014, p. 7; D. Schechter 2014, p. 5)
- Tensionalgia

- Psychogenic Neural Pain Syndrome (PNPS) (S. Ozanich 2014, p. 7)
- Tension Psychoneural Syndrome (TPS) (S. Ozanich 2014, p. 7)
- Distraction Pain Syndrome (DPS)
- Psychophysiological Pain Disorder (PPD) (D. Schechter 2014, p. 5)

Most commonly used terms in the literature are Tension Myoneural Syndrome, Tension Myositis Syndrome, Distraction Pain Syndrome, Psychophysiological Pain Disorder or The Mindbody Syndrome. Tension means the anger that is buried into the body, myoneural includes muscles and nerves and syndrome means a collection of symptoms (S. Ozanich 2014, p. 1). The name of the syndrome has been changed and modified many times because of the increased knowledge about this syndrome so that the name would describe the syndrome more accurately and precisely.

According to J. Sarno (1998) the disorders that can be included to be TMS are not illnesses or diseases – they are brain induced symptomatic responses of the body for a psychological purpose. There are many possible sources of stress and pressure in life when living in the modern society. When people are consciously trying to make their best in this life it simultaneously creates unconscious stress due to internal responses that people are unaware of. (J. Sarno 1998, p. 1-8) The emotional brain is still primitive and cannot distinguish between a real physical threat and a threatening emotion (D. Schechter 2014, p. 48-49) and what is important in understanding TMS is that sensory input can have emotional effects in the brain even when the stimuli does not reach conscious awareness (M. Bear et al. 2006, p. 567). At some point the stress might build up and instead of acknowledging the unconscious events going on and letting the conscious mind to make decisions the unconscious mind takes control and one develops physical symptoms. The manifestations of these symptoms are called TMS. (J. Sarno 1998, p. 1-8; D. Schechter 2014, p. 49)

Who gets TMS?

TMS can strike at any point of life, but most commonly it is found in people between 20-30 and 40-60 (J. Sarno 1981; J. Sarno 1998, p. 1-8). In the age of twenty and thirty there are a lot of possible sources of stress such as:

- what one really wants to do in life
- studying and getting a degree or qualification
- career
- to have family or not
- money problems
- pressures from marriage

In forties, fifties or sixties typical triggers of TMS are:

- experiencing a loss of purpose and importance
- wondering if life has been fulfilling
- marriage
- parents may need to be taken care of
- children leaving home
- not having any children
- retirement

These and other events can create a lot of internal anger that can lead to TMS. (J. Sarno 1998, p. 1-8)

According to H. Schubiner et al. (2012) TMS is more common among women. This observation is also supported by the fact that women are ten times more susceptible than men to develop fibromyalgia (A. Rosso 2016) that is considered as a severe form of TMS (I. Rashbaum et al. 2003). Irritable bowel syndrome (IBS), that can also be a manifestation of TMS, is two times more common among women than men (Duodecim 2018). There are many possible reasons for why women are more susceptible to TMS. Women's social role is more often to take care of other peoples' needs before their own and behave deferentially. Women more often end up in situations where they take care of children or other family member or aging parents and grandparents. Abuse is also a notable risk factor for TMS and women are more susceptible to abuse than men. In work women are more often in the positions that are subservient. In the modern society women are also expected to be sexy and beautiful but also manage family, children and home at the same time. Generally, women are less likely to assert themselves and they are much more likely conscientious and agreeable wanting to please other people and they are more likely to worry than men. (H. Schubiner et al. 2012, p. 47) All of these aspects create an opportunity to building up a large reservoir of internal anger that can manifest itself as TMS.

When this anger is not acknowledged and safely released it creates physical symptoms. (J. Sarno 1998, p. 1-8) The ambivalence over emotional expression has been observed to be positively correlated with pain and anger in patients with low back pain (J. Carson et al. 2007) and the neural circuits that process pain and regulate anger are overlapping (S. Bruehl et al. 2009). Somatization patients commonly block and inhibit emotions like anger (A. Abbass 2005). For example, S. Bigos et al. (1991) studied the risk factors for aircraft employees to develop back pain at work. They reported a possibility that there might be psychological factors behind back pain. The work perception and certain psychosocial responses were studied and those employers that reported that they hardly ever enjoyed their job were 2,5 times more likely to report a back injury. (S. Bigos et al. 1991) According to TMS theory the increased probability for back pain among employers that did not enjoy their job could be due to the internal repressed anger related to work. This is in line with the findings by J. Christensen et al. (2012): back pain severity is robustly

predicted by decision control, empowering leadership and fair leadership at work than by physical workload (J. Christensen et al. 2012).

The role of the unconscious mind and repressed emotions

All people are under some type of pressure and everyone reacts to those pressures consciously but also unconsciously. This unconscious reaction is out of one's control. If the unconscious interprets the feelings too frightening or threatening the brain induces physical symptoms to prevent these feelings to come into consciousness: TMS response to those feelings is established. It is important to notice that these physical manifestations are not signs of mental or emotional illnesses. The cause of these physical symptoms is often misinterpreted in the traditional medical view of the human body as only a mechanical machine. (J. Sarno 1998 p. 8)

The concept of conscious and unconscious mind and repressed emotions was first discovered by Sigmund Freud. It has been estimated that about 95 % of thoughts, feelings, memories and emotions reside in the subconscious. Also, it has been estimated by the number of receptor cells in each sense organs and the nerves that go to brain from these cells that the brain receives about eleven million pieces of information in a second. By observing how quickly people can read, recognize smells and detect flashes of light it has been estimated that about 40 pieces of information can be consciously processed per second. So, from these eleven million pieces of information that the human brain can process in a second only forty pieces come to the conscious processing. (T. Wilson 2002, p. 6, 24; H. Schubiner et al. 2012, p. 38). Repression is the precondition for the construction of neurotic symptoms and can happen without notification by the ego. Every mental process starts from the unconscious and if allowed it will reach consciousness. Symptoms are a substitute for something that is held back by repression. (S. Freud 1981, p. 335- 339) Psychological defenses are developed to protect the person in overwhelming situations such as abuse or another traumatic event. However, the long-term suppression and repression of emotions has substantial effects on health (S. Mann 2000) and the unresolved emotional issues are considered to be an important factor in development of somatic symptom disorders and physical illnesses (A. Abbass et al. 2009).

J. Sarno (1998) postulates that psychogenic physical disorders – disorders that are caused by emotions – are developed because of the existence of undesirable or frightening repressed feelings. In this theory it is important to examine Freuds three components of the mind that are ego, superego and id (Table 1). (J. Sarno 1998, p. 8-9; M. Sopher 2003, p. 19-20)

Table 1. *Main characteristics of id, ego and superego (S. Ozanich 2014, p. 29, used with permission).*

	ID <i>The Child</i>	EGO <i>The Adult, The repressing referee.</i>	SUPEREGO <i>The Moral Parent</i>
Operates on	The pleasure principle.	The reality principle.	The moral and values principle, solely to repress Id.
Awareness	Only in the unconscious.	Mainly in the conscious, but also at the unconscious.	Mainly in the conscious, but also at the unconscious.
Motto	I want pleasure.	I will use what others want, to get what I want.	I will do what my parents, family, friends, and society want.
Develops	At birth. All babies are Ids. First aspect of the psyche to develop.	In the first few years of life.	Develops last, 5 years old or late preschool.
Function	Does what it wants.	Does what is necessary to survive.	Does solely what others want.

The most primitive and basic needs of a human being are driven by id. Such needs are for example thirst, hunger, sex, anger and the avoidance of pain. Id can be considered as this selfish child that never grew up or matured and it never will, and this child is pleasure-oriented, entirely self-involved, dependent, irresponsible and often illogical and irrational. This child is perpetually angry. The id is immutable and always present with its aggressive impulses and instincts. Id plays a critical role in our daily lives but it operates in the unconscious – the thoughts of the id may be very disturbing and uncomfortable for one’s daily life. Superego is the ”moral parent” that does what other people want. Ego could be described as the adult that is trying to balance between ids and superegos desires. According to Freud the personality of a person is a combination of id, ego, superego and outer world. (S. Ozanich 2014, p. 28; Rashbaum et al. 2003; J. Sarno 1998, p. 10; H. Schubiner et al. 2012, p. 46-47; M. Sopher 2003, p. 19-20)

Heinz Kohut (1978) postulates the existence of a self that develops during the first months of a new born child. In his opinion narcissism is normal and healthy if it develops properly and narcissism characterizes a more or less cohesive self. This narcissistic character develops from primitive to fully mature and is never given up and is actually healthy and is developed into mature forms of self-esteem when given a good environment. (H. Kohut 1978)

However, Kohut postulated a term of narcissistic rage that is accumulated permanent rage from childhood in people with personality disorders. This narcissistic rage is born in infancy

or in childhood by an emotional trauma. (H. Kohut 1978). J. Sarnos (1998) theory is that this narcissistic rage might be present in all people and when the pressures are put great enough on this inherently narcissistic self it creates anger-rage that would seem to be responsible for mindbody disorders. (J. Sarno 1998, p. 11)

For the therapeutic process usually required for healing from TMS the subconscious mind plays a critical role. The subconscious mind is the realm of perception, cognition, reason, judgement, language, creativity and physical and instrumental skill. Because learning takes place in the subconscious the learning process required for healing also happens through the subconscious mind. (J. Sarno 1998, p. 15)

Neurotic symptoms and unconscious are closely related. Behind the symptoms there are unconscious processes that make sense for the symptoms to exist. Neurotic symptoms are never constructed from conscious processes: the symptoms must disappear when the unconscious processes concerned become conscious. The construction of a symptom is actually a substitute to something that never happened: some mental processes that would normally happen did not take place and consciousness did not reach information of them. Because of this the mental processes remained unconscious and the symptoms emerged. Reversing this action and bringing the unconscious thoughts to consciousness by therapy can end the neurotic symptoms. (S. Freud 1981, p. 320-321) The theory behind the induction of TMS symptoms is very similar to this of neurotic symptoms (J. Sarno 1991; 1999).

In TMS it is the **unconscious internal anger** that creates the physical symptoms. (J. Sarno 1998) Suppression of anger and ambivalence over emotional expression (desire to express the emotions but fearing the consequences if doing so) are observed to correlate with conditions like fibromyalgia, low back pain and gastrointestinal cancer (M. Lumley et al. 2011).

J. Sarno (1998) names three possible sources of rage in the unconscious mind. They are:

1. Rage that might be born in infancy or childhood and has never dissipated
2. Rage that is a result from self-imposed pressure (for example in driven, perfectionistic or goodist people)
3. Rage that is a reaction to the pressures experienced in everyday life (J. Sarno 1998, p. 11)

The accumulation of anger is explained by J. Sarno (1999) by emblemizing it to a bank account. Like money anger is generated through the persons' whole life since childhood and deposited into this bank account. If there is no withdrawal of this anger from the bank account, it reaches a critical level and anger becomes rage that is in danger to erupt into consciousness. (J. Sarno 1998, p. 11-12) Other feelings that the pain may be a distraction for are frightening and threatening emotions. To prevent these emotions to rise into con-

consciousness when the repression of these feelings is in danger to fail the brain creates physical symptoms to distract the attention to prevent this violent emotional explosion of these emotions. (I. Rashbaum et al. 2003; J. Sarno 1998, p. 11-12)

Childhood traumatic events

According to Freud, traumatic experiences in childhood or as an infant can lead to neurosis (S. Freud 1981, p. 313-317). He suggested the existence of *unconscious mental processes* (S. Freud 1981, p. 317-318) which the scientific community has largely accepted. The patient is aware of neurotic or obsessive actions that are performed but the reasons for these actions remain unconscious (unless they have been made conscious to the patient by analysis).

Childhood traumatic events (such as physical, emotional or sexual abuse, violation, parental loss or divorce) can affect mood and behavior even tens of years later in life. Also, the relationship between other health problems related to childhood trauma has been reported, such as correlation of irritable bowel syndrome with childhood sexual abuse. (S. Mann 2000) Childhood adversities and stress are also related to an increased risk of migraines and headaches (M. Sumanen et al. 2007; R. Anda et al. 2010), IBS (E. Mayer et al. 2001), fibromyalgia (K. Imbierowicz et al. 2003; B. Van Houdenhove et al. 2005), chronic pelvic pain (S. Melzer-Brody et al. 2007), autoimmune disease (S. Dube et al. 2009), interstitial cystitis and painful bladder (P. Latthe et al. 2006). Fibromyalgia patients more often have had severe psychological trauma compared to general population (N. Selfridge et al. 2001, p. 57). Children's separation from caregivers or having an insecure attachment to them is also suggested to be a risk factor for pain (M. Lumley et al. 2011). The unconscious mind has no concept of time and when decisions are made, all the past experiences are included into decision making from the unconscious mind. So, the emotionally painful experiences, hurt, anger, and sadness will stay in the unconscious mind even from the early childhood if they never were released. (J. Sarno 1998; J. Sarno 2007, p. 143) Even the events that have happened during the first two years of life that one cannot remember due to infantile amnesia can affect the behavior and feelings of the person later in life (D. Schechter 2014, p. 99).

So according to Sarnos theory these feelings and emotions that are generated in childhood permanently reside in the unconscious and might be causing different psychological or physical symptoms throughout a persons' life (J. Sarno 1998, p. 13-14). The ignorance and suppression of emotions may be a result of socialization: following cultural norms and rules, acceptable gender roles and social environment that punishes emotional expression (M. Lumley et al. 2011). Also, many feelings are repressed in the unconscious such as rage, shame and grief that are strong, painful, embarrassing and threatening feelings. These repressed emotions are constantly trying to rise into consciousness and the

purpose of the symptoms is to divert persons' attention from the emotions and thus prevent this burst of repressed emotions into consciousness to happen, like an avoidance technique. (J. Sarno 1998, p. 13-14)

Type-T personality

The personality type that is noticed to be more susceptible to develop TMS is often called type T-personality (T as tension): these people are goodists, conscientious, hardworking, people pleasers, perfectionist and very responsible. (D. Clarke 2016; S. Ozanich 2014, p. 212-222; J. Sarno 1981; J. Sarno 2007, p. 131, 144; D. Schechter et al. 2007; D. Schechter 2014, p. 58-61) These personality traits contribute to the reservoir of internal anger. There is something deeply rage provoking to expect a lot of oneself, if one drives oneself to achieve, succeed and to be perfect. Also, criticism to oneself, deep-down feelings of inferiority, and sensitivity to criticism create internal anger and may be even the forces driving one to be good and perfect. (J. Sarno 2007, p. 144)

The primitive child (id) does not like putting other peoples' needs ahead of the persons own needs and desires. So, even when on the conscious level one tends to be very helpful, wants other people to like them and always pleases them, puts family members needs before themselves and takes care and worries about everyone, in the unconscious level the primitive child might be furious and create a large reservoir of unconscious anger. (J. Sarno 2007, p. 144)

In a summary Figure 1 from H. Schubiner et al. (2012, p. 48) shows the psychology of TMS.

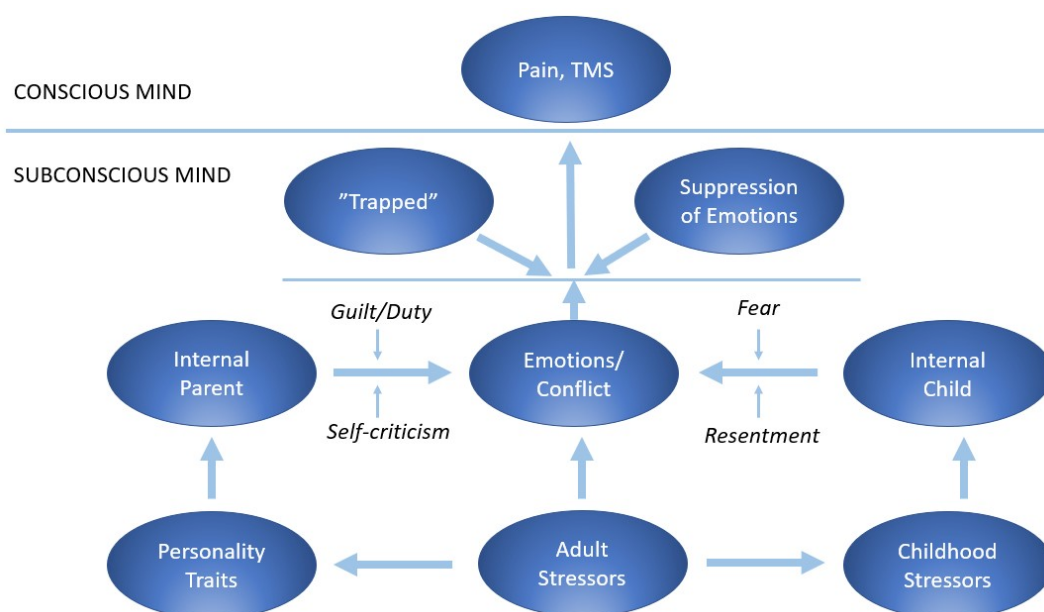


Figure 1. *The psychology of TMS, adapted from H. Schubiner et al. (2012, p. 48), used with permission.*

Social contagion

Social contagion may be partly responsible of what kind of TMS symptoms are developed. An example of social contagion is that some medical students may develop symptoms of the diseases that they are learning at the moment in medical school. (H. Schubiner et al. 2012, p. 36-37) The same phenomenon may occur with TMS and define the symptoms that are "in vogue". (S. Ozanich 2014, p. 153-164; H. Schubiner et al. 2012, p. 36-37) This could explain the rapid increase in back pain and why the epidemic of back pain did not exist earlier in history. The emerge and disappearance of stomach ulcers could also be explained by social contagion (S. Ozanich, p. 11).

One example of social contagion is whiplash. Whiplash is usually considered as a physical condition: neck pain occurring after a car accident. Interestingly H. Schrader et al. (1996) noticed that the rate of whiplash injuries that lead to disability is much lower in Lithuania compared to Norway. In Lithuania whiplash does not exist, the rate of chronic neck pain and headaches is the same among people who have been in a car accident and not. In Norway the patients are recommended rest, heat and anti-inflammatory medication while in Lithuania they are encouraged to return to work and normal activities, the awareness of possible disability following a whiplash injury is poor and not many car drivers or passengers are covered by insurance. (H. Schrader et al. 1996; H. Schubiner et al. 2012, p. 8-9)

It has been suggested that the mass media and internet feed the epidemic of fibromyalgia and it is similar to the epidemic of neurasthenia (a.k.a. chronic fatigue syndrome, CFS) in the 19th century (I. Rashbaum et al. 2003). When considering social contagion and back pain, it is notable, that back pain problem does not exist everywhere. There is no back-

pain epidemic (at least yet) in Asia or in many developing countries when compared to United States of America. Also, US citizens had more than a five time the rate of back surgeries when compared to those in England and Scotland. (D. Cherkin et al. 1994) It is a question to consider whether the modern western life style, busy schedules, deadlines and less time for close relationships are reasons for this difference or is it only about the structure of the health care system and the number of orthopedic and neurosurgeons and availability of treatment – or, is it because of social contagion of TMS related back pain?

Importance of acknowledging the unconscious emotions

It is important to note that the rage and anger that is felt consciously is not responsible for the mindbody disorders. It is the unconscious emotions that are not acknowledged that the mind perceives as dangerous or threatening and therefore represses them causing the mindbody disorders. (J. Sarno 1998, p. 16) Also, the symptoms experienced are not self-punishment for bad thoughts or guilt or neither substitutes for bad feelings (like anxiety is). The meaning of the symptoms is to keep the minds attention in the body to prevent the dangerous or threatening feelings to arise into consciousness or avoid confrontation with unbearable feelings. Even though the feelings are repressed the force of repression alone is not enough to keep the feelings unconscious because the powerful emotions, like rage, *will strive to rise to consciousness* and distraction as physical symptoms is needed to prevent the burst into consciousness. Jonathan Lear (Yale philosopher-psychoanalyst) refers to this as a desire for a *”conscious unification of thought and feeling”*. (J. Sarno 1998, p. 18-19) Also S. Freud makes a notice that the only endeavor of the unconscious is to break through the pressure that is weighing it down and either force its way to consciousness or to discharge through some other real action (S. Akhtar et al. 2001).

The experiences in therapeutic treatment support this concept. Many patients have found relief for their physical symptoms by becoming aware of their repressed rage and other unbearable feelings. The pain stops when the threat of these feelings is eliminated – no physical distraction is needed anymore. (J. Sarno 1998, p. 20) Alexithymia, a condition where the patient is unable to identify and process feelings, is more often prevalent among patients with back pain, fibromyalgia and TMJ and alexithymia usually correlates positively with the severity of pain (M. Lumley et al. 2011) which also supports the psychological explanation for the existence of TMS symptoms.

Psychogenic symptoms might be intensified by emotional distress such as fear or anxiety. (J. Sarno 1998, p. 42) For example, stress has been reported to intensify many illnesses and be a partial factor in their genesis (G. Mate 2003). Also the abolition or reduction of psychogenic symptoms is possible if the emotional distress is eased or removed, though this process rarely occurs spontaneously in civilian life. (J. Sarno 1998, p. 42-43)

It would seem logical that if people could choose between emotional pain and physical pain, they would choose emotional pain. But the nature of the unconscious mind is illogical and irrational. The automatic reaction to disturbing feelings is thus seen illogical but this is how the human emotional system is organized. (J. Sarno 1998, p. 19)

2.4 Pathophysiology of TMS

In this chapter the main mechanisms of TMS are demonstrated: how the repression of emotions can create physical symptoms in the body. The exact processes that take place are yet to be discovered and require more detail investigation.

If symptoms, such as TMS symptoms have been observed, can be cured by learning (J. Sarno 1998, p. 36-37), the *symptoms must originate from the brain*. J. Sarno (1998) suggests that because learning changes the brain chemistry, TMS healing by learning may proceed through chemical changes in the brain. (J. Sarno 1998, p. 38)

J. Sarno (1998) says that "*Emotional states are capable of inducing physical symptoms, with or without physical alteration of specific tissues in the body.*" (J. Sarno 1998, p. 44) So the symptoms are not induced by any damage or disease in specific parts of the body (J. Sarno 1998, p. 45-46). There are *no pathological* changes like tumors, damaged tissue or bacteria causing infection to be seen: TMS symptoms are due to reversible *physiological* changes. (H. Schubiner et al. 2013, p. 8) TMS symptoms are experienced as pain, numbness, weakness or blindness because the brain cells for this specific area in the brain are "fired off". This is called conversion reaction. The cells that deal with powerful unconscious emotions activate other brain cells. (J. Sarno 1998, p. 45-46)

Psychosomatic symptoms are real even if they originate from the brain and no physiological changes or structural reasons for the symptoms are detected (J. Sarno 1998, p. 35). Already in 1920s it was noticed that the electrical stimulation of the limbic cortex and amygdala would elicit a myriad of emotions ranging from powerful reactions of anger, joy and grief accompanied with the physical reactions related to the emotions like shaking, laughter, weeping and changes in temperature and blood pressure. (C. Pert 2003, p. 133) We all are familiar with symptoms like headache after a stressful day, face turning red in embarrassment or stomach ache before an important event. These all are autonomic nervous system responses to emotions: emotions can clearly affect the physiology of the body. The mechanisms of TMS symptoms are supposed to be very similar. (H. Schubiner 2012, p. 21-22)

It is thought that the amygdala is important in storing emotional memories in so called associative networks. Amygdala then affects hypothalamus that is the center of ANS. In a stressful situation this is exactly what happen, and blood flow is directed to the muscles in preparation for a fight or flight response. (H. Schubiner et al. 2012, p. 22-23)

Figure 2 from H. Schubiner et al. (2012, p. 32) shows the possible neurologic mechanisms for TMS. Triggers like a stressful life event or injury that produces strong emotions in the amygdala can start TMS symptoms. This can lead to nerve sensitization. The signals from amygdala get amplified by conscious and unconscious emotions that activate the ACC. This leads to the activation of ACC and stress reaction (fight, flight, freeze or submit) that leads to activation of nerve, muscle, gastrointestinal (GI), genitourinary (GU) and cardiovascular (CV) systems. If these nerve pathways are reinforced TMS symptoms and pain appears as a result. A patient may become conditioned by various triggers like sitting or lifting that then will activate the nerve pathways and produce symptoms. This cycle of pain can be broken with the activation of DLPFC in the conscious part of the brain: DLPFC can deactivate ACC and diminish the activity of ANS. (H. Schubiner et al. 2012, p. 32) It has also been shown that a perceived threat (like strong emotions) may alter amygdala, periaqueductal gray and rostral ventromedial medulla activity, which can lead to altered pain processing (D. You 2018).

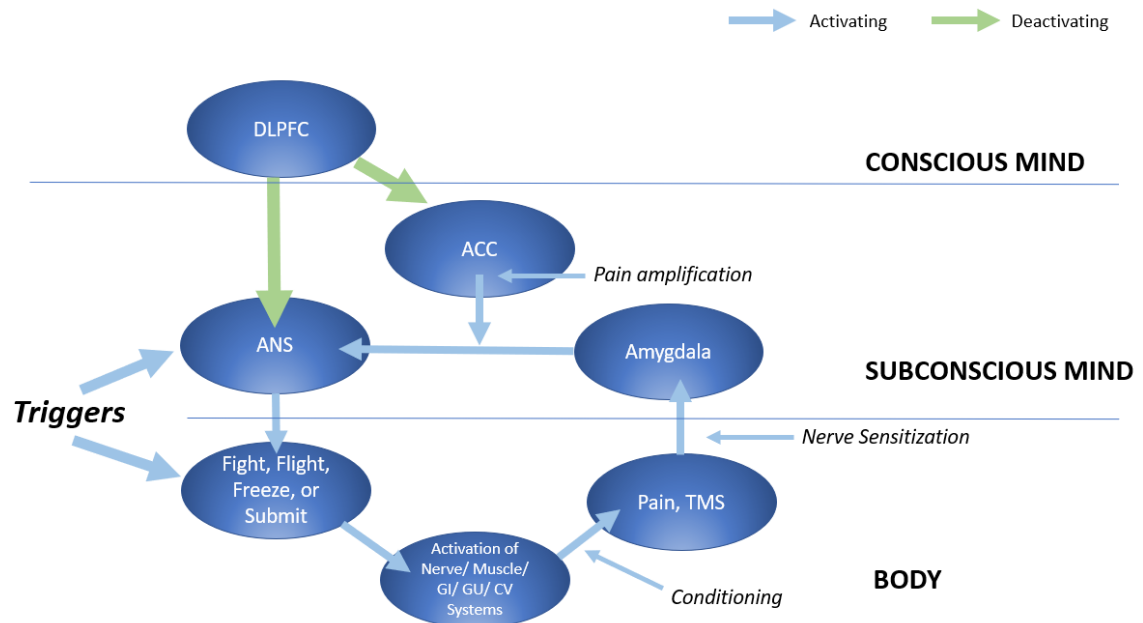


Figure 2. *Neurologic mechanism for TMS, adapted from H. Schubiner et al. (2012, p. 32), used with permission.*

In TMS the pain and the other symptoms experienced by the patients are very real and sometimes severe in intensity. In many cases there are real (but reversible) pathophysiologic alterations in patients' muscles, tendons and nerves. (J. Sarno 1998, p. 47-48)

Muscle

TMS can manifest itself in muscle, nerve or tendons and ligaments. Most commonly included are the postural muscles and the most common location of TMS is in the low back-buttock area. In addition, lumbar, neck and shoulder muscles are often involved though

the pain is possible to be located elsewhere as well. Many TMS patients (but not necessarily all) have tender points when pressure (palpation) is applied into both upper trapezius muscles, the outer aspects of buttocks and the muscles in the lumbar area. (J. Sarno 1981; J. Sarno 1991, p. 6-8; D. Schechter 2014, p. 135)

Nerve

Peripheral nerves are often involved in TMS and many times close in the areas of muscles that are involved most often. Most often affected are the sciatic nerve (it is located deep in the buttock muscle), cervical spinal nerves and brachial plexus (located under the upper trapezius) and lumbar spinal nerves (located under the lumbar paraspinal muscles). Though these are the most often involved nerves any nerves in the neck, shoulder, back and buttocks area can be involved in TMS. For example, chest pain (that is often associated with the heart) may be due to TMS. In some cases, there might be measurable muscle weakness that can be seen in electromyographic studies (EMG). TMS seems to be a *regional process*: it is not aimed to specific structures so all the tissues in the affected area suffer oxygen deprivation so that muscle and nerve pain can be experienced simultaneously. (J. Sarno 1991, p. 8-9)

Tendons and ligaments

Tendons connect muscle to bone and ligaments connect bones to bones. Both structures are fibrous connective tissue that can be affected by TMS. The involvement of tendons and ligament was first described by J. Sarno when patients with TMS reported that while their back pain healed so did also their tendon pain, like tennis elbow, too. So, it is assumed that tendonitis (tendonalgia) can often be a manifestation of TMS. TMS in ligaments and tendons can be found in elbow, knee, shoulder, wrist foot and ankle. Many times, these pains are thought to be a result of an overuse and possible diagnosis include neuroma, plantar fasciitis, bone spur, flat feet (in the feet) or bursitis and rotator cuff disorder (in the shoulder). J. Sarno (1991) also assumes that carpal tunnel syndrome (CTS) and hip pain may sometimes be due to TMS. (J. Sarno 1991, p. 11-12)

Biochemical network

The process of psychosomatic symptoms starts in the brain, possibly from the subcortical structures (basal nuclei, basal forebrain, amygdala) that are responsible for processing emotions and “deciding” whether they require physical symptoms. The biochemical network has been suggested to participate into the establishment of brain-body link through peptide communication. Thus, psychosomatic disorders may include the autonomic-peptide system, immunopeptide system and the endocrine peptide system. (I. Rashbaum et al. 2003) If the autonomic-peptide system is involved the psychosomatic disorders that appear are i.e. musculoskeletal mindbody syndrome (MMS), GI and GU disorders, tension and migraine headaches (I. Rashbaum et al. 2003; H. Schubiner 2012, p. 19, 23-24). When symptoms are concentrated on immune-peptide system the possible psychosomatic

symptoms include allergies, frequent infections and skin disorders. (I Rashbaum et al. 2003) Too much immune system activation leads to allergic reaction, too little makes one prone to illnesses like colds or urinary tract or yeast infections (J. Sarno 1998, p. 46). In case of endocrine-peptide system there are eating disorders and CFS (I Rashbaum et al. 2003). Most of this process happens unconsciously. (J. Sarno 1998, p. 46-47) The suggested process of psychosomatic symptom development is shown in figure 3.

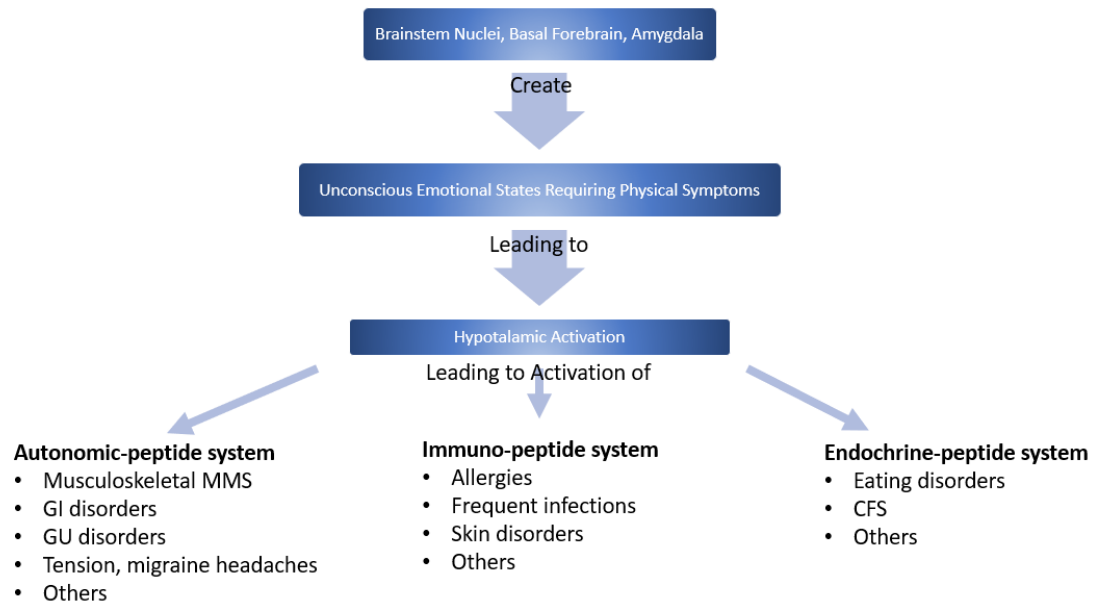


Figure 3. *Process of psychosomatic disorders, adapted from I. Rashbaum et al. (2003).*

Involvement of oxygen deprivation

Autonomic nervous system is responsible for the involuntary functions of the body and it also regulates the blood flow. It has been suggested that emotional repression activates the limbic and autonomic nervous system which then creates a mild restriction in blood flow. This causes a mild oxygen deprivation in target tissues and organs. (Schechter et al. 2007) This process is presented in Figure 4. If the target tissue is muscle or tendon the sensation experienced is pain (J. Sarno 1998, p. 49). The symptoms experienced may include muscle spasms, local soft tissue pain, tender points that are sensitive to touch and sometimes distant pain like sciatica (Schechter et al. 2007; H. Schubiner et al. 2012, p. 24). If target tissue is nerve it causes pain, numbness, tingling and weakness. (J. Sarno 1998, p. 49; H. Schubiner et al. 2012, p. 24) Also paresis may occur due to oxygen deprivation (I. Rashbaum et al. 2003). The oxygen deprivation that causes the pain is in no way dangerous but can be severe in intensity and in some cases debilitating. According to H. Schubiner et al. (2012) the pain produced by ANS can be located almost everywhere in the body, be mild or intense and be constant or occasional. The type of the pain may be tingling, numbness, feeling like an ache or a shooting pain. (H. Schubiner et al. 2012, p. 24)

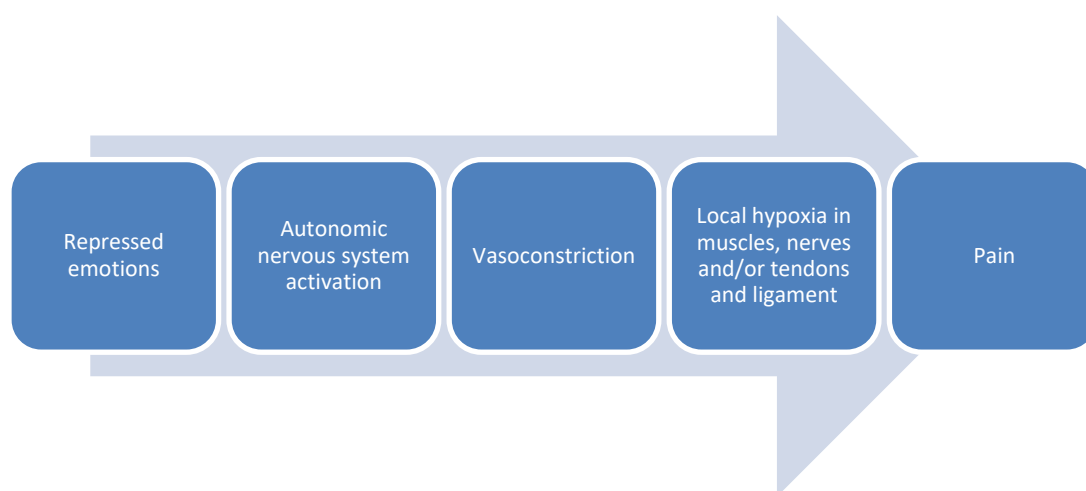


Figure 4. *Oxygen deprivation causing TMS symptoms (pain) in muscles, nerves, tendons and ligaments.*

The theory of oxygen deprivation is based on the observations that many TMS patients received temporary pain relief from physical therapy that included massage, high-frequency sound waves and exercise, which all improve local blood supply (J. Sarno 1998, p. 49). The theory of local ischemia would also explain some symptom patterns and why patients consistently report pain reduction when taking hot baths or shower (J. Sarno 1981). There is some laboratory evidence that the pain experienced in TMS could be from mild hypoxia. According to Sarno (1998) fibromyalgia is a severe form of TMS where muscles, tendons and nerves are involved. N. Lund et al. (1986) found out that fibromyalgia patients had reduced oxygen levels in their muscles compared to healthy volunteers (N. Lund et al. 1986). A. Bengtsson et al. (1988) reported pain and tender points reduction in fibromyalgia patients when the sympathetic nerves were blocked possibly by improved microcirculation (A. Bengtsson et al. 1988).

Priming of pain

Priming of pain may explain why chronic pain sometimes occurs in a location related to an old already healed injury. When something new is learned, like driving a bike or throwing a ball, those skills remain and are useable even years after not using these skills. They do not need to be learned again because the nerve pathways for these skills exist. In a case of an injury the pain diminishes after the injury heals. However, the pain pathways can lie dormant and become active later in life in stressful and emotional situations so that the pain pathways can re-emerge. The pain experienced is then similar to the initial injury even though it has already healed. (H. Schubiner et al. 2012, p. 30-31)

Possible role of inflammation in TMS

There is no consensus on whether inflammation is playing a part in TMS. According to J. Sarno (1991) there is no inflammation in TMS. Steroids (cortisone drugs) seem to banish TMS symptoms temporarily but why, it is not known. (J. Sarno 1991, p. 151-152)

It has been observed that positive emotions are closely associated with inflammation and trait positive affect decreases pro-inflammatory cytokine levels, such as interleukin-6 (IL-6), interleukin 1- β (IL-1 β) and tumor necrosis factor- α (TNF- α), that are central in chronic pain. Pro-inflammatory cytokines have been observed to promote the centrally maintained hyperalgesic states by activating signaling pathways in the dorsal horn of the spinal cord. (Hassett et al. 2016) There are animal studies suggesting that increased level of proinflammatory cytokines and the repeated activation of stress axes are related to pain sensitivity in rats. Also, childhood stress increases the level of epinephrine and IL-6 and the blockage of these could possibly prevent the development of long-term hyperalgesia caused by childhood adversity. (P. Alvarez et al. 2013; D. You et al. 2018) Because cytokines and inflammation are so closely related to chronic pain and pain sensitization (Hassett et al. 2016; D. You et al. 2018) the interventions that inhibit cytokine activity without the adverse effects of anti-cytokine therapies would probably be of great value (Hassett et al. 2016).

There is no denial that stress, and depression are present in chronic pain patients. According to the study of L. Jaremka et al. (2013) stress and depression have been considered to consistently elevate inflammation. For example, troubled relationships are a stress factor that lead to elevated inflammation. Generally stressed and depressed people are at greater risk to develop health problems than their less distressed counterparts. In fact, inflammation, that increases the risk of many age-related diseases such as cardiovascular disease, type II diabetes, metabolic syndrome and frailty, might be the linking factor between poor health and distress.

2.5 TMS equivalents and symptom imperative

”Mindbody disorders exist to serve a purpose. If you thwart that purpose by taking away the symptom without dealing with its cause, the brain will simply find a substitute symptom or disorder.” (J. Sarno 1998, p. 39)

What this means is that if a TMS symptom is artificially taken away for example with drug or other placebo (like in some cases physiotherapy, chiropractics or other alternative treatment) either

1. The symptoms return when the drug or other placebo is taken away
2. Another problem, emotional or physical, is developed to take its place (the symptom imperative phenomenon) (J. Sarno 1998, p. 39)

H. Schubiner et al. (2012, p. 19) presents a list of conditions that are commonly thought to be caused by TMS (Table 2). Also, according to J. Sarnos experience many of these conditions fall under the category of TMS (J. Sarno 1998). It is notable that most of these

conditions can also be caused by other physical disorders that need to be treated differently than TMS and no scientifically evaluated list of disorders that are TMS exists.

Table 2. *Conditions that are commonly caused by TMS according to H. Schubiner et al. (2012, p. 19), adapted from H. Schubiner et al. (2012, p. 19).*

Chronic pain syndromes	ANS related disorders	Other syndromes
Tension headaches	IBS	Insomnia
Migraine headaches	Interstitial cystitis (irritable bladder syndrome)	CFS
Back pain	Postural orthostatic tachycardia syndrome	Paresthesias (numbness, tingling, burning)
Neck pain	Inappropriate sinus tachycardia	Tinnitus
Whiplash	Reflex sympathetic dystrophy (Chronic regional pain syndrome, CRPS)	Dizziness
Fibromyalgia	Functional dyspepsia	Spasmodic dysphonia
Temporomandibular joint syndrome (TMJ)		Chronic hives
Chronic abdominal and pelvic pain syndromes		Anxiety
Vulvodynia		Depression
Sciatic pain syndrome		Obsessive-compulsive disorder
Repetitive stress injury (RSI)		Post-traumatic stress disorder (PTSD)
Foot pain syndromes		Multiple chemical sensitivities
Myofascial pain syndromes		

As can be seen, all the conditions presented in Table 2 are not chronic pain conditions. Another way to classify the TMS symptoms is to divide them into chronic pain conditions and TMS equivalents. These so thought tension related conditions often co-occur in TMS patients (J. Sarno 1981). These disorders appear to serve the same purpose as TMS. J. Sarno (1998) divides TMS-equivalents into seven categories:

1. The GI system
2. The circulatory system
3. The skin
4. The immune system
5. The GU system
6. The cardiac mechanism

7. Miscellaneous

Some of the conditions related to these categories are presented in Table 2. The empirical observations made by TMS practitioners support the existence of TMS equivalents (J. Sarno 1991, J. Sarno 1998; D. Schechter 1999, p. 10, 13; D. Schechter 2014; M. Sopher 2003; H. Schubiner et al. 2012). Also, allergies, asthma (R. Lietzen et al. 2011; G. Mate 2003; J. Sarno 1998, p. 44; D. Schechter 1999, p. 9), cancer, autoimmune disorders and cardiovascular disorders might be related to the emotional distress at some degree (G. Mate 2003; J. Sarno 1998, p. 44). For example, only by becoming aware of the repressed feelings or emotions related to childhood emotional trauma has been reported to alleviate hypertension and normotensive people are more aware of emotional distress than hypertensive individuals (S. Mann 2000). It has even been proposed that failure to express emotions can affect the development of cancer, and that cancer patients that are better connected with their emotions have stronger immune systems, their tumors are generally smaller and recovery rates faster than patients who are not so well in touch with their emotions (C. Pert 2003, p. 191-192). Also, higher ACE scores are related to an increased risk of lung cancer (D. Brown et al. 2010). S. Ozanich (2014, p. 341-356) names even more possible conditions that in his opinion could be emotional in origin. Due to the lack of scientific evidence available and for the define objects of this thesis they are not discussed here more closely even though they should be considered for closer study by the scientific community. However, it is probable that most illnesses have at least a definite psychological component if not already being psychological in foundation (C. Pert 2003, p. 18).

What seems to be common to many conditions that are thought that are or could be TMS equivalents is that the cause of these conditions is unknown. To many pain problems there seems not to be any clinical or laboratory studies that would reliably indicate any abnormalities in the peripheral tissue level where the patient experiences the pain and it is not abnormal that many of these dissimilar pain conditions co-occur. (M. Lumley et al. 2011).

Some psychic symptoms may be serving the same purpose as TMS. J. Sarno (2007) notes that: "*Psychic and physical symptoms are interchangeable, both serving the same psychological purpose.*" Anxiety is also considered to be a reaction to internal pain and anger. (J. Sarno 2007, p. 112, 119) N. Sachs-Ericsson et al. (2017) studied the connection between ACEs and painful medical conditions and how anxiety and depression are related to this connection. Higher ACE score increased probability for anxiety and depression which then led to increased risk for painful conditions. However, even though the ACEs increased the probability to painful medical conditions in high and low levels of anxiety and mood disorders the effect was more prominent for participants with lower levels of mood and anxiety disorders. (N. Sachs-Ericsson et al. 2017) This leads to a question that if the particular pain disorders are TMS and anxiety and other mood disorders are TMS equivalents it would seem logical that a distraction pain syndrome is "less" needed if a high level of distraction symptoms in a form of mood disorders already exist. But this

conclusion depends on the assumption that anxiety, depression and some other mood disorders would be TMS equivalents which is not scientifically proven. Some TMS practitioners' experience is that anxiety and depression are TMS equivalents, but more studies should be made in this field.

The *symptom imperative phenomenon* has been already described by Freud 100 years ago: when one symptom was treated another appeared to take its place. Notable is that Freud considered the cause of symptoms to punish and did not acknowledge the source of the symptoms to be unconscious rage. (J. Sarno 2007, p. 111) A. Abbass (2005) presents the prevalent somatization pathways and notes that the prevalent pathways may change and vary. This also supports the concept of symptom imperative phenomenon.

J. Sarno (2007) describes an example of a patient, Mr. Q., that did not come to terms that his symptoms were psychosomatic in origin. Mr. Q went through various health problems: starting from neck, shoulder and arm pain, with some relief from physical therapy, year later he needed a cardiac bypass surgery, few months after that he got severe shoulder pain that was treated as a torn rotator cuff and had surgery for that, but half a year later he had prostate cancer. All the symptoms relieved by placebo. But because the symptoms were removed by placebo and the real cause of the symptoms was not removed the symptoms just took another form according to Sarnos hypothesis about the symptom imperative phenomenon. J. Sarno (2007) says that the substituting symptoms may be serious in pathology such as autoimmune, neoplastic processes or cardiovascular. (J. Sarno 2007, p. 110-111)

During the healing process from TMS the symptoms may vary, and the pain can move around the body. The old distraction strategy does not apply anymore because the patient is aware of its origin and purpose. If the underlying emotional state still needs distraction it is thought the brain tries different distraction strategies when the old ones fail.

3. TREATMENT OF TMS

Unlike many other treatment forms for chronic pain and related conditions, TMS treatment is *not* about *pain management* or temporary pain relief. It is not a symptomatic treatment, it concentrates on the reasons for the pain: the goal is *permanent healing and a pain free state*.

3.1 Diagnosis

Before doing TMS diagnosis the physician needs to rule out all other possible diagnoses – so the TMS diagnosis is a diagnosis of exclusion. TMS cannot be diagnosed by any laboratory markers or by other imaging or exam results. It needs to be confirmed that the pain is idiopathic or non-specific in nature. (J. Sarno 2007, p. 134-135; D. Schechter et al. 2007) More accurately, all structural reasons such as localized inflammation, blood flow anomalies, tumors, nerve impingement and other neuropathies for the symptoms need to be excluded to make sure the pain is primarily centralized pain (M. Lumley et al. 2019b). "Normal abnormalities" that are not considered as reasons for the pain or are only a part of normal aging, such as age-related disc degeneration, minor abnormal curvature or mild protrusions, are considered as physiologically non-specific (J. Sarno 2007, p. 134-135; D. Schechter et al. 2007).

Personality characteristics, timing of symptoms and pain patterns, psychological stressors, tender points and failure of other treatments need to be considered while making the diagnosis: People with "type T personality" who are goodists, very self-critical, conscientious, people pleasers, pleasant, nice, perfectionistic and helpful are considered to be more prone to TMS. (D. Clarke 2016; J. Sarno 1981; D. Schechter et al. 2007)

If the patients' prior history includes other stress and tension related conditions like headaches, irritable bowel syndrome or heartburns it suggests that the patient may have TMS (D. Clarke 2016; D. Schechter et al. 2007; D. Schechter 2014, p. 132-134). Timing of the symptoms' onset and occurrence may be related to stressful or psychologically traumatic life events either during the stressful time or closely after (D. Clarke 2016; J. Sarno 1981; D. Schechter et al. 2007). It is typical that TMS pain relieves or goes away on a holiday or when otherwise distracted. (D. Clarke 2016; D. Schechter et al. 2007; D. Schechter 2014, p. 132-134) Besides stressful life events and current stressors ACEs are a risk factor for health problems including TMS (D. Clarke 2016).

Tender points indicate the possibility of TMS, though they are not necessary for a TMS diagnosis. Most common tender points are:

- at the trapezius muscles

- in the quadratus lumborum muscle in the lower back area
- the upper buttocks muscle in the upper outer gluteal region
- at the upper part of the iliotibial band that is located in the side of the leg from knee to hip (D. Schechter 2014, p. 135)

Moving of the pain into various locations in the body is also common (symptom imperative phenomenon). TMS fails, at least in long term considering the placebo effect, to respond to other type of treatments. (D. Schechter et al. 2007) Also, it is typical for centralized pain that it persists after the tissue has healed and has a distribution that is not neurophysiological. The TMS pain might be triggered by various mild stimuli like touch, sound, food, weather changes or light. (M. Lumley et al. 2019b)

A close look needs to be taken into a patient's psychosocial history: family status, children, married or not, quality of life now and in childhood, relationships with family members and parents and siblings, education and personalities and possible stressors in their current lives. (J. Sarno 2007, p. 134-135)

Common misdiagnoses

Good medical practice is to find out the correct reasons for the pain. Because many medical doctors are not aware that learned nerve pathways may cause chronic pain TMS is often misdiagnosed (H. Schubiner et al. 2013, p. 7). Common misdiagnosis for pain according to J. Sarno (1991) caused by TMS are listed in Table 3.

Table 3. *Most common misdiagnoses that usually are TMS (J. Sarno 1991, p. 118-141).*

Diagnosis	Explanation
Herniated disc	Soft interior of the disc pushes through the tougher exterior and compress a nerve.
Spinal Stenosis	Narrowing of the spinal canal that puts pressure on the nerve.
Pinched Nerve	Surrounding tissues putting pressure on the nerve.
The Facet Syndrome	Degeneration of facet joints between two spinal bones.
Arthritis of the Spine	Arthritis of the spine.
Transitional Vertebra	An extra bone located to the lower end of the spine.
Spondylolysis	A stress fracture or defect of a spinal vertebra.
Spina Bifida Occulta	A piece of bone missing at the end of the spine.
Spondylolisthesis	Two vertebral bones are not aligned properly with each other
Scoliosis	An abnormal sideways curve of the spine.
Osteoarthritis of the Hip	Degeneration of the hip joint.
Chondromalacia	Softening and deterioration of the underside of the patella.
Bone Spurs	Buildup of bone in the edges of bone.
Soft Tissue Disorders: Fibromyalgia (Fibrositis, Myofibrositis, Myofasciitis)	Unexplained pain in the muscles and soft tissues.
Bursitis	Inflammation of the bursae.
Tendonitis	Inflammation of a tendon.
Coccydynia	Pain in the tailbone area or coccyx and in the lower end of the sacrum, cause usually unknown.
Neuroma	A benign tumor on the bottom of the foot.
Plantar Fasciitis	A common cause for heel pain that is associated with inflammation of the plantar fascia.
Mononeuritis Multiplex	A painful condition that involves nerves and causes neural symptoms.
Tempomandibular Joint Syndrome (TMJ)	Related to the temporomandibular joint and thought to cause pain in the face and jaw.
Inflammation	Body's natural response to an injury or disease.
Sprain and Strain	Minor injuries.

Because the understanding that TMS is benign and treatable the correct diagnosis is relevant for patients' recovery (D. Schechter 2014, p. 35).

If a patient is reluctant to the idea that their physical symptoms are caused by stress it can be helpful to note to the patient that a) physical responses to stress are common, like blushing, tension headaches and abdominal pain before an exciting event b) make sure that the patient knows that their symptoms are real and not all in their head or imaginary, self-inflicted or related to deficient coping skills or malingering c) discuss the stress as affecting brain in such a way that it can cause physical symptoms early in the diagnostic process. (D. Clarke 2016) Psychophysiologic Disorder Association (PPDA) presents more specific instructions to how to talk with patients about TMS diagnosis that can be found in their webpage (PPDA 2018).

3.2 Current treatment techniques

The conventional treatment of chronic pain relies much on pain management programs that are explained more detail in chapter 2.1. It is notable that in case of chronic pain that is TMS the pain is mainly considered to be centralized chronic pain. For patients with peripheral chronic pain (nociceptive, neuropathic, or inflammatory pain) conventional PMPs that include CBT and ACT are recommended. (M. Lumley et al. 2019a)

There are no specific guidelines from major organizations how to treat TMS. Current treatment techniques are based on J. Sarno's original way to treat TMS patients. The requirements for healing are education about the syndrome, overcoming the fear of physical activity and journaling and/or psychotherapy. These are the foundations of TMS treatment and can be found in basically every treatment program. Some TMS practitioners have developed the treatment further but the basic principles of the treatment are still the same. Depending on the practitioner and patient different aspects may be emphasized in the treatment.

3.2.1 Education about the syndrome

The key in treatment of TMS is understanding (J. Sarno 2007, p. 129-135; M. Sopher 2003, p. 1). For this purpose, education (i.e. in a form of lectures or books) is noticed to be useful in the treatment (D. Clarke 2016; M. Lumley et al. 2019a; M. Lumley et al. 2019b; J. Sarno 2007, p. 129-135). Patients need to get familiar with the anatomy, physiology and psychology of TMS (J. Sarno 2007, p. 129-135) and understand that the brain is capable of generating and amplifying centralized pain (M. Lumley et al. 2019b).

It is very important to notice that understanding TMS itself might not be enough for healing. The patient needs to accept TMS diagnosis to fully recover. (J. Sarno 2007, p. 131; D. Schechter 2014, p. 158-159; M. Sopher 2003, p. 43) There is a clear difference between understanding, accepting and faith. Understanding of TMS does not necessarily lead to healing without acceptance. The mind would like to keep patients' attention in the syndrome, so *denial of the syndrome is thus part of the syndrome*: when the patient has doubt then the symptoms can better keep patients' attention and the syndrome going. As long

as there is doubt, the patient does not need to encounter the psychological reasons behind the symptoms. Blind faith can be described as placebo cure. So only acceptance can lead to permanent healing. (J. Sarno 2007, p. 131)

According to J. Sarno (2007, p. 136) there are two components in the education process that need to be achieved so that the brain will stop producing psychosomatic symptoms and that the symptoms can start to subside:

- *"Repudiate the physical-structural explanation for the pain and attribute it instead to the benign altered physiology, the physical-emotional basis of TMS"* (J. Sarno 2007, p. 136)
- *"Recognize that the pain is a reaction to a psychological state and that the tendency to have the physical reactions of TMS and its equivalents is universal and a normal component of everyday life"* (J. Sarno 2007, p. 136)

Important in the education about the physiology of TMS is that even if the symptoms (pain or neurological symptoms such as tingling, numbness and weakness) may be very severe there is no real and permanent harm of the mild oxygen deprivation in the muscles, nerves and tendons and that the symptoms are not permanent. Many times, conventional health care advice, and laymen advice is to avoid such situations that cause pain which often makes the symptoms even worse. (J. Sarno 2007, p. 137)

During the education about TMS the patients are introduced the most common structural abnormalities that are traditionally blamed for the reason to the pain. These include disk pathology, degenerative changes in spine, spondylolysis, spinal stenosis, scoliosis and spondylolisthesis. Also, most common TMS equivalents like lower and upper gastrointestinal disorders, headaches, tinnitus, dizziness, allergic and dermatologic conditions, which all are considered to be psychological in origin when more serious disorders have been ruled out, are covered. (J. Sarno 2007, p. 138) If the patient believes that the pain is due to structural or peripheral abnormalities it can maintain the brain's danger and alarm mechanism. This can lead to reduction in patients' self-efficacy in reducing and elimination of pain. (M. Lumley et al. 2019a) This is why correct diagnosis and the belief into this diagnosis is very important in TMS-recovery.

In education about TMS the role of Pavlovian conditioning is discussed as well as the importance of overcoming the fear towards physical activity (M. Lumley et al. 2019b; J. Sarno 2007, p. 138-139; H. Schubiner et al. 2012, p. 30). Pain can act as a powerful negative reinforcer. This leads to fear and to pain avoidance behavior: the patient learns to avoid activities that lead to pain (M. Lumley et al. 2011; E. Davey 2016). This is crucial in the case of acute pain where the pain is a sign of tissue damage and pain is there to indicate the damage and prevent further damage. However, in chronic pain this is usually not the case because in chronic pain the pain may be related to possible changes in the CNS or to instable dynamic control mechanisms. So, in chronic pain stimulus, that is not

dangerous but is still when associated with pain considered to be a danger to the body and tissues, fear avoidance behavior may develop towards this normally neutral stimulus. (E. Davey 2016)

In understanding the unconscious roots of the pain patients are introduced to id, ego and superego and how some troublesome negative feelings can be buried into the unconscious. For example, the feelings of dependency, inferiority and childlike narcissism are often repressed. The roots of the unconscious anger should be discovered, and it helps to look for the reasons from childhood emotional pain and sadness, from self-imposed pressures to be good and perfect, pressures of daily life and some miscellaneous things like fear, shame, guilt, vulnerability and insecurity. (J. Sarno 2007, p. 139) Patients are encouraged to think psychologically, not physically (D. Schechter 2014, p. 161-162). It is also important to become aware of the situations where anger is consciously felt but cannot be expressed in the situation. This is also suppressed anger and adds to the reservoir of rage. (J. Sarno 2007, p. 145)

There are postulated reasons for why knowledge is many times enough to diminish TMS symptoms. Because TMS "strategy" is to get minds attention away from emotional issues, learning that the pain is only a distraction makes this strategy useless. Also, by learning that the symptoms are psychosomatic might be a relief and diminish fear for pain and re-injury. (J. Sarno 2007, p. 148-150; D. Schechter 2005) This is consistent with the finding by D. Price et al. (1987) that chronic pain and cancer patients report higher affective Visual Analog Scale (VAS) (measures pain unpleasantness) than their sensory VAS (measures pain intensity) compared to women in labor or patients with experimental pain, which suggests that the perceived threat of the pain directly affects pain experience. (D. Price et al. 1987)

H. Schubiner et al. (2012) suggest that in the beginning of TMS-treatment the patient should repeat the sentence *"I have MBS (TMS), and I can cure myself"*. This activates the DLPFC which then inactivates the ACC. This rapidly helps to unlearn the nerve pathways that also include amygdala and ANS that have been maintaining the pain cycle. Consciously repeating this sentence or similar affirmations it is possible use the conscious brain (DLPFC) to affect the subconscious part of the brain where the nerve connections that maintain the pain cycle are located to stop the nerves firing. Other kind of calming self-talk may work the same way. This is consistent with the findings that people who feel self-efficacy and believe that they will get better and have control over their situation are much more likely to get better. (H. Schubiner et al. 2012, p. 70-71, p. 157; I. Kirsch 1985)

3.2.2 Overcoming the fear of physical activity

To heal from TMS the patients are encouraged to resume normal physical activity. J. Sarno (1991) treated his patients first by combining education (lectures) with physiotherapy and psychotherapy when needed. The problem arose from physiotherapy and eventually it was cut out from the treatment program. The physiotherapy kept the patients' attention in the physical body and re-enforced the underlining connection that the physical problems were physical in origin, not emotional. (J. Sarno 1991, p. 96-97)

Here is an example how conditioning in TMS can occur in a back-pain patient. The patient probably had pain while sitting and thus made a connection between sitting and pain, even though sitting is such a benign activity that it in no means can be dangerous. Now the patient's brain combines sitting with pain and expects the pain every time when sitting down – and so it happens. The patient has now been conditioned to experience pain when sitting down. J. Sarno (1991) describes a patient that went through his day which included a physically demanding job without any pain. However, this patient would wake up every night about 3 a.m. into severe back pain. Clearly a conditioned pain pattern. (J. Sarno 1991, p. 25-27)

During the process of healing patients need to recondition themselves from the fear of physical activity. Conditioning might be very powerful (S. Ozanich 2014); mental cues can alter physiology and the immune system can be conditioned at the autonomic (sub-conscious) level. Russian scientists have showed in the early 20th century that the Pavlovian conditioning can suppress and enhance the immune response. For example, when rabbits and guinea pigs were repeatedly injected with bacteria (that stimulated the immune system) simultaneously with a trumpet blast, the animals "learned" to activate their immune system even without the bacteria injection when they heard the trumpet blast. (F. McMillan 1999; C. Pert 2003, p. 190-191) Later in the 1970s R. Ader and N. Cohen (1975) gave lab rats an immune-suppressing drug that was flavored with sweet tasting saccharin. The rats became conditioned and the saccharine taste alone without the drug was enough to cause the suppression of their immune system. (R. Ader et al. 1975) During the TMS treatment the learned symptom patterns will promptly disappear (J. Sarno 2007, p. 138).

The idea of overcoming the fear of physical activity in chronic pain by in vivo exposure therapy that involves the emotion-regulation focuses on the difficulty of dealing with negative emotions related to physical movement or certain situations. This has been reported in small case series substantially improve patients' pain and physical functioning. (S. Linton et al. 2014; S. Linton et al. 2016) In TMS treatment the negative emotions related to physical activity are dealt with by telling the patient that the pain is in no means harmful which lessens the negative affect the pain has on the patient. Even though resuming the physical activity and losing fear for it is possibly the most important part of the healing process it is notable that the confidence in the diagnosis should be established at

least in some degree before starting to challenge the preprogrammed patterns and reconditioning oneself from the pain related patterns. (J. Sarno 1991)

The traditional diagnosis for back pain usually includes back sprain or strain, weak abdominal muscles, muscle pull, different length legs, some spinal disorders, narrowed disk spaces and sciatica (when leg pain is involved). The traditional treatment for these problems includes bed rest, muscle relaxants and analgesic, as also physical interventions in a form of physical therapy such as deep massage, treatment with heat (ultrasound), active exercises, sometimes injections for analgesia and steroids. Also, the physical activities are advised very carefully, like what kind of posture is "good" and how to lift and bend safely and what physical activity should be avoided completely. (J. Sarno 2007, p. 130) This view of treatment is still valid in modern medicine and many times people in pain are advised to avoid painful activity which is sensible in a case of an acute injury, but not in case of chronic pain. To heal the patient must challenge this culturally accepted view and believe that if the physical treatments work it is most likely only treating the symptoms or then placebo effect is playing a role.

If the pain has been severe or persistent patients may also be afraid of the continuity of the pain and disability as well as its effects on their responsibilities and work. The reassurance that the pain is nothing to be afraid of and that the patients have been misinformed about the structural causes for the pain and that TMS is a benign disorder is needed. (J. Sarno 2007, p. 139).

3.2.3 Psychotherapy and journaling

According to J. Sarno (2007, p. 142) about 80% of the patients heal with the help of educational program (lectures about TMS and follow-up meetings). The rest 20% of the patients are guided to psychotherapy to fully understand the unconscious conflicts and reasons behind the symptoms. (J. Sarno 2007, p. 142; I. Rashbaum et al. 2003)

Psychotherapy

Group meetings have been reported to be beneficial for many patients' progress. In the meetings they can share their experience, and many enjoy talking and listening to fellow participants. These meetings allow patients and the physician to ask questions and correct misperceptions about TMS and the healing process. (J. Sarno 2007, p. 146) Also, hearing from other patients' belief in the diagnosis, sharing their struggles and emotional problems can be helpful. The challenge in group psychotherapy is that every patient has unique emotional issues that may require individual attention (M. Lumley et al. 2019a).

Short-Term psychodynamic psychotherapies (STDP) and intensive short-term dynamic psychotherapy (ISTDP) have appeared to be effective in treatment of somatic symptom disorders (E. Anderson et al. 1995; A. Abbass 2005; A. Abbass et al. 2009; M. Lumley

et al. 2019a). Patients that need psychotherapy to heal are usually burdened with strong internal feelings that are not easily recognized and are many times denied. For many patients it is important to learn to feel and recognize feelings like rage, sadness, disappointment, anger and abandonment etc. (J. Sarno 2007, p. 152) Anger awareness and expression can help patients with chronic headaches to improve (O. Slavin-Spenney et al. 2013) and experiencing the true feelings in the moment weakens or overcomes the somatization symptoms (A. Abbass 2005). The main focus in psychotherapy is to uncover these defenses and the repressing behavior (J. Sarno 2007, p. 152).

For many patients the biggest stressors include other people and relationships with them that can cause continuous conflict and pain (M. Lumley et al. 2019a; N. Selfridge et al. 2001). These patients can benefit from learning how to differently relate to other people in real life. This includes finding balance between the need for assertion or power (like setting boundaries, saying "no" and expressing their desires) and their need for connection (like expressing love, sadness or gratitude). This kind of behavior might be very frightening at first and it can be practiced in session toward an imaginary person or in a role-play. (M. Lumley et al. 2019a)

The internal change that helps the patient to react differently to stressors and understand the motivations, fears and anger is very helpful in TMS healing. It is important to notice that the healing does not require changing the personality that very often is type T. What is often necessary is to learn how to tune down these personality characteristics with relatively small changes that helps reduce the pressure experienced in everyday life. (D. Schechter 2014, p. 57, 60)

Journaling

Bringing the unconscious feelings and emotions into consciousness is important in TMS healing process and it eliminates the need for the symptoms to act as a distraction. Besides psychotherapy writing about repressed feelings has appeared to be a successful way to bring those unconscious feelings into consciousness (D. Clarke 2016; I. Rashbaum et al. 2003; N. Sachs 2016; D. Schechter 2014, p. 139-145).

There are a lot of documented potential health benefits from journaling such as fewer stress related visits to the doctor, reduced blood pressure, improved immune system, lung and liver functioning, improved mood, fewer hospitalization days and improved psychological wellbeing. Journaling can affect social and behavioral outcomes by reducing absent days from work, improve working memory and sporting performance, alter social and linguistic behavior and heighten students' grade point average. (K. Baikie et al. 2005) Expressive writing has been reported to result in improvements in biochemical markers responsible for immune and physical functioning (K. Baikie et al. 2005), it has also been associated with increased number of lymphocytes and decreased Epstein-Barr virus titers (B. Esterling et al. 1994). According to J. Smyth et al. (1999) writing about stressful life

experiences reduced the symptoms of patients with mild to moderately severe asthma or rheumatoid arthritis compared to control group in a 4 month follow period. (J. Smyth et al. 1999) There is some evidence that also pain, and cancer patients might benefit from expressive writing (K. Baikie et al. 2005).

N. Sachs (2016) represents a technique by which the repressed unconscious feelings can be brought into daylight. The technique is called Journal Speak and it includes writing (or in case one is incapable of writing talking aloud) about feelings and emotions. (N. Sachs 2016) While other journaling instructions for TMS patients do exist, i.e. TMS-wiki structured education program (TMS Wiki 2018), The MindBody Workbook (D. Schechter 1999) or The five-week plan to heal fibromyalgia (N. Selfridge et al. 2001), N. Sachs approach is presented here because it is simple, easy to approach and demonstrates the purpose of journaling very clearly.

N. Sachs (2016) demonstrates that the reason people have chronic pain (and many other chronic conditions) is because people do not consciously *feel* their emotions. The unconscious repressed feelings could be demonstrated as droplets of water that are slowly accumulating into a bucket during the life. These negative feelings build up during life and more water is added into the bucket by different stressors each day. If the bucket is not drained it will be in danger to overflow and these emotions are in danger to arise into consciousness. What Journal Speak does is that it provides a safe way to slowly empty this bucket (reservoir of rage and other negative emotions unfelt) so that eventually pain is not needed to distract the person from his feelings.

To start the patient needs to make a list with headings like Childhood, Daily Life and Personality. Under each heading one must write meaningful things that need to be understood only by the patient. (N. Sachs 2016, p. 152) Table 4 demonstrates a possible list from which the patient chooses one topic a day to journal about.

Table 4. *An example list, adapted from N. Sachs (2016, p. 152).*

Childhood	Daily Life	Personality
My parents divorce.	My husband only concentrates on his job and I feel alone.	Need to be perfect all the time.
My sister bullying me in high school.	Money problems.	Trying to be a good person.
The girl who laughed at me in second grade.	Buying a new house.	Being afraid of failure.
High expectations in school.	Jealousy to my friends.	Feeling isolated.
Being late from school in third grade	No job.	Not being able to feel happy about my success.

It is notable that similar journaling techniques are involved in many other TMS treatment programs and suggestions. D. Schechter's *The MindBody Workbook* provides a guided journal with ready questions related to the patients' life (i.e. work, family, childhood etc.) (D. Schechter 1999; D. Schechter 2014, p. 139). There are also other programs that provide ready questions and topics for journaling (N. Selfridge et al. 2001, p. 185-249; TMS Wiki 2018), and some programs may include other ways to express and define the emotions like drawing and singing (D. Schechter 2014, p. 141; *The Cure for Chronic Pain* 2016-2017). The purpose of journaling is the same in all the programs: bring the unconscious feelings into consciousness and help the patient open up and feel the repressed emotions. During the journaling process the patient learns a new psychological thinking style and a way to process uncomfortable feelings that is also a helpful every day tool for emotional stress relief after psychotherapy (if the patient has needed it) has ended (D. Schechter 2014, p. 140).

It is very important to note that journaling or expressive writing for TMS healing purposes is very different from journaling in a traditional way. For the journaling to be "efficient" it is very important that the patient is very honest with their feelings. It is not just writing a journal, it is deep reflection and thinking about the feelings and why one is feeling them and connecting them to childhood, personality and past events. 15-20 minutes every day is the usually recommended time for journaling (N. Sachs 2016; D. Schechter 2014, p. 139-143), though sometimes even more time is recommended (N. Selfridge et al. 2001). Sometimes patients can also be instructed to write an unsent letter (M. Lumley et al. 2019a).

Reflection and thinking about these possible causes of internal rage will help them to arise into consciousness and to be felt – and release the need for distracting symptoms. It is important to reflect every day as well as review the study material of TMS. This is the way to get the knowledge and understanding into the unconscious mind. (J. Sarno 2007, p. 145)

Emotional awareness and expression therapy (EAET)

M. Lumley et al. (2019a; 2019b) present an approach of emotional awareness and expression therapy that can be very useful in the treatment of chronic pain. EAET combines elements from ISTDP, experiential therapy, expressive writing, exposure therapy and emotional rescription. In this approach patients are guided to experience and express their primary emotions related to previous trauma or conflict. This takes place first in sessions and later in actual relationships in a balanced and moderated manner. (M. Lumley et al. 2019a; M. Lumley et al. 2019b)

It could be argued that if the TMS symptoms are arising primarily from suppressed anger, why aren't the patients just advised to verbally or nonverbally express their emotions? The answer is that the sources of this anger and its existence is unconscious, so some deep

reflection is needed to bring it into consciousness. Even if the patient would be aware of their emotions reversing the suppression might also have maladaptive consequences: it may burden close relationships and alienate family member and health care providers that could otherwise provide help (M. Lumley et al. 2011). Thus, the consequences of the emotional expression would be even more damaging to the patient than emotional suppression. For these reasons psychotherapy and journaling are helpful tools to process the feelings and anger that lead to TMS symptoms.

Why does journaling help?

Even though the exact mechanism why expressive writing seems to be beneficial for health is unclear, some sophisticated hypotheses have been made. One theory, that could line up with TMS theory, is that active inhibition of thoughts and feelings related to traumatic events requires effort and is accumulated as stress in the body. This trauma related stress manifests itself as increased physiological activity, obsessive thinking or ruminating about the event and long-term disease. Journaling about feelings and emotions related to these events helps to confront and acknowledge the associated emotions which may then slowly reduce the overall stress level in the body. Writing or talking involves translating the event and emotions into words which requires cognitive processing and deeper understanding: this may help to organize and understand the events and result in more adaptive integrated schemas about self and the surrounding world. (K. Baiki et al. 2005) Writing about traumatic experiences and emotional and cognitive processing of these traumas can normalize pain processing. It is possible that the childhood adversity increases threat vigilance which then may lead to continuous decreases in descending inhibition from brainstem nuclei, PAG and rostral ventromedial medulla, which then leads to increase of excitation in spinal neurons and enlargement of their receptive fields. (D. You et al. 2018) For example, M. Lumley et al. (2008) reported that from the 10 fibromyalgia patients who participated into 10-session trauma-focused emotional expression therapy 2 had substantial improvement, four reported moderate improvement and two modest improvement and two patients did not benefit from the treatment (M. Lumley et al. 2008).

C. Pert (2003) also believes that *"Repressed emotions are stored in the body – the unconscious mind- via the release of neuropeptide ligands, and that memories are held in their receptors."* Because of this emotional catharsis is usually the focus in many mindbody therapies and their goal is to let out the emotions that are lodged in the psychosomatic network. (C. Pert 2003, p. 147) E. Rossi (2004) suggests that the relaxation and the resolution of stress-induced mindbody symptoms may have something to do with the alternative splicing related to acetylcholine.

Meditation

J. Kaufman (2018) proposes that the modern urban world does not support humans innate evolutionarily evolved healing mechanisms and may even be the cause of disease. Urban

life is stressful and full of distractions that activate the sympathetic nervous system. The natural environment is also full of distractions, but the nature of distractions is less conscious attention requiring and more calming. Time spent in the nature activates the parasympathetic nervous system. To facilitate health and healing time in the nature, meditation and hypnosis is recommended by J. Kaufman (2018). Meditation directs attention and guides to relaxation and is associated with greater activation of parasympathetic nervous system (J. Kaufman 2018) and in recent imaging studies meditation has been shown to attenuate the brain's pain circuit activity (M. Lumley et al. 2011). D. Clarke (2016) and N. Selfridge et al. (2001, p. 112-125) mention that mindfulness and meditation are helpful tools for many TMS patients. Hypnosis is associated with the altered state of consciousness where people are more susceptible to suggestions and hypnosis can alter mindbody function. Hypnosis (by using suggestions) has also been reported to reduce the likelihood to respond habitually thus resulting into reduced likelihood of perceived internal conflicts or threats. (J. Kaufman 2018)

Conscious breathing, that is present in many meditation techniques, has been observed to be efficient in controlling pain. PAG that is located around the aqueduct between the third and fourth ventricles in the midbrain contains a large amount of opiate receptors. The quantity and variety of peptides that are released from the brain stem are affected by the rate and depth of breathing and vice versa. These peptides, many of which are endorphins and other pain-relieving substances, can diffuse through the cerebrospinal fluid to achieve homeostasis which then can lead into pain relief. It is speculated that for example some yogis and mothers in childbirth can through breath training gain conscious access into their PAG and thus reset their pain threshold. (C. Pert 2003, p. 186-187) Whether this is the reason why meditation and conscious breathing techniques are often included into TMS healing programs and considered to be helpful is not completely clear. Anyway, meditation is a great way to relax and manage stress which will help to calm down the nervous system (D. Schechter 2014, p. 146).

Other requirements for healing

As already mentioned, self-talk can help with TMS recovery and some TMS-practitioners advice patients to talk to their brain. This reinforcing the message helps to rewire the brain and calm and reassure the patient about their health and reduces concern about the pain, in a similar way as in CBT. (M. Lumley et al. 2019a; M. Falk et al. 2015; J. Sarno 1991, p. 93; D. Schechter 2014, p. 144; H. Schubiner et al. 2012; N. Selfridge et al. 2001, p. 152-164) In addition, visualization and imaginary practice is thought to do the same thing. (D. Schechter 2014, p. 144; N. Selfridge et al. 2001, p. 164-166) According to the treatment recommendations for fibromyalgia in Finland hypnosis and conscious imagination practice can reduce the symptoms in fibromyalgia, but only temporarily. (Kipu 2017)

Having enough counterbalancing fun and maintaining positive attitude is important (M. Lumley et al. 2011; N. Selfridge et al. 2001, p. 68-71); positive emotional states and optimism have been shown to reduce pain (M. Hanssen et al. 2013; M. Lumley et al. 2011). Laughter is known to suppress stress hormone release and lower the cortisol levels in blood. Laughter also triggers the release of endorphins and natural painkillers into the spinal canal – a natural analgesic response. Because cortisol also suppresses immune system, laughter is good for boosting one's immune system. (S. Ozanich 2014, p. 308) Some TMS patients may lack self-care skills and for them it could be beneficial to set aside 2-5 hours a week to find an enjoyable activity (D. Clarke 2016).

3.2.4 Treatment programs and information sources for patients

The treatment programs and information sources presented in this thesis are considered to be the most reliable, commonly known and available for TMS patients. Other materials that are reliable but are not mentioned here do probably exist - there is no scientifically trustworthy collection of TMS treatment materials and options. TMS wiki and other TMS related webpages and books have some lists of TMS related books and materials that can be very helpful for patients. It is notable that the reliability of the materials is up to the user because no profound scientific evaluation has been done by any major organization.

Because there is not (yet) support for TMS diagnosis and treatment from major organizations the recovery programs and TMS related materials are mostly developed by TMS practitioners (i.e. medical doctors and psychotherapists) or former TMS sufferers. Because guidelines for treatment from major organizations and scientific research about TMS are lacking there is no clear answer which materials would be the best for the treatment. The options presented here are just a collection of materials and resources for TMS treatment to give the reader an overview about what kind of possibilities already exist. However, all the treatment materials and programs presented here rely on J. Sarnos original TMS treatment techniques.

Evaluation by a TMS practitioner

Consulting a TMS physician would be the best option for a TMS patient. A trained TMS physician could confirm the diagnosis, evaluate the optimal treatment strategy, monitor the progress and change the treatment if needed. A TMS practitioner could guide the patient to read and go through educational and other self-help materials related to TMS. Because direct consultation of a TMS practitioner is not an available option for many patients the role of education and self-help materials is irreplaceable in many patients' recovery.

Education and self-help materials

According to D. Schechter et al. (2004) the education material would need to be clear, reliable and professional quality. It is also important that at home education material is user-friendly (avoids medical jargon), understandable and considers the patients' education level and language. In the pedagogical point of view there should be different materials for different learners like kinesthetic, visual and audio learners. Also, the portability of the materials should be considered and the possibility for utilizing recorded media. A good education material would also be interactive and would include task-oriented materials that require patients' active involvement, like journaling. (D. Schechter et al. 2004)

There are different education and self-help materials that the patient can be "prescribed" to read and go through. Some helpful books are presented in Appendix A. More interactive materials are usually meant to help the patient to discover and release the repressed emotions or otherwise support the patients' recovery journey. A list of some of these materials is presented in Appendix B. A more profound presentation and evaluation of these materials is beyond the scope of this thesis.

Additional material is to be found in individual webpages, blogs and YouTube, but again then the reliability is up to the user to define. However, when the websites or interviews that can be found are performed by a TMS practitioner the reliability increases and I would consider them to be good information resources. The problem with this kind of materials is that identifying a good TMS practitioner and reliable material is not usually possible for a patient who is unfamiliar with TMS.

There are some materials available in other languages, but English is the predominant language in the educational materials about TMS. Translations of these materials are lacking or are not necessarily good quality or are not presented by reliable organizations.

At the moment (4.3.2019) the author is aware of only one webpage that presents TMS in Finnish. The material includes a simple presentation about TMS and a questionnaire of whether a person might have TMS or not. Even though it refers to J. Sarnos and D. Schechter's materials and seems to be correct about TMS, the reader may not consider it to be reliable because the information is not presented by any major organization and the is only a collection of lecture slides. (Grafil)

Some patients may do well only with the knowledge that their symptoms are TMS and nothing malignant is going on. For some guided treatment programs and journaling exercises may be needed so that they understand the roots of their unconscious rage. However, these materials do not replace the guidance of a medical professional in the treatment and some patients may require the help of a trained TMS therapist.

3.2.5 Future technology for TMS treatment

TMS can be effectively treated without any modern technological interventions. However, the ANS and especially sympathetic and parasympathetic nervous system activation levels are related to TMS symptoms. Measurement of this activity and helping to return the ANS into balance by activating parasympathetic nervous system and suppressing the constant activation of sympathetic nervous system could possibly be done with current technology.

Stress level measurement device

TMS patients tend to repress their feelings. In the treatment an important factor is to learn to recognize the repressed feelings and situations that trigger symptoms (often these situations include repressed feelings and anger). Because these feelings are unconscious the patients would benefit for additional help in detecting these situations. This of course relies on the assumption that emotions can be somehow “measured” and that repressed emotions also cause physiological symptoms related to traditional stress response that can be detected. Whether this happens when repressing emotions is not known.

One possibility could be a portable device, like a wrist watch, that would measure the stress level and help the patient to assess daily stress levels and notice stressful situations. The idea of this kind of device was originally presented by David Schechter. Common physiological markers of a stressful situation are that heart rate goes up, respiration frequency increases, heart rate variability becomes lower and the skin conductance changes.

The intensity of emotional states could be measured by galvanic skin response (GSR) that refers to the activity of sweat glands. Skin conductance is regulated by the ANS and is not in conscious control. Increased skin conductance means increased emotional arousal.

Cortisol level would indicate stress level, but unfortunately frequent saliva or blood cortisol level measurement is not practical or even possible.

Some stress level measurement and management devices already exist. Moodmetric ring and app by Vigofere Oy are developed to help with stress management (Moodmetric 2019). Oura ring (Oura 2018) and Firstbeats Heart Rate Variability measurement (Firstbeat 2019) are other examples of existing technology that can help with stress management.

If the stress level would build up above a certain level the device would recognize it and inform the patient. Thus, the patient would recognize the need for psychological insight related to the situation. The patient would know to reflect the situation and possibly journal or talk with therapist about the situations and emotions involved. This could also help the patient to recognize the need for relaxation and meditation.

Vagus nerve stimulation

Another approach is to consider vagus nerve stimulation. Vagus nerve is responsible much of the function of parasympathetic nervous system (M. Bear et al. 2006). For the treatment of epilepsy and seizures there are surgically implemented vagus nerve stimulators as well as recently transcutaneous vagus nerve stimulators (the efficacy still needs to be studied) (H. Hamer et al. 2019; A. Raslan et al. 2018, p. 109). A similar device without surgical intervention could be considered to assist in TMS treatment: if the excitation of the nerve could be measured and maybe properly stimulated, it could be part of TMS treatment.

It is notable that vagus nerve can be stimulated by other means i.e. conscious breathing etc. The need for technology to excite vagus nerve might not be necessary if natural means appear to be as efficient as the possible device. In addition, TMS healing should not depend on any external device – internal balance should be able to be maintained without external devices. But maybe similar principles could be applied with this as with medication usage during TMS-healing: sometimes momentarily treating an acute attack with medication can be considered helpful. Momentarily activating the parasympathetic nervous system with external stimulation can help the patient to get over a difficult period in healing.

Points to acknowledge

It is notable that any current measurement device cannot separate between positive and negative emotions. Because most often the emotions repressed are negative only the recognition of negative emotions would usually matter. This could be dealt in a way that when the device would recognize emotional arousal it would ask the user whether the emotion is positive or negative. However, it is also notable that the role of repression of positive emotions in TMS is not clear.

If some technological interventions are to be developed in the future to assist with TMS healing the role of placebo related to these technological interventions should be carefully considered. TMS healing will not be permanent if the patient relies on the device or any other technological intervention to do the healing work for them. For this reason, I would be very careful when considering technological interventions as a part of the TMS treatment. Whether this kind of devices could be developed and successfully utilized in TMS treatment is a future engineering question.

3.3 Success rate of TMS treatment approach

It has been noted that people who cannot repudiate the physical/structural diagnosis and reject the TMS diagnosis generally do not heal. In general, it has been observed that the mindbody treatment approach has 70-90% success rate among the patients who accept

the TMS diagnosis. (D. Schechter et al. 2005) However, there is no consensus or statistics based on scientific studies about the effectiveness of TMS-treatment. The results of the following scientific studies support TMS-treatment approach and give some assumptions of the possible success rate. It is notable that the mindbody approaches to treatment as well as the duration and forms of treatment vary in these studies.

J. Sarno (1991, p. 123-124) describes a follow-up survey by telephone in 1987 for 109 patients with back pain that was attributed to a herniated disc. The patients were selected randomly from a large pool of patients and each of these patients were diagnosed and treated with TMS 1-3 years prior the survey. 88% (96) of the patients were free or nearly free of pain and were unrestricted in physical activity, 10% (11) were improved though had some pain and were restricted in physical activity and 2% (2) were unchanged. The patients that had not improved continued in psychotherapy and seemed to have severe and persistent psychological problems. (J. Sarno 1991, p. 123-124)

An uncontrolled study performed by A. Burger et al. (2016) supports the efficacy of psychological intervention and mindbody approach in treatment of chronic musculoskeletal pain. They studied a new therapy method aimed at psychological attribution and emotional expression and awareness with 72 participants. The program consisted of education about the mindbody neural pathway model in chronic pain, emotion awareness techniques, expressive writing exercises about current and past life stressors and re-engagement into activities that were previously avoided. After six months about two-thirds of the patients had improved 30 % or more in pain and other outcomes, 70 % improvement was detectable in one-third. (A. Burger et al. 2016)

M. Hsu et al. (2010) studied the effect of a mindbody model of pain based on J. Sarnos work with affective self-awareness intervention on fibromyalgia patients in a randomized controlled trial. The results showed that the intervention group had significantly lower pain severity, improved physical activity and higher tender point threshold than the control group: 45,8 % of the fibromyalgia patients had at least 30 % reduction of pain after 6-months follow-up, when the pain reduction was 0 % among the waitlist controls. (M. Hsu et al. 2010)

In a randomized controlled trial with 230 fibromyalgia patients EAET approach to chronic pain was tested against the benefits of fibromyalgia education and CBT. In the trial the patients in each group were given eight 90-minute sessions. EAET appeared to be more effective than fibromyalgia education and had some advantages over CBT on pain. (M. Lumley et al. 2017)

D. Schechter et al. (2007) studied the mindbody treatment program for chronic back pain patients diagnosed with TMS. The treatment program appeared to show reduction in pain: VAS scores decreased 52% for average pain, 35% for worst pain and 65% for least pain.

In addition, quality of life was improved, medication use decreased, and activity levels of the patients increased. (Schechter et al. 2007)

J. Carty et al. (2018) targeted an EAET based life stress interview to women with chronic pelvic pain in a randomized controlled trial. The study included 62 patients from whom 37 had a 90-minute interview targeting i.e. the disclosure about stressors and awareness of connections between stress, emotions and symptoms. 25 patients who were treated as usual served as a control group. The group that received the interview improved in physical symptoms, but no improvement was detected in psychological symptoms. (J. Carty et al. 2018)

In a randomized controlled trial by E. Thakur et al. (2017) the effects of EAET to IBS was compared to relaxation training and patients on waitlist. The study contained 106 patients and included three 50-minute individual sessions of EAET or relaxation training. The EAET approach reduced the severity of IBS symptoms significantly. The life quality was improved by EAET and relaxation training. The psychological symptoms were not affected by EAET treatment but improved with relaxation training. (E. Thakur et al. 2017)

A randomized controlled trial that included 75 patients presenting to primary care with medically unexplained symptoms studied the efficacy of an EAET interview. One 90-minute interview had significant effects on pain severity, pain interference and sleep problems and psychological symptoms in 6-weeks follow-up. (M. Ziadni et al. 2018)

The effects of anger awareness and expression training (AAET) on chronic headaches was compared with group-based relaxation training and waitlist controls in a randomized trial. The study included 147 patients who received either three group sessions of AAET or relaxation training. Both AAET and relaxation had similar positive effects on headache-related outcomes. Also, psychological stress was significantly reduced by relaxation training but not by AAET. (O. Slavin-Spenny et al. 2013)

An emotional exposure treatment was tested on 10 patients with fibromyalgia and trauma history. The treatment targeted emotional processing of trauma-related avoidance behavior and contained 8-15 therapy sessions. After three months there were small to medium benefits on pain and disability and substantial effects on fibromyalgia impact, emotional stress and trauma symptoms. 20 % of the patients showed substantial improvement, 40 % showed moderate gains, 20 % had modest improvement and 20 % did not benefit from the treatment. (M. Lumley et al. 2008)

It is notable that many of the studies made about the efficacy of TMS treatment are based on “theoretically pure” EAET approach. Thus, those studies did not include CBT or ACT based approaches and thus excluded i.e. mindfulness and re-engagement to physical activities. M. Lumley et al. (2019b) believe that if these approaches are combined with EAET the patients will receive even greater benefits from the treatment. (M. Lumley et al. 2019b)

3.4 Problems in TMS treatment

Ability to see a TMS practitioner

The best option for a patient would be to consult a TMS practitioner, but unfortunately there is limited availability to TMS practitioners. There are not many trained TMS physicians because TMS is currently unknown to mainstream medicine. According to TMS-Wiki (2018) there are total 141 TMS practitioners from which 52 are physicians, 78 therapists and 11 others. The PPDA (2018) gives a list of 166 TMS practitioners: 56 physicians, 95 therapists and 15 others. Most of them work in USA, but some are to be found in Australia, Canada, Ireland, Israel, Germany, Italy and United Kingdom. There might be TMS practitioners in other countries, but collective reliable data about the number and distribution of these practitioners does not exist. So, the limited availability, distance and in some cases the price of the treatment may be a problem. Some practitioners do offer services via internet or telephone which is good if a TMS practitioner is not available in a proximity of the patient.

Also, a difficulty for the patient that cannot see a TMS physician is to find the best and the most reliable education material that would support the patients' recovery. To choose the best material for the patient it is needed to know that what kind of learner the patient is and what kind of material would support TMS healing the most.

Accepting the diagnosis

People with mindbody disorders may be susceptible to the fact that their physically manifested symptoms have an emotional cause (D. Clarke 2016) According to Marc Sopher's (M.D.) experience as a medical doctor, only 10-20 % of patients with clear TMS are willing to accept the diagnosis. (J. Sarno 2007, p. 340) People who are in need of the psychological defense mechanisms that are maintained by the pain, or do not want to deal with the emotional factors contributing for the pain, do not usually accept the diagnosis and thus are not possible to be treated as TMS patients (D. Schechter 2005). Also, many patients describe themselves often being fine and happy with their lives and being on a holiday at the onset of symptoms. What is not realized is that there is always stress and people constantly worry about different things. It is also notable that it is not needed to be a big stressor to trigger the symptoms because what counts is the size of the reservoir of negative and repressed feelings and rage: even a minor stressful thought may threaten this reservoir to overflow. With the words of Marc Sopher, it is the "*straw that breaks the camel's back*". (J. Sarno 2007, p. 345)

Willingness to embrace difficult emotions

Besides the fact that the presence of unconscious emotions may be denied or not recognized, the repressed emotions may be so deep and painful that there is no willingness to embrace them and because people are not aware of repressed emotions they may not be

motivated to try psychotherapy. Especially patients with childhood trauma may not be willing to embrace or encounter the emotions related to this trauma. Also depending of the victims' personality and environmental factors the survival from the emotional trauma may vary.

False believes

Media and faulty medical advice can also be in the way of healing from TMS. People have false believes about how to lift heavy objects, how to sit or stand (S. Ozanich 2014, p. 208). Many times, rest is recommended for acute back pain which according to recent studies is usually not the best treatment option. Keeping the patient active may enhance patient's recovery and reduce the risk of developing chronic pain conditions. (S. Linton et al. 1993, A. Malmivaara et al. 2014; T. Ojala 2018) Also nocebo effect is accumulating: people are warned by different sources from different diseases (S. Ozanich 2014, p. 208). The unconscious mind hears everything: social contagion of symptoms through media or friends is not uncommon. The same with placebo: a person sees a commercial how some medicine helps, believes it and it works. Or a person hears from a close friend that has had a successful back surgery (which in most cases probably works because of placebo), he believes it and goes to surgery – and back pain is gone (though because the origin of the symptom was not treated there will probably be another symptom created soon after to take its place). The same can also happen with physiotherapy: it can help for a while, also because it increases local circulation in the location of hypoxia. But because physiotherapy does not remove the real reason for the symptoms they will remain or in case of the symptom imperative they will move to another location or system. (Sarno 1991, p. 151)

In the Western culture most people have learned (as a misconception) that all physical symptoms can be explained by abnormal pathology and thus can be treated and cured with physical interventions (E. Davey 2016). In the clinical setting pain is often seen as a purely sensory experience related to tissue damage and the possibility of emotional contribution to the pain is neglected (M. Lumley et al. 2011). Thus, people may be offended if the health care professionals propose that they have psychosomatic disorder: a normal misconception is that the pain is "all in their head" or that they are making up the pain. (E. Davey 2016) In addition, rare medical professionals are aware of the mindbody disorders. TMS is not included into the medical training of most doctors so the recognition of these problems is weak and due to this reason misdiagnosis is common (D. Clarke 2016; D. Schechter 2014, p. 67, 71-72). As a result, many patients are misinformed about their pain by their medical doctors (D. Schechter 2014, p. 40).

Education of TMS-practitioners

If a medical professional would like to get familiar with TMS only few options are available. In the UK a practitioner interested in TMS can participate SIRPA practitioner training-program that is available online (SIRPA UK 2018). The Psychophysiologic Disorder Association (PPDA) also has some training available (PPDA 2018). For many doctors and psychotherapists, the way to be a TMS practitioner is through private learning i.e. by reading materials and participating seminars. One possibility is to be mentored by a TMS practitioner and learn by working with patients with chronic pain.

As can be seen, systematic education of medical practitioners is lacking. The education of a practitioner about TMS depends a lot on personal interest. In addition, the existing education programs are in English, which can exclude many practitioners due to inadequate language skills.

Current treatment setting

The proper recognition of the causal link between stressful life events and chronic pain is poor at the moment. Thus, the health care is organized in an inefficient way: patients' pain is managed separately to trauma. It is important to notice that psychological factors directly contribute to chronic pain and that the patients' cognitions, emotions and behaviors are not only consequences of the pain. (M. Lumley et al. 2019a). These two are actually so closely related to each other that the patient would benefit from a reorganization of health care where the pain and trauma could be treated in the same clinic. This would also help in the mental change that is needed among practitioners and patients: that many physical conditions are psychological in origin and they can be cured by learning.

Identification of the real cause of the symptoms is poor

Nowadays chronic pain is treated in the basis of secondary gain and structural abnormalities are usually considered as the causes of the pain. There might be benefits from the treatments but because many of these patients have TMS the relief is only temporary because the benefits of the treatments are based on placebo effect. (J. Sarno 2007, p. 113; H. Schubiner et al. 2012, p. 19-20; M. Sopher 2003, p. 38)

Along with the development of diagnostic technology such as x-ray, MRI and CT scan the diagnosis of bodily conditions has become more accurate. However, it is notable that not all seen in these images has anything to do with why a patient is in pain and all causes of pain cannot be seen with this technology (M. Lumley et al. 2019a; D. Schechter 2014, p. 2). TMS is also difficult to measure and there is no simple test, like blood test or x-ray, that would confirm the diagnosis with 100% accuracy (M. Sopher 2003, p. 42).

Traditionally medicine has focused how to treat the symptoms, not the cause of disease. For example, how does the traditional medicine deal with depression: depression is seen

as a pathological state with specific chemical state in the brain. The balance is then restored by drugs and the disorder is then cured. According to TMS theory the cause of depression is not cured, only the symptoms are made to disappear. The cause of depression are the frightening and disturbing feelings in the unconscious which cause the chemical changes in the brain and thus depression. So even though the chemistry of this clinical state can be identified it does not establish its cause – the chemical state itself might be a result, not the cause. It can be asked: is a disorder being cured if the symptoms have disappeared by medication even though the cause of the disorder remains uncertain? (J. Sarno 1998, p. 37, 39)

Scarce research data

In the way of accepting TMS in the field of medicine is that it is not easy to study, not many scientific publications exist and not enough is yet known to understand TMS completely. Also J. Sarno (1999) addresses: *"The psychosomatic phenomena cannot be studied in the test tube or by using laboratory animals. Unconscious emotions are not revealed by the administration of tests or personality profiles"*. (J. Sarno 1998, p. 35) Unfortunately current scientific approach demands treatments to be evaluated by formal testing, which in the case of psychosomatic conditions is hard to do (M. Sopher 2003, p. 42).

TMS healing requires an effort from the patient

Healing from TMS is a process. Thus, it is not a quick fix which might also be a problem for many people: we live in a culture where in case of physical problems we go to the doctor, they examine us and prescribe a pill, or we even go to hospital and have a surgery and suffer a day or two but after that we are supposed to feel better. Many people would rather take the quick-fix-now and the modern health care relies much on medication and physical or invasive procedures. This is not the case in TMS healing. The process of healing might take weeks, months or even years. (S. Ozanich 2014, p. 139; D. Schechter 2014, p. 3; N. Sachs 2016) Changing the programming of the unconscious mind through the conscious mind can be difficult (B. Lipton 2015, p. 121-123; 180), which might also play a role in the time of recovery from TMS. Changing awareness happens through deeper understanding – one must view their lives and reflect on it and change their perception when needed and challenge conditioned patterns. (S. Ozanich 2014 p. 208) Reaching this awareness and understanding is needed for the recovery when just education is not enough to banish the symptoms – and this takes time. The problem is that people rarely stop and think about their lives. In the modern world and culture people are not encouraged to take time to do so. (S. Ozanich 2014, p. 139)

4. DEVELOPMENT OF AN ONLINE DIAGNOSTIC QUESTIONNAIRE

TMS cannot be diagnosed purely with any specific physical test or examination. In the field of psychology questionnaires are often used to assess the patients' health. Because TMS involves the psychological component a questionnaire can be helpful in the diagnostic process.

It is important to note that *TMS diagnosis should always be made by a medical practitioner* and all other malignant diagnoses should be ruled out first. This tool is meant to *assist* the patient and medical practitioners to do the TMS diagnosis along with a medical examination and interview.

The questionnaire used for this tool already existed as a paper version and is also presented by D. Schechter et al. (2007). However, making an online version of the questionnaire could probably make the questionnaire more easily available for a larger population of patients. Some patients may not have a possibility to see a TMS practitioner, so an online questionnaire could help them to assess the possibility whether they have TMS or not and then discuss the possibility with their doctor. The results of the questionnaire, if performed alone by the patient, should always be discussed with a medical practitioner.

The usability of the questionnaire was tested so that the suitability of the questionnaire for online use could be evaluated. Thus, possible improvements could be made to the online questionnaire if it is to be taken for larger use; possibly this kind of questionnaire could be available for laymen online, so people could estimate their risk for TMS, in a similar fashion that there are questionnaires that assess the patients' possibility of other illnesses like diabetes.

4.1 Development of the tool

Background

The questionnaire was based on the questionnaire presented in an article by D. Schechter et al. (2007) and in the book *Think Away Your Pain* by D. Schechter (2014, p. 76-80, 131-137). The original paper version of the questionnaire is presented in Appendix C. This questionnaire with ready questions was chosen because a) the existing questionnaire is well done, already used with patients and suitable to be transformed to a short online questionnaire b) the author of this thesis is not a medical doctor, so the questionnaire made by Dr. D. Schechter is considered to be much more reliable. The paper version of this questionnaire has already been used by D. Schechter when diagnosing patients with TMS (or not TMS) for about two decades.

Translation of the TMS questionnaire into Finnish is presented in the Appendix D and the result page in Appendix E. TMS is not well known in Finland so it was seen important to translate the questionnaire for future purposes. All Finns do not understand English well enough to use the English version of the questionnaire. Also, filling the questionnaire is much easier for patients in their own native language. When the health care system in Finland decides to accept TMS diagnosis to general health care, an assisting tool for diagnosing TMS is then needed and it would already exist.

The program used for the development of the online questionnaire is Webropol questionnaire program. This program was chosen because various types of questionnaires can be created with it in a user-friendly way and it is free of charge for TUT students.

Development

For the online version of the questionnaire a short explanation about TMS was added at the beginning of the questionnaire (see Appendix D).

According to the answers given to the questionnaire the person doing the test would receive results of the probability of having TMS. Besides that, a short explanation of the result was added as well as some TMS information resources. This will be needed, if the questionnaire is not performed under the supervision of a medical practitioner who can explain the results and provide the patient with further information. The result page is presented in Appendix E.

4.2 Testing the tool

To assess the understandability and user experience of the questionnaire (both Finnish and English versions), it was tested with university researchers. The questionnaire was sent with instructions by e-mail to 33 possible participants. Altogether 14 people completed the questionnaire. The participants were given the option to answer the English and Finnish versions (the native language of the participants was unknown): 13 completed the English version of the online TMS-questionnaire, 11 completed both the English and Finnish version of the questionnaire.

57 % (8) of the participants were female and 43 % (6) male. Only one participant was familiar with TMS before performing the questionnaire so TMS information presented in the questionnaire was new to most participants. The age division of the participants is presented in Figure 5. One participant did not give the background information about age, familiarity with TMS and did not answer question 4 in feedback.

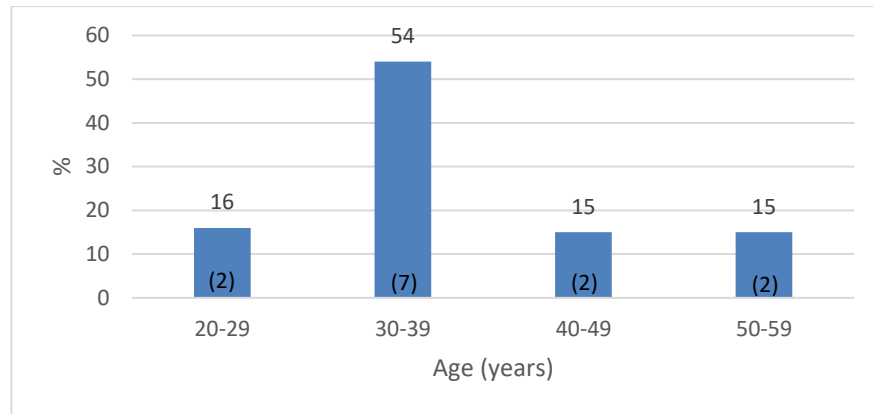


Figure 5. Age distribution of the participants.

The researchers were guided to try to take the role of a patient when answering the questionnaire. After that they replied to a third questionnaire (Feedback, Appendix F) that assessed the usefulness of the online questionnaire. The Feedback questionnaire was developed with the Webropol-questionnaire tool and the questions can be seen in Appendix F.

The answers of the researchers to the TMS questionnaire were not assessed and both the TMS-questionnaire and the feedback were anonymous.

4.3 Assessment of the tool

Overall participants found the questions clear and easy to answer. Table 5 shows the results related to the usability of the questionnaire. Most participants found the questionnaire easy to use. According to the feedback, the questions were easy to understand by most participants. Also, the results were easy to understand but the info about TMS even though evaluated as good by most participants could possibly need some improvements. The questionnaire was informative enough by majority of the participants.

Table 5. *Usability of the questionnaire.*

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree	Total	Average
A. The questionnaire was easy to use.	0	0	0	3	10	13	4,77
	0%	0%	0%	23,08%	76,92%		
B. The questions were easy to understand.	0	0	0	7	6	13	4,46
	0%	0%	0%	53,85%	46,15%		
C. The results were easy to understand.	0	0	0	5	8	13	4,62
	0%	0%	0%	38,46%	61,54%		
D. The info about TMS provided in the end of the questionnaire was good.	0	0	2	6	5	13	4,23
	0%	0%	15,39%	46,15%	38,46%		
E. The questionnaire was informative.	0	0	0	7	6	13	4,46
	0%	0%	0%	53,85%	46,15%		
Total	0	0	2	28	35	65	4,51

The visual outlook of the questionnaire was suggested to be improved, especially the clarity of the results that the patient receives after completing the questionnaire. This recommendation was expected: the Webropol tool allows only few visual changes to the result page. Due to this reason the result page is not visually as clear as it was originally planned to be. Unfortunately, this aspect cannot be changed with this program.

One good recommendation was to add a year and a publisher into the information about the informational books. Now the feedback page only includes the name of the author and the name of the book. The books can be found with this information very easily, but of course more detail information makes finding the resources easier. In addition, few spelling mistakes were corrected from the result page.

The English questions were copied directly from the original questionnaire. The language skills of the participants were not considered, and it could be seen in the feedback from the questionnaire. There were some issues possibly related to the native language of the participant being other than English, i.e. some abbreviations and questions were found difficult to understand by some participants. Whether these comments were due to inadequate language skills or to the original English appearance of the questionnaire not being clear enough, the questions of questionnaire will not be changed due to the reasons a) and

b) explained earlier. These comments however point out the importance that the diagnostic questionnaire should be very clear and in the native language of the patient to avoid misunderstanding.

Some of the feedback was related to the setting of questions and answer options in the original version of the questionnaire. The questionnaire has been used for such a long time that probably these changes could have been made already if they had proven to be needed. The feedback included:

- good amount of questions: the questionnaire is not too long
- adding a “maybe” option in yes/no questions (though one participant commented that it is good that there are not too many options)
- adding a numerical answer scale to some questions and questions related to pain intensity

I personally would not recommend adding a numerical estimate to this questionnaire. At least the numerical measurement of pain is proven to be very difficult. For example, VAS-score (in a scale of 0-10) is often used in health care to measure pain. However, nowhere is defined what the numbers in the scale mean. I.e. what does number 3 mean in the scale? Or if number 10 is to mean the worst pain, how can the patient know if the pain he is experiencing is the worst it can be? (T. Ojala 2015, p. 115-116) In addition, the chronic pain patient can get used to the pain in such a way that estimating the pain intensity may be misleading. Asking about the overall functionality would better define the state of the patient.

Finnish TMS-questionnaire feedback

The feedback of the Finnish questionnaire concentrated on the accuracy of translations and language. Here are some examples of the comments.

One participant found the text “disclaimer” not so necessary and recommended that it could maybe be taken out. It is true that the word “disclaimer” is not often used in Finnish language and might give an untrustworthy impression to the person doing the questionnaire. However, if the “disclaimer” is taken out in the next version of this questionnaire, the text needs to be very clear that this test will not replace doctors’ evaluation and diagnosis.

A lot of feedback concentrated on translations. Question number two was translated grammatically incorrectly and should read i.e. *“Oletko mielestäsi vaativa itseäsi kohtaan, hyvin perinpohjainen, järjestelmällinen tai perfektionisti? Kannatko voimakasta vastuuta muista ihmisistä?”* to be correct. Into the Finnish version of question one there could be more specific translation including the *“onset of pain”*. Some more subtle translations issues and opinions were also presented in the feedback. To make the translations better,

counselling an interpreter familiar with medical terminology would probably be beneficial so that the content of the Finnish questions would match the English questions accurately enough leaving no room for personal interpretation.

Limitations

Only 14 people participated into testing the online questionnaire. Even though the number of participants was not great, it was considered to be enough for analysis. The feedback was profound and individual additional comments and suggestions were mostly in line with each other. In addition, it is notable that the participants of this study were mainly university researchers – so most probably highly educated people which may differ from the actual population of patients that might use this questionnaire in the future. Another limitation of this study was that the native language of the participants was not considered.

One limitation to be noticed is that the TMS-questionnaire in general assesses only the likelihood that *chronic pain* is due to TMS. There are other possible conditions that are possible TMS equivalents that the questionnaire does not assess.

Future of the questionnaire

The next step would be to perform the recommended changes to the questionnaire. Especially the translation of the Finnish version should be developed and consulting a medical professional and an interpreter could be beneficial. After this the online version could be tested with actual patients.

Notable is that this questionnaire is meant to be used along with the guidance of a medical professional or doctor who is familiar with TMS. If this questionnaire would be presented online one big problem would be how the patient could discuss with a medical professional about TMS diagnosis when the medical community largely lacks awareness of TMS. In case this questionnaire is to be put available online it would be important to a) present it in a reliable context supported by some major organization b) provide the patient with information where to find a TMS practitioner who could confirm the TMS diagnosis. The possible search terms (i.e. chronic pain, back pain, TMS, tension myositis syndrome, tension myoneural syndrome, the mindbody syndrome, psychophysiological disorder or other TMS equivalents) that would guide a patient with chronic pain to this questionnaire should be considered so that patients could find this questionnaire.

I would like to address that no questionnaire does not diminish the need for a deep discussion between the patient and the medical professional doing the diagnosis. The reasons for psychogenic pain (and also other type of chronic pain) may vary. In order to assess patients' susceptibility to TMS, a medical professional should be able to understand the patient as a person and pay attention what is going on in his life. This can only happen through a profound discussion with the patient.

5. DISCUSSION

What is known and what is not known about the TMS symptom induction

According to the information about TMS presented in this thesis the hypothesized process of TMS symptom induction is summarized in Figure 6.

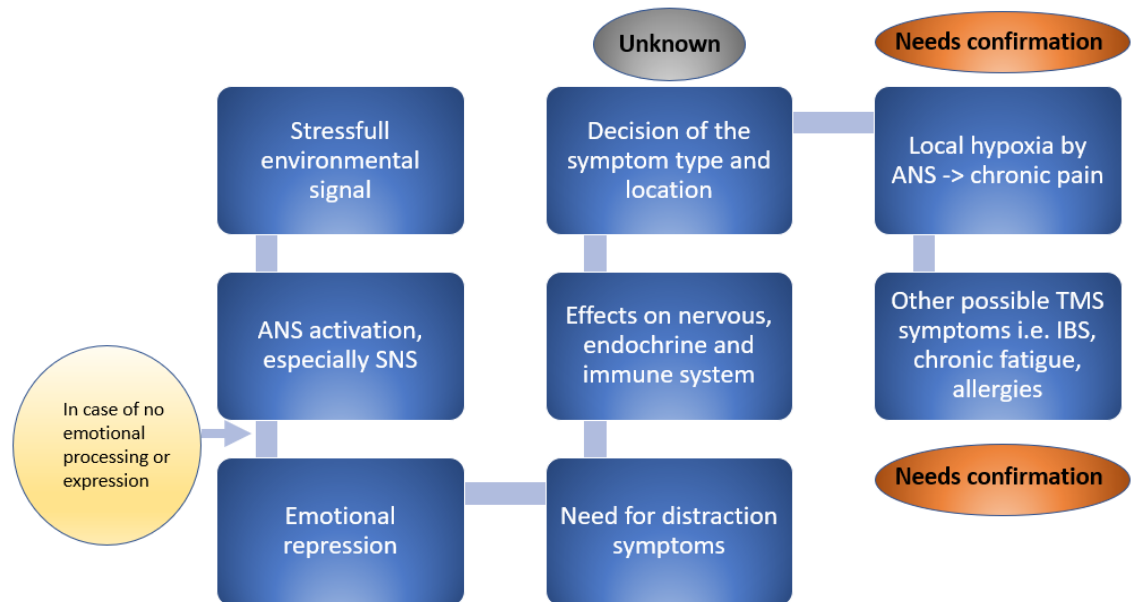


Figure 6. *What is known and what is not known about the TMS symptom induction.*

TMS symptoms start with an environmental signal that is considered to be stressful by the brain. Same signal may not be stressful for everyone and the perceived threat value of a signal is much based on childhood experiences and learned behavior. In case the signal is perceived threatening it leads to ANS activation, in a stressful situation SNS activation specifically.

At this point there is a chance to either express the emotion or otherwise process it. Processing the emotion and dampening the stress producing effect of various environmental signals is usually the goal of journaling and psychotherapy. If the process of symptom induction is stopped here the process does not develop to the stage where TMS symptoms occur. In the prevention of TMS this is important to understand.

If the emotions are not adequately processed they become repressed. This is an unconscious process. If the reservoir of repressed feelings grows too large, even a minor stressor can be enough to initiate TMS symptoms. When the need for symptoms is “decided” there are changes in the nervous system and possibly in the endocrine and immune system as

well. It is not known how the type and location of symptoms is “decided”. If the symptoms are chronic pain they are likely to be caused by the ANS that causes local hypoxia and buildup of waste products which leads to pain in involved muscles, nerves and ligaments. In case of the involvement of endocrine and immune system possible symptoms generally include allergies, IBS and chronic fatigue, but the content of TMS equivalents still needs further study and confirmation.

Analysis of the healing process

Analysis of the proposed healing process according to the information presented in this thesis is shown in Figure 7.

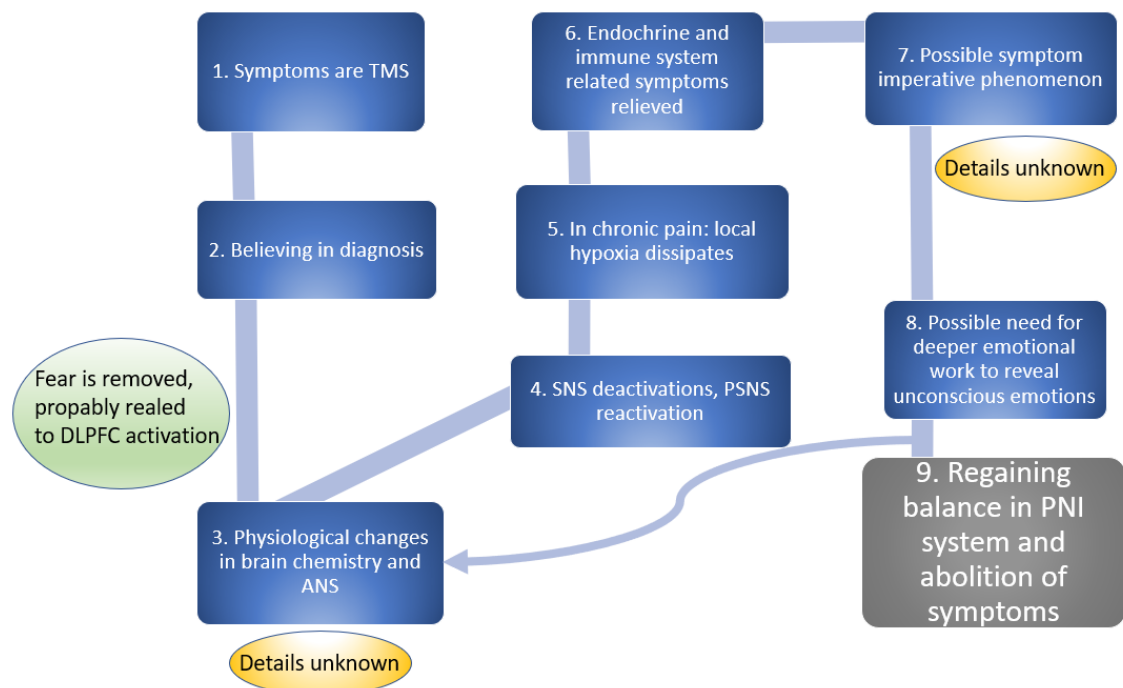


Figure 7. Analysis of the healing process.

The first part of the healing process is realizing that the symptoms are TMS. The patient needs to decide whether to believe in the diagnosis or not. If the patient stays doubtful, full recovery is not likely. N. Sachs (2016) encourages people to try journaling approach to their symptoms even if they still have doubt on the diagnosis - journaling may help to release repressed emotions, which leads to reduction of symptoms. Experiencing this change in symptoms can help the patient to achieve enough confidence in the diagnosis.

Developing belief in the diagnosis is important in recovery (M. Lumley et al. 2019b; H. Schubiner et al. 2012, p. 32, 70-71). It is thought that when the patient believes in the TMS-diagnosis the fear towards the symptoms and future dissipates. The details of this process are not known but it is likely that the DLPFC is related to this process by reducing the activation of ACC (H. Schubiner et al. 2012, p. 32, 70-71). Also, other physiological

changes in brain chemistry occur, though the details are still to be uncovered. ANS activation and especially the reactivation of PSNS follows from the changes in the brain. In case of chronic pain this leads to dissipation of local hypoxia and the pain is removed. In case of the involvement of endocrine and immune system the symptoms related to these systems are also relieved.

Sometimes the symptom imperative phenomenon occurs. Why this happens and how the brain “chooses” the new location of symptoms is yet to be discovered. It is thought that the reason for the existence of the symptom imperative phenomenon is that when the old “distraction technique” does not work but the patient still has strong emotions they need to be distracted from the brain creates symptoms in other location to keep the minds attention away from those emotions.

If the patient has strong emotions that require repression only education about the syndrome is not enough to abolish the symptoms. In this case deeper emotional work is needed i.e. in a form of journaling or psychotherapy. Finally, when repressed emotions are discovered and properly felt there is no need for the TMS symptoms and balance in the PNI-system can be restored and the symptoms disappear.

The role of inflammation

It is questionable whether inflammation is playing a part in TMS. Sarno (1991) says that there is no evidence of inflammation at least in back pain patients. Still steroidal and nonsteroidal medication is used to treat this condition. It is difficult to evaluate the efficacy of this medication because most of these drugs have analgesic effect too, but because there is no inflammation present in TMS patients it is most likely that the efficacy of these drugs is based on their analgesic abilities or placebo. Only steroids (cortisone drugs) seem to banish TMS symptoms temporarily. (J. Sarno 1991, p. 151-152)

Placebo and nocebo effect

Placebo is important factor to consider in this thesis because many treatments for chronic pain may seem successful or beneficial at first – until they after a while often fail to provide permanent pain relief. Also, when considering why TMS treatment works the possibility of placebo needs to be considered even though the permanent pain relief suggests that the main mechanism by which TMS treatment works is not placebo. (M. Lumley et al. 2019a) Nocebo is the opposite of placebo (B. Lipton 2015, p. 136; T. Ojala 2018, p. 30). Nocebo effect is important when explaining why many people do not heal or may even get worse if they are not expected to benefit from conventional treatment. The existence of placebo and nocebo effect also supports the fact that the brain can generate and modulate pain without or with little peripheral nociception (M. Lumley et al. 2019a).

Placebo effect can be considered as the "physiology of expectancy" (J. Deutsch et al. 2008, p. 88) and the word placebo comes from Latin and means "I will please" (S. Ozanich 2014, p. 136). For example, during World War II it was noted that even when the wounded soldiers got a saline injection instead of a morphine injection they experienced substantial pain relief if they believed they were getting morphine (J. Deutsch et al. 2008, p. 89).

There are many factors that contribute to the efficacy of placebo: does the patient believe that the therapy will help, what expectations do they have and patient's degree of susceptibility. Also, independently of the treatment or medication it has been noted that positive interaction with a person who reassures the patient that they will be well, listens to their problems and genuinely shows that they care and do their best to help the patient has been reported to mediate a subset of effects. (J. Deutsch et al. 2008, p. 89)

First evidence that biological process is responsible for placebo response was published in 1978 followed by a series of studies on placebo effect (J. Levine et al. 1978). In these studies, it was concluded that the body's pain suppression system could be induced by placebo. The same system could be blocked by an opioid receptor antagonist, naloxone, and in further studies it was suggested that a same opinegic mechanism might be shared by morphine and placebo. The analgesic effect was estimated to be equivalent to 4-6 mg of morphine. (J. Levine et al. 1981; J. Levine et al. 1984) Later studies showed that the expectations of analgesia activated central areas in the brain that are involved in the endogenous opioid transmission and analgesia, so the opioid system seems to be the most important biochemical mechanism in placebo induced analgesia. (K. Hall 2015) There is also evidence that there are nonopioid mechanisms included in placebo analgesia besides the opioid mechanisms. For example, the endocannabinoid system has been shown to play a role in placebo analgesia. (F. Benedetti et al. 2011)

Expectancy of benefit or reward might be important in the process mediating the placebo response and this theory was tested by examining the opioid and dopamine receptor activation in brain regions that are associated with reward. It was shown that these pathways were activated in the expectation of placebo response and in those persons with higher placebo responses a higher amount of dopamine receptors were activated. (K. Hall 2015)

Placebo effect may play a role in various treatments and in surgery (B. Moseley et al. 2002; I. Rashbaum et al. 2003). In a study of the effectiveness of arthroscopic knee surgery by B. Moseley et al. (2002) 180 patients with osteoarthritis in knee were divided into three groups. Two groups perceived either arthroscopic debridement or arthroscopic lavage and the third group received a sham surgery (placebo group). Interestingly during the follow up period (24 months) there was no difference between the groups that had gotten real surgery and placebo: there was equal amount of improvement in pain and function in all groups. (B. Moseley et al. 2002) J. Schofferman et al. (1992) discovered that childhood traumas greatly predicted the outcome of lumbar spine surgery. Patients with three or

more childhood traumas had an 85% probability to have an unsuccessful surgical outcome and 75% of patients with poor surgical outcome had an incidence of a childhood trauma. Conversely from 19 patients with no risk factors only 5% of surgeries were unsuccessful. (J. Schofferman et al. 1992) D. Cherkin et al. (1998) compared the efficacy of physical therapy, chiropractic manipulation and an educational booklet in the treatment of acute low back pain and found minimal to difference between these interventions. (D. Cherkin et al. 1998) Also, there is not significant difference between the surgical and nonoperative treatment approach of lumbar disk herniations (J. Weinstein et al. 2006) or in surgical treatment compared to cognitive interventions and exercises for low back pain and disc degeneration (J. Brox et al. 2003)

According to this knowledge and additional research (W. Peul et al. 2007; H. Österman et al. 2006) there is reason to believe that surgery might not be the optimal solution for chronic back pain. The placebo effect and symptom imperative may play a role in the disappearance of the back pain related to conventional treatment. Also, it is notable that surgery as a placebo also provides the patient an opportunity to momentarily escape his problems, job, spouse, kids etc. thus momentarily escape their tension filled lives that causes their back pain (S. Ozanich 2014, p. 138-139).

Nocebo effect is less known than placebo and comes from Latin words "I will harm" (S. Ozanich, p. 136). The suffering of a patient may increase by nocebo effect if a doctor (in his unsound belief) happens to tell a patient that he has a bad back, knee or shoulder or should not engage in some activities (T. Ojala 2018, p. 30; S. Ozanich 2014, p. 136-137; J. Sarno 1991, p. 26). Also J. Sarno (1998) believes that the chronic pain epidemic has a lot to do with the nocebo effect and TMS patients have reported that their symptoms have gotten worse when their symptoms have been attributed to imaging results by the practitioner (J. Sarno 1991, p. 63-65).

According to B. Lipton (2015) persons beliefs and perceptions control gene expression and thus their biology. So eventually placebo and nocebo effects are just that in the context of health care.

A good question to consider is that is TMS healing mediated by placebo effect? Placebo effect requires belief. In this light TMS healing could be considered as placebo because belief is needed to heal. According to D. Schechter (2014) belief can cause changes in the pre-frontal cortex (PFC) and anterior cingulate gyrus that are responsible for the attention paid for the pain (D. Schechter 2014, p. 35). However, the healing from TMS is permanent as with placebos the symptoms ultimately come back (or as symptom imperative phenomenon just change the location or type). In addition, TMS healing does not depend on any ritual, it is more about reflection and finding one's truths (S. Ozanich 2014, p. 143).

Obstacles in current treatment

The attitude towards treatment of chronic pain needs to change. T. Ojala (2018, translated from Finnish) says that: “*We need to accept the fact that there is no cure for chronic pain – though miracles can happen – but you can get along with the pain if you ignore it*”, “*...- no-one has been able to cure chronic pain –...*” and “*The meaning of chronic pain is unclear*” (T. Ojala 2018 p. 94, 170, 78). This clearly shows the predominant attitude and misperception that the current health care professionals have towards chronic pain. TMS theory explains why most of chronic pain exists and because the reason for the pain is known it can be cured.

Current treatment programs that are applied after a patient is diagnosed with TMS seem to be effective (A. Burger et al. 2016; M. Hsu et al. 2010; M. Lumley et al. 2017; D. Schechter et al. 2007). There are variety of options, but all of them have the same foundation and basic elements of education, overcoming the fear of physical activity and emotional awareness through journaling and/or psychotherapy. Because all the treatment programs share the same principles it is not so important which kind of treatment program the patient chooses. More important would be that the treatment would be supervised by a medical doctor or other TMS practitioner that could help the patient overcome possible obstacles in their recovery. Hopefully TMS will be studied more in the future so that major organizations can provide good guidelines for medical practitioners and patients. In Finland Käypä hoito-suositukset could possibly contain treatment recommendations for TMS in the future.

To support the TMS-treatment process the patient would need reliable information resources and materials about TMS. These do exist in English and translations are made in some other languages but for example in Finland there would be a huge need for education and self-care materials. One good possibility to enhance patient’s availability to information would be to develop education and self-care materials online, preferably with no charge for the patient to access with the support of some major organization in the patient’s own native language.

In the treatment of TMS the most important objective at the moment would be the ability of the doctors and other health care practitioners to be able to recognize if the patients’ symptoms are manifestations of TMS. This would require a systematic **training program** for medical practitioners. Too often a patient is misdiagnosed only because the physician is unaware of TMS and this often leads to unsuccessful treatment (M. Sopher 2013, p. 6). In addition, the general public is unaware of the existence of TMS. To change this and include TMS into the medical training of doctors would require a change in the way the human body is seen by the society: it should be considered as a psychophysical entity not as a mechanical bio machine. The way of thinking is slowly changing and hopefully TMS will soon be taught in medical schools.

Comparison to PMPs

PMPs include psychological approach to chronic pain that has similarities with TMS healing. For example, ACT and CBT do acknowledge the role of psychology and stress in the patients' pain and aims to increase patients' self-efficacy, self-regulation, reduce negative emotions and pain catastrophizing and support adaptive behavioral models. They do not however, consider that chronic pain is heterogenous: chronic pain that is TMS and thus CNS-based should be treated differently from peripheral pain (M. Lumley et al. 2019a). The interesting question arises that what part of the TMS healing program is crucial to the difference from PMPs to make the pain from management to complete healing.

The role of childhood trauma and psychological conflicts in chronic pain conditions is underappreciated and not well understood. In traditional psychological treatment of chronic pain, the target of the treatment is more in acceptance and management skills, not in the processing and understanding emotionally difficult life experiences. For example, in CBT the focus is in downregulation of negative emotions (i.e. through relaxation, pleasant activity engagement and cognitive reappraisal) not in targeting trauma, conflicts and life adversities that seem to be important factors in TMS induced pain. In TMS treatment the focus is in the emotional processing, awareness and expression. (M. Lumley et al. 2019a; M. Lumley et al. 2019b)

Social pain overlaps with physical pain

N. Eisenberger et al. (2004) propose the fact that social and physical pain overlap: if this is the case it is hypothesized that the sensitivity to one kind of pain enhances the sensitivity to other kind of pain and vice versa with the downregulation of pain. (N. Eisenberger et al. 2004) It is impossible to say but maybe similar brain processes take place when downregulating TMS pain through psychological interventions like education, journaling and psychotherapy that reduces stress and fear.

Primary care interventions

Recognition of the role of the mind in the physical wellbeing could possibly help patients early on in their treatment path. A lot of patients present to primary care with medically unexplained symptoms (D. Clarke 2016). As already mentioned in chapter 3.3, targeting stress and avoided emotions with a 90-minute life stress interview that encourages disclosure and emotional awareness improved physical pain for women with chronic urogenital pain (J. Carty et al. 2018). Also, a study by M. Ziadni et al. (2017) suggests that patients with medically unexplained symptoms could benefit from integration of a disclosure and emotional awareness and expression interview when they seek help in primary care (M. Ziadni et al. 2017).

Education of children as a prevention

Education of children to prevent TMS would be one of the future goals. The roots of TMS are often in childhood and in the upbringing of children. Teaching children how to react to pain and to teach children to see it as a warning that there are some emotional issues that need attention would probably reduce the probability for health problems and chronic pain in adulthood. (D. Schechter 2014, p. 54-56) In Finland the health education at schools could include education about how to recognize and process difficult emotions. Children should know that if feelings and emotions are not adequately processed they can manifest themselves as physical symptoms. This kind of education could prevent unnecessary suffering, improve life quality and produce saves in health care costs. An estimation of the amount of reduced costs is beyond the scope of this thesis but would probably be of great interest, especially among politicians deciding about health care.

Personal empowerment

Eventually TMS model emphasizes the role of personal empowerment. It is up to the patient whether they will accept the diagnosis and do the internal work needed for healing. The health care professionals can and should be supporting this healing journey. But they cannot do all the work for the patient and there is no magic pill that can be prescribed that would heal TMS. The personal responsibility and empowerment over health and healing of the patient is too often neglected in the context of conventional health care.

Future studies

There are multiple challenges in the field of TMS research. First a TMS study would require a complex setting and much more detail planning. Money, time and work is required to find, recruit and randomize patients and to diagnose, treat and follow their recovery. This differs a lot from a simple pharmaceutical study where two groups from which the other gets the active form of the drug and the other one inactive sham medication are compared with each other. Also, better infrastructure is needed to study TMS. (D. Schechter 2014, p. 183)

The effect of unconscious repressed emotions to health is difficult to study for the simple reason that the emotions involved in TMS are *unconscious* – they do not pop up in psychological questionnaires or interviews because people simply are not aware of them. To get the repressed emotions to arise into consciousness, a deeper talk or even psychotherapy is needed. This may take a lot of time. Thus, the studies that examine the connection between repressed emotions and disease need to be very carefully planned and prepared.

To study TMS the mind and body need to be studied together and cannot be separated. This creates a challenge for researchers. Also, very little is known about the brain and emotional processing. The physiological basis of emotions is still not well understood and progress in this field is needed.

The most important organ in TMS is the brain. An important part of future research would be understanding what is going on in the brain during TMS treatment and recovery. The functional MRI studies would probably be very useful in proving hypothesis and providing new knowledge. This could confirm how the brain actually causes chronic pain and that chronic pain is a learned unconscious response. In addition, the brain areas involved in the induction of TMS symptoms could be recognized and confirmed. Functional MRI studies could also help to understand the symptom imperative phenomenon and TMS equivalents.

Even though brain is very important in TMS, the human body is not only the brain and nervous system: they are just one part of the PNI-system. Even if it is possible that TMS might originate solely from the brain it should also be considered that other systems like the immune and endocrine system can be involved in TMS as well. The fact that supports this view is that many TMS practitioners agree that anxiety and depression, which are generally related into changes in brain chemistry, are TMS equivalents. Also, some patients have reported the disappearance of their seasonal allergies along with TMS treatment which could indicate that immune system is involved as well. Patients who suffer from fibromyalgia, have lower levels of growth hormone (GH), which would indicate the involvement of the endocrine system (R. Bennet 2002). Taken this information it would seem logical that the whole PNI-system is involved in TMS. Whether the disappearance of symptoms related to endocrine and immune system is a consequence of the changes in the nervous system or the other way around is not known. It is also possible that the whole PNI-system is working as an entity and it is not possible to say what is a cause and what a consequence. More research should be done in this field: what way are the endocrine and immune system involved in TMS? How are they related to the changes in the brain and nervous system that lead to TMS symptoms? Current evidence would seem to point to the direction that the chronic stress response and whole PNI-system is in various degrees involved in TMS.

There would be a great need for defining which symptoms and disorders are TMS; even among TMS experts and physicians the answers can vary. This is closely related to symptom imperative phenomenon and the moving of pain and changes in symptoms. Even more interesting would be to discover how the brain “chooses” the location of symptoms and how and why they move around? Hopefully, future MRI studies will help to answer these questions.

Evaluating and developing working guidelines and treatment recommendations would be needed. For this purpose, follow up studies and randomized controlled trials of chronic pain patients treated with TMS approach should be done. Thus, the effectivity of treatment and different treatment approaches could be evaluated more accurately. In addition, it is still unclear which part of the treatment makes the difference, though it would seem that all parts of the treatment (education, regaining physical activity and psychological insight) are often needed. When performing follow up studies it is needed to address that

according to current knowledge the acceptance and belief in the diagnosis is important in healing. In addition, if a person who has gone through a TMS-treatment program, through which they have developed a deeper awareness and understanding, it would be interesting to know if they are less prone to develop other chronic health conditions in the future.

Limitations of this thesis

Scientific research directly related to TMS is scarce. A lot of information presented in this thesis is based on observations recorded by individual TMS practitioners. There is no doubt that observations by individual practitioners can be questioned but taken the large amount of these observations and how they are in line with each other they could not have been neglected in this thesis without losing some value. The nature of the source materials was taken into account in this thesis: the materials were chosen very carefully, and the authors' backgrounds were evaluated before including their work into this thesis. The reader should keep in mind that the purpose of this thesis is just to provide an overview of the existing data available and present the current theories about TMS so that future studies could have better foundation where to start.

No major organization by far has accepted TMS as a valid diagnosis and TMS is missing from ICD10 (ICD10). In addition, the current cultural and social environment in science and health care does not support holistic view of the human and acknowledge the role of emotions in disease and illness enough. Acceptance of this kind of model takes time and some people may not be able to embrace the approach to chronic illness presented in this thesis. However, this thesis is not meant to anyway neglect the achievements of medicine based on the physiological approach of human body – on the contrary there is no question that it has helped millions of people.

TMS combines many fields of science. This makes it a large area to do research on. A multidisciplinary team would probably get a deeper look for many areas for which this thesis only provides an overview. Also because of the defined objects of this thesis some areas are discussed only superficially.

Recognition of mindbody connection

People, especially the scientific community and health care professionals, may need to ask themselves whether the view of the human body and health is missing a crucial component: the mind itself. I would like to address that biotechnological and medical progress is advantageous and irreplaceable for mankind. Modern medicine is very good at dealing with acute physical traumas – but too often we are looking to the wrong direction and missing the actual cause of many chronic symptoms and diseases. Currently medicine predominantly concentrates a lot on treating the symptoms even though many times the origin of the disease is not known. According to E. Davey (2016) *"Chronic pain is an area that does not sit well with a traditional dualist medical perspective"*. Even though the concept of the idea that psychological distress can cause physical symptoms is starting

to be more broadly accepted, the lack of scientific evidence and validity of mindbody treatments prevents applying this view adequately to chronic pain treatment. (E. Davey 2016) Ultimately, we live in a mindbody system: the mind, its reactions and the environment, plays an important role in health. It is time to recognize that and implement this concept to health care.

6. SUMMARY AND CONCLUSIONS

In this thesis the current knowledge and existing empirical and scientific data of TMS was presented. Chronic pain is a major health problem and traditional treatment options are failing to erase the problem. According to current knowledge it seems to be that a great deal of chronic pain could be due to TMS. Applying the TMS treatment model could help many patients who are struggling with chronic pain and some other chronic illnesses.

According to current knowledge TMS starts in the brain. The psychological process in the induction of TMS symptoms includes repressed emotions and the pain is thought to act as a distraction to prevent these uncomfortable feelings, especially anger, to rise into consciousness. In the biological perspective the ANS activation by these repressed feelings leads to vasoconstriction in the affected area which leads into hypoxia and buildup of waste products that causes the pain. Some theories emphasize the involvement of the brain and nervous system: central sensitization and the brain's ability to create pain. After all the pain experience is always created in the brain so neuroplasticity and learning are definitely involved in TMS. Empirical observations suggest that the endocrine and immune system may possibly be involved as well.

TMS treatment is based on learning and deconditioning. Because TMS originates from the brain the brain can learn not to cause pain. Education about the syndrome diminishes fear and deconditioning is important in regaining physical activity. In some cases, more profound psychological insight is needed to heal. To this purpose psychotherapy and journaling have been observed to be beneficial.

There are a lot of possible treatment options and information sources available. However, the predominant language that the educational and treatment materials are available is English. Thus, there is a huge need to develop and translate materials into other languages. For example, no profound TMS literature or treatment guidelines are available in Finnish. The other big problem with TMS treatment is the lack of educated health care professionals that could diagnose and treat TMS patients. To achieve this goal, support of the TMS approach from major organizations would be helpful.

The online questionnaire developed in this thesis can hopefully help in the diagnostic process. The results from testing the online questionnaire was that it is usable and can be made more user-friendly with minor adjustments. When testing the questionnaire, the native language of the participants was not considered which might have affected the results. Next step would be testing the online questionnaire with real patients. Possibly this questionnaire could someday be used to help with patients' risk assessment i.e. in a similar way that people can do online questionnaires that assess their risk for diabetes or

heart disease. It is notable that the questionnaire does not replace a diagnosis made by a medical practitioner.

Biotechnology approaches the human body from a very narrow point of view. Not that it would not have been beneficial: many new treatments are developed because of the advances in the field of tissue and molecular biology. The pathological approach has done a lot of good. However, this reductionistic approach that looks for a reason and a cure in the cellular and molecular level cannot be utilized in the study and treatment of TMS: a broader, more profound, holistic view of the human body is needed. TMS is not a pathological disorder, it is caused by reversible physiological changes in the brain and nerve pathways. (H. Schubiner et al. 2012, p. 8, 19)

Future research should concentrate on validating the mechanisms by which the brain causes TMS symptom. We know so little about brain and emotions, but current imaging techniques could help with that. Also randomized controlled trials should be performed to better evaluate the efficacy of TMS treatment.

The biggest limitation of this thesis was the availability of reliable materials and literature. There is limited amount of scientific research about TMS. Thus, also empirical observations based on carefully chosen TMS practitioners were included. It is good to note, that because many suggestions in this thesis are based on observations the results presented in this thesis could be considered as hypothetical. On the other hand, TMS is something that cannot be studied in the laboratory. In the past science (i.e. S. Freud's theories) were based on clinical observations. The TMS information presented in this thesis is based on large amounts of observations made by medical practitioners and even more patient testimonials exist. All these observations appeared to be in line and support each other and the TMS model. Thus, this data is worth to be considered as a reliable source of information.

Chronic pain presents a major health problem in today's society. I would like to address the fact that even though scientific research is important there already exists an effective treatment for chronic pain. Completing this research that reveals us the details of TMS may take decades. In the meanwhile, millions of people are suffering from chronic pain and related conditions because of missing information and the resistance to accept the mindbody approach to health and illness. TMS treatment seems very promising to chronic pain and has no side effects. In my opinion enough is known about TMS and its treatment so that the implementation process of TMS treatment could be started into public health care as a part of holistic care of the patients' health and wellbeing. Someday, hopefully, the mindbody approach to health could also be utilized as a part of preventive treatment, especially targeting children and their emotional development. In time, this could lead into huge improvements in public health and national wellbeing as well as to financial saves in the national level.

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APPENDIX A: BOOKS ABOUT TMS

Here are some helpful books for a TMS patient to read:

- John Sarno: Mind over Back Pain (1982)
- John Sarno: Healing Back Pain (1991)
- John Sarno: The Mindbody Prescription (1998)
- John Sarno: The Divided Mind (2006)
- Howard Schubiner: Unlearn Your Pain (2010)
- David Schechter: Think Away Your Pain (2014)
- Nicole Sachs: The Meaning of Truth (2016)
- Frances Sommer Anderson & Eric Sherman: Pathways to Pain Relief (2013)
- Marc Sopher: To Be or Not To Be... Pain-Free (2003)
- Steven Ozanich: The Great Pain Deception (2011)
- Nancy Selfridge & Franklynn Peterson: Freedom from Fibromyalgia (2001)
- Scott Brady: Pain Free for Life (2006)
- Fred Amir: Rapid Recovery From Back and Neck Pain (1999)
- Stephen Conenna: Use Your Mind to Heal Your Body (2013)

Dr. John Sarnos (MD) books, Mind over Back Pain (1982), Healing Back Pain (1991) and The Mindbody Prescription (1998), were the first TMS books available to general public. The first one, Mind over Back Pain introduces TMS and the successful treatment results by J. Sarno. Healing Back Pain also explains the theory for TMS and introduces an effective treatment approach. The Mindbody Prescription goes even deeper to the psychology behind chronic pain and introduces a variety of other health conditions that can possibly be psychological in origin. The Divided Mind (2006) adds some deeper background information not mentioned in the previous books and has few chapters written by other TMS physicians as well. From these books Healing Back Pain and The Mindbody Prescription would probably be the best ones to read for most patients: they are easy to read and to comprehend. Healing Back Pain is also available as an audiobook.

Howard Schubiners' (MD) book Unlearn Your Pain (2010) gives a very good introduction to TMS and how the mindbody symptoms are caused by learned nerve pathways and nerve sensitization. The book also contains a profound 28-day program for healing from TMS. This self-help program is very profound and is composed of education about TMS and emotions and writing exercises and journaling that will help the patient to recognize and become aware of repressed emotions. There is also a helpful CD with additional material included.

The book *Think Away Your Pain* (2014) by Dr. David Schechter (MD) introduces the reader to a current model and understanding of pain, teaches the reader about TMS, introduces profound scientific evidence about TMS and chronic pain. The book has a 12-step guide how to heal from TMS.

Nicole Sachs' (LCSW) book *The Meaning of Truth* (2016) concentrates on guiding the reader to understand and embrace their repressed emotions and how these emotions when not felt create chronic pain and illness. The book is a good guide how to start journaling and to safely release the repressed emotions. In the book Sachs also shares her own personal experience with chronic back pain and how she recovered from it as well as some examples of her patients.

Frances Sommer Anderson (PhD) and Eric Sherman (PsyD) are psychotherapists that have worked together with J. Sarno and treated patients with TMS. In their book *Pathways to Pain Relief* (2013) they describe case stories of different TMS patients. This book is special in a way that it really brings the psychological issues that can be the source of TMS into surface and may help a TMS patient to notice their repressed emotions as well.

Marc Sopher (MD) has written a book *To Be or Not To Be... Pain-Free* (2003). This book is excellent for basic information about TMS. The author especially introduces specific health conditions that are often misdiagnosed as something else than TMS.

The Great Pain Deception (2011) by Steven Ozanich (TMS Mindbody Health Consultant) describes the authors almost 30 yearlong battle with chronic pain and how he recovered from it. The book goes very detail to the process, life events and personality traits that can lead to TMS and to the possible roadblocks on the way to recovery. This book also describes TMS as a phenomenon.

Nancy Selfridge (MD) & Franklynn Peterson have written the book *Freedom From Fibromyalgia* (2001). The authors of this book have recovered from fibromyalgia by using J. Sarnos TMS healing approach. The book is specifically about fibromyalgia as a mind-body syndrome. The book contains a five-week program to heal fibromyalgia.

Pain Free for Life (2006) by Scott Brady (MD) introduces the authors treatment method for patients with chronic back pain and some other chronic conditions and explains a 6-week treatment program. The book concentrates much on why the understanding of emotions is so important in healing from TMS.

Rapid Recovery from Back and Neck Pain (1999) by Fred Amir introduces a program with nine key steps to help a TMS patient quickly recover. The book is part a treatment guide, part biography.

The book *Use Your Mind to Heal Your Body* (2013) written by Stephen Conenna, a former Dr. Sarnos patient, describes how he suffered from chronic pain and how he recovered from it by using TMS approach. The book gives a patient's perspective to TMS.

APPENDIX B: OTHER INFORMATION RESOURCES

More interactive treatment programs and other information resources about TMS:

- online programmes like
 - Dr. Howard Shubiner's Online Mind Body Program
 - Nicole Sachs, Freedom from Chronic Pain
 - TMS Wiki's Structured Educational Program
 - Alan Gordon's TMS Recovery Program (available in TMS wiki)
- websites
 - Psychophysiologic Disorder Association: ppdassociation.org
 - Dr. Howard Schubiner's website and Mind Body Program: unlearnyour-pain.com
 - The Pain Psychology Center: painpsychologycenter.com
 - Mindbody Medicine: mindbodymedicine.com
 - TMS-Wiki: tmswiki.org *
 - N. Sachs website The Cure For Chronic Pain and online program: thecureforchronicpain.com
- CDs and DVDs
 - Georgie Oldfield: SIRPA Recovery CD
 - David Schechter: The MindBody Audio Program. (MindBody Medicine Publications, Los Angeles, 2001)
 - The MindBody Patient Panel (D. Schechter)
- Podcasts
 - Nicole Sachs: The Cure for Chronic Pain Podcast
 - Katelyn Michals: Mindbody Mastery Podcast
- Others
 - Mind-body workbook by D. Schechter (1999)

* TMS wiki is maintained since 2009 by the nonprofit organization PPD/TMS Peer Network (PTPV) and contains resources and information about TMS that is available online. The website is for informational and support purposes and it does not provide diagnosis, treatment recommendations or medical advice. (TMS Wiki 2018)

APPENDIX C: ORIGINAL TMS QUESTIONNAIRE

The original TMS questionnaire is from D. Schechter et al. (2007).

The following questionnaire has been designed to assist you in evaluating the possibility of your having TMS. It cannot replace a detailed medical history, examination, and review of x-rays and MRI scans. Only a medical doctor with expertise in this condition should make the diagnosis of TMS following an examination in the office.

Please circle your responses and total your points below:

	Points
1. Have you noticed a relationship between your pain and your emotional state/stress level just prior to the onset of pain?	Definitely 2 At times 1 Not really 0
2. Would you describe yourself in general as: very hard on yourself, highly responsible for others, very thorough, orderly, or perfectionistic?	Definitely 2 I've noticed some of these characteristics 1 Not really 0
3. Have you suffered from other tension-related illnesses such as:	Definitely, two or more categories 2 Yes, at least one 1 No 0
<ul style="list-style-type: none"> • hives, eczema, rashes brought on by tension • spastic colon, irritable bowel, gastritis, reflux/heartburn • tension or migraine headaches • unexplained prostate trouble or pelvic pain • TMJ, teeth grinding, plantar warts 	
4. Have you been told regarding the cause of your pain that "there's nothing that can be done surgically," "there's nothing wrong," "it's a soft issue problem," or "the cause is degenerative changes"?	Yes 1 No 0
5. Do you spend a fair amount of time during the day thinking and worrying about your pain, researching an answer, obsessing about its cause?	Yes 1 No 0
6. Have you tried several different treatments or approaches for your pain and received only temporary or limited relief from each of them?	Yes 1 No 0
7. Do you find that massage helps your pain significantly or that you are quite sensitive to massage in several parts of your back or neck?	Yes 1 No 0
Key to total points:	
Highly probable for TMS	7-10 points
Possibly TMS	4-6 points
Probably not TMS	0-3 points
Total Points: _____	
Additional Questions (don't score these):	
8. Does the pain ever move to another location in your body or jump around?	___ yes ___ no
9. Have you noticed the pain improve when you have another tension-related illness?	___ yes ___ no
10. Has the pain significantly changed or gone away while you're on vacation, away from home, or while distracted?	___ yes ___ no

FIGURE Tension Myositis Syndrome Questionnaire

APPENDIX D: ONLINE TMS QUESTIONNAIRE

The TMS questionnaire online version in English and in Finnish.

TMS questionnaire

Tension myoneural syndrome (TMS) is a syndrome that was firstly discussed to be responsible for back pain and other unexplained chronic pain conditions. TMS refers to a collection of symptoms and disorders that are psychological in origin. This questionnaire will help you to assess whether your pain could be due to TMS.

Disclaimer: This questionnaire is not meant to replace a diagnosis made by a medical practitioner and it cannot replace a detailed medical history, examination and review of x-rays and MRI scans. You should always discuss the diagnosis with your medical doctor.

1. Have you noticed a relationship between your pain and your emotional state/stress level just prior to the onset of pain? *

- Definitely
- At times
- Not really

2. Would you describe yourself in general as very hard on yourself, highly responsible for others, very thorough, orderly or perfectionistic? *

- Definitely
- I've noticed some of these characteristics
- Not really

3. Have you suffered from other tension-related illnesses such as:

- hives, eczema, rashes brought on by tension
- spastic colon, irritable bowel, gastritis, reflux/heartburn
- tension or migraine headaches
- unexplained prostate trouble or pelvic pain
- TMJ, teeth grinding, plantar warts

*

- Definitely, two or more categories
- Yes, at least one
- No

4. Have you been told regarding the cause of your pain that

- "there's nothing that can be done surgically",
- "there's nothing wrong",
- "it's a soft tissue problem", or
- "the cause is degenerative changes"?

*

- Yes
- No

5. Do you spend a fair amount of time during the day thinking and worrying about your pain, researching an answer, obsessing about its cause? *

- Yes
- No

6. Have you tried several different treatments or approaches for your pain and received only temporary or limited relief from each of them? *

- Yes
- No

7. Do you find that massage helps your pain significantly or that you are quite sensitive to massage in several parts of your back or neck? *

- Yes
- No

8. Does the pain ever move to another location in your body or jump around? *

- Yes
 No

9. Have you noticed the pain improve when you have another tension related illness? *

- Yes
 No

10. Has the pain significantly changed or gone away while you're on vacation, away from home, or while distracted? *

- Yes
 No

TMS-kysely

TMS-oireyhtymä diagnosoituna on alun perin kehittynyt selkävaurion ja muiden kroonisten kipujen tarkastelun yhteydessä. TMS on kokoelma oireita, joiden taustalla ovat psykologiset syyt. Tämän kyselyn tarkoituksena on auttaa arvioimaan, johtuvatko kipuoireesi mahdollisesti TMS-oireyhtymästä.

Vastuunvapausero: Tämän kyselyn tarkoituksena ei ole korvata lääkärin tekemää arviota taikka muita lääkärin tekemiä tutkimuksia ja kuvauksia. TMS-diagnoosista tulee aina keskustella lääkärin kanssa.

1. Oletko huomannut ajallista yhteyttä kipujesi ja tunnetilasi tai stressitasosi välillä? *

- Ehdottomasti
 Ajoittain
 En oikeastaan

2. Oletko mielestäsi vaativa itseäsi kohtaan, kannat voimakasta vastuuta muista ihmisistä, hyvin perinpohjainen, järjestelmällinen tai perfektionisti? *

- Ehdottomasti
 Olen huomannut joitakin näistä piirteistä itsessäni
 En oikeastaan

3. Oletko kärsinyt joistakin stressiin liittyvistä sairauksista kuten esimerkiksi:

- nokkosihottumasta, atooppisesta ihottumasta tai stressiin liittyvästä ihottumasta
- ärtyvän suolen oireyhtymästä, mahakataarrista, närästyksestä
- jännityspäänsärystä tai migreenistä
- selittämättömistä eturauhasvaivoista tai lantion alueen kivuista
- purentaelimistön toimintahäiriöistä, hampaiden narskuttelusta, jalkapohjan syyliästä

*

- Ehdottomasti, kahdesta tai useammasta
 Kyllä, ainakin yhdestä
 En

4. Onko sinulle sanottu kivustasi esimerkiksi, että

- "sille ei voida kirurgisesti tehdä mitään",
- "mitään ei ole vialla",
- "se on tavallista lihas- tai nivelkipua" tai
- "syynä ovat rappeutumisen aiheuttamat muutokset"?

*

- Kyllä
 Ei

5. Käytätkö paljon aikaa päivästäsi miettien ja murehtien kipuasi sekä etsien ahdistuneena niiden aiheuttajaa? *

- Kyllä
 En

6. Oletko yrittänyt useita eri hoitovaihtoehtoja kipuusi ja saanut niistä vain hetkellistä tai osittaista helpotusta? *

- Kyllä
 En

7. Oletko huomannut joko hieronnan merkittävästi helpottavan kipuasi TAI oletko hyvin herkkä kosketukselle ja hieronnalle useasta kohtaa selän ja niskan alueella? *

- Kyllä
 En

8. Siirtykö kipusi koskaan toiseen kohtaan kehoasi tai liikkuuko se jatkuvasti paikasta toiseen? *

- Kyllä
 Ei

9. Oletko huomannut kipujesi vähentyvän jonkin toisen stressiin/jännitykseen liittyvän vaivan yhteydessä? *

- Kyllä
 En

10. Onko kipusi helpottunut tai kokonaan kadonnut kun olet ollut lomalla, poissa kotoa tai keskittynyt johonkin muuhun asiaan? *

- Kyllä
 Ei

Lähetä

APPENDIX E: THE RESULT PAGE OF THE QUESTIONNAIRE

The result page in English and in Finnish with example answers.

TMS questionnaire

Answer Time 7.5.2019 15:55:51

Points: 6

Maximum points: 10

Here is a summary of your results. According to your score you can see whether it is likely that your pain is due to TMS.

7-10 p: Highly probable for TMS

It is highly probable that you have TMS. What this means is that your pain is most likely psychological in origin, not structural. TMS is a benign disorder and it is curable so if you have TMS it is very likely that you will make a full recovery. However before starting TMS treatment be sure to affirm the diagnosis with your medical doctor and make sure that nothing malignant is going on.

4-6 p OR you answered "yes" to any of the questions 8-10 (last three questions): Possibly TMS

It is possible that your pain is due to TMS. What this means is that your pain might be psychological in origin. Discuss the possible TMS diagnosis with your medical doctor to make sure whether your pain is due to TMS or another reason. TMS is a benign disorder and it is curable so if you have TMS it is very likely that you will make a full recovery.

0-3 p: Probably not TMS

You probably do not have TMS. If you have doubt about your diagnosis discuss it with a medical practitioner.

Additional information about TMS

Here are some beneficial links to webpages where you can find more info about TMS and its treatment:

- Psychophysiologic Disorder Association: <https://ppdassociation.org/patient>
- MindBody Solutions to Pain: <https://www.mindbodymedicine.com/>
- The Cure for Chronic Pain: <https://www.thecureforchronicpain.com/>
- TMS wiki: [https://www.tmswiki.org/ppd/An_Introduction_to_Tension_Myositis_Syndrome_\(TMS\)](https://www.tmswiki.org/ppd/An_Introduction_to_Tension_Myositis_Syndrome_(TMS))

Books about TMS:

- J. Sarno, Healing Back Pain
- D. Schechter, Think Away Your Pain
- N. Sachs, The Meaning of Truth
- H. Schubiner and M. Betzold, Unlearn Your Pain

Have you noticed a relationship between your pain and your emotional state/stress level just prior to the onset of pain?

Points: 2

Maximum points: 2

Answer option	Answer
Definitely	<input checked="" type="radio"/>
At times	<input type="radio"/>
Not really	<input type="radio"/>

Would you describe yourself in general as very hard on yourself, highly responsible for others, very thorough, orderly or perfectionistic?

Points: 1

Maximum points: 2

Answer option	Answer
Definitely	<input type="radio"/>
I've noticed some of these characteristics	<input checked="" type="radio"/>
Not really	<input type="radio"/>

Have you suffered from other tension-related illnesses such as: hives, eczema, rashes brought on by tension spastic colon, irritable bowel, gastritis, reflux/heartburn tension or migraine headaches unexplained prostate trouble or pelvic pain TMJ, teeth grinding, plantar warts

Points: 1
Maximum points: 2

Answer option	Answer
Definitely, two or more categories	<input type="radio"/>
Yes, at least one	<input checked="" type="radio"/>
No	<input type="radio"/>

Have you been told regarding the cause of your pain that "there's nothing that can be done surgically", "there's nothing wrong", "it's a soft tissue problem", or "the cause is degenerative changes"?

Points: 1
Maximum points: 1

Answer option	Answer
Yes	<input checked="" type="radio"/>
No	<input type="radio"/>

Do you spend a fair amount of time during the day thinking and worrying about your pain, researching an answer, obsessing about its cause?

Points: 0
Maximum points: 1

Answer option	Answer
Yes	<input type="radio"/>
No	<input checked="" type="radio"/>

Have you tried several different treatments or approaches for your pain and received only temporary or limited relief from each of them?

Points: 1
Maximum points: 1

Answer option	Answer
Yes	<input checked="" type="radio"/>
No	<input type="radio"/>

Do you find that massage helps your pain significantly or that you are quite sensitive to massage in several parts of your back or neck?

Points: 0
Maximum points: 1

Answer option	Answer
Yes	<input type="radio"/>
No	<input checked="" type="radio"/>

Does the pain ever move to another location in your body or jump around?

Points: 0
Maximum points: 0

Answer option	Answer
Yes	<input checked="" type="radio"/>
No	<input type="radio"/>

Have you noticed the pain improve when you have another tension related illness?

Points: 0
Maximum points: 0

Answer option	Answer
Yes	<input checked="" type="radio"/>
No	<input type="radio"/>

Has the pain significantly changed or gone away while you're on vacation, away from home, or while distracted?

Points: 0
Maximum points: 0

Answer option	Answer
Yes	<input type="radio"/>
No	<input checked="" type="radio"/>



[Print](#)

[Edit answers](#)

[Finish](#)

TMS-kysely

Vastausaika 7.5.2019 16:09:13

Pisteet: 2

Maksimipisteet: 10

7-10 pistettä: Hyvin todennäköisesti TMS

On hyvin todennäköistä, että sinulla on TMS-oireyhtymä. Tämä tarkoittaa, että on hyvin todennäköistä, että kipuoireesi taustalla ovat psykologiset syyt, eivät rakenteelliset tai fysiologiset syyt. TMS-oireyhtymä on vaaraton ja parannettavissa oleva, joten on hyvin todennäköistä, että paranet täysin. On kuitenkin tärkeää, että varmistat TMS-diagnoosin lääkäriltäsi ennen kuin aloitat TMS hoito-ohjelman varmistaaksesi, ettei kipujesi takana ole mitään vakavampaa sairautta.

4-6 pistettä tai vastasit "kyllä" vähintään yhteen kysymyksistä 8-10: Mahdollisesti TMS

On mahdollista, että kipusi johtuvat TMS-oireyhtymästä. Tämä tarkoittaa, että kipusi taustalla on mahdollisesti psykologisia syitä. Keskustele lääkärisi kanssa johtuvatko kipusi TMS-oireyhtymästä vai jostain muusta. TMS-oireyhtymä on vaaraton ja parannettavissa oleva, joten on hyvin todennäköistä, että paranet täysin.

0-3 pistettä: Todennäköisesti ei TMS

Todennäköisesti sinulla ei ole TMS-oireyhtymää. Jos kuitenkin epäilet diagnoosia, keskustele siitä lääkärisi kanssa.

Lisätietoa: Valitettavasti suomenkielistä materiaalia ei TMS-oireyhtymästä ole saatavilla, mutta seuraavista englanninkielisistä lähteistä löytyy lisää tietoa TMS-oireyhtymästä ja sen hoidosta:

- Psychophysiologic Disorder Association: <https://ppdassociation.org/patient>
- MindBody Solutions to Pain: <https://www.mindbodymedicine.com/>
- The Cure for Chronic Pain: <https://www.thecureforchronicpain.com/>
- TMS wiki: [https://www.tmswiki.org/ppd/An_Introduction_to_Tension_Myositis_Syndrome_\(TMS\)](https://www.tmswiki.org/ppd/An_Introduction_to_Tension_Myositis_Syndrome_(TMS))

Hyödyllisiä kirjoja:

- J. Sarno, Healing Back Pain
- D. Schechter, Think Away Your Pain
- N. Sachs, The Meaning of Truth
- H. Schubiner and M. Betzold, Unlearn Your Pain

Oletko huomannut ajallista yhteyttä kipujesi ja tunnetilasi tai stressitasosi välillä?

Pisteet: 0

Maksimipisteet: 2

Vastausvaihtoehto	Vastaus
Ehdottomasti	<input type="radio"/>
Ajoittain	<input type="radio"/>
En oikeastaan	<input checked="" type="radio"/>

Oletko mielestäsi vaativa itseäsi kohtaan, kannat voimakasta vastuuta muista ihmisistä, hyvin perinpohjainen, järjestelmällinen tai perfektionisti?

Pisteet: 0

Maksimipisteet: 2

Vastausvaihtoehto	Vastaus
Ehdottomasti	<input type="radio"/>
Olen huomannut joitakin näistä piirteistä itsessäni	<input type="radio"/>
En oikeastaan	<input checked="" type="radio"/>

3. Oletko kärsinyt joistakin stressiin liittyvistä sairauksista kuten esimerkiksi: nokkosihottumasta, atooppisesta ihottumasta tai stressiin liittyvästä ihottumasta ärtyvän suolen oireyhtymästä, mahakataarrista, närästyksestä jännityspäänsärystä tai migreenistä selittämättömistä eturauhasvaivoista tai lantionalueen kivuista purentaelimistön toimintahäiriöistä, hampaiden narskuttelusta, jalkapohjan syylistä

Pisteet: 1
Maksimipisteet: 2

Vastausvaihtoehto	Vastaus
Ehdottomasti, kahdesta tai useammasta	<input type="radio"/>
Kyllä, ainakin yhdestä	<input checked="" type="radio"/>
En	<input type="radio"/>

Onko sinulle sanottu kivustasi esimerkiksi, että "sille ei voida kirurgisesti tehdä mitään", "mitään ei ole vialla", "se on tavallista lihas- tai nivelkipua" tai "syynä ovat rappeutumisen aiheuttamat muutokset"?

Pisteet: 0
Maksimipisteet: 1

Vastausvaihtoehto	Vastaus
Kyllä	<input type="radio"/>
Ei	<input checked="" type="radio"/>

Käytätkö paljon aikaa päivästäsi miettien ja murehtien kipuasi sekä etsien ahdistuneena niiden aiheuttajaa?

Pisteet: 0
Maksimipisteet: 1

Vastausvaihtoehto	Vastaus
Kyllä	<input type="radio"/>
En	<input checked="" type="radio"/>

Oletko yrittänyt useita eri hoitovaihtoehtoja kipuusi ja saanut niistä vain hetkellistä tai osittaista helpotusta?

Pisteet: 0
Maksimipisteet: 1

Vastausvaihtoehto	Vastaus
Kyllä	<input type="radio"/>
En	<input checked="" type="radio"/>

Oletko huomannut joko hieronnan merkittävästi helpottavan kipuasi TAI oletko hyvin herkkä kosketukselle ja hieronnalle useasta kohtaa selän ja niskan alueella?

Pisteet: 1
Maksimipisteet: 1

Vastausvaihtoehto	Vastaus
Kyllä	<input checked="" type="radio"/>
En	<input type="radio"/>

Siirtykö kipusi koskaan toiseen kohtaan kehoasi tai liikkuuko se jatkuvasti paikasta toiseen?

Pisteet: 0

Maksimipisteet: 0

Vastausvaihtoehto	Vastaus
Kyllä	<input checked="" type="radio"/>
Ei	<input type="radio"/>

Oletko huomannut kipujesi vähentyvän jonkin toisen stressiin/jännitykseen liittyvän vaivan yhteydessä?

Pisteet: 0

Maksimipisteet: 0

Vastausvaihtoehto	Vastaus
Kyllä	<input type="radio"/>
En	<input checked="" type="radio"/>

Onko kipusi helpottunut tai kokonaan kadonnut kun olet ollut lomalla, poissa kotoa tai keskittynyt johonkin muuhun asiaan?

Pisteet: 0

Maksimipisteet: 0

Vastausvaihtoehto	Vastaus
Kyllä	<input checked="" type="radio"/>
Ei	<input type="radio"/>



[Tulosta](#)

[Muokkaa vastauksia](#)

Valmis

APPENDIX F: FEEDBACK FROM TMS QUESTIONNAIRE

Feedback form from TMS questionnaire.

Feedback from TMS questionnaire

This feedback is designed to assess your experience about the TMS questionnaire you just filled. If you need please feel free to see the whole questionnaire that is added to the e-mail you got earlier. Your answers to this feedback will stay anonymous.

1. Age: *

- under 20
- 20-29
- 30-39
- 40-49
- 50-59
- 60-69
- over 70

2. Gender: *

- Female
- Male

3. I was familiar with Tension Myoneural Syndrome (TMS) before doing this questionnaire. *

- Yes
- No

4. Choose the option that best describes your opinion. *

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
A. The questionnaire was easy to use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
B. The questions were easy to understand.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C. The results were easy to understand.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
D. The info about TMS provided in the end of the questionnaire was good.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
E. The questionnaire was informative.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Would you propose some changes to the questionnaire? If yes, then what could it be? *

- Yes
- No

6. Any other comments or suggestions?

7. If you did both the Finnish and English questionnaire, please answer also the following question.

Did you notice any significant differences between the Finnish and English versions? If yes, then what?

- Yes
- No