Changes in the Complexity of Chronic Pain and the Effectiveness of Acceptance and

Commitment Therapy for Patients with (Complex) Chronic Pain

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Abstract

Chronic pain (CP) is highly associated with anxiety, depression and low mental health (MH) indicating a psychologically complexity that needs to be treated accordingly. ACT for CP increases psychological flexibility (PF) enabling patients to live fully in the presence of pain and decreases the impact of pain on their life. The present study investigates changes in complexity of CP from 2012 until 2019, the effectiveness of ACT on increasing PF and MH, decreasing depression, anxiety and pain-related disability (PRD) and changes in effectiveness due to an increased psychological complexity of CP. A total of 3115 participants suffering from CP following a treatment at the Roessingh Center for Rehabilitation with an age ranging from 18 to 83 participated in the study. The treatment is ACT-based within a multidisciplinary team including services from different healthcare providers for six weeks up to six months. Statistical methods included Kruskal Wallis', Wilcoxon Signed Ranks' test and Spearman correlations to test significant changes in psychological complexity of CP and the effectiveness of ACT. Psychological complexity of CP increased within the past eight years regarding the deterioration of anxiety, depression, PDI, PF and MH. ACT has a moderate effect on increasing PF, an nearly moderate effect on decreasing anxiety and depression, low effect on decreasing PDI and increasing MH. There is a slight decrease in effectiveness of ACT in increasing PF and an increase in effectiveness in improving PRD from 2013 until 2018. Future studies should investigate the mediating function of PF on depression, anxiety and MH. It is advised to integrate ACT or at least any psychological treatment to the treatment of CP since psychological symptoms are evidently present and need to be treated accordingly.

Keywords: ACT, psychological complex chronic pain, treatment effectiveness

Effectiveness of the Acceptance and Commitment Therapy (ACT) for Patients with

(Psychological Complex) Chronic Pain

Introduction

Chronic pain is defined as "pain that lasts longer than six months and is independent of the initial injury or illness that led to the pain" and has a prevalence rate ranging from 12% up to 30% in Europe, with a prevalence of 18% in the Netherlands (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006). Approximately 21% experienced pain for longer than 20 years, which has a severe impact on the patient's behaviour, social life, emotions, thoughts and physical functioning. Patients suffering from chronic pain report impairments in participating in various activities such as sleeping, work, social activities or household chores. Among the individuals experiencing chronic pain, 25% report difficulties in maintaining sexual or family relationships. Due to their suffering and impairment in functionality, 19% lost their jobs (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006). The most common chronic pain conditions worldwide are headache, back or neck pain, arthritis and joint pain (Tsang et al., 2008).

The Biomedical Perspective on Chronic Pain

According to the neurophysiological model of pain, one has to differentiate between the dimensions of nociception and pain perception to understand pain. The first dimension, nociception, is the physiological activation of sensory transmission of stimulus information

through the nerves. The second dimension, pain perception, refers to the modulated result of neurophysiological processes and requires conscious awareness of an individual. Therefore, the neurophysiological model of pain puts an emphasis on the biological origin of pain.

Based on this perspective, the biomedical model of pain supports using biomedical treatment such as pharmacological treatment with analgesics such as opioids and co-analgesics like antidepressants and anticonvulsants, focusing on the somatic aspect of pain and therefore on eliminating the pain (Center, 2011). Unfortunately, the biomedical treatment options are incapable to ultimately resolve, diminish or eliminate the symptoms of pain (Turk, Wilson, & Cahana, 2011). Due to ineffectiveness and long-term harm as a consequence, patients are encouraged to reduce their use of analgesics (McCracken & Vowles, 2009).

The study of Breivik et al. (2006) shows that only 38% of the respondents that had non-pharmacological treatments, such as counseling, the use of herbal supplements, relaxation, nerve stimulation, exercise, acupuncture, physical therapy or massages experienced their treatment as extremely or very helpful. Strikingly, regarding the execution of the treatment and treatment satisfaction, only 2% of the chronic pain patients were seeing a pain specialist and almost 70% were treated by a general practitioner, whilst 56% of the chronic pain patients in the Netherlands feel inadequately treated (Breivik et al., 2006).

Chronic Pain and its Relation to the Psychological Learning Theory

Based on the issue that chronic pain is present in patients despite the absence of somatic pathology, the Fear Avoidance model aims to explain how individuals develop chronic pain by avoidance behaviour based on fear. It aims to describe the possible vicious cycle of chronic

disability and suffering as a result of experiencing acute pain (Crombez, Eccelston, Damme, Vlaeyen, & Karoly, 2012; Hasenbring & Verbunt, 2010).

According to the Fear Avoidance model, ruminative, thus exaggerated negative thoughts, are a response to pain from pain sufferers. As a result of these cognitions, emotions such as fear of movement or fear of reinjury occur which lead to avoidance behaviour. The model addresses the relevance of emotions in the treatment of chronic pain to break the vicious cycle of pain catastrophizing, fear, behavioural avoidance and inactivity (Crombez et al. 2012). The Avoidance Endurance model of chronic pain extends the Fear Avoidance model, supposing that pain sufferers that engaging in distress response to pain with thought suppression, anxiety, depression and task persistence leads to entering a vicious negative learning cycle that prolongs their pain-related impairment in their daily life. Both models address the importance of psychopathological responses to pain explaining the psychological complexity of chronic pain.

Both models are based on operant and classical conditioning. Pain is associated with a high threat leading to a high priority given to pain control. This leads to fear, avoidance and a series of events that promote the chronification of pain. The underlying classical conditioning is based on interpreting pain with neutral clues and therefore acting as a conditioned stimulus (CS) which results in a conditioned response (CR), such as fear, avoidance or safety-seeking behaviour. Consequently, chronic pain develops based on pain-related fear and avoidance behaviour that is promoted due to operant conditioning based on positive reinforcement (Meulders, Vansteenwegen, & Vlaeyen, 2011). These aspects need to be kept in mind to enable a proper treatment for patients with chronic pain. The models are combined in Figure 1.
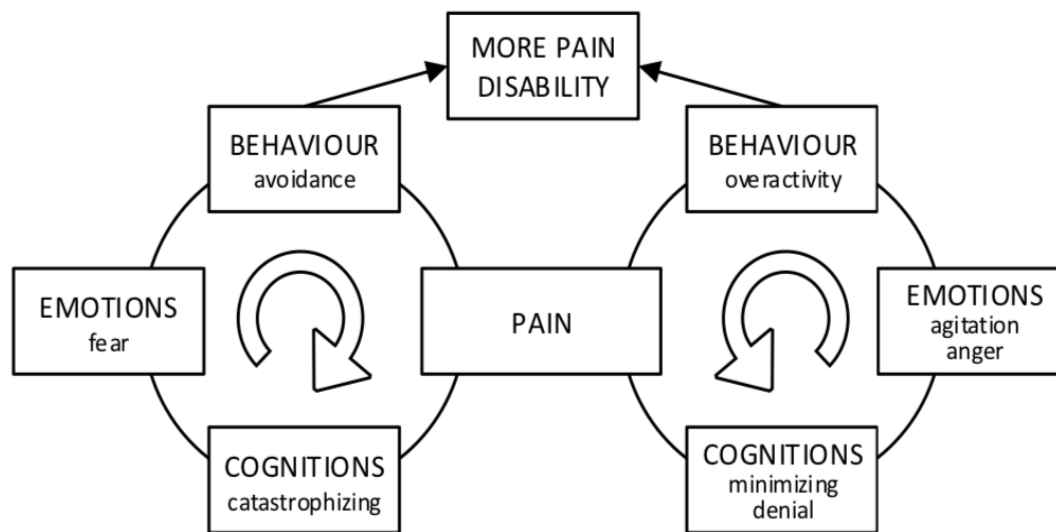
Figure 1. Fear Avoidance model and avoidance Endurance model combined. From "Chronische pijn en toch vitaal. Een uitdaging voor de patiënt en de gezondheidszorg." by Schreurs, K. M. G., 2013.

These two models indicate that chronic pain is more than just a somatic problem. It includes conditioned and operant learning and consequently psychological aspects. Therefore, a biological or medical focus on chronic pain does not fully explain chronic pain and cannot be the basis of a successful treatment for chronic pain patients. This is a first indication that a psychological treatment is necessary to help chronic pain patients effectively.

The Biopsychosocial Perspective on Chronic Pain

In 1977 the pathologist and psychiatrist Engel introduced the biopsychosocial model. The model focuses on how individuals live with and respond to chronic pain in contrast to the biomedical model which emphasizes the impairment of the body due to pathology. The

biopsychosocial model includes biological, psychological and social aspects of the experience of pain. Engel (1977) proposed a conceptual model of illness that suggested a progression from a physical problem to distress, resulting in illness behaviour and finally leading to an adoption of a sick role (see Figure 2). The sick role incorporates impaired biological, psychological and social components.This role is prominent in cultural aspects and social interaction (Bevers, Watts, Kishino, & Gatchel, 2016).

As already described, patients suffering from chronic pain report difficulties in maintaining relationships, decreased mental health as well as pain as part of physical health. Therefore, the biopsychosocial model fully integrates several challenging and impaired factors of functioning present in patients with chronic pain. As Biderman, Yeheskel, and Herman (2005), the biopsychosocial model is still relevant today. Since the model addresses the patient's individuality, it is still a highly relevant model in the patient-centered health care. According to Biderman et al. (2005) there is an increased sophistication of the biopsychosocial model within the past decades. In addition, Wade and Halligan (2017) also report growing uptake by medical specialities with regards to integrating the model to chronic health interventions among others. The authors report evidence of the effectiveness of the model supporting its validity as a powerful tool in health care.

Figure 2. Biopsychosocial view of chronic pain by Engel (1977).

This model gives a first indication for the psychological complexity of chronic pain. It indicates that patients suffering from chronic pain are challenged by more factors than the presence of pain. Therefore, it is concluded that chronic pain is a psychological complex disease that requires more than a treatment eliminating the presence of pain but also psychological support in order to improve deeper psychological aspects.

Chronic Pain and Psychopathological Comorbidities

In addition, research has revealed that within pain disorders psychiatric and medical pathologies interface prominently (Gatchel, 2004). Depressive disorders are related to an increase in physical symptoms as well as the intensity and number of physical symptoms increase the likelihood of an anxiety or depressive disorder (Gatchel, 2004; Kroenke, Spitzer, & Williams, 1994).

Tsang et al. (2008) found a comorbidity of chronic pain with depression and anxiety disorders. McWilliams, Goodwin, and Cox (2004) reported an association between anxiety disorders as well as depression and chronic pain, agreeing with the findings of Breivik et al. (2006) in which 21% of all european respondents reported an additional diagnosis with depression. Fishbain, Cutler, Rosomoff, and Rosomoff (1997) reviewed studies investigating the relationship of depression and chronic pain and found that depression is commonly a consequence of chronic pain, supporting the diathesis-stress model of psychiatric disorder onset due to chronic pain, indicating that chronic pain is a psychological complex chronic disease involving several aspects such as psychiatric comorbidities, social interaction and activities as well as physical and overall functioning that need to be treated accordingly (Breivik et al., 2006; Dersh, Polatin, & Gatchel, 2002; Peppin, Cheatle, Kirsh, & McCarberg, 2015). The presence of psychopathology is one indication of psychological complex chronic pain, which challenges the treatment since there are multiple factors influencing the patients' functionality (Dahan, 2014; Weisberg & Clavel, 1999). Based on the psychological complexity of chronic pain, i.e. the comorbidity of psychiatric disorders and influences of several other aspects, such as social interaction, a multidisciplinary team creating an individualized multidisciplinary treatment is required (Dahan, 2014; Weisberg & Clavel, 1999).

In 2017, Revalidatie Nederland published a report about future perspectives of rehabilitation in 2030 in the Netherlands. According to the organization, the prevalence of chronic diseases increases in the future based on the increasing longevity. This results in increasing comorbidities with other diseases. Another result of the increasing longevity is the increasing number of vulnerable elderly who are especially vulnerable to suffer from

psychological distress, i.e. loneliness and psychopathologies such as depression. Based on the technological and scientific progresses in the past decades, people diagnosed with chronic diseases can live longer with their disease meaning that the number of chronic diseases increase and people suffer from multimorbidities. Therefore, chronic disease increases in psychological complexity. These perspectives indicate an increasing psychological complexity of chronic pain within the next decades. Therefore and based on the literature review presented above, it is also expected that the psychological complexity of chronic pain increases.

In addition, shadowing the psychological disorders of the past decades, there is an increasing trend in anxiety and mood disorders (Nielen & Pools, 2020). According to Nielen and Pools (2020) the prevalence of mood disorders will increase with 7% in the period of 2015 until 2040. The prevalence of anxiety disorder will prospectively increase with 4% in the period of 2015 until 2040 (Nielen & Pools, 2020). Consequently, it is expected that the prevalence of psychopathological disorders and chronic pain increase within the next decades and that patients suffering from a chronic disease show a complex cluster of symptoms. Accordingly, this indicates that there is an increasing trend of patients suffering from chronic pain and psychopathology. Therefore, the psychological complexity of chronic pain might have increased within the past years and increases perspectively within the next decades. Menting, Schelven, van Grosscurt, Spreeuwenberg, & Heijmans (2019) reported that one in twenty patients with a chronic disease, thus including chronic pain, is suffering from clinical relevant depression. The number of patients suffering from depressive symptoms might be even higher. This shows the importance of a suitable treatment for psychological complex chronic pain in order to provide a treatment that addresses all factors involved as demonstrated by Engel (1977).

Consequently, the Fear Avoidance and Fear Endurance model of chronic pain and the comorbidities of chronic pain with depression and anxiety indicate that a psychological intervention is necessary to improve the patients overall functioning. Chronic pain is therefore a psychological complex disorder that requires a treatment that successfully addresses several aspects of the disorder.

Treatment of Chronic Pain

As opposed to the biomedical model focusing on removing the pain, a multidisciplinary and psychological rehabilitation treatments wants to improving the functionality of patients and reduce the pain interference in physical, psychological, occupational and social domains (Gatchel, McGeary, McGeary, & Lippe, 2014). Due to the psychological complexity of chronic pain patients need an individually adapted treatment offered by a multidisciplinary team addressing each involved factor of suffering (Peppin et al., 2015). A multidisciplinary treatment is characterized by the bundle of services from different healthcare providers such as physicians, physiotherapists, psychologists, social workers and rehabilitation physicians in order to provide a comprehensive rehabilitation program based on all needs stated in the biopsychosocial model of chronic pain.

One of the prevailing psychological frameworks as a part of the multidisciplinary treatment is Cognitive Behavioural Therapy (CBT) (Ehde, Dillworth, & Turner, 2014). CBT for chronic pain is based on the aspects of operant and classical conditioning in the Fear Avoidance model and Avoidance Endurance model described above. CBT identifies and challenges maladaptive pain-related cognitions central in avoidance behaviour and overreacting to pain that

lead to an increased pain-related disability. Concluding, CBT is a control-oriented approach to chronic pain (Hayes & Duckworth, 2006). The aim of CBT is to increase the patient's overall functioning and teach how to live with chronic pain by changing the content of cognitions, i.e thoughts, of the patient resulting in increased coping with pain(-related) experiences (Hayes & Duckworth, 2006). Used techniques are for instance relaxation, cognitive restructuring and problem solving training (Turner & Romano, 2004).

Research has shown that the Acceptance and Commitment Therapy (ACT) for chronic pain is evenly effective as CBT. The main difference between CBT and ACT is that ACT aims acceptance of thoughts and pain and therefore to change the awareness of thoughts and the relationship to thoughts instead of the content of thoughts as in CBT (Hayes & Duckworth, 2006). Based on the ongoing presence of pain, acceptance should be central to the treatment of chronic pain patients. ACT therefore focuses on the acceptance of and living in the presence of pain. Accordingly, as opposed to the more pain control-oriented such as CBT, ACT aims to decrease the interference of the patients' pain in their daily lives (Hayes & Duckworth, 2006; Hayes, Strosal, & Wilson, 2002).

Acceptance and Commitment Therapy for Chronic Pain

ACT focuses on improving the patient's psychological flexibility instead of eliminating the experienced pain. In the context of chronic pain, an increased psychological flexibility, defined as the ability to experience the present moment consciously and to change or persist in behaviour, that serves valued ends that benefit an individual's life, leads to better ability to adapt to the presence of pain in daily life (Bohlmeijer, Bolier, Westerhof, & Walburg, 2013; Hayes,

Luoma, Bond, Masuda, & Lillis, 2006). Thus, ACT aims to achieve a mindfulness and value-driven life in the presence of chronic pain by combining acceptance and mindfulness methods and activation and behaviour change methods with an emphasis on cognitive processes and emotional experiences (McCracken & Vowles, 2014).

This aim is based on the theoretical framework that flourishing and optimal functioning cannot be achieved without effective coping and accepting experiences, including painful and negative experiences (Bohlmeijer et al., 2013). According to ACT, sorrow and psychopathology arises from the individual's negative interpretation of the world. This interpretation consequently leads to an adaption of behaviour, called psychological inflexibility (Bohlmeijer et al., 2013; Hayes et al.,2006). Psychological flexibility can be achieved by changing the reaction to pain to accepting it and by working towards value-driven actions (Hayes & Duckworth, 2006). In that process, patients face certain psychological barriers to give up the unworkable current system (Hayes, Strohsahl, & Wilson, 1999). In order to address these barriers, ACT consists of six interrelated core processes, which can be combined in three response styles (Hayes et al., 2006). The processes and response styles are combined in Figure 3.
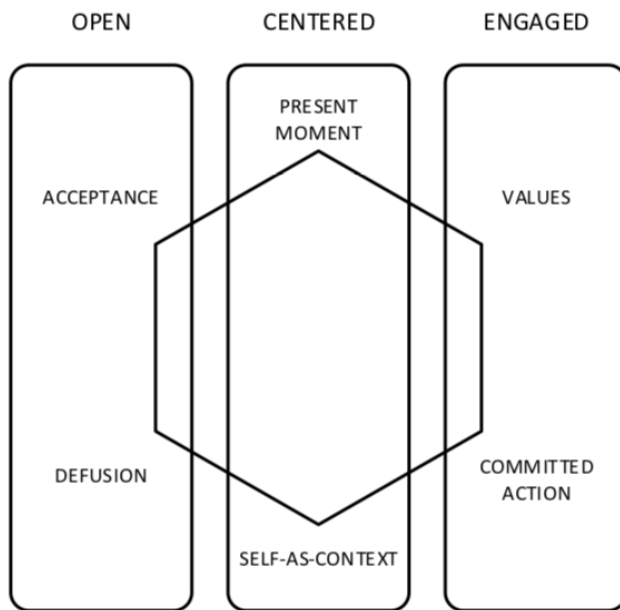
Figure 3. Response styles and six therapeutic processes. From "*Acceptance & Commitment*
Therapy: The process and practice of mindful change (2nd. ed.)." by Hayes, S. C., Strosahl, K.,
& Wilson, K. G., 2012.

The first response style uniting the core processes *acceptance* and *cognitive defusion* is
called the 'open response style'. These aim to enable distancing oneself from negative events and
embracing those actively with awareness to let go of the control of feelings and thoughts. Patients
learn to consider thoughts as nothing more and nothing less than words or pictures that do not
necessarily reflect the reality (Hayes et al., 2006). The second response style is called 'centered
response style' and unites the core process *being present* and *self as context*. Patients learn
techniques to instead of judging the event, stay in the here and now. ACT aims to help observing
events without being attached to inner experience but being aware of events from an objective
point of view instead (Hayes et al., 2006). These first two response styles show an essential

difference to CBT in which the content of thoughts are changed instead of the interpretation of thoughts. Consequently, ACT helps to adhere behaviour that serves their values, which leads to the third response style 'engaged response style'. This response style unites the core processes *values* and *committed action*. Patients realize what gives their life meaning and how situations can lead to more constructive actions by stepping back from everyday problems of life. This refers to committed action, which relates to doing what is important to achieve harmony in life with one's values, even if painful and unpleasant (Hayes et al., 2006; Hayes et al., 2012). These processes and response styles clearly show the focus of acceptance of thoughts and values of ACT as opposed to the control-oriented CBT.

Hughes, Clark, Colclough, Dale, and McMillian (2017) compared the effects of ACT to Expressive Writing, Applied Relaxation, CBT and other therapies delivered by trained therapists and based on recognized psychological theories as a treatment for chronic pain in terms of pain acceptance, quality of life, functioning in the presence of pain, anxiety, depression, psychological flexibility and pain intensity. For each measure, except Quality of life, ACT has better effects compared to other therapies. ACT had a large effect for pain acceptance, depression and psychological flexibility, a medium effect on anxiety and overall small effect on functioning in the presence of pain and pain intensity, showing that ACT addresses numerous factors present in psychological complex chronic pain (Hughes, Clark, Colclough, Cale, & McMillian, 2017).

Wicksell, Olsson, and Hayes (2010) found that psychological flexibility central in ACT significantly mediates life satisfaction and disability, while pain, emotional distress, fear of movement and self-efficacy do not. Therefore, ACT produces significant improvements for chronic pain patients and this improvement is based on the underlying theory of psychological

flexibility and therapeutic progress. In addition, an increase in pain acceptance is correlated with improvements during treatment regarding reduced anxiety, depression and pain-related disability (McCracken, Vowles, & Eccelston, 2005; Vowles & McCracken, 2008). This supports favoring ACT as a treatment for chronic pain patients since one main focus is on acceptance.

The Present Study

As the literature review indicates, chronic pain involves several psychological aspects and comorbidities. Therefore, the present study aims to investigate the psychological complexity of chronic pain. Knowledge about the psychological complexity of chronic pain gives indications about which psychological factors are prominent in chronic pain. These findings indicate the relevance of a suitable (psychological) treatment for psychological complex chronic pain. Therefore, a treatment for psychological complex chronic pain needs to address more factors than the pain conditions. Interventions for comorbidities should therefore be embedded. Consequently, the present study aims to give insights in how to treat factors involved in psychological complex chronic pain and whether ACT leads to beneficial results in improving the patients psychological wellbeing. The results can be used for further adaptation of treatments for psychological complex chronic pain and aims to give evidence that chronic pain is a complex disease that requires an individualized patient-centered treatment.

Since there are many factors involved in chronic pain, such as psychopathology and the resulting pain disability, and literature shows the value of ACT as a treatment for those suffering from (complex) chronic pain with regards to depression, anxiety and level of pain disability, the present study also aims to investigate how the psychological complexity of chronic pain changed

during the past eight years and whether ACT is a beneficial treatment for those who suffer from

psychological complex chronic pain at the Roessingh Center for Rehabilitation (RCR) in

Enschede, the Netherlands. The specialized treatment for chronic pain at the Revalidatiecentrum

is explained in detail in the method section.

The following research question with its sub questions arose: How effective is ACT in a

multidisciplinary treatment in increasing psychological flexibility and hence reducing depression,

anxiety and pain-related disability for chronic pain patients in the Netherlands with regards to

changes in psychological complexity during the past eight years?

It is hypothesized that:

H 1: Psychological complexity of chronic pain significantly increased within the past

eight years with regards to an increase in anxiety, depression and pain-related disability

and a decrease in psychological flexibility and mental health.

H2: ACT within a multidisciplinary treatment significantly increases psychological

flexibility at the end of the treatment and three months after with an effect size close to

moderate or higher.

H 2 a: ACT within a multidisciplinary treatment significantly increases psychological

flexibility and decreases anxiety significantly at the end of the treatment and three months

after with an effect size close to moderate or higher.

H 2 b: ACT within a multidisciplinary treatment significantly increases psychological

flexibility and decreases depression significantly at the end of the treatment and three

months after with an effect size close to moderate or higher.

H 2 c: ACT within a multidisciplinary treatment significantly increases psychological

flexibility and increases mental health significantly at the end of the treatment and three

months after with an effect size close to moderate or higher.

H 3: ACT within a multidisciplinary treatment significantly decreases pain-related

disability at the end of the treatment and three months after with an effect size close to

moderate or higher.

H 4: The effectiveness of ACT within a multidisciplinary treatment decreases in terms of

decreasing effect sizes of psychological flexibility and pain-related disability over the

years due to an increased psychological complexity of chronic pain.

Methods

The present study uses a quantitative method with primary data while executing an experimental

research by statistically comparing pre and posttest.

Treatment Description

The RCR offers an ACT-based treatment which is adapted to the needs of the patients. Its

philosophy is that the RCR is a place that welcomes all participants, no matter how complex their

disease is. It offers treatment for those patients that did not experience a successful treatment in

other institutions. The duration and intensity of the treatment differed per participant based on the

complexity of their disorder. Therefore, the duration ranged from six weeks up to six months.

Alternating, there were periods of treatment and without treatment to give the participants the

time to adapt the learned principles in their daily life to engage in the learning process. Also, the

treatment itself differed per participant based on their needs. Depending on the severity of the

participants physical and psychological condition, it was decided whether the participants receive

a clinical or polyclinical treatment. Participants that are relatively resilient followed the

polyclinical treatment whereas participants who were physically not resilient enough or needed to

practice the new principle in a clinical setting followed the clinical treatment. If the participants

were able to follow the group treatment, they were following that treatment instead of an

individual treatment. That way, the participants could exchange experiences and learn from each

other. The treatment included assistance from a rehabilitation doctor, who was responsible for the

treatment, social workers, psychologists, physiotherapists and occupational therapists.

Concludingly, the treatment offered at the RCR is according to the guidelines reported by the

Nederlandse Vereniging van Revalidatieartsen (2017).

Participants and Recruitment

Within the present study convenience sampling was used since all patients at the RCR

who aimed to follow a treatment there were asked to participate. There were two criteria that had

to be met for participating in the present study. First, the participants had to be diagnosed with

chronic pain at WPN 3 or 4 level and second the participants had to follow the treatment at the

RCR (Nederlandse Vereniging van Revalidatieartsen, 2017). Participants who faced contra-

indications for the treatment (such as insufficient resilience, possibility of decompensation during

the treatment or language and communication difficulties) were rejected.

In the beginning, an email was sent asking the participants to verify the email-address

received at RCR. After verifying their email-address, a request to fill in the questionnaires above

was sent. Therefore, the participants could take their time to answer the questions at home. Then, the participants had an intake interview in which their goals were formulated in order to prepare a treatment plan. Afterwards an email was sent asking the participants to verify the email-address received at RCR. When accepted for treatment at RCR, the participants got the same email asking them to fill in the same questionnaire again. In case the participants did not have an email-account or impairments due to their diagnosis, employees at RCR offered help to fill in the questionnaires together at the RCR. This ensured a great amount of reliable data. Together with a professional of the RCR, the results were discussed based on the importance of the insights for the further treatment process. The participants were asked for consent of the usage of their data for the present study. Additionally, the patients were informed about the scientific use of the data and were ensured that the data will be completely anonymized.

To investigate changes in psychological complexity, data of each participant that applied for a treatment (Ta) at the RCR were used. In total the data of 3115 (male = 1050, female = 2063) participants were used in the present study with an age ranging from 18 to 83 (M = 43.65, SD = 13.16). Figure 4 gives an overview of changes in average age at the start of the treatment. Appendix A gives insights in the educational level of the participants based on the Dutch education system (Figure A1) and information about the different pain conditions of the participants (Figure A2).
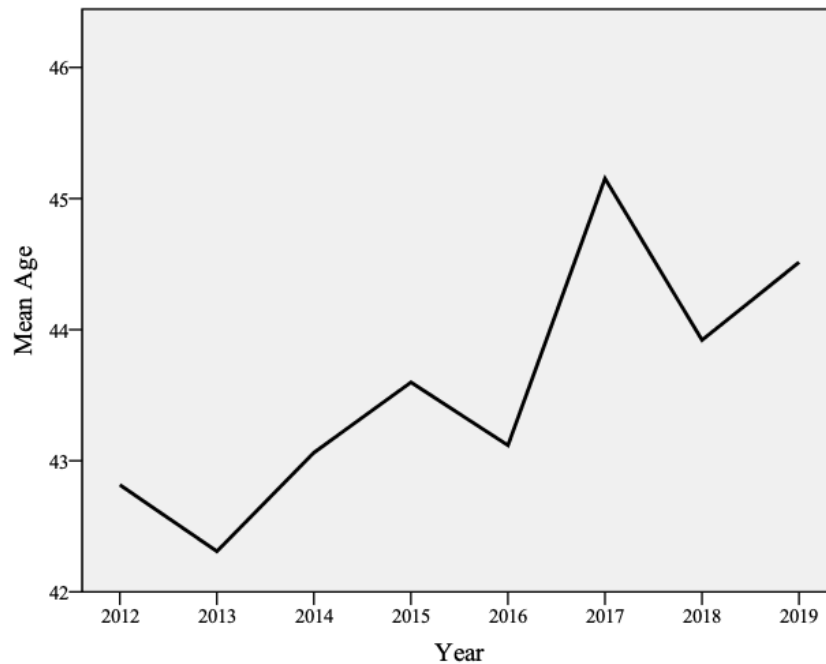
Figure 4. Overview of changes in average age at the start of the treatment from 2012 until 2019.

Design

The present study used a longitudinal, descriptive, observational one-group quasi experimental pretest-posttest design. Since the present study was a quasi experiment, there is no independent manipulated variable. There were several dependent variables in order to answer the research question. To measure depression in the participants the scores of the subscale depression of the HADS-D was used. In order to investigate the severity of anxiety in the participants, the scores of the subscale anxiety of the HADS-A was used. To get further insights in the mental health of the participants, which is influenced by levels of depression and anxiety, the score of the subscale mental health of the RAND-36 was used. In order to examine changes in self-reported pain-related disability, the PDI-DL was used. To investigate the effectiveness of ACT

the data of Ts was compared with Te and Tf3 and Te was compared with Tf3 to investigate long-term effects.

Measuring Instruments

All participants were asked to fill in several questionnaires on the computer at home accessed by a link sent via email.

Psychological flexibility. The Psychological Inflexibility in Pain Scale (PIPS) is a 16-item measure of psychological flexibility. The item content was designed to reflect avoidance behaviour, acceptance, fusion, values orientation and discomfort. Each item is rated on a 7-point likert-scale (1 = *never true* and 7 = *always true*). The higher the score, the higher the level of psychological inflexibility (Wicksell, Renöfält, Olsson, Bond, & Melin, 2008). The item rankings are averaged to form the total score of psychological flexibility. Subscales are avoidance and cognitive fusion. The subscale avoidance of pain measures the tendency to avoidance behaviour of pain and related distress. The subscale cognitive fusion measures the thoughts that are likely to lead to avoidance behaviour. Wicksell et al. (2010; 2008) supported a 2-factor solution with satisfactory statistical properties. Barke, Riecke, Rief, and Glombiewski (2015) demonstrated a high internal consistency with Cronbach's alpha of .91 for the subscale avoidance and .26 for the subscale fusion. The results of Trompetter et al. (2014) are consistent with the findings. According to the authors, the PIPS shows moderate to high relationships with aspects of mindfulness, pain interference in daily life, pain disability and mental health, indicating that the PIPS is suited for the present study.

Depression and anxiety. A reliable measure to detect anxiety and depression among patients in medical settings in the Hospital Anxiety and Depression Scale (HADS-NL) (Zigmond & Snaith, 1983). The 14-item questionnaire is rated on a 4-point likert scale and forms two subscales: anxiety and depression and a sum score. A high score on each scale indicates higher pathology. Mykletun, Stordal and Dahl (2001) showed that the HADS is quite good in terms of factor structure, intercorrelation, homogeneity and internal consistency. In the present study, Cronbach's alpha of the subscale depression was .87, of the subscale anxiety was .88 and of the sumcore was .92 showing high internal consistency for all scales.

Mental health. To investigate mental health, it was chosen to use the "mental health" subscale of the RAND SF-36. The subscale mental health consists of 5 items considering depression and nervosity on a 6-point likert scale (1 = *always* and 6 = *never*) (van der Zee & Sanderman, 2012). A low score indicates that the participants suffer from nervosity and depression constantly whereas a high score indicates that the participants felt calm and happy in the past weeks (van der Zee & Sanderman, 2012). Moorer, Suurmeijer, Foets and Molenaar (2001) investigated the psychometric properties of different chronic diseases in the Netherlands and found that first, most subscales (excluding general health perception and vitality) are strong unidimensional scales and second, a high reliability with Cronbach's alpha above .80. The authors conclude that all subscales can be used to compare individuals with different chronic illnesses. In addition, McHornes, Ware and Raczek found a high construct validity for the subscale mental health and reported that interpretations of the subscales are unequivocal. In the present study Cronbach's alpha was .76.

Pain-related Disability. The Pain Disability Index, Dutch language version (PDI-DLV) assesses the interference of chronic pain in the patients daily activities. It is a 7-item self-report questionnaire rated on an 11-point likert scale (0 = *no impairment* and 10 = *fully impaired*). The item rankings are averaged to form the total score of psychological flexibility. A high sum score indicates a high level of impairment or pain-related disability. Based on the findings of Tait, Margolis, Duckro, and Krause (1987), it is concluded that the PDI is especially suited for the present study based on its psychometric properties and ease of administration. The authors state that it is suited for longitudinal studies conducted on patients with chronic pain. Regarding its reliability, Cronbach's alpha of .87 was found indicating a high internal consistency. Tait, Chibnall and Krause (1990) found evidence for high concurrent and construct validity. In the present study Cronbach's alpha was .87.

Data Analysis

The provided data of each participant were stored in comma-separated values (CSV) files. All data of the different measurements were merged in the IBM SPSS software version 23. With the aid of the IBM SPSS software, scores of the questionnaires were reversed if necessary and the sum scores and subscales were computed into new variables. Then, boxplots were used to find potential outliers. Descriptive statistics were conducted for all variables (subscale depression of the HADS-D, subscale anxiety of the HADS-A, sumscore of the HADS, subscale mental health of the RAND, sum score of the PDI, subscale cognitive defusion of the PIPS, subscale avoidance of the PIPS and sumscre psychological flexibility of the PIPS). To investigate the distribution of the data, the Kolmogoroc-Smirnov test was used. To explore the homogeneity of the variances,

Levene's test was used. The reliability of all scales was checked using Cronbach's Alpha. A value of $\alpha > .7$ was considered as acceptable (Tavakol & Dennick, 2011). Participants who followed the treatment more than once (n = 122) were excluded from the data to guarantee reliable data with regards to the correctness of the merged questionnaires. The participants were renamed in new ID's starting at 1.

To investigate changes during the past eight years in psychological complexity with regards to increasing mean scores of depression (HADS-D), anxiety (HADS-A), pain-related disability (PDI), mental health (subscale RAND) and psychological flexibility (PIPS) of each participant collected at the intake of the treatment were used since there is more data available of the intake (Ta) than of the start of the treatment (Ts). To do so, the data was grouped according to the year of participation and mean scores of depression, anxiety, pain-related disability, mental health and psychological flexibility were compared. To test statistical significance Kruskal Wallis and Wilcoxon H test were executed.

To investigate the effectiveness of ACT with regards to decreasing psychological inflexibility, depression, anxiety and pain-related disability and increasing mental health, the data collected at the start of the treatment (Ts) was compared with the data collected at the end of the treatment (Te) and three months after the end of the treatment (Tf3, follow up). First, the mean scores of decreasing psychological inflexibility, depression, anxiety, pain-related disability and mental health at the start of the treatment and at the end of the treatment and the follow up were compared. In addition, to investigate possible further improvements after the end of the treatment (Te) the mean scores collected at the end of the treatment and three months after the end (Tf3) of the treatment were compared. To test statistical significance the Wilcoxon Signed Ranks test was

executed in order to evaluate the effectiveness of ACT when comparing Ts with Te, Ts with Tf3 and Te with Tf3. The Wilcoxon Signed Ranks test was executed for psychological inflexibility, depression, anxiety, mental health and pain-related disability. Effect sizes were calculated. An effect size of r = .3 is considered as low, an effect size of r = .5 is considered moderate and an effect size of r = .8 is considered as high. In order to investigate the association of psychological flexibility and its dimensions, thus avoidance and cognitive fusion with anxiety, depression and mental health, spearman's rank correlation coefficient of each point of measurement were computed. A correlation of r_s = .3 was considered as low, a correlation of r_s = .5 as moderate and a correlation of r_s = .8 as high.

Since it is hypothesized that chronic pain increased in psychological complexity, it was chosen to compare the mean scores of psychological inflexibility and pain-related disability of the years 2013 until 2018 of Ts with Te and Tf3 and to investigate a further reduction after the treatment, the mean scores of Te was compared with the mean scores of Tf3. It was chosen to compare the years between 2013 and 2018 since the data collection started in 2012 and there is no data of Te and Tf3 for 2012 and the analyses were executed in 2019 meaning that there is no data for Te and Tf3 for 2019 either. The Wilcoxon Signed Ranks test was executed for psychological flexibility and pain-related disability for each year to test statistical significance. Effect sizes were calculated. An effect size of r = .3 is considered as low, an effect size of r = .5 is considered moderate and an effect size of r = .8 is considered as high.

Results

Descriptive Statistics and Reliability

First, descriptive statistics and cronbachs' alpha were computed for each scale. The reliability of all scores was found to be acceptable (Table 1). To estimate the distribution of the data, the Kilomogorov-Smirnov test was executed. None of the variables were normally distributed (Figure 1). To assess the homogeneity of the data, Levenes statistics were executed. Levene's test showed that the variances for anxiety and depression were equal, $F(7, 2994) = 1.076$, $p = .376$ for anxiety and $F(7, 2994) = 19.191$, $p = .304$ for depression. The same was found for pain-related disability, $F(7, 2985) = 1.826$, $p = .078$). Regarding the data of mental health, Levene's test shows that the variances were not equal, $F(7, 300) = 2.412$, $p = .018$. Levene's statistics showed that the variances of psychological flexibility were not equal either. These results show that the assumptions of ANOVA are not met. Therefore, it was chosen to continue with nonparametric tests.

Table 1

Descriptive Statistics for HADS, RAND, PDI and PIPS

Scale	*M*	*SD*	*α*	*Kolmogorov Smirnov*	*Levene Statistics*
Anxiety	9.26	3.76	.88	.004	.376
Depression	10.19	3.32	.87	.002	.304
Mental Health	60.05	17.72	.76	.000	.018
Psy. Inflexibility	77.02	17.03	.91	.000	.534

Pain-related Disability	43.2	12.72	.87	.000	.078

In addition, descriptive statistics for each year and point of measurement were executed. Table 3 shows the number of participants and mean scores of pain-related disability, depression, anxiety, mental health and psychological inflexibility for each year at the intake (Ta), start of the treatment (Ts), at the end of the treatment (Te) and three months after the end of the treatment (Tf3, follow up). Furthermore, the mean age is displayed. To get insights in the distribution of the age of the participants, percentages of participants between 18 and 30 years, 30 and 45 years, 45 and 60 years and 60 and 85 years are displayed in Table 2.

Table 2

Descriptive Statistics per Year for PDI, HADS-A, HADS-D, RAND, PIPS, Age and Sex.

Year		N	PRD (SD)	D (SD)	A (SD)	MH (SD)	PIF (SD)	Age					Sex in %	
								Mean (SD)	18-30 in %	30-45 in %	45-60 in %	60-85 in %	Female	Male
2012	Ta	125	39.40 (12.84)	10.18 (3.54)	9.53 (4.88)	61.53 (19.2)	75.78 (16.18)	42.82 (13.63)	22.4	37.6	28	12	71	28
	Ts	2	40 (15.56)	10.00 (0)	10.5 (6.36)	68 (5.66)	73.00 (1.41)	58.00 (19.8)	0	50	0	50	50	50
2013	Ta	460	40.53 (12.15)	10.12 (3.77)	9.12 (4.83)	63.22 (18.44)	75.70 (16.91)	42.31 (12.35)	20.7	37.1	35	7.1	66	33
	Ts	64	36.67 (10.99)	9.38 (2.91)	8.33 (4.0)	61.19 (17.74)	68.84 (13.78)	40.49 (12.46)	29.2	32.3	36.9	1.5	76.6	23.4
	Te	19	35.26 (11.76)	7.95 (1.57)	8.73 (4.1)	61.26 (17.59)	61.32 (15.58)	40.95 (10.89)	26.3	42.1	31.6	0	84.2	15.8
	Tf3	8	35.13 (9.357)	9.25 (3.37)	8.00 (4.66)	59 (25.37)	70.38 (18.39)	42.62 (10.61)	12.5	50	37.5	0	87.5	12.5
2014	Ta	435	42.30 (12.51)	10.03 (3.49)	9.13 (4.85)	63.05 (17.04)	75.02 (16.3)	43.06 (13.14)	19.8	37.7	31.3	11.3	63	36
	Ts	178	40.17 (10.97)	9.62 (3.31)	8.42 (4.21)	57.82 (20.6)	72.59 (12.79)	43.79 (12.35)	15.6	44.7	28.5	11.2	70.4	29.6
	Te	69	36.29 (13.54)	8.73 (3.24)	6.91 (3.33)	66.9 (16.49)	66.24 (14.74)	43.26 (11.42)	14.5	40.6	39.1	5.8	72.5	27.5
	Tf3	58	34.31 (15.39)	8.29 (3.64)	7.31 (4.53)	63.51 (20.55)	61.39 (16.19)	40.59 (11.28)	22.4	46.6	27.6	3.4	75.9	24.1
2015	Ta	459	44.33 (12.88)	10.71 (3.81)	9.55 (4.7)	59.53 (18)	77.22 (17.16)	43.60 (12.70)	17.5	37,8	34.1	10.6	67.6	32.4
	Ts	178	41.69 (12.12)	10.07 (3.37)	8.53 (4.03)	57.76 (20.12)	67.65 (15.19)	44.68 (11.87)	12.9	35.4	41	10.7	64	36
	Te	64	34.89 (17.9)	8.11 (3.62)	7.29 (3.66)	68.08 (17.9)	64.54 (18.65)	46.05 (11.90)	9.4	34.4	45.3	10.9	68.8	31.3
	Tf3	55	34.56 (16.22)	8.12 (3.75)	6.95 (3.4)	64.29 (22.81)	64.85 (18.63)	44.53 (12.01)	12.7	40	38.2	9.1	69.1	30.9

ACT FOR (COMPLEX) CHRONIC PAIN PATIENTS

		N							A	D	PDI	PIF	MH	
2016	Ta	298	44.10	10.55	9.55	60.09	77.58	43.12	20.1	35.9	34.9	9.1	69.1	30.9
			(12.25)	(3.62)	(4.54)	(17.99)	(15.05)	(12.89)						
	Ts	106	43.24	10.12	9.53	52.42	72.257	44.23	11.3	44.3	36.8	7.5	68.9	31.1
			(12.65)	(3.25)	(4.09)	(18.49)	(17.51)	(11.17)						
	Te	31	34.97	7.19	6.67	65.81	63.4	45.97	6.5	38.7	48.4	6.5	67.7	32.3
			(16.37)	(2.98)	(2.68)	(16.90)	(14.11)	(8.8)						
	Tf3	10	36.1	8.40	5.4	62.40	55.11	44.6	0	50	40	10	70	30
			(21.46)	(3.84)	(2.32)	(19.16)	(21.07)	(8.95)						
2017	Ta	470	44.53	11.00	10.20	58.48	79.12	45.15	18.3	28.9	39.9	13	66.2	33.8
			(11.72)	(3.6)	(4.5)	(16.22)	(17.45)	(13.46)						
	Ts	99	41.20	10.24	9.81	52.65	71.1	42.84	21.2	34.3	34.3	10.1	77.8	22.2
			(11.63)	(3.28)	(4.18)	(18.34)	(14.17)	(13.66)						
	Te	53	38.09	8.81	8.46	61.28	66,73	45.3	11.3	35.8	45.3	7.5	67.9	32.1
			(12.89)	(3.84)	(4.43)	(18.81)	(15,6)	(11.62)						
	Tf3	38	34.95	9.11	8.5	57.58	64.00	42.63	23.7	31.6	36.8	7.9	60.5	39.5
			(13.43)	(3.58)	(3.65)	(20.32)	(14.85)	(13.74)						
2018	Ta	525	55.62	11.21	10.42	57.50	77.85	42.92	19.2	31.6	38.6	10.6	63.3	36.7
			(12.8)	(3.67)	(4.67)	(17.61)	(17.04)	(13.19)						
	Ts	121	43.28	11.28	10.31	51.37	74.138	44.8	11.6	40.5	41.3	6.6	71.1	28.9
			(10.20)	(2.88)	(3.98)	(16.32)	(14.95)	(11.53)						
	Te	70	38.6	9.00	8.65	59.14	87.809	45.84	11.4	38.6	38.6	11.4	67.1	32.9
			(13.75)	(3.32)	(3.72)	(18.8)	(16.7)	(12.15)						
	Tf3	41	34.76	8.24	7.41	63.51	65,537	48.12	4.9	34.1	48.8	12.2	70.7	29.3
			(15.38)	(3.53)	(3.85)	(18.12)	(16.04)	(10.81)						
2019	Ta	218	42.00	10.62	10.36	57.16	76.76	44.51	19.7	33	34.9	11.9	64.7	32.1
			(13.1)	(3.69)	(4.76)	(17.21)	(17.44)	(14.48)						

Note. Ta = Intake, Ts = Start of the treatment, Te = End of the treatment, Tf3 = 3 months after the end of

the treatment (follow up), A = Anxiety, D = Depression, PDI = Pain-related Disability, PIF =

Psychological Inflexibility, MH = Mental health.

1

Comparing Means of the Past Eight Years

To test the first hypothesis, the Kruskal Wallis H test was executed. Regarding psychological flexibility, Figure 5 shows that from 2012 to 2014 psychological inflexibility decreased slightly but there is a crucial increase in psychological inflexibility from 2014 to 2019 when comparing the mean scores from the participants per year. Therefore, there is a statistically significant difference in psychological inflexibility between the years, $\chi^2(7) = 22.76$, p = .02, with an effect size of .42 (Appendix B). This shows that the amount of psychological inflexibility in chronic pain patients increased during the past eight years.
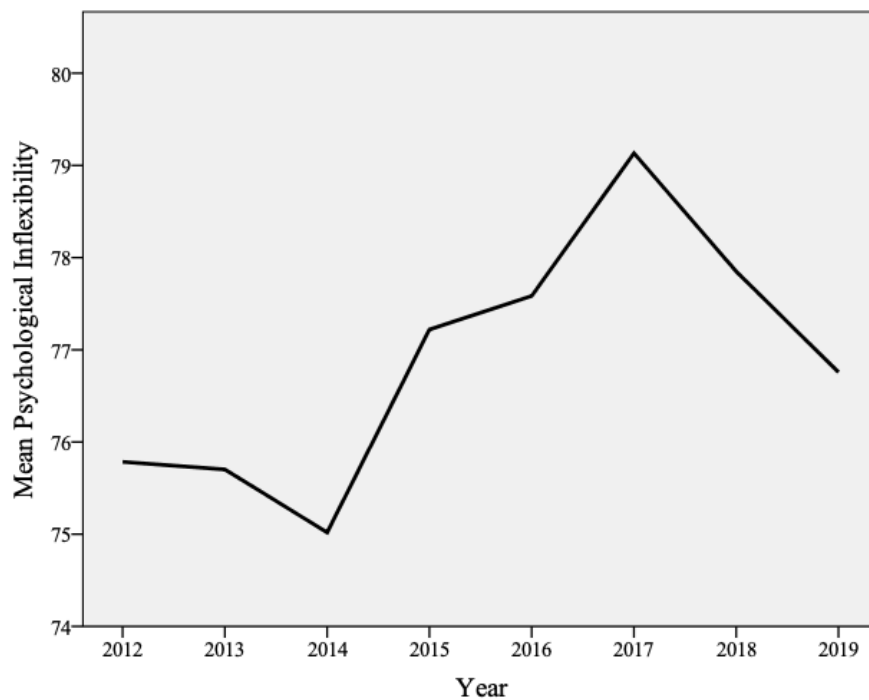

Figure 5. Changes in average psychological inflexibility during the past eight years at the intake.

As displayed in Figure 6, when comparing the mean scores of the participants per year it is noticeable that there is a slight decrease in anxiety from 2012 to 2014 but a great increase in

anxiety from 2014 until 2019. While the mean score of anxiety in 2014 is 8.81 ($SD = 4.51$), the average score on anxiety in 2019 is 10.36 ($SD = 4.76$) (Appendix B). Therefore, there is a statistically significant difference between the years, $\chi^2(7) = 47.281$, p = .00, with an effect size of .86 (Appendix B). Comparing the means of the different years, it is noticeable that the means increased from 2014 to 2019, indicating a great increase of anxiety in chronic pain patients within the years.
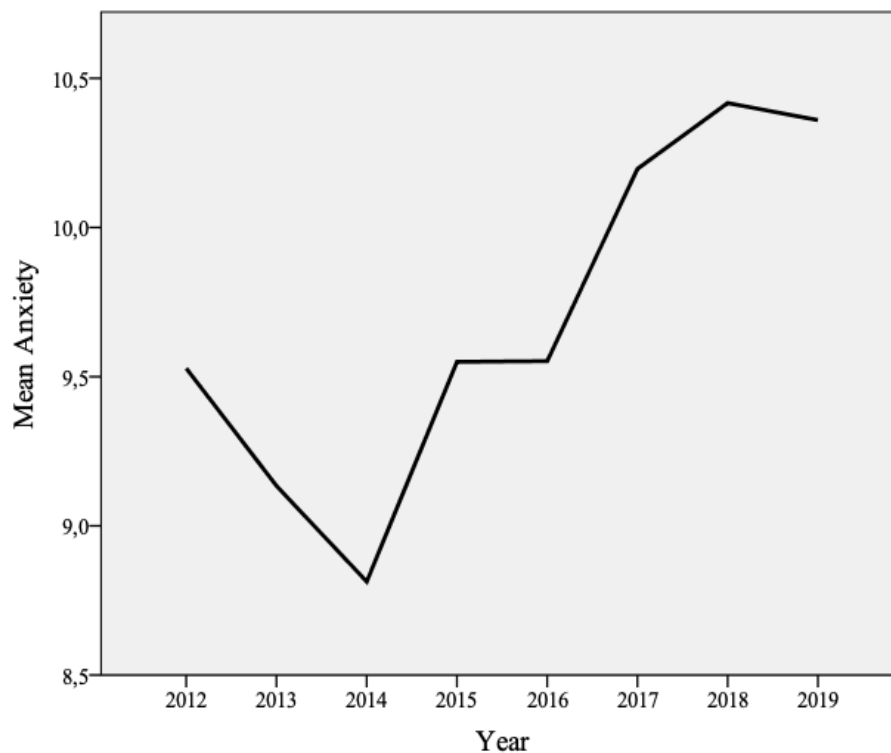
Figure 6. Changes in average anxiety during the past eight years at the intake.

Exploring differences within the past eight years with regards to depression, the analysis shows a slight decrease in depression from 2012 to 2014 and a noticeable increase of depression from 2014 until 2019 as displayed in Figure 7. For instance, the mean depression score in 2014

was 10.03 (*SD = 3.49*) whereas the mean score on depression in 2019 was 10.62 (*SD = 3.69*) and

even higher in 2018 with a score of 11.31 (*SD = 3.67*) (Appendix B). Therefore, there is a

statistically significant difference between the years, $\chi^2(7) = 42.303$, p $= .00$, with an effect

size of .77 (Appendix B). This shows that depression in chronic pain patients evidently and
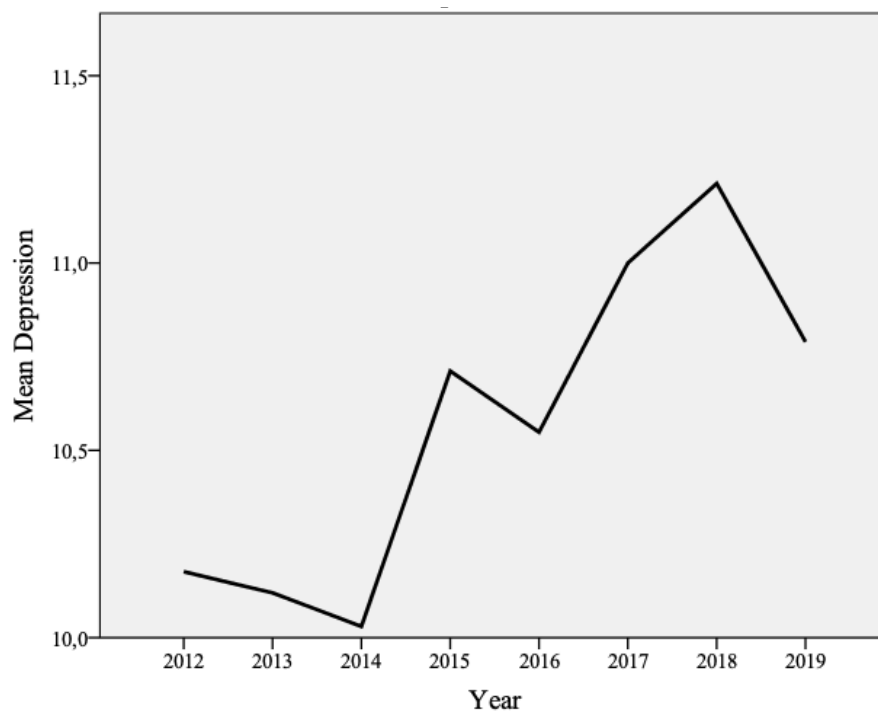
greatly increased within the past eight years.

Figure 7. Changes in average depression during the past eight years at the intake.

Appendix B and Figure 8 show that the mean scores of pain-related disability increased

from 2012 until 2019 from an average score on pain-related disability of 40.53 (*SD = 12.15*) in

2012 to an average score of 42.00 (*SD = 13.1*) in 2019 and the highest in 2018 with an average

score of 55.62 (*SD = 12.8*). Except for year 2019, there is a noticeable increase in pain-related

disability within each year (Figure 8). This increase of pain-related disability is statistically

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significant, $\chi^2(7) = 53.151$, p = .00, with an effect size of .97 (Appendix B).
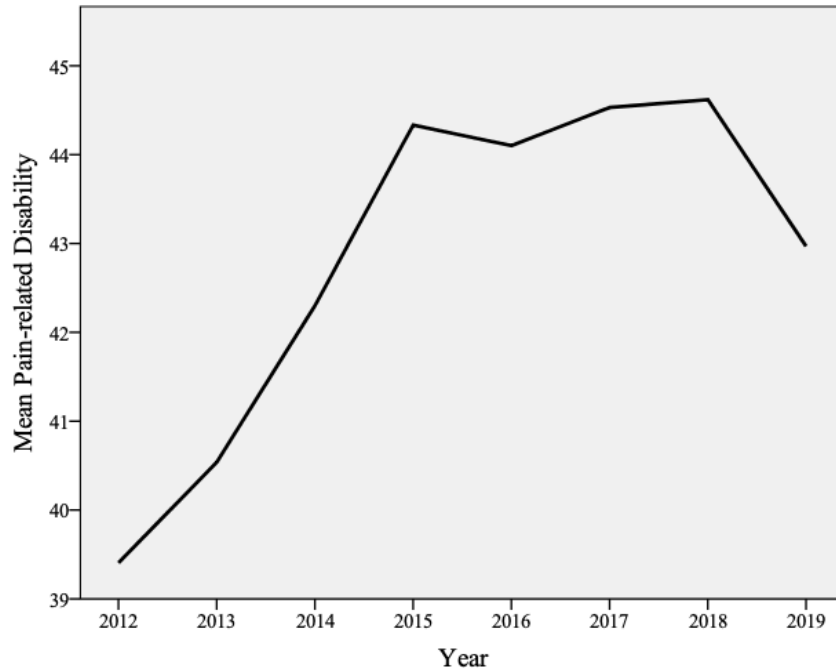
Figure 8. Changes in average pain-related disability during the past eight years at the intake.

Regarding mental health, the analysis shows that the mental health of chronic pain patients noticeable decreases within each year (see Figure 9). While chronic pain patients in 2012 reported an average score of mental health of 61.53 (*SD = 18.44*), patients in 2019 score on average 57.16 (*SD = 17.21*) on mental health. It is noticeable that the mental health of chronic pain patients decreases with every year as displayed in Figure 9. This decrease is statistically significant, $\chi^2(7) = 51.139$, p = .00, with an effect size of .93 (Appendix B). The scores decrease within the years, indicating that the mental health of chronic pain patients worsened over the past years.
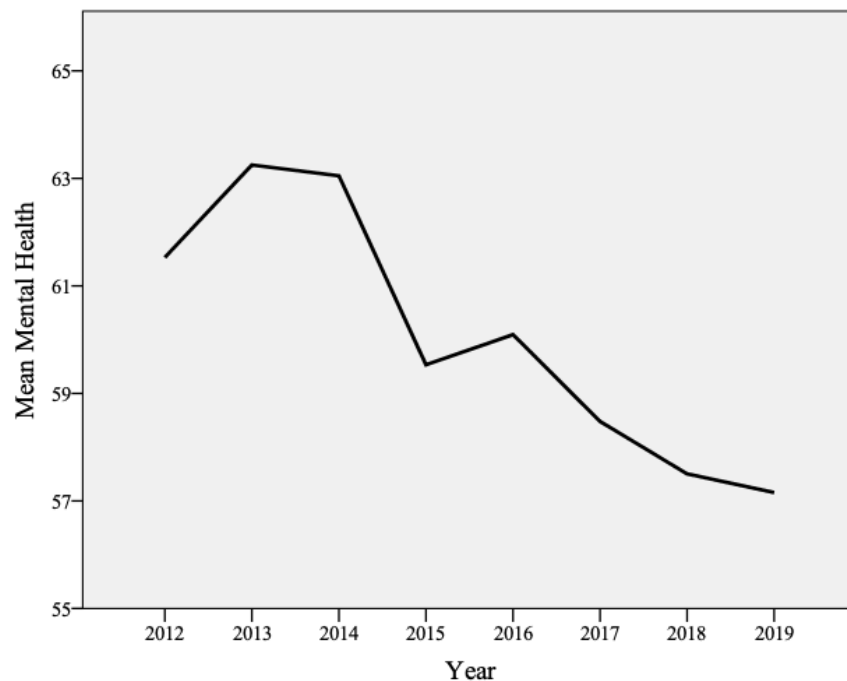
Figure 9. Changes in average mental health during the past eight years at the intake.

Summarizingly, the Kruskal Wallis H Test shows that anxiety, depression, mental health and pain-related disability worsened enormously over the past years, whereas the statistically significant worsening of psychological inflexibility is lower in comparison. Concludingly, the first hypothesis is accepted.

Assessing the Effectiveness of ACT with Regards to Changes in Depression, Anxiety, Pain-related Disability, Psychological Flexibility and Mental Health

ACT and Psychological Inflexibility. To test the second hypothesis exploring the effectiveness of ACT in increasing psychological flexibility, it was chosen to execute the Wilcoxon Signed Ranks Test. As shown in table 4, when comparing the mean scores of the start of the treatment with the end of the treatment and the three months follow up, there is a

noticeable decrease in psychological inflexibility. The average score on psychological

inflexibility of the start of the treatment is 71.92 (*SD = 14.89*) and decreased to an average score

of 65.84 (*SD = 16.13*) at the end of the treatment and to 63.64 (*SD = 16.64*) at the three months

follow up. This shows an evidently decrease in psychological inflexibility during the treatment

and after. The decrease in psychological inflexibility is statistically significant when comparing

the start of the treatment with the end of the treatment, Z = 8.130, p = .00, *r* = .48, and the start of

the treatment with the three months follow up, Z = 6.801, p = .00, *r* = .58, indicating a moderate

effect size of ACT on psychological flexibility. It is noteworthy that there is no statistically

significant change in psychological inflexibility between the end of the treatment and the 3

months follow up, Z = 1.367, p = .172, *r* = .11. Nevertheless, the present analysis shows that

comparing the start with the three months follow up, there is a moderate effect size, indicating

that ACT has a long term effect on psychological inflexibility in chronic pain patients. ACT

significantly decreases psychological inflexibility with a moderate effect size. Therefore, the

second hypothesis is accepted.

ACT and Anxiety. As presented in Table 4, the mean scores on anxiety decreased when

comparing the start of the treatment with the end of the treatment and the three months follow up.

In the beginning of the treatment, chronic pain patients showed an average score of 9.10 (*SD =

4.14*) on anxiety, while the score at the end of the treatment decreased to 7.83 (*SD = 3.76*) on

average and to 7.51 (*SD = 4.04*) three months after the end of the treatment. These scores show

that anxiety decreased while following ACT within a multidisciplinary treatment.

The analysis shows that anxiety statistically significantly decreased when comparing the

start of the treatment with the end of the treatment, Z = 6.92, p = .00, *r* = .41, and the three

months follow up, Z = 6.74, p = .00, *r* = .48 (Table 4). The effect sizes indicate a significant

effect close to moderate of ACT within a multidisciplinary treatment on anxiety. In addition,

there is a significant decrease in anxiety between the end of the treatment and the three months

after the end of the treatment, Z = 3.84, p = .00, *r* = .32, indicating a small statistically significant

effect of ACT within a multidisciplinary treatment on anxiety (Table 4). Therefore, it is

concluded that ACT within a multidisciplinary has significant short and long term effects on

anxiety.

To test Hypothesis 2a, it was chosen to establish the Spearman rank correlation

coefficient of psychological flexibility and the subscale anxiety. The Spearman correlation

indicates a significant weak positive association between psychological flexibility and anxiety at

the start of the treatment, r_s = .382, p < .001, and a significant moderate positive association at

the end of the treatment, r_s = .496, p < .001, and the three months after the end of the treatment,

r_s = .497, p < .001 (Appendix C). Therefore, regardless of a decrease in psychological

inflexibility, it is positively associated with anxiety and therefore has an effect on anxiety. In

addition, it is noticeable that psychological inflexibility is stronger associated with anxiety at the

end of the treatment and three months after the treatment. This indicates that a lower

psychological inflexibility is stronger associated with low anxiety than a higher score of

psychological inflexibility with a higher score on anxiety. Thus, the lower psychological

inflexibility, the stronger the association of psychological inflexibility with anxiety. Associations

between anxiety and avoidance and cognitive fusion are both significant but avoidance seems to

have a stronger association with anxiety at each point of measurement. These findings indicate

that an increase in psychological flexibility, thus a decrease in avoidance and cognitive defusion

is associated with a decrease in anxiety. Concludingly, ACT within a multidisciplinary treatment statistically significantly decreases anxiety with an effect size close to moderate, which is positively associated with psychological flexibility indicating that a high psychological flexibility is associated with lower anxiety. Therefore, hypothesis 2a is accepted.

ACT and Depression. Assessing the reduction of depression, Table 4 shows a decrease of the average score on depression when comparing the start of the treatment (M = 10.15, *SD = 3.26*) with the end of the treatment (M = 8.43, *SD = 3.46*) and three months after the end of the treatment (M = 8.47, *SD = 3.65*). Comparing the average score of the end of the treatment (M = 8.43, *SD = 3.46*) with the average score three months after the end of the treatment (M = 8.47, *SD = 3.65*) there is a slight increase.

The analysis showed a significant decrease in depression when comparing the start with the end of the treatment, Z = 8.43, p = .00, *r* = .50, as well as the three months follow up, Z = 6.25, p = .00, *r* = .45 (Table 4). The effect size shows that there is a significant effect of ACT on depression that is almost moderate. The analysis shows that ACT has a statistically significant moderate effect on depression during the treatment and a statistically significant close to moderate long term effect when comparing the start of the treatment with the three months follow up after the end of the treatment. Nevertheless, when comparing the end of the treatment with the three months follow up, no significant decrease of depression was found, Z = .235, p = .814, *r* = .02 (Table 4). Therefore, it can be concluded that there is no further decrease of depression after the end of the treatment but when comparing the score of three months after the end of the treatment with the start, there is a statistically significant effect of ACT on depression indicating

that there is a long term effect close to moderate. It is noteworthy, that depression in chronic pain patients did not further decrease after the end of the treatment.

To test hypothesis 2b, it was chosen to establish the Spearman rank correlation coefficient of psychological flexibility and depression. Depression and psychological flexibility have a significant moderate positive association at each point of measurement (Appendix C). It is noteworthy that psychological inflexibility is stronger associated with depression at the end of the treatment, $r_s = .62$, p < .001 and three months after $r_s = .62$, p < .001 indicating that low psychological inflexibility is stronger associated with low depression than high psychological inflexibility with high depression. The analysis shows that the lower psychological inflexibility, the stronger it is associated with depression. Avoidance seems to have a stronger relationship with depression with a moderate effect as opposed to the weak effect of cognitive fusion. Nevertheless, both associations are statistically significant. Based on the increasing effect sizes from the start to the end of the treatment, the results show that a low score on avoidance is stronger associated with a low score on depression than the opposite. This indicated that a decrease in avoidance behaviour is associated with a decrease in depression. Summarizing, the analysis shows that ACT within a multidisciplinary treatment has a moderate effect size on depression. In addition, the findings indicate that an increase in psychological flexibility, thus a decrease in avoidance and cognitive defusion is statistically significantly associated with a decrease in depression. Thus, H 2b is accepted.

ACT and Mental Health. As presented in Table 4, when comparing the average score on mental health at the start of the treatment (M = 55.47, *SD = 19.25*) with the average score on mental health at the end of the treatment (M = 63.23, *SD = 18.24*) and three months after the end

of the treatment (M = 62.07, *SD = 20.63*) mental health noticeably increased during the

treatment. Nevertheless, there is a decrease in mental health when comparing the end of the

treatment with the average scores three months after the end of the treatment.

The Wilcoxon Signed Ranks test showed that there is a statistically significant increase of

mental health when comparing the start of the treatment with the end, Z = 7.456, p = .00, *r* = .44

with an effect size close to moderate and three months after the end of the treatment, Z = 4.859, p

= .00, *r* = .35, showing a small effect of ACT on increasing mental health (Table 5). Thus, ACT

has a close to moderate short term effect and a small long term effect on mental health.

Comparing the end of the treatment with the 3 months follow up, no significant increase was

found, Z = .051, p = .96, *r* = .34 (Table 4). This indicates that there is no further improvement

with regards to a reduction of depression after the end of the treatment. Nevertheless, ACT shows

a small long term effect when comparing the start of the treatment with three months after the end

of the treatment.

To test hypothesis 2c, a series of Spearman rank-order correlations were of psychological

flexibility and mental health were computed. There is a significant weak negative association

between psychological inflexibility and mental health at the start of the treatment, r_s = -.389, p <

.001. Mental health and psychological inflexibility have a significant moderate negative

relationship at the end of the treatment, r_s = -.485, p < .001, and the three months follow up, r_s =

-.422, p < .001 (Appendix C). This indicates that low psychological inflexibility is associated

with high mental health. The results show that the lower psychological inflexibility the stronger

the association with mental health. Therefore, it can be concluded that a low score on

psychological flexibility is stronger associated with a high score on mental health than a high

score of psychological inflexibility with a low score of mental health. Therefore, psychological

flexibility seems to play a major role with regards to a good mental health. Again, avoidance

appears to have a moderate negative association with mental health whereas cognitive fusion has

a significant weak association with mental health (Appendix C). Concludingly, ACT leads to a

statistically significant decrease in depression with an effect size close to moderate in long term

and moderate in short term. A decrease in psychological inflexibility is moderately associated

with an increase in mental health. Avoidance is stronger associated with mental health than

cognitive fusion. Therefore, H2b is accepted.

ACT and Pain-related Disability. When comparing the average score on pain-related

disability at the start of the treatment (M = 41.40, *SD = 11.52*) with the end of the treatment (M =

37.04, *SD = 14.52*) and three months after the end of the treatment (M = 35.17, *SD = 15.21*)

pain-related disability evidently decreased during the treatment and afterwards. Therefore, ACT

seems to have short and long term effects on pain-related disability.

To test the third hypothesis and explore the effectiveness of ACT with regards to a

decrease in pain-related disability, the analysis shows that pain-related disability statistically

significantly decreases when comparing the start with the end of the treatment, Z = 6.038, p =

.00, *r* = .36, and with the three months follow up, Z = 4.522, p = .00, *r* = .33 (Table 5). This

indicates that ACT has a small significant effect on pain-related disability. Comparing the end of

the treatment with three months afterwards, no significant change was found, Z = .982, p = .326,

r = .08 (Table 4). It is noteworthy, that no further statistical significant decrease in pain-related

disability is found. Nevertheless, the analysis shows that ACT has a small statistically significant

short and long-term effects on pain-related disability. Therefore, the third hypothesis is not

accepted, since the effect is not close to moderate or higher.

Table 4

Summary of Wilcoxon Signed Ranks Test of HADS, PDI, RAND 36

Scale	Point of measurement	N	Mean (*SD*)	Neg. ranks	Pos. ranks	Z	p	*r*
PIPS	Ts	273	71.92 (*14.89*)					
	Te	317	65. 84 (*16.13*)					
	Tf3	226	63.64 (*16.64*)					
	Ts - Te	273		188	76	-8.130	.00	.49
	Ts - Tf3	148		100	30	-6.801	.00	.58
	Te - Tf3	136		76	64	-1.367	.11	.11
HADS-A	Ts	781	9.10 (*4.14*)					
	Te	281	7.83 (*3.76*)					
	Tf3	231	7.51 (*4.04*)					
	Ts - Te	281		158	63	-6.92	.00	.41
	Ts - Tf3	193		134	38	-6.74	.00	.48
	Te - Tf3	142		76	38	-3.84	.00	.32
HADS-D	Ts	782	10.15 (*3.26*)					
	Te	324	8.43 (*3.46*)					
	Tf3	231	8.47 (*3.65*)					
	Ts - Te	281		174	67	-8.43	.00	.50
	Ts - Tf3	193		127	49	-6.25	.00	.45
	Te - Tf3	152		59	59	-.235	.814	.02
PDI	Ts	776	41.40 (*11.52*)					

	Te	324	37.04 (*14.52*)					
	Tf3	231	35.17 (*15.21*)					
	Ts - Te	281		177	94	-6.038	.00	.36
	Ts - Tf3			177	67	-4.522	.00	.33
	Te - Tf3	152		73	69	-.982	.326	.08
RAND	Ts	780	55.47 (*19.25*)					
	Te	329	63.23 (*18.24*)					
	Tf3	234	62.07 (*20.63*)					
	Ts - Te	284		69	173	-7.456	.00	.44
	Ts - Tf3	195		69	113	-4.859	.00	.35
	Te -Tf3	155		64	64	-.051	.96	.34

Assessing Changes in the Effectiveness of ACT due to an Increased Psychological Complexity of Chronic Pain during the past years

As presented above, the present study shows an increased psychological complexity of chronic pain within the past eight years. In the period of 2012 till 2019, there is a slight increase in psychological inflexibility, strong increase in anxiety, depression and pain-related disability and strong decrease in mental health of chronic pain patients.

ACT and Psychological Flexibility. Figure 9 shows that psychological inflexibility decreased in every year when comparing the average scores on psychological inflexibility at the start of the treatment with the end of the treatment and three months after the end of the treatment. In 2013, chronic pain patients scored 68.84 (SD = 13.78) on average on psychological inflexibility at the start of the treatment, 62.09 (SD = 13.60) on average at the end of the

treatment and 58.80 (SD = 14.78) three months after the end of the treatment (Appendix D).

Comparable results were found for 2018, in which the participants scored 74.14 (SD = 14.95) on

average on psychological inflexibility at the start of the treatment, 67.00 (SD = 16.29) at the end

of the treatment and even lower with an average score of 64.50 (SD = 15.84) three months after

the end of the treatment (Appendix D). Therefore, psychological inflexibility notably decreased

due to ACT within each year. Except for 2015, psychological inflexibility further decreased when

comparing the end of the treatment with three months after the end of the treatment (see Figure

9). In 2015 is a slight increase of psychological inflexibility when comparing the end of the

treatment (M = 62.37, SD = 15.41) with three months after the end of the treatment (M = 63.15,

SD = 15.74). Nevertheless, psychological flexibility decreased in each year in short and long-

term due to ACT within a multidisciplinary treatment when comparing the average scores on

psychological flexibility.

  In addition, within each year there is a statistically significant decrease in psychological

inflexibility when comparing the start of the treatment with the end of the treatment (Figure 10).

The effect sizes of each year are close to moderate or higher (Appendix D). There is a statistical

significant decrease of psychological inflexibility in each year. Shadowing the effect sizes of the

decrease in psychological inflexibility of every year, a decrease in effectiveness is detected from

2016 (r = .55) to 2018 (r = .43) indicating a slight decrease of the effectiveness of ACT with

regards to a decrease of psychological inflexibility (Appendix D). Nevertheless, the effect sizes

of each year when comparing the start of the treatment with the end of the treatment are at least

close to moderate and statistically significant.

Comparing the start of the treatment with three months after the end of the treatment there is a statistically significant decrease of psychological inflexibility except for 2015 and 2017. Each statistically significant decrease of psychological inflexibility has a moderate effect size, except for 2014 which shows an effect size close to moderate ($r = .46$). In 2016 and 2018 effect sizes above $r = .80$ were detected indicating a high effect size. It is noteworthy that the long term effects are slightly higher in 2013 ($r = .63$) than in 2018 ($r = .58$). For 2015, a small statistically not significant effect size ($r = .01$) for an increasing psychological inflexibility was found. No tendency is detected with regards to increasing or decreasing effect sizes over the years.
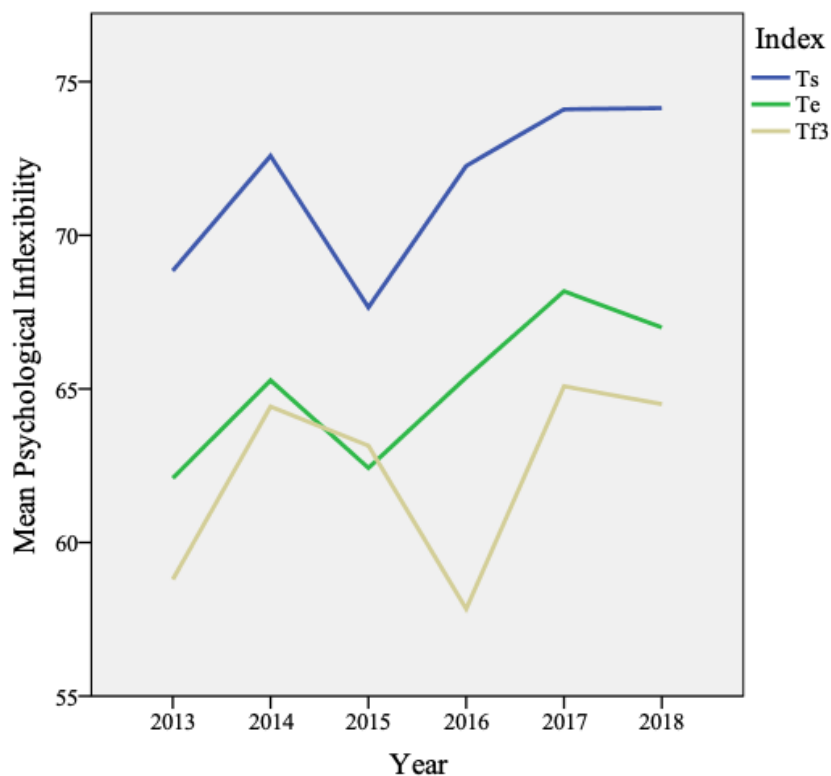

Figure 10. Comparison of the average psychological inflexibility at the start, the end of the treatment and three months after the end of the treatment.

ACT and Pain-related Disability. As presented in Figure 11, pain-related disability increased within the years. In 2013, chronic pain patients scored on average 36.67 (SD = 10.99) on pain-related disability, in 2015 the patients scored on average 41.69 (SD = 12.12) on pain-related disability and in 2018 on average 43.28 (SD = 10.20) (Appendix E). When comparing the start of the treatment with the end of the treatment, the participants scored within each year lower on pain.related disability in the end of the treatment and three months after the treatment. Therefore, ACT seems to have short and long-term effects on pain-related disability when comparing the mean scores of each year. Comparing the mean scores of the end of the treatment with three months after the end of the treatment, pain-related disability seems to further decrease after following the treatment in every year except for 2015 (Figure 11). In 2013, chronic pain patients scored an average 36.67 (SD = 10.99) at the start of the treatment, 34.53 (SD = 12.03) at the end of the treatment and 30.88 (SD = 14.45) three months after the end of the treatment. Comparable decreases in pain-related disability can be seen in 2018 in which chronic pain patients scores on average 43.28 (SD = 10.20) at the start of the treatment, 40.49 (SD = 12.49) at the end of the treatment and 37.37 (SD = 14.83) three months after the end of the treatment (Appendix E). It is noticeable that the patients of 2018 scored higher on pain-related disability after following the treatment and three months later than the patients of 2013 did at the start. This is just another indication for an increasing psychological complexity of chronic pain. This finding is exemplary for the increasing scores within the year at the start of the treatment, at the end of the treatment and three months after the end of the treatment.
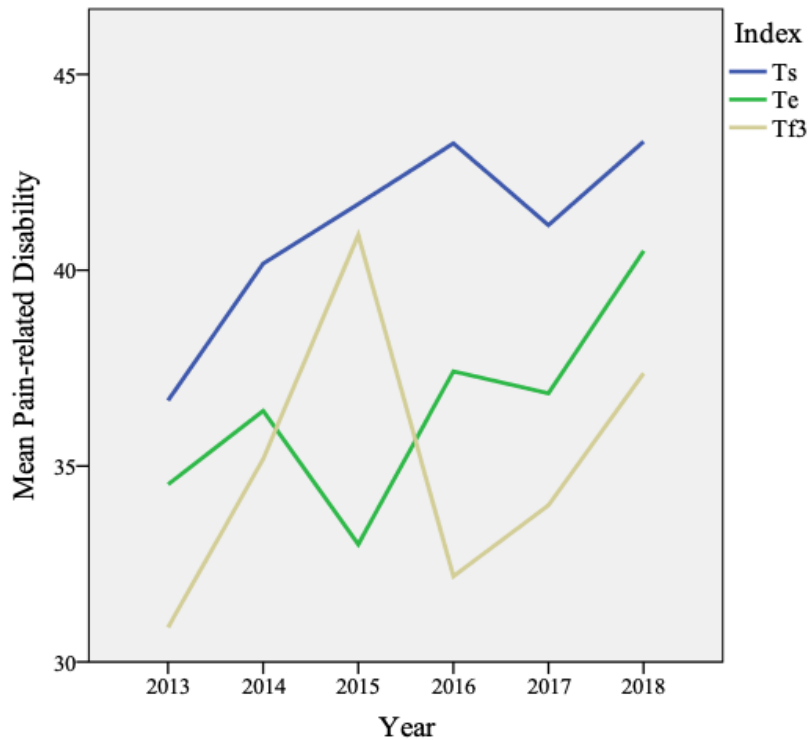
Comparing the start of the treatment with the end of the treatment the effect sizes increase within the years from $r = .27$ in 2013 up to $r = .41$ in 2018 (Appendix E). The decrease in pain-

related disability when comparing the start of the treatment with the end of the treatment is statistically significant except for the years 2013 and 2016. The effect sizes in 2013 until 2016 are considered low whereas the effect size of 2017 is moderate ($r = .5$) and of 2018 is considered close to moderate ($r = .41$) (see Appendix E). Nevertheless, comparing these findings, it is concluded that ACT has a short term effect on pain-related disability that increased within the years and is statistically significant except for the years 2013 and 2016.

Regarding the long term effects, an increasing tendency of effectiveness can be detected by comparing the effect sizes of each year when comparing the start of the treatment with three months after the end of the treatment . Effect sizes ranged from an effect size of $r = .27$ in 2018 up to an effect size of $r = .48$ in 2018 (Appendix E). There are variations between the years but the effect sizes seem to increase from 2013 to 2018. The effect sizes of 2013 ($r = .26$), 2014 ($r = .35$), 2015 ($r = .08$) and 2017 ($r = .25$) are considered low whereas the effect size of 2016 (r = .52) is considered as moderate and of 2018 (r = .48) as close to moderate (Appendix E). The decrease of pain-related disability is not statistically significant except for the years 2014, 2016 and 2018. Nevertheless, this indicates that the effectiveness of ACT increased with regards to pain-related disability over the years. To investigate a further decrease of pain-related disability after the end of the treatment, the end of the treatment is compared with a measurement three months after the end of the treatment. This further decrease seems to decrease within the years from $r = .36$ in 2013 to $r = .02$ in 2018. None of the changes after the end of the treatment are statistically significant. Nevertheless, chronic pain patients report a decreased pain-related disability after three months after the end of the treatment when compared to the start of the treatment as described above.

Figure 11. Comparison of the average pain-related disability at the start, the end of the treatment and three months after the end of the treatment.

Concludingly, hypothesis 4 is not accepted since the effectiveness of ACT with regards to decrease in psychological inflexibility and pain-related disability did not decrease based on an increasing psychological complexity of chronic pain. Contradicting, ACT seems to be more effective for psychological complex chronic pain in decreasing pain-related disability. The findings for pain-related disability have to be considered cautiously since these were not statistically significant each year. The findings indicate that the effectiveness of ACT decreased in terms of improving psychological flexibility in chronic pain patients.

Discussion

Key Findings

The present study aimed to get insights in changes in psychological complexity of chronic pain during the past eight years and in the effectiveness of ACT for psychological complex chronic pain. First, the psychological complexity of chronic pain increased within the past eight years. The psychopathology of chronic pain patients significantly increased within the past eight years. Chronic pain patients report higher depression, anxiety, psychological inflexibility and pain-related disability and lower mental health. Especially depression, anxiety, mental health and pain-related disability worsened over the years, while in comparison psychological inflexibility increased slightly. Therefore, chronic pain is a psychologically complex disease that requires a treatment that enables a life with the presence of pain and a reduction of psychopathological symptoms.

Second, ACT within a multidisciplinary setting lead to significant improvements of the patient's psychopathological symptoms and well-being. Psychological flexibility increased significantly due to the ACT-based treatment in short- and long-term. In addition, due to the treatment, there is a significant reduction of depression, anxiety, pain-related disability and a significant increase in mental health in short- and long-term. Therefore, it is concluded that ACT within a multidisciplinary treatment is fulfilling the main aim to increase the patient's psychological flexibility. The patients learned to live with the presence of pain by learning to accept the discomfort and working towards higher values. Additionally, ACT within a

multidisciplinary treatment is a beneficial treatment to treat depression, anxiety and pain-related disability in psychological complex chronic pain patients.

Third, psychological flexibility is related to depression, anxiety and mental health. Avoidance has a stronger association with depression, anxiety and mental health than cognitive fusion indicating that an decrease of avoidance leads to a stronger decrease in depression and anxiety and increase of mental health than cognitive fusion. Nevertheless, both lead to a decrease in anxiety and depression and an increase of mental health. Therefore, if avoidance and cognitive fusion decrease, anxiety, and depression decreases as well and overall mental health increases. It is remarkable that high psychological flexibility is stronger related to low depression and low anxiety or vice versa. Therefore, if psychological flexibility increases, depression decreases or vice versa. Consequently, ACT shows positive results for treating depression, anxiety and improving overall mental health as well.

Fourth, it is noteworthy that the present study shows that avoidance seems to play a major role in depression, anxiety and mental health. Decrease in pain avoidance is strongly correlated with decrease in depression, anxiety and increase in mental health or vice versa. This indicates that voidance of pain seems to play a major role in the impairment of chronic pain patients.

Fifth, since chronic pain increased in psychological complexity during the past years, it was chosen to investigate changes in effectiveness based on the increased psychopathological symptoms. The present study shows that ACT within a multidisciplinary treatment shows good results for psychological complex pain as well. First, the findings described above give an indication that ACT within a multidisciplinary treatment leads to a decrease in psychopathology in terms of reducing anxiety, depression, pain-related disability and increasing mental health. In

addition, the analysis shows that when comparing the effectiveness of ACT in terms of

psychological flexibility and pain-related disability of 2013 until 2018, there is an increase in

effectiveness with regards to pain-related disability while the symptoms increased over the years.

The present study shows that the effectiveness of ACT with regards to increasing psychological

flexibility decreased slightly when comparing the years from 2013 until 2018 by shadowing the

effect sizes. Nevertheless, there is a statistically significant decrease in psychological flexibility

in each year indicating that ACT is still at least moderately effective for psychological complex

chronic pain but not evenly effective with regards to decreasing psychological flexibility.

Reflection of the Findings

The psychological complexity of chronic pain increased during the past eight years.

The present study shows that chronic pain evidently increased in psychological complexity

during the past years. Especially anxiety, depression, pain-related disability and mental health

worsened during the past years. In addition, psychological flexibility decreased as well. Previous

studies reported high comorbidities of chronic pain with anxiety and depression, indicating that

chronic pain is a psychological complex disorder (Breivik et al., 2006; McWilliams, Goodwin, &

Cox, 2003; Tsang et al., 2008). Nevertheless, no previous study investigated a trend in

psychological complexity of chronic pain. Menting et al. (2019) examined changes in clinical

relevant depression of chronic pain patients and found no trent. The number of patients suffering

from a clinical relevant depression did neither increase nor decrease from 20010 until 2018.

Weisberg and Clavel (2015) discussed the difference between simple chronic pain and

complex chronic pain. In their view, complex chronic pain involves several factors, such as

multiple pain problems and medical problems, long pain duration of at least six months, multiple

visits at different healthcare providers, frequent use of medication, significant decompensation of

physical condition, significant lifestyle disturbances and significant psychopathology. In their

study, the author discussed how these factors should be tackled in a treatment. According to

Weisberg and Clavel (2015) a patient-centered multidisciplinary treatment is necessary. The

present study investigated the psychological complexity based on levels of anxiety, depression,

mental health, psychological flexibility and pain-related disability of chronic pain and its

development. This is highly relevant because as mentioned above, psychopathology is a

significant and prominent factor in patients suffering from complex chronic pain. Therefore, the

present study gives more insights about the psychological complexity of chronic pain present in

complex chronic pain patients. It indicates the relevance of psychological support within a

multidisciplinary treatment for complex chronic pain patients and which problems to address. An

additional relevance of a psychological treatment is presented in the literature review above.

Psychological variables that explain the etiology and maintenance of chronic pain need to be

addressed accordingly in a treatment to enable a more effective treatment.

It is noteworthy that the prevalence of mood disorders and anxiety disorders generally in

the Netherlands increased within the past year. The prevalence of mood disorders in the

Netherlands increased 15% from 2011 until 2018. While in 2011 169.300 of the male Dutch

population and 314.400 of the female Dutch population suffered from a mood disorder, the

number increased up to 207.400 in 2018 for the male Dutch population and up to 382.700 for the

female Dutch population (Nielen & Poos, 2020). Nielen and Poos (2020) found that mood

disorders are mostly present in the Dutch population between 40 and 65 years. Kesseler et al.

(2007) found the same results. As Table 3 shows, the average age of the chronic pain patients of the present study is between 40 and 48 years. Most of the chronic pain patients were between 35 and 60 years old. Therefore, the increase in depression might also be related to the high prevalence of depression between 40 and 65 years.

Regarding anxiety disorders, the prevalence of the Dutch population doubled from 2011 till 2018. While in 2011 94.900 of the male Dutch population were diagnosed with an anxiety disorder, the number increased to 152.400 in 2018. Regarding the female Dutch population, 185.200 patients were diagnosed with an anxiety disorder in 2011 and 310.500 in 2018 (Nielen & Poos, 2020). This indicates that the increase in depression and anxiety and decrease of mental health might be related to the general trend of increasing mood and anxiety disorders in the Netherlands. There are more women than men diagnosed with a mood and anxiety disorder in the Netherlands. Since there are three times as many women as men who participated in the present study, the high numbers of anxiety and depression might be related to the high prevalence of Dutch women suffering from anxiety and mood disorders.

ACT within a multidisciplinary setting increases psychological flexibility. The findings of the present study confirm that psychological flexibility is a central variable in the theoretical framework of ACT for chronic pain. There is a large effect of ACT in increasing psychological flexibility. Therefore, the present study is in accordance with the findings of Hughes et al. (2017) who found a large effect of ACT on psychological flexibility. The review of Scott and McCracken (2015) also showed that there is growing evidence that psychological flexibility is a mechanism of change in ACT for chronic pain patients. Wicksell, Olsson, and Hayes (2010) found a significant increase of psychological flexibility after following an ACT-

based intervention within an interdisciplinary treatment. Their study showed that ACT has a large effect on psychological flexibility. Furthermore, Fledderus, Bohlmeijer, Fox, Schreurs, and Spinhoven (2013) found that psychological flexibility in chronic pain patients significantly increases after following an ACT-based online intervention. This indicates that ACT shows beneficial results when followed within a multidisciplinary treatment in a rehabilitation center as well as when followed online.

ACT within a multidisciplinary treatment decreases depression. Forman, Herbert, Moitra, Yeomans, and Geller (2007) reported that ACT shows beneficial and statistically significant good results for patients suffering from depression. Therefore, ACT is proven to be a beneficial treatment for patients diagnosed with depression. Tamannaeifar, Gharraee, Birashk, and Habibi (2014) who compared the effectiveness of cognitive group therapy and ACT found the same results. The authors concluded that ACT is evenly effective as cognitive therapy in treating major depression.

Hughes et al. (2017) also reported that ACT positively influences depression of psychological complex chronic pain patients. In addition, Wicksell et al. (2010) found a large effect of ACT within a multidisciplinary treatment on depression. Scott and McCracken (2015) also investigated changes in depression in chronic pain patients due to following an ACT-based treatment. Using a different questionnaire than in the present study, the same results were found. ACT significantly decreases depression in chronic pain patients. The study of Fledderus et al. (2013) showed that an online ACT-based intervention for chronic pain patients results in a significantly decreasing depression as well. Therefore, ACT seems also beneficial when followed

online. Therefore, the findings of the present study are in line with previous studies investigating the effect of ACT on depression of chronic pain patients.

   ACT within a multidisciplinary treatment decreases anxiety. According to the present study, following an ACT-based treatment leads to a reduction of symptoms and feelings of anxiety of chronic pain patients. This finding is supported by several previous studies investigating an effect of ACT on anxiety of chronic pain patients. Hughes et al. (2017) for instance found the same results. In addition, Wicksell, et al. (2010) found a nearly large effect of ACT on anxiety when comparing the start of the ACT-based treatment with the end of the ACT-based treatment. Fledderus et al. (2013) also found a significant decrease in anxiety after following the intervention online. Forman, et al. (2007) found that ACT is a promising treatment for patients suffering from anxiety. The authors found that ACT shows statistical significant effects of ACT on reducing anxiety in anxiety patients. Swain, Hancock, Hainsworth and Bowman (2013) reported in their review of the effectiveness of ACT for anxiety, that the treatment significantly reduces anxiety. Therefore, ACT seems to be a beneficial treatment for anxiety disorders in general but also for anxiety in psychological complex chronic pain patients.

   ACT within a multidisciplinary treatment increases mental health. Regarding the study of Wicksell et al. (2012) the present study supports that psychological flexibility of chronic pain patients is central to their mental health. The present study contributes that the resulting psychological flexibility is associated with a decrease in depression and anxiety and an increase in overall mental health.

   Psychological flexibility is correlated with depression, anxiety and mental health. The present study evidently shows a correlation of psychological flexibility and depression,

anxiety and mental health. Thus, an increase in psychological flexibility leads to a decrease in depression and anxiety and an increase in mental health or vice versa. The study of Vowles and McCracken (2010) investigated the role of psychological flexibility in effect outcomes after following an ACT-based intervention within a multidisciplinary setting. Within their study, no correlation of psychological flexibility and depression was found. This might be based on the usage of a different measurement instrument for depression and psychological flexibility. In contrast, Scott, Hann, and McCracken (2016) found that 6-27% of the variances in the change in depression was explained by changes in psychological flexibility, indicating a relationship of psychological flexibility and depression.

Fledderus et al. (2013) investigated the role of psychological flexibility in psychological distress and found that psychological flexibility had positive effects on the level of depression and anxiety. During their study Fledderus et al. (2013) found an interaction effect of psychological flexibility and depression indicating that the effect on depression is higher for patients who show high psychological flexibility. The same results were found for anxiety. In addition, their findings indicate a long-term effect on further reduction of anxiety. Levin, MacLane, Daflos, Seeley, Hayes, Biglan, & Pistorello (2014) reported that psychological inflexibility is related to current and lifetime depressive and anxiety disorders. Additionally, the authors found a relation of psychological inflexibility with a comorbid depressive and anxiety disorders. These findings examine the role of psychological inflexibility in psychological disorders. Therefore, it is of high relevance to take psychological inflexibility into account while treating patients suffering from anxiety and depressive symptoms.

Hayes et al. (2006) showed in their review that levels of psychological flexibility impact mental health. They reported that jigger levels of psychological flexibility predict better mental health to a medium extent. In addition, they found that high levels of psychological flexibility are associated with a lower probability of developing a psychiatric disorder. Within their review, they reviewed different studies that used the Acceptance and Action Questionnaire (AAQ) or its specific variants (e.g., the CPAQ). These studies did not investigate findings of chronic pain patients but report the same results as the present study. This indicated that psychological flexibility plays a major role in psychopathology in general and not specifically for chronic pain patients.

Consequently, the finding that psychological flexibility is correlated or at least associated with depression, anxiety and mental health is supported by previous literature. In addition, the present study found that avoidance seems to be stronger correlated with anxiety, depression and mental health than cognitive fusion. There is no previous study investigating the correlation of avoidance and cognitive fusion with depression, anxiety and mental health of chronic pain patients. Gentili, Rickardsson, Zetterqvist, Simons, Lekander, and Wicksell (2019) investigated the role of psychological flexibility as a resilience factor of chronic pain patients. Within their study, they found a moderate correlation of avoidance (measured as a subscale of the PIPS) and depression ($r = 0.514$) and a low correlation of anxiety and avoidance ($r = 0.342$). The present study found higher correlations indicating a stronger effect upon another. This indicates that avoidance as an underlying factor of psychological inflexibility plays a major role in the psychological well-being of individuals. Consequently, a focus of treating anxiety and depressive symptoms needs to be on avoidance. An explanation might be that due to the willingness to

experience private or aversive events and social withdrawal, individuals do not experience

positive experiences. Decreasing the avoidance behaviour might lead to more social interaction,

increasing positive experiences and decreasing social withdrawal. Consequently, by having more

positive experiences, the depressive and anxious symptoms and thought might decrease. This is

the main content of the vicious cycle of both, anxiety and depression. Depressive moods lead to

reduced activities based on negative cognitive biases, loss of pleasure and achievement and a

negative view of oneself. The withdrawal results in less positive and correcting experiences,

increasing loneliness and depressive symptoms (Kennerley, Kirk, Westbrook, & Oxford, 2017).

Comparable mechanisms are present in anxiety. Patients suffering from anxiety overinterpreted a

perceived threat and show avoidance behaviour and exaggerated anxiety responses. By avoidance

behaviour due to the lack of helpful coping reactions, the anxiety remains active (Kennerley,

Kirk, Westbrook, & Oxford, 2017). Therefore, by addressing avoidance and incorporating

experiential avoidance in a treatment, a reduction of depression and anxiety might be the result.

Unfortunately, there is missing literature about the correlation or relationship of cognitive fusion

and depression, mental health and anxiety of chronic pain patients.

ACT within a multidisciplinary treatment decreases pain-related disability. This

finding is supported by previous studies investigating the effectiveness of ACT on pain-related

disability. For instance, Wicksell et al. (2010) found a large effect size of ACT on pain-related

disability. In addition, Vowles, Fink, and Cohen (2014) reported a decrease in disability after

following an ACT-based treatment.

Pain-related disability can be defined as "The limitation of a patient's performance

compared with a fit person's of the same age and sex" (Waddell & Main, 1984). Therefore, it

describes the deviation of the functionality of an individual suffering from chronic pain from a healthy individual. This definition is very broad and therefore captures various factors of functioning. It is hypothesized that due to a decreased avoidance behaviour and avoidance of pain, the functionality of chronic pain patients might have increased. Additionally, due to accepting the presence of pain it is hypothesized that individuals suffering from chronic pain learned to integrate the pain in their daily life. This might have led to an increased functionality and therefore a decreased pain-related disability. Concludingly, pain-related disability is comparable with the sick role described by Engel (1977). Patients show a deviation in social and cultural interaction based on their suffering from chronic pain. This shows the relevance of the biopsychosocial model in the treatment of chronic pain. Thus, ACT successfully stimulated the function of pain resulting in less disability behaviour in chronic pain patients and tackled the sick role described by Engel (1977). Consequently, chronic pain patients seem to find a way to integrate the presence of pain in their life without feeling disabled by the presence of pain.

ACT within a multidisciplinary treatment is a suitable treatment for psychological complex chronic pain. The findings of the present study indicate that chronic pain increased in psychological complexity in terms of worsening depression, anxiety, mental health, psychological flexibility and pain-related disability. As mentioned above, this is in accordance with the increasing trend of mood and anxiety disorders in the Netherlands within the past years. Nevertheless, this is a challenge for the treatment of chronic pain. Still, ACT has sufficient effects on reducing anxiety, depression and pain-related disability, and increasing mental health and psychological flexibility. Therefore it can be concluded that ACT is a beneficial treatment to psychological complex chronic pain. The present study shows that the effectiveness surprisingly

increased in terms of a decrease in pain-related disability within the past years. The effectiveness

of ACT on psychological flexibility slightly decreased over the years. Nevertheless, the analysis

shows moderate or greater effect sizes for ACT on psychological flexibility within each year.

This indicates that ACT is leading to good results in improving pain-related disability and

psychological flexibility. As Dindo, van Liew, and Arch (2017) stated, ACT is a suitable therapy

for transdiagnostic diseases including mental health and medical conditions. Since the present

study is the first to investigate changes in psychological complexity and effectiveness of ACT,

there are no comparable results.

Wetherell et al. (2011) compared the effectiveness of ACT and CBT for chronic pain

patients regarding the reduction of depression and pain-related disability and found that both

treatments are evenly effective. Nasah, Ponto, Townsend, Nelson and Bretz (2013) also reported

that CBT is effective in reducing depression in chronic pain patients. Concludingly, the present

study gives insights in the effectiveness of ACT for psychological complex chronic pain patients

regarding a reduction of depression, anxiety, pain-related disability and an increase of mental

health and psychological flexibility. Based on the evidence of the present study, no conclusions

can be made whether ACT is preferable to CBT.

The results of the present study also underline the importance of a treatment that is

created based on the biopsychosocial view by Engel (1977). It is hypothesized that the increase of

psychological complexity of chronic pain is an ongoing process in the next decades. Therefore, as

Engel (1977) proposed, it is of high relevance to include psychological treatment to the treatment

of chronic pain. The present study is another evidence that chronic pain is not a pure medical

disease but a psychological complex disease including several psychological mechanisms and symptoms that need to be addressed accordingly in the treatment.

Limitations and Strengths

There are two main limitations of the present study. First, the internal validity can be considered as moderate. Literature has shown that a multidisciplinary treatment for chronic pain patients is most beneficial (Peppin et al., 2015; Gatchel et al., 2014). A multidisciplinary treatment provides support from different healthcare providers such as physicians, physiotherapists, psychologists, social workers and rehabilitation physicians in order to provide a comprehensive rehabilitation program based on all needs stated in the biopsychosocial model of chronic pain. Each specialized healthcare provider offers an individualized treatment adapted to the patients suffering and symptoms. With regards to the present study, the multidisciplinary treatment indicates that there might be a confounding variable that influenced the outcomes of the treatment. It is hypothesized that if there is an influence of these factors on the outcome, it is only a slight influence. The present study showed that ACT reached its goal in improving psychological flexibility and how the patients deal with their pain. All investigated components of the present study are of psychological origin. Nevertheless, there is a possibility of confounding variables. Therefore, it can be concluded that ACT within a multidisciplinary treatment is beneficial in increasing the patient's symptoms of depression, anxiety, pain-related disability, mental health and psychological flexibility. Still, it is unanswered whether the multidisciplinary treatment is influencing the outcome or not. No statement can be made whether the outcomes are exclusively based on ACT.

Second, since the present study only showed that depression, anxiety and mental health are correlated with psychological flexibility, the function of psychological flexibility is unclear. The findings show that if mental health, depression and anxiety improve, psychological flexibility improves too or vice versa. Therefore there is no indication that an increased psychological flexibility as the main goal of ACT is leading to a reduction of psychopathology. Therefore, it can be concluded that there is a correlation but not which factors influence the other. Thus, there is a lack of an explanation value with regards to the effect of psychological flexibility on psychopathology. It can exclusively be concluded that ACT is beneficial in reaching its main goal of improving psychological flexibility but also shows a significant increase in mental health and decrease in anxiety, depression and pain-related disability.

There are also important strengths of the present study. As described, the present study is executed in a real-life setting based on a well thought through therapy program at the RCR. It is a rehabilitation program especially designed for chronic pain patients and addressed all the patients' needs. Each part of the multidisciplinary treatment has the exact knowledge about the therapy program, therapy process and the disorder itself. The healthcare providers are based on their experience specialized in the treatment of chronic pain. This eliminates possible deviations from the planned therapy program. Thus, the healthcare providers followed a routine therapy program with each patient in order to offer each patient the same program and chances of improvement. Each patient followed the same program at the same rehabilitation center and therefore had the same possibilities with regards to improving their symptoms and suffering. Therefore, the chances of random error is low.

Second, the external validity of the present study is high. The participants of the present study varied in age, education level and pain condition. Therefore, it is hypothesized that the outcomes can be at least generalized to the Dutch population above 18 years suffering from chronic pain. Thus, the findings are not restricted to the province of Overijssel. In addition, the ecological validity of the present study increased due to the real-life setting.

Recommendations for Further Research

The present study shows that the psychological complexity of chronic pain increased within the past years. This is in accordance with the trend that the prevalence of mood and anxiety disorders increased during the past years as well. Nevertheless, the findings of the present study do not show a trend in the increase of psychological complexity. It is unclear whether there is an exponential or linear increase in psychological complexity. To get insights in the prognosis for the following decades it is of relevance to know whether the psychological complexity increased exponentially or linearly. An exponential increase indicates that the psychological complexity is rapidly increasing in the next decades, while a linear increase would indicate a low but ongoing increase in psychological complexity of chronic pain. This knowledge is of high relevance in order to adapt a treatment in a way that psychological aspects such as depression, anxiety, mental health and psychological flexibility are addressed accordingly and sufficiently. An exponential increase indicates that chronic pain treatment in general should additionally focus on aspects of psychopathology quickly since it shows that psychopathology of chronic pain patients is becoming increasingly problematic. A linear increase in the psychological complexity of chronic pain implicates the same but enables more time for adjustments since the increase is

steady but lower. Based on the findings of the present study, a refocus on ACT would be beneficial for psychological complex chronic pain. Therefore, in order to provide proper treatment to chronic pain patients, it is advised to investigate the trend of increase of psychological complexity to get insights in the amount of time given to address this problem sufficiently.

As figure 3 shows, the mean age of the participants of the present study increased within the past years. Taken together with the future perspectives for 2030 of Revalidatie Nederland (2017), it is hypothesized that the age of people suffering from chronic pain will increase within the next decades based on the increase in life expectancy. More older patients will suffer longer from chronic pain and require treatment. Therefore, the demand for treatment and an adaption of the treatment regarding the (psychological) complexity of chronic pain is essential.

The same recommendation is given for investigating the trend of effectiveness of ACT. It is of high relevance to know whether the effectiveness of ACT by increasing psychological complexity of chronic pain shows the same trend. If there is a linear increase in the effectiveness of ACT while the psychological complexity of chronic pain is increasing exponentially, this might be an indication to further adaptation of ACT with regards to the aspects of psychological complexity. There is no security that ACT is evenly effective for exponentially increasing psychological complexity of chronic pain. Therefore, it is important to get insights in the trends of both aspects in order to provide a beneficial treatment for patients with increasing psychological complex chronic pain. It is relevant to get further insights on the resistance of ACT with regards to linear or exponential increasing psychological complexity of chronic pain. This should be a focus of further research.

In addition, it is recommended to replicate the present study with control groups. Control groups should be for instance ACT in a multidisciplinary treatment, ACT in an outpatient treatment and no treatment in order to get insights in the effectiveness of ACT for chronic pain patients for the different conditions and exclude random effects by the control condition. By doing so, the possible confounding variables based on the multidisciplinary treatment are investigated as well. Additionally, it is of high relevance to know whether ACT without a multidisciplinary treatment, thus as an outpatient treatment is evenly effective for psychological complex chronic pain. This would give patients the possibility to follow an ACT-based treatment while following their daily routines and continuing working if possible. Therefore, there would be economical advantages as well since the patients could continue following their profession while following an ACT-based outpatient treatment.

Moreover, it is recommended to replicate the present study with a control group following a CBT-based treatment. Previous studies already showed the effectiveness of CBT for chronic pain patients in reducing depression and anxiety and improving mental health. A replication of the present study would give more insights about the effectiveness of CBT on psychological complex chronic pain regarding a reduction pain-related disability and an increase of psychological inflexibility and changes in avoidance behaviour. Additionally, the hypothesis over the role of avoidance in depression and anxiety should be examined in order to get insight whether avoidance is an underlying factor of anxiety and depression in chronic pain patients.

Furthermore, the present study evidently shows that psychological flexibility is associated with anxiety, depression and mental health. Nevertheless, it is unclear whether psychological flexibility acts as a mediator. Therefore, no conclusion can be made whether depression, anxiety

and mental health increased based on an increased psychological flexibility or vice versa. It is therefore unclear whether psychological flexibility mediates the effect of ACT for depression, anxiety and mental health. The relation of the effect needs to be investigated. A reduction of depression, anxiety or increase of mental health accordingly can therefore be a reason for an increased psychological flexibility as well. Therefore, it is necessary to investigate psychological flexibility as a mediator. This analysis would give additional insight in whether ACT reached its goal in improving psychological flexibility. It excludes the possibility of the influence of depression, anxiety and mental health on psychological flexibility. Thus, insights in whether psychological flexibility actually leads to a decrease in psychopathology is necessary. The present study indicates that ACT is beneficial in treating psychopathology of chronic pain patients as well, but it is unclear whether this is achieved by the main goal of ACT, thus increasing psychological flexibility.

The present study shows that avoidance of pain seems to play a major role in depression, anxiety and mental health of chronic pain patients. It is highly recommended to investigate that correlation. Based on the analysis of the present study, it is still unclear whether avoidance influences depression, anxiety and mental health or vice versa. Nevertheless, as explained above, it is hypothesized that the experiential avoidance plays a major role in changes of depressive and anxiety symptoms based on the disruption of the viscous maintenance cycle and the end of the withdrawal due to the symptoms. This hypothesis should be examined in detail in future studies.

More and concrete knowledge of the role of pain avoidance in improving depression, anxiety and mental health would give new insights about the focus the ACT-based treatment should have. Since the present study shows that avoidance seems to be stronger correlated with

depression, anxiety and mental health, this indicates that if avoidance is a mediator, a focus on avoidance of pain in the treatment of chronic pain would lead to beneficial results. Thus, to improve the effectiveness of ACT it is important to investigate the role of avoidance in chronic pain patients and, if necessary, adapt the ACT-based intervention accordingly.

In addition, it can only be hypothesized that the quality of life of the patients increased by the decrease of psychopathology, pain-related disability and increased psychological flexibility. No explicit analysis is executed for investigating changes in the quality of life. Since the pain in chronic pain patients is ongoing even after the treatment, this might still interfere with their quality of life. Therefore, it is recommended to further investigate whether ACT within a multidisciplinary treatment leads to an improved quality of life of chronic pain patients as well.

Implications for Practice

The present study has practical implications for practice. First, the findings of the present study show the psychological complexity of chronic pain. It is emphasized how many other factors except from pain are prominent in the patients suffering of chronic pain. Therefore, it is advised to keep an eye on other aspects of mental health of chronic pain patients. The present study clearly shows that the psychological complexity of chronic pain increased within the past years which gives a tendency to a further increase of psychological complexity of chronic pain. Therefore, by treating patients with chronic pain the practitioner should not undermine the chance of further mental health issues. As already addressed, it is of high relevance to adapt the treatment of chronic pain in such a way that the patients' mental health is addressed as well. Chronic pain treatments should be adapted accordingly to the psychological complexity of

chronic pain. The present study gives an indication that psychopathology and the medical disorder are closely related. This supports the relevance of integrating medical and psychological support for disorders such as chronic pain. In addition, the present study gives another indication that a pure medical focus on chronic pain is not resulting in a reduction of the patients suffering, since their mental health is not treated accordingly.

Second, the present study is in accordance with Nielen and Poos (2020) who found an increasing trend of mood and anxiety disorders in the Dutch population. This indicates that healthcare providers should be prepared for a further increase in psychopathology, not only in handling chronic pain patients. It does not indicate that the increase of psychopathology is based on the increasing prevalence of chronic pain but simply that psychopathological disorders will increase in the future regardless of the comorbidity with chronic pain. It is expected that the psychopathology of chronic pain will increase in the future as well based on the trend described by Nielen and Poos (2020).Based on the findings of the present study and of the investigation of Nielen and Poos (2020) it is recommended to increase the capacity of a treatment for psychological complex chronic pain patients that show low depression, anxiety, mental health and psychological flexibility and high pain-related disability. Suffering from chronic pain influences the patients' life and well-being but paired with high psychopathological symptoms, the impairment of the patient might be increasing as well. Thus, an increased psychological complexity might result in an increased need for a treatment based on the increasing suffering and symptoms of the patients. Therefore, firstly the treatment should be adapted to an ACT-based treatment as mentioned before. Secondly, as the need for a treatment might increase within the

next decades based on the increasing symptoms, the capacities for a treatment should be enlarged to enlarge the chance that the patients can follow a treatment.

Third, the present study prominently shows how patients with psychological complex chronic pain can benefit from ACT within a multidisciplinary treatment. Therefore, it is strongly advised to focus on this type of treatment when working with patients that show symptoms of (complex) chronic pain. In addition, it shows that a multidisciplinary treatment results in good therapy outcomes. Thus, there is a clear preference on a multidisciplinary treatment including an ACT-based intervention in order to sufficiently help patients suffering from psychological complex chronic pain that is also supported by literature (Peppinet al., 2015; Gatchel et al., 2014).

Fourth, the present study evidently shows that ACT influences anxiety, depression and overall mental health. Even though it is unclear whether it is based on the mediating function of psychological flexibility. It indicates that ACT might be beneficial for treating symptoms of anxiety, depression and also for increasing overall mental health. Therefore, it is advised to integrate ACT in treatments of depression and anxiety. Since the findings do not give an indication about how patients with mood and anxiety disorders react towards the treatment, it is advised to integrate ACT within the treatment for mood and anxiety disorders instead of replacing it fully.

Conclusion

The present study aims to investigate a change in psychological complexity of chronic pain regarding an increase of depression, anxiety and pain-related disability and a decrease in

psychological flexibility and overall mental health and the effectiveness of ACT in a multidisciplinary treatment to help patients suffering from psychological complex chronic pain. The results show that within the past eight years the psychological complexity of chronic pain clearly increased. In accordance with the literature the present study shows that ACT has moderate or higher effects on psychological flexibility, depression, anxiety, mental health and pain-related disability. Psychological flexibility is moderately associated with depression, anxiety and mental health. The higher psychological flexibility, the stronger the association with depression, anxiety and mental health. Avoidance seems to be stronger associated with depression, anxiety and mental health than cognitive fusion. The effectiveness of ACT increased by increasing psychological complexity in terms of a reduction in pain-related disability. Effect sizes of ACT on improving psychological flexibility are moderate or higher in each year. This indicates that ACT is a beneficial treatment for psychological complex chronic pain.

It is recommended to further investigate a trend of the increase in psychological complexity of chronic pain and the effectiveness of ACT for chronic pain patients in order to guarantee that ACT is a beneficial treatment for exponentially increasing psychological complexity of chronic pain. In addition, it is recommended to investigate the effectiveness of ACT in an outpatient treatment. This knowledge would give the opportunity for chronic pain patients to follow an ACT-based treatment during their daily routines and would enlarge the possibilities to follow a treatment. Concluding, ACT seems to be a beneficial treatment in a multidisciplinary setting to reduce the symptoms of psychological complex chronic pain prominent in chronic pain patients.

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Appendix A.

Educational Level
- None
- Primary Education
- Primary Education - VMBO, LHNO, LTS, LEAO, HAVO 1-3, Primary Agriculture School, Practical Diploma
- Secondary Education - MAVO, MEAO, MTS, Partial Certificate HAVO or VWO, Apprenticeship Shorter Than 24 Months
- Secondary Education - HAVO, MMS, Apprenticeship Longer Than 24 Months, HBS, VWO
- Propedeuse HBO, WO, HOVO, WO Candidates
- Second Cycle Higher Education - WO doctoraal, HEAO, HTS, Sociall Pedagogical Academy, Masters
- Third Cycle Higher Education - WO Teacher Education after PhD, Doctor, Pharmacist

Figure A1. Overview of the Educational Level of the Participants based on the Dutch Education System.
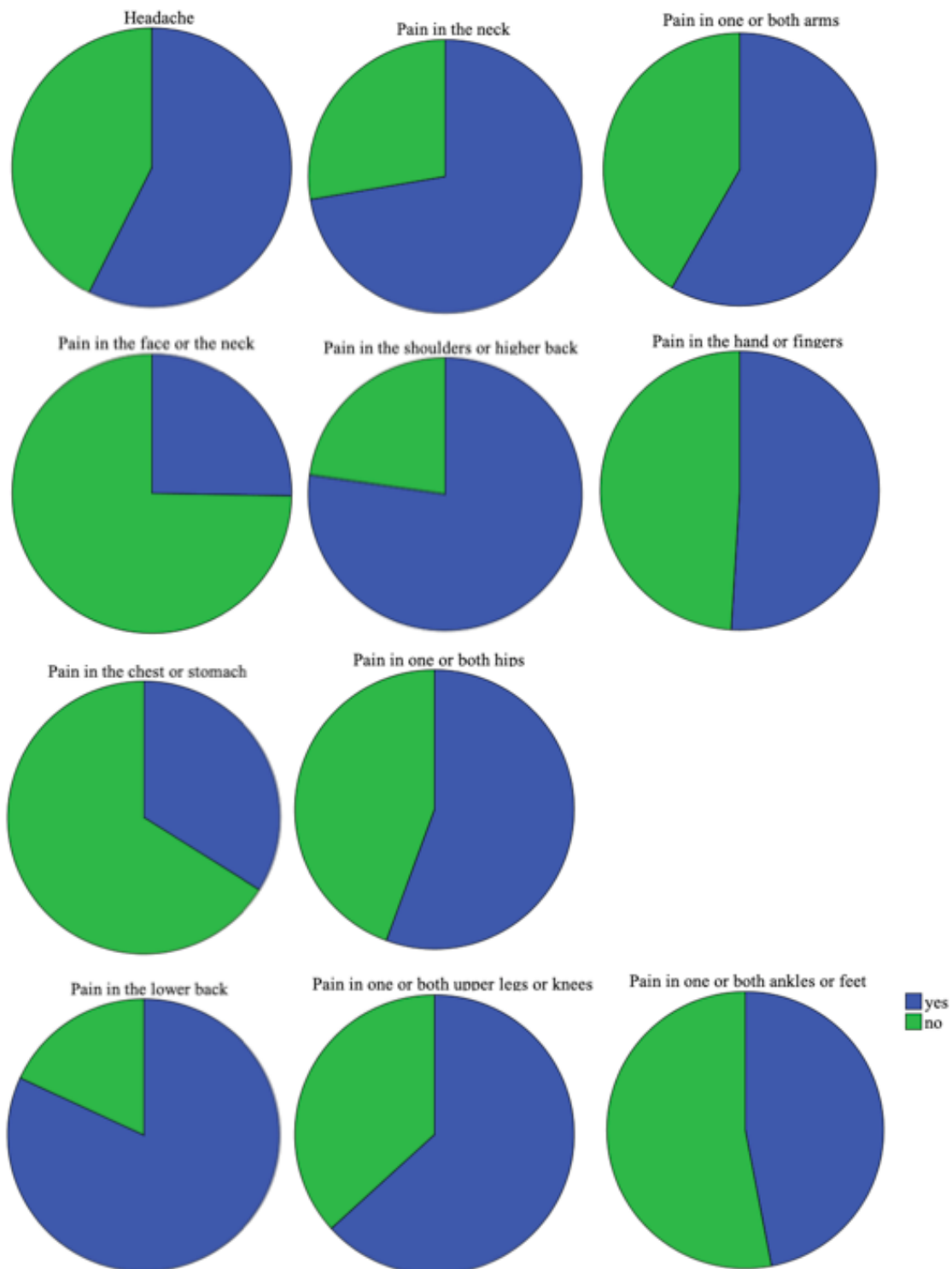
Figure A2. Overview of the different pain conditions of the participants.

Appendix B.

Table B1. Summary of Kruskal Wallis and Wilcoxon H Test of PIPS, HADS, PDI, RAND 36

Scale	Year	N	M(*SD*)	Mean Rank	χ^2	p	df	r
PIPS	2012	125	75.78 (*16.18*)	1427.64				
	2013	460	75.70 (*16.91*)	1411.41				
	2014	435	75.02 (*16.30*)	1391.50				
	2015	459	77.22 (*17.16*)	1499.88				
	2016	298	77.58 (*15.05*)	1533.94				
	2017	470	79.12 (*17.45*)	1616.76				
	2018	525	77.85 (*17.04*)	1540.27				
	2019	218	76.76 (*17.44*)	1488.35				
	Total	2990	77.02 (*17.03*)		22.760	.02	7	.42
HADS-A	2012	125	9.53 (*4.88*)	1381,46				
	2013	461	9.13 (*4.85*)	1302.90				
	2014	433	8.81 (*4.51*)	1246.41				
	2015	460	9.55 (*4.70*)	1374.27				
	2016	299	9.55 (*4.54*)	1391.04				
	2017	473	10.20 (*4.50*)	1504.92				
	2018	537	10.42 (*4.67*)	1517.58				
	2019	214	10.36 (*4.76*)	1628.73				
	Total	3002	9.69 (*4.69*)		47.281	.00	7	.86
HADS-D	2012	125	10.18 (*3.54*)	1301.94				
	2013	461	10.12 (*3.77*)	1283.59				

	2014	433	10.03 (*3.49*)	1267.65				
	2015	460	10.71 (*3.81*)	1409.91				
	2016	299	10.55 (*3.62*)	1389.07				
	2017	473	11.00 (*3.60*)	1483.95				
	2018	537	11.21 (*3.67*)	1524.37				
	2019	214	10.62 (*3.69*)	1553.72				
	Total	3002	10.62 (*3.69*)		42.303	.00	7	.77
PDI	2012	126	39.40 (*12.84*)	1234.52				
	2013	460	40.53 (*12.15*)	1308.66				
	2014	436	42.30 (*12.51*)	1434.42				
	2015	460	44.33 (*12.88*)	1588.00				
	2016	296	44.10 (*12.25*)	1565.58				
	2017	469	44.53 (*11.72*)	1579.02				
	2018	525	55.62 (*12.80*)	1590.34				
	2019	221	42.00 (*13.10*)	1485.07				
	Total	2993	43.20 (*12.72*)		53.151	.00	7	.97
RAND	2012	128	61.53 (*19.2*)	1590.49				
	2013	463	63.22 (*18.44*)	1659.47				
	2014	437	63.05 (*17.04*)	1655.46				
	2015	462	59.53 (*18.00*)	1478.78				
	2016	298	60.09 (*17.99*)	1503.78				
	2017	468	58.48 (*16.22*)	1419.09				
	2018	527	57.50 (*17.61*)	1387.55				
	2019	225	57.16 (*17.21*)	1348.83				
	Total	3008	60.05 (*17.72*)		51.139	.00	7	.93

Appendix C.

Table E1. Summary of Spearman's Rank Correlation Coefficients

Scale	Time	*Psychological Inflexibility*	*Avoidance*	*Cognitive Fusion*
HADS-A	Start	.382*	.413*	.367*
	End	.496*	.524*	.339*
	Follow up	.497*	.497*	.327*
HADS-D	Start	.472*	.523*	.285*
	End	.565*	.620*	.356*
	Follow up	.565*	.565*	.359*
MH	Start	-.389*	-.428*	-.349*
	End	-.485*	-.492*	-.359*
	Follow up	-.422*	-.457*	-.259*

* p < .001

Appendix D.

Table C1. Summary of Wilcoxon Signed Ranks Test of PIPS from 2013 to 2018

Year	Point of measurements	N	Mean (*SD*)	Neg. ranks	Pos. ranks	Z	p	*r*
2013	Ts	32	68.84 (*13.78*)					
	Te	32	62.09 (*13.60*)					
	Tf3	25	58.80 (*14.78*)					
	Ts - Te	32		21	9	-2.943	.00	.52
	Ts - Tf3	21		16	5	-2.904	.00	.63
	Te - Tf3	21		13	8	-1.061	.288	.23
2014	Ts	65	72.58 (*13.79*)					
	Te	65	65.28 (*17.83*)					
	Tf3	55	64.93 (*17.13*)					
	Ts - Te	65		45	16	-4.287	.00	.53
	Ts - Tf3	37		25	10	-2.786	.00	.46
	Te - Tf3	38		19	18	-.363	.717	.06
2015	Ts	40	67.65 (*15.19*)					
	Te	40	62.43 (*14.54*)					
	Tf3	20	63.15 (*15.74*)					
	Ts - Te	40		27	13	-2.623	.00	.41
	Ts - Tf3	15		12	3	-2.332	.02	.60
	Te - Tf3	15		8	7	-.057	.955	.01**
2016	Ts	35	72.26 (*17.51*)					
	Te	35	65.37 (*15.41*)					
	Tf3	25	57.84 (*14.95*)					
	Ts - Te	35		26	8	-3.449	.00	.58
	Ts - Tf3	21		19	1	-3.755	.00	.82
	Te - Tf3	21		11	7	-1.613	.11	.35

Year		N						
2017	Ts	40	74.10 (*14.17*)					
	Te	40	68.18 (*15.95*)					
	Tf3	23	54.09 (*13.61*)					
	Ts - Te	40		29	11	-3.026	.00	.48
	Ts - Tf3	14		9	4	-2.274	.02	.61
	Te - Tf3	15		6	6	-.157	.875	.04
2018	Ts	58	74.14 (*14.95*)					
	Te	58	67.00 (*16.29*)					
	Tf3	40	64.50 (*15.84*)					
	Ts - Te	58		38	18	-3.240	.00	.43
	Ts - Tf3	28		19	7	-3.050	.00	.58
	Te - Tf3	29		13	13	-.598	.55	.11

** based on positive ranks

Appendix E.

Table D1. Summary of Wilcoxon Signed Ranks Test of PDI from 2013 to 2018

Year	Times of measurements	N	Mean (*SD*)	Neg. ranks	Pos. ranks	Z	p	*r*
2013	Ts	64	36.67 (*10.99*)					
	Te	32	34.53 (*12.03*)					
	Tf3	25	30.88 (*14.45*)					
	Ts - Te	32		19	12	-1.530	.13	.27
	Ts - Tf3	25		14	8	-1.283	.20	.26
	Te - Tf3	20		15	5	-1.625	.10	.36
2014	Ts	178	40.17 (*10.97*)					
	Te	66	36.41 (*14.41*)					
	Tf3	56	35.18 (*14.34*)					
	Ts - Te	66		43	23	-2.781	.00	.34
	Ts - Tf3	56		36	19	2.628	.00	.35
	Te - Tf3	39		18	18	-.535	.59	.09
2015	Ts	176	41.69 (*12.12*)					
	Te	41	33.00 (*18.02*)					
	Tf3	20	40.90 (*14.84*)					
	Ts - Te	41		26	14	-2.461	.01	.38
	Ts - Tf3	20		9	11	-.374	.71	.08
	Te - Tf3	15		5	10	-1.478	.14	.38
2016	Ts	105	43.25 (*12.65*)					
	Te	36	37.42 (*16.50*)					
	Tf3	27	32.19 (*16.39*)					
	Ts - Te	36		22	13	-1.459	.15	.24
	Ts - Tf3	27		16	7	-2.679	.00	.52
	Te - Tf3	22		12	8	-1.626	.10	.35

2017	Ts	99	41.15 (*11.58*)					
	Te	42	36.86 (*13.21*)					
	Tf3	24	34.00 (*14.83*)					
	Ts - Te	42		28	11	-3.225	.00	.50
	Ts - Tf3	24		14	9	-1.218	.22	.25
	Te - Tf3	15		8	7	-.427	.67	.11
2018	Ts	120	43.28 (*10.20*)					
	Te	61	40.49 (*12.95*)					
	Tf3	41	37.37 (*14.83*)					
	Ts - Te	61		38	19	-3.176	.00	.41
	Ts - Tf3	41		28	13	-3.093	.00	.48
	Te - Tf3	39		12	14	-.102	.92	.02