Matchmaking in pain practice
Till familjen.

Det är ni som betyder mest, till slut.
Abstract


All people experience pain and for some people, acute pain may over time develop into long-term disabling problems. Already at an early stage, it is possible to identify people at risk for long-term problems and psychologically oriented interventions have been shown to successfully prevent future disability. However, not all people are helped by treatment and there is room for improvement. Moreover, subgroups of people suffering from pain, with different profiles of psychological factors have been identified, indicating that people with pain problems differ. The first aim of this dissertation was to improve the understanding of how people differ. The second aim was to use these individual differences and to match people to psychological treatment based on their psychological profile. The third aim was to explore what happens during treatment that might be important for treatment outcome.

The findings show that people who belonged to subgroups with elevated levels of psychological factors had less favorable outcomes over time, despite treatment, than people with no elevations. Moreover, people with elevations in several psychological factors had even less favorable outcomes. Psychological treatments aimed at preventing future disability performed well, but using profiles to match people to treatment did not improve outcomes further; people who were matched to a treatment and people who were unmatched had similar outcomes. However, the profiles used for matching were unstable over time and there is need to improve the identification of psychological variables used for treatment matching. Finally, a number of psychological factors were shown to be valuable targets for treatment; if the treatments successfully produced change in people’s thoughts and emotions related to pain the treatment outcomes were better. The findings were summarized in a flow chart showing the recommended clinical approach to people seeking health care for acute pain problems.

Keywords: pain, psychological profiles; psychological treatment; early intervention; secondary prevention; treatment matching.

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List of Papers

This dissertation is based on the following papers, which will be referred to by their Roman numerals.


Study IV: Bergbom, S., Boersma, K., & Linton, S.J. (2012). Both Early and Late Changes in Psychological Variables Relate to Treatment Outcome for Musculoskeletal Pain Patients at Risk for Disability. Behaviour Research and Therapy, 50(11), 726-734.

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Introduction

Physical pain is a common and inevitable part of most people’s lives. Throughout a lifetime, any human will have had a range of painful experiences, from an upset stomach before eating to an acute, crippling pain after stubbing a toe on a table-leg or a long-term back ache. Some people will experience pain to a greater extent than others. Some will even have pain most of the time throughout their lives, and pain has the potential of becoming a major obstacle for wellbeing. In the past decades, advances in the understanding of pain as a normal mechanism as well as pain as a source of suffering have been made. Yet, in many ways pain remains a mystery.

In addition to being a normal and naturally occurring phenomenon pain can be seen as one of the biggest challenges for healthcare, worldwide. Musculoskeletal pain, that is, pain from muscles, limbs and bones, is one of the most frequent reasons for general ill health and absence from work in Sweden and elsewhere (Eurostat, 2010; SBU, 2003). It affects up to 15-30 % of the population at any given point and as many as 60-70 % of the population some time in their lives (Nachemson & Jonsson, 2000). In other words, musculoskeletal pain affects individuals in terms of suffering and at the same time society in terms of cost for healthcare and decreased productivity. It is in all our interest to investigate means of understanding the mechanisms determining why people are affected by disabling pain and who risks developing problems with long-term pain, and decreasing suffering and societal expenses for musculoskeletal pain.

Historically, our view of pain has changed from being purely biomedical to including other aspects of pain experience. Indeed, it has been shown that in around 90 % of the cases musculoskeletal pain is medically unexplained (Manek & MacGregor, 2005) and there is no clear relationship between disease or injury severity and pain intensity (Kerns, Sellinger, & Goodin, 2011). In the 1960’s, a ground-breaking conceptualization of pain experience was presented: The gate control theory (Melzack & Wall, 1965). The instigators of the gate control theory suggested a crucial role of emotions and cognitions to pain experience. Building on this, contemporary theoretical models of pain include biological as well as psychological and social variables as important for pain experience (Gatchel, Peng, Peters, Fuchs, & Turk, 2007).

Recent advances in the pain field have included new formats for intervention, taking off in empirical findings of crucial mechanisms involved in
experience of pain. Successful examples of interventions include those taking into account psychological variables and aiming to alter peoples’ cognitive and emotional reactions related to pain (Morley, Eccleston, & Williams, 1999). However, interventions, despite being considered effective, do not help everyone and there is room for improvement (Vlaeyen & Morley, 2005). Moreover, there is no clear consensus regarding how to best proceed in research and in the clinic in order to handle the widely spread pain-related suffering. How might we best incorporate the current knowledge of the mechanisms of pain into clinical practice, and in what direction should we advance? How can we develop more effective treatments? And, are there ways that we can decrease, or even prevent pain-related suffering from occurring?

The paradigm shift from a biomedical problem framing to an understanding of pain as a multidimensional phenomenon has brought about advances, scientific as well as clinical. It has been shown that it is possible to identify people at an early stage of pain problem development, even as early as within hours after an injury, who risk developing long-term problems (Pearce, McGarity, Nicholas, Linton, & Peat, 2008). Brief and easily-administered instruments have been developed that can correctly identify people early on in their pain problem development (Linton & Boersma, 2003; Nicholas, Linton, Watson, & Main, 2011), and there are interventions available that have the potential of preventing long-term problems (e.g. Linton, 2002). Moreover, strategies to improve existing interventions have been suggested, such as customizing and matching interventions to individual’s problem profile (Turk, 1990, 2005). Hence, progress has been made and important findings have been presented. However, many questions remain.

The overall aim of this dissertation is to expand our current knowledge about early interventions for musculoskeletal pain, and to explore ways of improving outcomes of interventions. Another aim has been to contribute to the understanding of psychological mechanisms involved in the development and maintenance of long-term pain-related disability. The dissertation will investigate subgroups of people experiencing musculoskeletal pain and their long-term outcomes of physical therapy. Moreover, the dissertation will attempt to understand how people in different subgroups respond to psychological treatments, and if outcome of treatment is better if treatment content is matched to individual characteristics rather than unmatched or random. Finally, the dissertation will investigate the process of change throughout treatment for pain-related disability. A number of
concepts have been used to approach the aims and need to be clarified before we get to the theoretical and clinical aspects of pain problems.

**Definitions**

Within this dissertation, several concepts will be discussed and related to each other and some of them need to be clarified. The first concept is “pain”; the common denominator for the research presented. The other concept in need of clarification is “disability” and how it is related to pain. Both are described and defined below.

**Pain**

The International Association for the Study of Pain has incorporated the multidimensional approach to pain in its definition: “An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage” (IASP, 1994). This definition includes the notion that pain involves physical sensations as well as emotions, and that it is not necessarily related to factual injury or damage to the body. It is thus clear that the predominant definition of pain includes psychological aspects as well as sensorial, and that the experience of pain is only possible to determine based on subjective description.

This dissertation deals with musculoskeletal pain, mainly pain from the back, neck, and shoulders. The focus is on the transition from acute, or short-term, pain to chronic, or long-term pain problems.

**Acute, subacute and chronic pain**

The distinction between acute, subacute and chronic pain is normally made on the basis of duration of the pain problem. In order to be considered chronic or long-term pain, the pain shall “persist past the normal time of healing” (IASP, 1994). The general recommendation is that pain with a longer duration of pain than three months or in some cases six months be regarded as chronic (ibid.). Moreover, there have been suggestions to divide pain problems with a shorter duration than three (or six) months into acute pain, with a proposed duration of less than two weeks, and subacute pain with a duration of two weeks to three (or six) months (Kovacs, Abraira, Zamora, & Fernández, 2005). However, this perspective has been challenged. Among others, Nicholas et al. (2011) have argued that the point of onset of non-malignant musculoskeletal pain is difficult to determine and that most people have recurrent episodes of pain. In this dissertation, the severity of disability has been used as a
marker for chronicity and due to the arbitrary nature of duration based classifications the time frames have been given less importance.

**Disability**
Disability is a term incorporating biological, individual and societal aspects, and is described by the World Health Organization as “an umbrella term for impairments, activity limitations, and participation restriction” (World Health Organization, 2001). Within this dissertation, the concept of disability is focused on the limitation in common daily activities that the pain is perceived to result in. Disability is thus aimed to capture how limited an individual perceives him- or herself to be in daily life, rather than measuring the degree of physical impairment.

**Operationalizations**
Throughout this dissertation, variables are operationalized and measured through self-report. This is common and to some extent unavoidable when studying psychological phenomena only accessible through asking participants about their perceptions, thoughts, and feelings (Kazdin, 2010a). When available, we have chosen to include self-report questionnaires of good quality, with well-established psychometric properties.

**Theoretical framework**

**The psychology of pain**
As was mentioned in the introductory paragraphs, pain is a complex phenomenon incorporating the above mentioned psychological aspects along with many others. Understanding the full extent of pain experience is thus not an easy task. Indeed, many attempts have been made to clarify the relationship among various normal as well as pathological psychological phenomena and pain experience. These attempts can be sorted into the theoretical framework commonly referred to as “the psychology of pain” or “pain psychology”. The determinants of a person’s pain experience comprise different levels of psychological functioning, from emotional reactions to cognitive processing and behavior. In an attempt to clarify the complexity of how these psychological processes are integrated, Linton (2005b, 2013a) presented a generic model of the psychology of pain perception (Figure 1). The model is applicable to a wide range of painful ex-
periences, from acute and quickly overridden pain sensations to long-term problematic pain.

The starting point of the figure is the triggering of a nociceptive signal through the spinal cord to the brain. This triggering can happen through a tissue wound or an injury, but in some cases there is no visible injury to account for the nociceptive signal. Immediately, the stimulation draws attention to the sensation, and the affected person engages in interpretations of the stimulus and strategies such as distraction to cope with the pain. A person who, for example, is running barefoot on the beach, eager
to get to the cool water for a refreshing dip, and who suddenly steps on a piece of glass and cuts their foot thus engages in psychological processes as an immediate reaction to the nociceptive signals reaching the brain. The psychological processing is emotional as well as cognitive, and is influenced by sociological (e.g. culture, family) as well as psychological history (e.g. earlier learning). This immediate reaction to nociceptive stimuli in turn influences \textit{behavior}, and \textit{consequences} of the behavior are assimilated into the person’s learning history and will determine the probability of similar behaviors in the future. If, for example, the person were to fall to the ground and call out for help, the immediate consequences of that behavior, such as help and compassion from other people, would have the potential of determining if the person next time he or she experiences acute pain will act in a similar way. Thus, the model frames the psychology determining pain experience, and describes psychological processes that can help us understand the role of pain in a person’s functioning. Moreover, the model captures the scientific understanding of the psychology of pain, and depicts some major mechanisms that are important to investigate in research settings.

Indeed, the research on pain psychology includes a wide range of study areas from experiments carried out in laboratory settings to longitudinal studies exploring the development of pain problems over time and clinical investigations of treatment effects. Morley (2008) suggested a division of pain psychology into three categories: Research aiming at understanding the \textit{interruptive} effect of pain, research aiming at understanding how pain \textit{interferes} with people’s ability to perform tasks, and research aiming at understanding how pain can affect a person’s \textit{identity}. The three categories overlap to some extent, and put together they collect the theoretical and empirical approaches to understanding psychological mechanisms involved in the experience of pain. A suggested integration of the generic model of the psychology of pain and the three categories of psychological pain research is presented in Figure 2.
In Figure 2, the three categories of psychological pain research can be found within the generic model. One overriding theme in the generic model is the role of **learning** for pain experience; how pain influences behavior and has the potential of interfering with a person’s functioning. Indeed, the way pain **interferes** with the life of the person who is affected has been investigated from a number of perspectives (Morley, 2008) including interference of behavior through respondent and operant learning (e.g. Gatzounis, Schrooten, Crombez, & Vlaeyen, 2012; Turk, Wilson, &
Swanson, 2011). Research on learning in the pain area focuses on two mechanisms involved in the interference of pain in daily life: First, the mechanism through which pain elicits fear and activates disruption of an ongoing behavior, typically a movement that is associated with the pain: Respondent learning (e.g. den Hollander et al., 2010). And second, the mechanism through which disruption of behaviors is reinforced by a decrease in pain and in the longer run replaced by avoidance of behaviors that previously have been associated with pain: Operant learning (den Hollander et al., 2010). In sum, research on pain as interference demonstrates how pain can interfere with daily life, both in the short term and in the long term, and how it may lead to a person disrupting as well as avoiding behaviors that he or she wishes to perform. People seeking care for pain problems normally complain about the interfering effect of pain in their daily lives. The main body of research on treatment for pain-related problems has thus focused on pain as interference, and it is also within this category that this dissertation can be placed.

Research on pain as interference, in turn, includes a number of more specific theoretical models aiming at explaining mechanisms through which pain can become a factor interfering, for instance, with daily activities, other desired behaviors, and relationships. One of the most prominent theoretical models is the fear avoidance model, integrating learning theory and cognitive theories in an attempt to explain the roles of pain catastrophizing, fear, attention, avoidance behavior, depression and disability in the development and maintenance of a pain problem.

The fear avoidance model

A little more than a decade ago, a new theoretical model for the understanding of the psychology of long-term pain problems was presented; the fear avoidance model (Vlaeyen & Linton, 2000). In their formulation, the authors integrated the notion of fear of pain as a crucial mechanism for subsequent behavior, and avoidance as a key maintaining factor (Lethem, Slade, Troup, & Bentley, 1983). What is more, they acknowledged the role of pain catastrophizing as a precursor to pain-related fear (see Figure 3).
The fear avoidance model thus deals with the way pain interferes with the life of the person experiencing pain (Morley, 2008). The model suggests two alternative responses following the experience of potential injury and subsequent pain. The first possible route does not involve neither catastrophic thoughts nor fear, and consist of confrontation of daily activities and eventually recovery from pain. The second possible route involves pain catastrophizing, which is hypothesized to lead to fear of the pain and/or activities related to the pain. The fear is the followed by avoidance of the activities and increased vigilance towards bodily sensations. In the longer run, avoidance and hypervigilance towards the body may lead to disability, depression, and disuse, that is, biomedical changes such as deteriorations in muscular strength. Hence, when a person experiences an injury or increase in pain for any reason, this person can thus respond in different ways to the pain. If the pain experience triggers catastrophic thinking about the pain, the person also risks becoming fearful and start avoiding any activities related to pain while at the same time paying a lot of attention to changes in the pain perception. After avoiding activities
and possibly generalizing the avoidance to other activities, there is the risk that the person becomes significantly disabled by the pain and he or she may also risk developing depression due to a decrease in positively reinforced behaviors. Both disability and depression have the potential of further aggravating the person’s pain problem, constituting the final link in a vicious circle. The model thus posits a suggestion on psychological processes that are crucial for the route towards long-term problems with pain, and how they may function together.

The fear avoidance model has generated considerable research. Since it was presented in 2000, the model and its components have been evaluated empirically using different methodologies (e.g. Leeuw et al., 2007; Wideman, Adams, & Sullivan, 2009; Vlaeyen, Crombez, & Linton, 2009) and the model has been discussed, elaborated and extended (Asmundson, Norton, & Vlaeyen, 2004; Crombez, Eccleston, Van Damme, Vlaeyen, & Karoly, 2012; Vlaeyen & Linton, 2012). Moreover, specific treatment approaches for problematic pain conditions have been presented, such as graded exposure in vivo for pain-related fear and avoidance (Boersma et al., 2004; Leeuw et al., 2008; Vlaeyen, de Jong, Geilen, Heuts, & van Breukelen, 2001, 2002; Vlaeyen, de Jong, Leeuw, & Crombez, 2004). The model has thus given rise to a substantial line of research that has expanded our knowledge of the processes involved in determining when, why and for whom pain becomes a severe and disabling problem.

Hence, in addition to the physical sensation of pain and the influence of pain on physical function, pain is also related to a number of psychological phenomena (Nicholas et al., 2011). This dissertation investigates and touches upon several of them, and the central psychological concepts are defined below.

**Psychological aspects of pain experience**

The psychology of pain explores how a person may react emotionally, cognitively and behaviorally in relation to pain. The studies in this dissertation have included key emotions, cognitions and behaviors and focused on the investigation of five important variables: Depressive symptoms, anxiety, pain catastrophizing, worry, and fear and avoidance.

Depressive symptoms and anxiety

In many studies reviewing psychological factors related to musculoskeletal pain, *distress* is mentioned as one key variable (Linton, 2000; Nicholas et al., 2011; Pincus, Burton, Vogel, & Field, 2002). Distress, or emotional
distress, is a concept occurring in everyday language as well as in scientific definitions. Informally, “distress” comprises “a feeling of extreme worry, sadness or pain” (Cambridge Dictionaries Online, n.d.) or “pain or suffering affecting the body, a bodily part, or the mind” (Merriam Webster's online dictionary, n.d.). Thus, the term “distress” can comprise many aspects of psychological ill-health and has for scientific purposes been clarified and defined further. In the pain area, distress is generally conceptualized as a psychological phenomenon incorporating depressive symptoms (Pincus et al., 2002) as well as anxiety and other symptoms (see e.g. Severeijns, Vlaeyen, van den Hout, & Weber, 2001). Consequently, for the purpose of conceptual clarity, distress has in this dissertation been defined as and separated into the two variables depressive symptoms, sometimes referred to as depressive mood, and anxiety.

Pain catastrophizing
Pain catastrophizing is another well researched aspect of psychological functioning in relation to pain. Currently, pain catastrophizing is defined as “an exaggerated negative ‘mental set’ brought to bear during actual or anticipated painful experience” (Sullivan et al., 2001). The definition thus includes a description of pain catastrophizing as being a cognitive process, more intense than expected given the circumstances, negative in nature, and occurring when a person experiences or expects to experience pain. It aims to capture the experience of repeatedly thinking about the pain, the tendency to expect the worst outcome of the pain, and the feeling of being unable to influence the pain in any way (Sullivan, Bishop, & Pivik, 1995).

Pain-related worry
According to the predominant psychiatric definition, worry is a concept related to anxiety as well as depression, and can be described as an avoidant strategy that a person engages in, in attempts to problem solve (Andrews et al., 2010). When compared to anxiety, the definition of worry focuses on the thinking process while anxiety incorporates physiological arousal to a larger extent (e.g. Andrews et al., 2010; Brown, Antony, & Barlow, 1992). In the pain area, the concept of worry includes repetitive thoughts concerning causes and consequences of the pain problem, and is closely connected to fear and avoidance beliefs (Von Korff et al., 1998).
Fear and avoidance
Fear and avoidance are mechanisms suggested to play a role in the perpetuation of a pain problem (Lethem et al., 1983; Vlaeyen & Linton, 2000). Conceptually, fear and avoidance is often operationalized in terms of beliefs or persuasions about a relationship between a behavior and a painful consequence (Kori, Miller, & Todd, 1990). Fear and avoidance is closely related to anxiety as well as worry.

Overlap and distinctions
All of the above mentioned concepts are linked to one another, and may share different amounts of variance. This overlap has sometimes been brought up in the literature as a weakness, leading to difficulty determining the impact of each concept on pain (e.g. Linton, Gross, et al., 2005). However, the overlap is seldom total and the concepts chosen for analysis in this dissertation have all been shown to contribute uniquely to the variance in outcomes. Moreover, the concepts capture different qualities of a painful experience; some are primarily emotional, some are primarily cognitive, and some primarily involve behavior. Figure 4 captures a hypothesized overlap among the psychological concepts included in this dissertation, giving a visual overview of how they overlap and at the same time have the opportunity of contributing uniquely to variation in outcomes. Please note that the amount of variance shared between concepts varies depending on population, definition and means of measurement.

Hence, the psychology of pain includes a general understanding of psychological mechanisms as important for the pain experience in many ways. Moreover, the identification of important psychological mechanisms and their interrelationships has contributed to the more specific understanding of how pain has the ability to interfere with people’s lives and affect their functioning both in the short and in the long term. This knowledge has, among other areas, been applied to the understanding of why some people overcome a pain problem rather quickly and why some people develop chronic problems.
Figure 4. Illustration of the hypothesized overlap between depressive symptoms, anxiety, pain-related worry, fear and avoidance, and pain catastrophizing as they are used in this dissertation. Please note that the amount of overlap is not proportionate and differs depending on population and means of measurement.

**Development of chronicity**

Musculoskeletal pain is common, and the majority of people experiencing pain in the back, neck and shoulders improve within a few weeks. However, between 10 and 20 % of the people who experience an acute episode of back pain do not fully recover and the pain persists (Andersson, 1999). In line with the findings indicating a weak link between injury and pain intensity along with the high rate of medically unexplained pain (i.e. pain with no clear biomedical etiology), research has shown that psychological and psychosocial predictors are the most powerful in identifying who will develop a chronic pain problem and who will not (Nicholas et al., 2011). Hence, the psychological processes for people with acute or subacute pain need to be in focus when attempting to understand the transition from short- to long-term pain problems.
From acute to chronic pain

When a pain problem changes in nature from an acute or subacute problem into a long-term, disabling problem, a number of psychological factors are in action. Many are included in the theoretical models mentioned above, and separately or together they fuel to spawn aggravation of pain-related disability. When reviewing the literature on variables associated with future pain-related disability, Main, Kendall, and Hasenbring (2012) concluded that a number of well-known psychological variables function as moderate to strong predictors of future problems. Included among those variables relevant for the understanding of the transition from acute to chronic pain are the person’s perception of his or her general health, psychological distress, depression, fear and avoidance beliefs, pain catastrophizing and pain behavior. There are thus numerous psychological variables that statistically act as predictors for later problems. It is of utter importance to bring this knowledge into the clinic (Nicholas et al., 2011), and one area for implementation is to assess people seeking for pain in terms of psychological functioning. Assessment would enable early identification and risk assessment, with the purpose of altering prognosis and preventing future development of pain-related disability.

Risk assessment

When a person seeks health care for an episode of pain, may it be acute or subacute, or even recurrent, there are ways of attempting to predict the future development of the pain experience for that certain person. Variables that are associated with the future development of a disease or condition such as chronic pain can be conceptualized as risk factors (Main et al., 2012). Risk factors are thus variables that can determine the risk for an unwanted outcome. The recognition of risk factors may for example be useful for clinicians who want to investigate which patients will improve with no or brief interventions and which patients will be worse off over time (Nicholas et al., 2011). Hence, using the current knowledge about psychological variables related to future pain-related disability and is one way of predicting future development for a person, and selecting patients who might be in need for specialized interventions.

Screening

As the vast majority of people experiencing acute back pain will improve quite rapidly (Andersson, 1999), there is a need to identify those who will not in order to make effective clinical decisions. For people who present
Several structured instruments for assessment of risk factors have been developed. The common purpose of these instruments is to screen people at an early stage of pain problem development, and to identify and select those who are at a higher risk for long-term disability and sick leave (Linton & Boersma, 2003). In the longer run, the selection of people will allow for early interventions aimed at those who are at higher risk, and for screening out people who will improve anyway. There are two main approaches to screening of psychological risk factors; both approaches focusing on cut-off (who will be “screened out” and who will be “screened in”) but one approach involving a focus on content and one approach involving a focus on levels of risk (“high”, “medium” and “low”).

One widely spread screening instrument is the Örebro Musculoskeletal Pain Screening Questionnaire (ÖMPSQ; Linton & Halldén, 1998), a self-administered screening instrument comprising 25 items where the person is asked to rate their levels of the most important risk factors such as depressive symptoms, catastrophizing and fear avoidance beliefs on 10-point likert-type scales. Moreover, the questionnaire includes similar ratings of pain intensity and disability. The ÖMPSQ has been shown to correctly identify around 80% of the people who will develop future problems (Boersma & Linton, 2002; Hockings, McAuley, & Maher, 2008; Linton & Boersma, 2003), and in addition to guiding the clinician when determining who is in need of specialized interventions the questionnaire can give the clinician ideas about what is needed in terms of intervention. The ÖMPSQ can thus be considered an example of the content approach; it can be used to “screen in” and “screen out” based on a cut-off score, and the ratings in the questionnaire can also give cues as to what characterizes each individual’s specific problem in terms of psychological risk factors.

Another example of instruments used for screening of people at an early stage of pain problem development is The STarT Back Tool (SBT; Hill et al., 2008). This instrument is briefer than the ÖMPSQ, allowing for easier administration. It involves 9 items with dichotomous response alternatives (“agree” or “disagree”), and contains psychological variables predictive of poor prognosis such as fear, catastrophizing, depressive symptoms and anxiety. The purpose of the SBT is to assign people into one of three risk levels; high risk, medium risk, and low risk, and it can thus be considered to belong to the second screening approach.

Both approaches have proven effective for their common purpose, to facilitate clinical decision making by identifying people who are at a high-
er risk for long-term pain-related disability (Hill, Dunn, Main, & Hay, 2010). However, while the SBT may be easier to administer the ÖMPSQ allows more in-depth understanding of the individual characteristics in terms of psychological functioning.

Profiles of risk factors
While the screening instruments have contributed a great deal to the clinical decision making and the psychological assessment of people seeking health care for pain, a rather recent line of research has extended the classification of people with the expressed aim of describing the clinical characteristics of their pain problem. Using person-oriented methodologies, researchers have succeeded in identifying subgroups of people with pain, with distinctively different profiles of psychological risk factors.

Focusing on the most prominent risk factors for pain-related disability included in the ÖMPSQ, Boersma and Linton (2005) were able to identify four separate subgroups of people at risk for pain-related disability. The four subgroups presented with distinct psychological profiles in terms of pain intensity, fear and avoidance beliefs, function, and depressive mood. Two subgroups were categorized by no or small elevations in terms of depressive mood and fear and avoidance and had close to no occurrence of sick leave after one year. Remaining subgroups however, characterized by elevations in fear and avoidance only and fear and avoidance along with depressive mood, had much higher rates of sick leave during the same time span. Moreover, the subgroup with elevations in both fear and avoidance and in depressive mood had by far the highest rates of sick leave. The subgroups thus differed at baseline in terms of patterns of elevations in psychological variables, and these differences were clearly related to development of pain-related disability over time. These results contributed both to the understanding of how patterns of elevations may have impact on risk for pain-related disability, and also which psychological variables might be the most important to assess and target in treatment.

These findings were extended in a subsequent study investigating subgroups in another sample of people with musculoskeletal pain (Boersma & Linton, 2006). Rather than using the ÖMPSQ to subgroup people, the authors used longer self-rated questionnaires with good psychometric properties to measure catastrophizing, fear and avoidance, and depressive mood. They were able to replicate the finding of one subgroup characterized by fear and avoidance along with depressive mood, one subgroup characterized by fear and avoidance only, and one subgroup characterized
by no elevations in psychological risk factors. Moreover, in addition to these subgroups the authors found one subgroup characterized by elevations in depressive mood only, and one subgroup with moderate elevations in fear and avoidance. Despite slight differences in the profiles, the pattern of outcome was replicated. The three subgroups characterized by fear and avoidance or depressive mood, or both, reported higher rates of sick leave and more healthcare visits than the other two subgroups after seven months. Moreover, people in these three subgroups were worse off in terms of disability. These findings lend further support to the notion that fear and avoidance and depressive mood are crucial mechanisms for the development of a long-term pain problem and that it is of importance to target these variables in treatments aiming at preventing future problems.

The identification of subgroups within the population of people at risk for or already suffering from pain-related disability have been replicated and extended even more. For example, a study from primary care in Sweden could demonstrate that subgroups reporting different levels of self-efficacy and fear and avoidance beliefs had significantly different outcomes (Denison, Åsenlöf, Sandborgh, & Lindberg, 2007). Another study could demonstrate subgroups in a sample of people with chronic pain (Westman, Boersma, Leppert, & Linton, 2011); thus, the psychological risk factors can be considered viable variables not only to assess risk but may also function as maintaining factors for a chronic pain problem. Finally, the findings have been extended to yet other populations. One recent study could identify distinct subgroups within a population of workers where work-related risk factors were included along with psychological risk factors (Reme et al., 2012). Hence, researchers have succeeded in identifying subgroups in several populations and at different stages of problem development, again indicating the importance of psychological variables for pain-related suffering.

Implications of subgroups for intervention

The identification of subgroups of people at risk for or already suffering from long-term pain-related disability has multiple aims and can contribute to the understanding of psychological processes involved in pain in many ways. First, the analyses identify variables and combinations of variables that, if elevated, may function as important risk profiles for the development of long-term pain. Second, and even more importantly, the qualities of risk factors and combinations that are identified have the potential of giving cues as to what is needed in terms of intervention. The
patterns revealed by the profiles easily inform clinicians about similarities and differences between people in different subgroups, and what key targets of treatment might be. Subgrouping might be a way of addressing a key challenge in pain research: How can we alter the prognosis for people with elevations in risk factors?

**Psychological treatment of pain disability**

Psychological interventions for pain-related disability, mostly interventions within the cognitive-behavioral spectrum, have been implemented and investigated since the 1970’s (Williams, Eccleston, & Morley, 2012) and are today well established in pain practice (Morley, Williams, & Eccleston, 2013). The effects of psychological treatments have been quite stable across trials with moderate effect sizes, and while they vary in content there are common denominators concerning focus and goals of treatment.

**Targets of treatment**

When developing treatments, independent of area, there are underlying assumptions as to how the treatments will affect the outcomes that one wants to affect. Theoretical models in general formulate hypotheses about mechanisms through which psychological treatments may function but there is still little available evidence of what makes psychological treatments work (Kazdin, 2007). In treatment for chronic pain, the target of treatment is oftentimes the same as the outcome; in the case of disability, for example, when people are already disabled treatments can target the disability directly through activity increases and physical exercise. Recent findings however point to psychological variables as important targets for treatment in studies showing superior outcomes of interventions specifically targeting psychological reactions to pain when compared to interventions not specifically addressing psychological variables (e.g. Vibe Fersum, O'Sullivan, Skouen, Smith, & Kvåle, 2012). Despite that the findings are inconsistent (Kent & Kjaer, 2012) they are indeed of high interest for interventions implemented at an earlier stage of problem development. Early on in the pain history, people might not yet be disabled by their pain and disability is hence not a viable target for treatment. The focus needs to be on the mechanisms through which the person in the longer run risks developing disability. The underlying assumption is that treatments will prevent a person from becoming disabled by the pain through affecting target psychological mechanisms.
Among the few available findings from early interventions in the pain field, there have been indications that changes in psychological variables throughout treatment are indeed associated with changes in outcomes (Jensen, Turner, & Romano, 1994, 2001; Tota-Faucette, Gil, Williams, Keefe, & Goli, 1993). Hence, if people participating in treatment improve in terms of depression, pain catastrophizing, and other variables important for the prognosis, the chance that they improve in terms of disability and other outcomes is higher. Or, as suggested recently by Nicholas et al. (2011), the usage of psychological risk factors can be extended and risk factors with empirical support can be used also as targets in treatment. Available theoretical models, such as the fear avoidance model, can give cues as to the psychological mechanisms through which treatments produce change.

In sum, while more in-depth studies of treatment mediators are needed the available evidence suggests that targets of treatment should be variables that are possible to modify, that are theoretically related to outcomes, and that have previously been shown to be empirically associated with outcomes.

Process
Closely related to the decisions of targets of treatment is the notion of therapeutic process. In psychotherapy research, a key area for investigation is the one involving treatment mediators (Kendall, Holmbeck, & Verduin, 2004). Mediators for treatment are variables through which a treatment impacts on an outcome (Baron & Kenny, 1986). Hence, a modifiable treatment mediator would be an appropriate target for treatment. Based on the fear avoidance model, the treatments included in this dissertation are hypothesized to have an effect on the outcomes through changes in catastrophizing, fear and avoidance beliefs, avoidance behaviors, and depressive mood. These variables are thus hypothesized to function as treatment mediators and the treatments are developed to target these variables.

Another area for discussion has been about timing of treatment change; that not only how people report change during treatment is important for outcome but also when people report change. Some evidence from patients participating in psychological treatment for depression or mixed psychological complaints suggests that early change as opposed to late change is related to treatment outcome (Fennell & Teasdale, 1987; Haas, Hill, Lambert, & Morrell, 2002; Ilardi & Craighead, 1994). This issue has been
largely unattended in research investigating outcome of psychological treatment for pain problems, but there is some evidence indicating a similar temporal pattern (Burns, Glenn, Bruehl, Harden, & Lofland, 2003; Burns, Kubilus, Bruehl, Harden, & Lofland, 2003; Sullivan, Adams, Thibault, Corbière, & Stanish, 2006). However, the inclusion of timing of change as a variable explaining difference in outcome needs more scientific attention.

Outcome
The main aim of most psychological treatments in the pain area is to counter and prevent pain-related disability. Disability can be assessed through self-report, generating a measure of perceived disability, or through more objective measures such as sick leave. The main outcome in treatments included in this dissertation is thus disability, measured both through self-report and through accounts of sick-leave. Moreover, the dissertation includes secondary outcomes aiming to capture a more thorough picture of people’s well-being. Secondary outcome variables include perceived health status and pain intensity.

Treatment and early intervention
Interventions targeting psychological variables of importance for the development and maintenance of pain-related disability may operate not only through the targeting of different variables, but also at different time points in the transition from acute to chronic pain problems. The majority of the RCTs and consequently the meta-analyses performed within the area concern treatments for chronic pain (Williams et al., 2012). However, an important line of research is the one investigating secondary preventive approaches, that is, interventions aimed at preventing the transition of acute pain into chronic pain-related disability (Linton, 2002). Given the definitions of acute, subacute and chronic pain the framing of an intervention (as a treatment for chronic pain problems or as an early intervention) can be decided either by the factual duration of pain or by the severity of disability. Using time frames to define the category of treatment results in an intervention implemented within three to six months from onset being framed as an early intervention, and an intervention implemented when the pain has already caused long-term disability being framed as a treatment for chronic pain. In contrast, this dissertation aims to investigate early preventive interventions for people seeking health care for a pain problem, who at inclusion are not yet chronically disabled by their pain.
problem independent of the first onset of pain. The investigation takes place in two different populations: One sample of people seeking primary care physical therapy for pain problems, and another sample of people participating in psychologically informed early interventions in the context of occupational health care.

**Formats of treatment**

Pain and pain-related disability can be approached, from a psychological perspective, in a number of different ways. Coming back to the division of pain psychology research into three categories (Morley, 2008), common to all psychological and psychologically informed interventions for pain is their focus on pain as interference and psychological processes involved in the interfering effects of pain. In this dissertation, we have investigated three main formats of psychological interventions for secondary prevention of pain-related disability. All three approaches intervene with how pain interferes with peoples’ functioning in daily life, but through different hypothesized process variables: Operant activity, based on learning principles with physical function as its main target, graded exposure in vivo based on the fear-avoidance model with fear of pain and/or reinjury as its main target, and a broader cognitive behavior therapy treatment with worry, depression, and problem solving as its main targets. All three interventions can be conceptualized as cognitive-behaviorally oriented therapies, with theoretical foundation in learning theory and the fear-avoidance model.

**Operant activity**

One of the first approaches to the psychological treatment of pain-related disability was based on learning theory and mainly the principles of operant conditioning (Fordyce et al., 1973). The main aim of operant activity training is to increase healthy behaviors and physical activity through the use of positive reinforcement (Leeuw et al., 2008). The positive reinforcement following pain behaviors (i.e. attention) is replaced with positive reinforcement following activity increase and can be conveyed in multiple ways: Through praise from the therapist or relatives such as a spouse, and through the use of graphical registrations of activity performance (Leeuw et al., 2008). The basic principles are still commonly used, often under the name “Graded activity” (see e.g. George, Fritz, Bialosky, & Donald, 2003; George et al., 2008; Leeuw et al., 2008) and they have been concluded to be more effective than no treatment or usual care for some outcomes.
Matchmaking in pain practice (Henschke et al., 2010). Hence, principles of operant activity and activity increase can be viewed as evidence-based for pain-related disability and a cornerstone in pain rehabilitation programs.

Exposure in vivo
A rather recent approach to the treatment of pain-related fear and associated disability is the application of exposure in vivo techniques, traditionally used in treatment of anxiety. Even though exposure in vivo was suggested in the treatment of chronic pain as early as the mid 1980’s (Philips, 1987), in its current form the treatment can be viewed as a clinical application of the theoretical development in the field, driven by the introduction of the fear-avoidance model (Leeuw et al., 2007; Vlaeyen & Linton, 2000).

The main purpose of exposure in vivo is to decrease pain-related fear through the gradual exposure to fear-provoking movements and activities (Vlaeyen et al., 2001). The treatment is thus tailored to fit people who report significant levels of fear associated with pain and movement (Leeuw et al., 2008; Linton et al., 2008), indicating that it will not necessarily be helpful for all people suffering from pain-related disability. In line with this assumption, the evidence so far originates from studies where people participating have been selected on the basis of at least moderate levels of pain-related fear (e.g. Leeuw et al., 2008). Available studies indicate that exposure in vivo is a viable treatment with promising results in terms of pain-related fear, pain catastrophizing, avoidance and pain-related disability (Boersma et al., 2004; Leeuw et al., 2008; Vlaeyen et al., 2001, 2002; Vlaeyen & Linton, 2012). Exposure in vivo can thus be viewed as being an evidence-based treatment for pain-related disability.

Cognitive behavior therapy
Cognitive and behavioral treatment (CBT) techniques are often collected into a “package” aimed to target a broad range of issues commonly related to pain. Despite large differences in terms of content, these treatment packages are generally developed to target problematic thoughts, such as catastrophizing, and mood, such as depressive symptoms, as well as problematic behaviors, such as avoidance (see e.g. Williams et al., 2012). Included techniques are among others patient-oriented education about pain and the psychological models of pain, increase in physical and social activities, problem solving techniques and management of stressful situations (Linton, Boersma, Jansson, Svärd, & Botvalde, 2005). Numerous system-
atic reviews and meta analyses have concluded that CBT-treatments administered individually or in group formats are beneficial for people with long-term pain-related disability and that they produce small to moderate effects in outcome variables (Williams et al., 2012). Hence, in addition to operant activity and graded exposure in vivo also CBT treatment delivered in a “package” format can be viewed as an evidence-based treatment for pain-related disability.

All in all, cognitive-behaviorally oriented therapies seems to be beneficial for people reporting long-term pain-related problems, but the effects have been argued to be quite modest (Vlaeyen & Morley, 2005). In terms of early intervention, CBT has also been shown to produce better outcomes than no treatment (e.g. Linton & Andersson, 2000; Linton, Boersma, et al., 2005; Schiltenwolf et al., 2006; van den Hout, Vlaeyen, Heuts, Zijlema, & Wijnen, 2003). However, again, the effects are rather small and several prominent clinical researchers have called for new approaches to treatment in order to enhance treatment effects for early interventions (e.g. Williams et al., 2012; Vlaeyen & Morley, 2005). Randomized controlled trials administering manual-based broad-spectrum CBT treatments have been performed, and there is a need to investigate interventions more carefully.

Might it be so that the age of randomized controlled trials with waiting-list control groups is over? Are there ways that we can adjust treatment content to peoples’ particular needs? Might it be time to investigate tailoring of treatments to individuals?

Enhancing treatment effects

The habit of offering the same type of treatment to a large group of people with the same medical diagnosis or pain in the same area of the body can be seen as a result of the “patient uniformity myth” or the idea that all people participating in treatment are similar in all important aspects (Turk, 2005). Throughout this introduction, we have seen that this is hardly the case. It is possible to identify subgroups of people with distinctly different patterns in terms of important psychological variables, and these different patterns have traditionally been disguised in treatment outcome studies. However, the current theoretical and scientific development has allowed for new approaches to the investigation of treatment efficacy and effectiveness (Morley et al., 2013). Merely a few examples of the integration of subgroups into treatment outcome studies have been published,
with slightly different methodologies. This is an area demanding more scientific attention.

**Stratifying**
Recently, a group of researchers in Great Britain implemented an interesting procedure with the aim of taking subgroups into consideration when offering treatments to people seeking primary care for back pain. They called their procedure “stratified primary care management for low back pain”, and the principle goal was to determine the risk level of each person who was included, and then adapt the intensity of treatment to level of risk (Hill et al., 2011). Risk level was determined using the STarT Back Tool taking psychological risk factors into consideration (Hill et al., 2008). Three levels were possible: Low risk, leading to a one-session physiotherapy intervention, medium risk, leading to a more extensive physiotherapy intervention, and high risk, leading to a psychologically informed physiotherapy intervention. People in the experimental condition were allocated to treatment based on these risk levels, and people in the control condition were allocated to treatment based on the physiotherapist’s clinical judgment. The main findings indicate that the use of risk factor screening and allocation to treatment based on risk level results in better outcomes in terms of disability. However, the observed differences between the experimental group and the control group were rather small and while the approach is interesting and the results are promising, more research is needed.

**Matching**
Another approach to the integration of individual differences in psychological risk into treatment administration is to take the quality of the individual differences into account. This would imply identifying psychological variables that are determinants of outcome in certain ways, and developing interventions aimed at differentially targeting these variables. This approach can be conceptualized as customizing and matching treatment to individuals or groups of individuals (Turk, 2005).

**Suggested strategies for matching**
Turk (2005) published a theoretical review focusing on the patient uniformity myth within research on treatment for chronic pain, and possible approaches to treatment matching. In this review, the author brought up a number of strategies for subgrouping people with pain-related problems,
and how this knowledge could be ground for treatment matching. Common to all strategies is the attempt to identify qualitatively different subgroups, either through biomedical or biomechanical processes or psychological or psychosocial processes. Moreover, common to the strategies is the attempt to develop tailored treatments aiming to target and alter the processes of interest.

Up until now, the available evidence for matching treatment to subgroups of people originates primarily from the retrospective identification of subgroups and investigation of their differential treatment response. For example, a rather early attempt was to use the Minnesota Multiphasic Personality Inventory (MMPI) to categorize patients and to investigate how people with different personality profiles responded to treatment (Guck, Meilman, Skultety, & Poloni, 1988; McGill, Lawlis, Selby, Mooney, & McCoy, 1983; Moore, Armentrout, Parker, & Kivlahan, 1986; Swimmer, Robinson, & Geisser, 1992). The general pattern was that some outcome differences could be identified for the different subgroups. To our knowledge, no study has been realized using this knowledge to develop interventions targeting the specific problem profiles from the MMPI. More recent approaches have included psychological processes and investigated differential treatment responses for different subgroups. For example, Turk, Okifuji, Sinclair, and Starz (2005) retrospectively identified subgroups based on disability, psychological distress and pain intensity and could demonstrate that people in the different subgroups responded differentially to treatment. Other studies have identified similar subgroups but found no differential effects of interventions (Gatchel et al., 2002; Walen, Cronan, Serber, Groessl, & Oliver, 2002). Another recent example involved fear and avoidance beliefs as a key risk factor (George et al., 2008). The authors investigated the effects of graded activity and graded exposure for people with pain, but could find no support for the hypothesis that people in a subgroup with elevations in fear and avoidance beliefs would benefit more from graded exposure in vivo than from graded activity.

In sum, the research about matching treatment to subgroups up until now is mainly based on retrospective investigations and the findings are mixed. Despite this, the need for customized treatments and systems for matching is often expressed in the literature. Hence, there is a clear need for hypothesis-driven investigations of differential treatment response for subgroups of people with pain complaints seeking health care.
Using risk factors for matching
Among the number of ongoing processes that can function as determinants of who will develop long-term pain problems and who will not, some are crucial to the development such as pain catastrophizing (Sullivan et al., 2001) and fear and avoidance beliefs (Vlaeyen & Linton, 2000). Moreover, some may act together and might need special attention. For example, ongoing pain catastrophizing and depressed mood have been identified as two processes that can act together to worsen prognosis and treatment outcome further (Linton et al., 2011). Common to these variables is that they are potentially modifiable, and that there are developed and evidence-based treatment interventions that aim to target them. Hence, an appealing suggestion is to further extend and implement the current knowledge of modifiable risk factors, ongoing psychological processes, and effective treatment interventions and to match psychological profiles with treatment.

Aims and research questions
To date, researchers and clinicians have developed the understanding of psychological mechanisms that are important for pain. This knowledge has been applied and is currently used for both risk assessment and interventions for people with pain complaints who seek health care. For example, risk factors such as depression, anxiety, pain catastrophizing, and fear and avoidance beliefs have been identified as contributors to the development of long-term pain-related disability. Moreover, brief instruments have successfully been used to identify people who are at a higher risk of long-term problems. Finally, the important variables have been targeted in early interventions. However, while it is possible to screen people in pain and help those people at an early stage of problem development, neither screening procedures nor interventions are optimal and there is room for improvement. Specifically, screening routines and CBT programs are general and more specificity in screening and intervention may improve outcome through matching and targeting. That is, early psychologically informed interventions for pain related disability could possibly be improved by increased awareness of individual variability and improved tailoring of treatments.

Hence, this dissertation has numerous goals. The vision was to bridge the gap between pain theory and pain practice. The first aim was to understand the variability in psychological risk factors for people seeking health care for pain complaints. This aim was approached through the
identification of subgroups of pain patients with different patterns of risk factors, and through exploring how patterns of risk factors are related to treatment outcome. The second aim was to implement the knowledge about individual variation in psychological risk profiles to realize theoretically and empirically informed treatment matching. This aim was approached by administering three evidence-based, psychologically informed treatments and matching these treatments to three distinctively different subgroups of people with musculoskeletal pain. The third aim was to improve the understanding of treatment processes, and how treatment processes can be important for treatment outcome. This aim was approached through the investigation of how changes in risk factors occur throughout treatment, and how these changes are related to treatment outcome.

The overarching research questions were:

1. What are the key processes that should be targeted in early intervention for pain problems?
2. Can early interventions for pain problems be improved if people are matched to a treatment specifically targeting their risk factor profile?

The specific research questions were:

Study I

1. Are there subgroups of people with different profiles of pain catastrophizing and depressed mood within a population of people seeking physical therapy for pain?
2. Do people maintain similar profiles across physical therapy treatment?
3. Is subgroup membership at baseline related to outcome of physical therapy?

Study II

1. Do people participating in early preventive interventions for pain-related disability improve in terms of primary and secondary outcomes?
2. Do people who are matched to a treatment, based on their psychological profile, have better outcomes than people who are unmatched?

Study III

1. Are simple profiles used for subgroup assignment stable over time?
2. How do simple profiles used for subgroup assignment correspond with more thorough assessment and profiling using full validated questionnaires?

Study IV
1. Do psychological variables change during early interventions for pain-related disability? If so, to what extent?
2. Are early changes or late changes in psychological variables better predictors for outcome in terms of disability, perceived health status, and pain intensity?
Empirical studies

The empirical studies included in this dissertation are based on samples from two different populations of people seeking health care for pain complaints. Both populations are approached at an early stage of pain problem development, and the interventions included in the studies can be framed as early interventions.

The first population, investigated in Study I, is people seeking physical therapy within primary care. They participated in an earlier study with two main aims. The first aim was to investigate the effect of a university course on physical therapists’ knowledge about the role of psychosocial variables for development of long-term pain problems (Overmeer, Boersma, Main, & Linton, 2009). The second aim was to investigate whether patients of physical therapists who had participated in the university course had better treatment outcomes, than patients of physical therapists who had not participated in the university course (Overmeer, Boersma, Denison, & Linton, 2011). In Study I, we included the patients and their treatment outcomes. We investigated the patients’ psychological profiles at baseline, and the relationship between psychological profile and outcome of treatment.

The second population, investigated in Study II through IV, is people seeking occupational health care. In these studies, we aimed to apply the existing knowledge about psychological risk factors and psychological profiles. We matched people to psychological treatments, based on their psychological profile, and investigated if people who were matched to treatment had better treatment outcomes than people who were not matched. Study II presents the main findings regarding the effects of matching. Study III is an in-depth follow up study investigating the psychological profiles used to allocate participants to treatment more in detail, and Study IV focuses on change processes occurring throughout treatment.

All studies included in the dissertation have been reviewed and approved by the Regional Ethical Review Board in Uppsala, Sweden.
Study I

Relationship Among Pain Catastrophizing, Depressed Mood, and Outcomes Across Physical Therapy Treatments

Introduction

Although most people experiencing musculoskeletal pain recover, some will develop long-term disability (Reid, Haugh, Hazard, & Tripathi, 1997). The importance of psychological factors for identifying who will and who will not develop disability has been underscored numerous times (Linton, 2005a). One of the leading theoretical models, the fear-avoidance model (Vlaeyen & Linton, 2000), proposes relationships between different psychological factors and development of long-term problems. Among other ideas, the model puts forward that catastrophic thoughts about pain sensations (i.e. pain catastrophizing) in the long run will lead to depression and functional disability. However, recent data suggests that depression and pain catastrophizing may occur in isolation as well as together for people experiencing pain (Westman et al., 2011). Thus, there is a need to explore further interrelationships between depression and pain catastrophizing and their relationship to outcome.

Aim

The aim of the first study was to investigate differences between people in levels of pain catastrophizing and depressed mood. Different levels lead to several possible configurations of these risk factors, and thus possible subgroups. Three questions were posed:

1. Are there subgroups of people with different profiles of pain catastrophizing and depressed mood?
2. Do people maintain similar profiles across physical therapy treatment?
3. Is subgroup membership at baseline related to outcome?

Design

This study was a secondary analysis of a randomized controlled trial, published previously (Overmeer et al., 2011; Overmeer et al., 2009). The original design involved 42 physical therapists participating in a university course, and the primary outcomes were twofold: First, the physical therapists’ changes in knowledge about psychosocial factors relevant to long-term pain problems throughout the course, and second, the patients’ improvements throughout treatment. This study used a prospective design...
aiming to investigate the course over time for different subgroups of patients.

**Participants**
A total of 297 patients seeking care for musculoskeletal pain and participating in physical therapy interventions in primary care were included. They participated in psychosocially oriented physical therapy treatment. The participants’ mean age was 47.4 years, and 76.4 % of the participants were female. The Regional Ethical Review Board in Uppsala, Sweden, approved the study.

**Measurements**
The participants filled out questionnaires at baseline, after treatment, and at follow up. Data from baseline and follow up were included in this study.

**Measures used to form subgroups**
The subgroups were determined using the depression subscale of the Hospital Anxiety and Depression scale (Zigmond & Snaith, 1983), and the Pain Catastrophizing Scale (Sullivan et al., 1995).

**Outcome measures**
Treatment outcomes of the study were determined to comprise disability, level of anxiety, pain intensity, sick leave, and health care use. The design was prospective and aiming to investigate participants’ functional status over time. Hence, end state functioning rather than improvements throughout treatment was considered “outcome”. Disability was assessed using the Quebec Back Pain Disability Scale (Kopec et al., 1995), and anxiety was assessed using the anxiety subscale of the Hospital Anxiety and Depression scale (Zigmond & Snaith, 1983). Pain intensity, sick leave and health care use were all measured with items from the Örebro Musculoskeletal Pain Screening Questionnaire (Linton & Halldén, 1998): One item where the participants rated their pain intensity the preceding week on a scale from 0 to 10, and two items asking for number of days on sick leave and number of health care visits, respectively, in the preceding six months. For sick leave and health care use, we created dichotomous variables using cutoffs. People were considered to have used sick leave if they had reported at least one day on sick leave due to pain during the past six months. Moreover, more than ten health care visits during the past six months was
determined to equate “significant use of health care” and people who reported more than ten visits were considered to have used health care.

**Statistical analyses**

We used cluster analyses to identify subgroups of people at baseline and follow up. Further, we explored the movement between subgroups over time using EXACON. And finally, we compared the subgroups on outcome variables using ANOVA and chi square analyses.

**Results**

We could identify four subgroups of participants (Figure 5). One group of people had elevated levels of both depressed mood and pain catastrophizing. One group of people had low levels of depressed mood and slightly elevated levels of pain catastrophizing. A third group of people reported the opposite pattern, elevated levels of depressed mood and low levels of pain catastrophizing. The last group of people had low levels of both depressed mood and pain catastrophizing. Similar groups were identified at baseline and at follow up, and people normally stayed in the same group during the treatment.

![Figure 5. Subgroups created with cluster analysis at baseline. Four distinct subgroups were identified: One “high risk” cluster with high levels of both pain catastrophizing and depressive symptoms, one “medium catastrophizing” cluster with moderate elevation in pain catastrophizing and no elevation in depressive symptoms, one “depressive mood” cluster with elevations in depressive symptoms but no elevation in pain catastrophizing, and one “low risk” cluster with low levels of both pain catastrophizing and depressive symptoms. The subgroups were stable from baseline to follow up.](image)
The treatment outcomes for people, divided into clusters formed at baseline, are presented in Table 1. As can be seen in the Table, the group considered to be at high risk was the smallest, comprising 29 people (9.8 % of the total sample). People in the high risk group reported elevations in both depressed mood and pain catastrophizing at baseline. The group reporting moderately elevated levels of pain catastrophizing and no depressed mood at baseline (“Cat cluster”) comprised 97 people (32.7 % of the total sample). The group of people reporting elevated levels of depressed mood but no elevation in pain catastrophizing at baseline (“Dep cluster”) comprised 41 people (13.8 % of the total sample). Finally, the group considered to be at low risk was the largest, comprising 130 people. They had no elevations in either depressed mood or pain catastrophizing at baseline.

Table 1.

Prospective comparison of clusters formed at baseline.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Clusters</th>
<th>$\chi^2/F$</th>
<th>Post Hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High Risk</td>
<td>Cat</td>
<td>Dep</td>
</tr>
<tr>
<td>$n$</td>
<td>29</td>
<td>97</td>
<td>41</td>
</tr>
<tr>
<td>Disability $\bar{x}$ (SD)</td>
<td>31.3 (17.2)</td>
<td>19.8 (16.4)</td>
<td>23.0 (14.9)</td>
</tr>
<tr>
<td>Pain Intensity $\bar{x}$ (SD)</td>
<td>5.5 (2.7)</td>
<td>4.2 (3.6)</td>
<td>4.1 (2.0)</td>
</tr>
<tr>
<td>Anxiety $\bar{x}$ (SD)</td>
<td>9.8 (4.0)</td>
<td>5.0 (4.2)</td>
<td>7.8 (4.4)</td>
</tr>
<tr>
<td>Sick leave (%)</td>
<td>51.7</td>
<td>27.8</td>
<td>26.8</td>
</tr>
<tr>
<td>Health care (%)</td>
<td>55.2</td>
<td>32.0</td>
<td>56.1</td>
</tr>
</tbody>
</table>

* $p < .001$. People in the clusters differed significantly after treatment, in terms of disability, pain intensity, anxiety, % of people who had been on sick leave during the past six months, and % of people who reported more than ten health care visits during the past six months.

The ANOVA and chi square analyses demonstrated that people in the clusters differed significantly from each other after treatment. Post Hoc analyses revealed that people in all three clusters that were characterized by elevations in either one or both psychological variables had significantly poorer treatment outcomes in terms of disability, pain intensity, and anxiety sensitivity, as compared to the people with low levels of both vari-
ables. People with elevations in one of the two variables had in general outcomes somewhere in between those with high levels and those with low levels of both factors. Moreover, more people in the high risk group and less people in the low risk group report having been on sick leave than what would be expected by chance. And finally, more people in the depressed mood group and less people in the low risk group report more than ten health care visits during the past six months, than what would be expected by chance.

**Discussion and conclusions**

We identified four distinct subgroups and demonstrated their impact on treatment outcomes. These results have critical clinical and theoretical implications. First, subgrouping people seems to have a value since those with a combination of several elevated psychological factors seem to be worse off over time than those with no elevations in or elevations in one variable. Elevated levels of depressive mood along with elevated levels of pain catastrophizing should be given attention in clinical settings since this combination may signal even less favorable treatment outcomes over time. Second, despite treatments that were psychosocially oriented, people typically did not change profiles during treatment. Thus, psychosocially oriented physical therapy does not seem to be enough to achieve change in psychological risk factors and treatment interventions may need to be improved. Third, the study gives further support to the notion that psychological factors have to be assessed as well as targeted in treatment within primary care. If psychological factors are still active and treatments have not succeeded in lowering levels of depressive mood and pain catastrophizing, outcomes are likely to be worse. Hence, treatments could possibly be more helpful if they were designed to assess, target, and successfully modify psychological factors. One alternative would be to clearly target psychological factors by matching interventions to risk profiles.
Study II
Early Psychologically Informed Interventions for Workers at Risk for Pain-Related Disability: Does Matching Treatment to Profile Improve Outcome?

Introduction
Musculoskeletal pain is a common and costly complaint (Picavet & Schouten, 2003), and many people are affected by pain in their daily lives. Early interventions aiming to prevent the development towards pain-related disability have had promising results (Linton, Boersma, et al., 2005), but it has been argued that treatment effects are still suboptimal and there is room for improvement (Williams et al., 2012). In a number of studies, researchers have identified distinctively different subgroups of people with pain and people in each subgroup have different profiles of psychological risk factors (Bergbom, Boersma, Overmeer, & Linton, 2011; Boersma & Linton, 2005, 2006; Reme et al., 2012). In general, the studies have identified one “high risk” group with elevations in several psychological variables, one group characterized by pain catastrophizing and/or fear and avoidance beliefs, and one group at risk but with no major elevations in psychological variables. These findings contradict the patient uniformity myth and indicate that psychological treatments for pain problems may need to target different psychological factors for different people. Moreover, the subgroups do not only suggest a need for differential treatments but they also generate hypotheses of important psychological mechanisms to target in treatment. Up until now, there has been no structured attempt at investigating whether treatment effects can be enhanced through matching customized treatments to psychological profiles.

Among the available psychological treatments for pain problems that have empirical support, some can be conceptualized as well suited to match to the different subgroups. Operant activity training (Leeuw et al., 2008) with its main focus on activities and activity increase, might be a suitable treatment alternative for people with low activity levels but no major elevations in psychological variables. Exposure in vivo, specifically developed for people with high levels of fear and avoidance beliefs (Vlaeyen et al., 2001, 2002) might be a suitable alternative for people who report fear and avoidance. And finally, cognitive behavior therapy techniques such as problem solving, mindfulness, and behavioral experiments might be a suitable alternative for people with high levels of emotional distress.
Aim
The overall aim of this study was to investigate the effects of matching on outcome for people with pain, at an early stage of problem development. Two research questions were posed:

1. Do people participating in early preventive interventions using evidence-based techniques improve on primary and secondary outcome measures?
2. Do people who are matched to a treatment, based on their psychological profile, have better outcomes than people who are unmatched?

Design
The study was a randomized controlled trial, involving three different psychologically informed interventions known to be effective for patients with pain complaints. Each intervention was chosen to target the specific problems of three different subgroups of participants. A block randomization procedure assigned people randomly to either a treatment matched to their subgroup or another treatment. Figure 6 shows an overview of the design.

Participants
Out of the 268 people who expressed interest, 105 fulfilled inclusion criteria and were randomized to treatments. Ninety-five participants completed measurements, whereof 90 participated in all treatment sessions. The mean age of the ninety-five who completed measurements at baseline was 48.6 years, and 80.0 % were female.

The Regional Ethical Review Board in Uppsala, Sweden, approved the study.
Figure 6. Design of the randomized controlled trial. People who scored 90 or more on the screening questionnaire were included. They were then assigned psychological profiles based on their ratings in a few key items. Half of the people with each profile were matched to a customized treatment, while half were allocated to an un-matched treatment.

**Measurements**

The participants filled out measurements at screening, at treatment baseline, weekly throughout treatment, after treatment, and at follow up nine months after completing treatment. Data from screening, baseline, post-treatment and follow up were used in this study.

**Screening and subgrouping**

The participants’ ratings on the Örebro Musculoskeletal Pain Screening Questionnaire (Linton & Halldén, 1998) determined inclusion as well as subgroup belonging. Participants with a total score of ≥ 90 were included. Those with elevated levels of fear and avoidance beliefs (mean score of ≥ 6 on items 19 and 20) were allocated to a fear and avoidance profile, and those with elevated levels of depressive mood (≥ 4 on item 14) independent of scoring on fear and avoidance beliefs were allocated to a distress profile. Remaining participants, with no significant elevations in either fear and avoidance beliefs or depressive mood, were allocated to a medium risk profile.
Primary outcome measures

Primary treatment outcomes were perceived disability and sick leave. Perceived disability was assessed with the Quebec Back Pain Disability Scale (Kopec et al., 1995), and sick leave was assessed with one item asking for number of days off due to the pain problem during the past six months. We created a dichotomous variable with a cutoff of 14 days, where sick leave ≤ 14 days was considered “no sick leave” and > 14 (when the National Insurance Office takes over the financial responsibility for the person) days was considered “sick leave”.

Secondary outcome measures

Secondary treatment outcomes were self-rated health status, fear and avoidance beliefs, pain intensity, pain catastrophizing, depressive symptoms, anxiety, worry, and health care consumption. Self-rated health status was measured with one item from the EQ-5D (EuroQol Group, 1990), asking for the person’s experience of his or her total health on a scale from 1 to 100. Fear and avoidance beliefs were assessed with the Tampa Scale of Kinesiophobia (Kori et al., 1990), and pain intensity was rated for the past week on a scale from 0 to 10. Pain catastrophizing was assessed with the Pain Catastrophizing Scale (Sullivan et al., 1995). Depressive symptoms and anxiety were both assessed with the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983), worry was assessed using items described by Von Korff and colleagues (Von Korff et al., 1998). Health care consumption was assessed using four items asking for number of visits to general physician, physical therapist, hospital/specialist or other health care professional during the past six months. Again, we created a dichotomous variable where any visit to a health care professional was considered “health care use”.

Statistical analyses

We performed repeated measures ANOVAs for all continuous outcome variables, using time as the within-subjects factor and matching/non-matching as the between-subjects factor. In case of a significant main effect of time, we calculated within-groups effect sizes using Cohen’s $d$. For sick leave, a categorical outcome variable, we determined the relationship between matching and sick leave with Fisher’s exact test. For the other categorical outcome variable, health care use, we determined the relationship with matching using a $\chi^2$ test.
**Results**

For all continuous outcome variables, the analyses revealed significant main effects of treatment; people improved in terms of the primary outcome, perceived disability, as well as on secondary outcomes. Figure 7 gives an overview of how the three treatment groups changed in disability throughout treatment and until follow up. Effect sizes $d$ ranged from 0.23 to 0.66, that is, the treatments produced small to medium-sized effects.

![Diagram](image)

*Figure 7. Change in disability for the three treatment groups throughout treatment and until follow up. All treatment groups improved, and demonstrated similar improvement patterns.*

Hence, people in all three treatments improved and the improvements continued until follow up. However, there were no significant differences between matched and unmatched participants; matching did not improve effects of treatment. Figure 8 gives an overview of how matched and unmatched participants changed in disability throughout treatment and until follow up. Worth noting is that this pattern is also apparent when analyzing the three treatment formats in isolation; matched and unmatched participants reported similar changes in all treatments. For self-rated health status, the analysis showed a significant interaction effect. This interaction effect indicated that in addition to a general improvement for all participants, people who were *not* matched to treatment improved further from post-treatment to follow-up while people who were matched did not. Moreover, the analyses of sick leave and health care use did not reveal any relationship with matching; matched and unmatched participants did not
differ in terms of sick leave or health care use. Hence, the results did not support the hypothesis that matching would yield better treatment outcomes than random allocation to treatment.

![Figure 8. Matched and unmatched participants’ change in disability throughout treatment and until follow up. There were no indications that matched and unmatched participants differed in improvement, and hence no support that matching further improves the effect of early psychological interventions for pain-related disability.](image)

**Discussion and conclusions**

The treatments offered in this study were associated with improvement both in terms of treatment outcomes but also in terms of possible treatment mediators; the targeted psychological variables. However, matching was not significantly better than no matching. The answer to the first research question was thus YES, people did improve, and the answer to the second research question was NO, people who were matched to treatment did not have better outcomes than people who were not matched. These two answers taken together give rise to a new question: WHY does matching not improve outcomes? While it might indeed be true that matching does not produce better outcomes, three main issues potentially shedding

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light on why matching was not successful in this study were brought up: (1) The profiling system, (2) the population, and (3) the treatments.

The profiling system was based on earlier findings from our group and others, but prospective subgrouping based on profiles had never been realized before. The profiles were created using few items from a questionnaire administered several weeks before treatment start, risking instability in profile belonging. Hence, the system of profiling needs to be explored and possibly improved in future studies investigating matching.

The interventions were developed to target psychological issues in a population of people rather early on in their pain problem development. The mean levels of pain as well as disability and psychological complaints were thus rather low. This population might not be appropriate for understanding the effects of matching, and future studies should possibly aim to include a more heterogeneous population with greater variance in the psychological variables. This would allow identification of more distinct subgroups, and leave more room for improvement.

The issue of the treatments offered is again an issue of distinctness. We chose to include three types of psychologically informed interventions, all evidence-based and all behaviorally oriented. All three treatments succeeded in altering psychological factors associated with improvement in outcomes; possibly a result of the treatments not being distinguished enough from one another.

The overall conclusion is thus that the early psychological interventions offered in this study were associated with improvements, but that the matching procedure did not improve outcomes further. However, we cannot rule out that matching is effective. In-depth studies of possible explanations for these results could aid the understanding of whether treatment matching can enhance moderate treatment effects. There is a need to explore possible reasons for the lack of effect of matching, in order to improve the design of future matching studies.
Study III
When Matching Fails – Understanding the process of matching pain-disability treatment to risk profile

Introduction
Matching psychological treatments to risk profiles, hence, seems logical and appealing. However, while the psychological treatments in Study II had effects on outcomes such as disability matching did not improve outcomes further (Bergbom, Flink, Boersma, & Linton, 2013). A few issues were brought up as possible explanations to the lack of effect of matching, including the use of a short screening questionnaire to determine each participant’s profile. Moreover, the profiling was realized a period of time before treatment start. While psychological profiles previously have been found rather stable over time, such as the profiles in Study I, some findings indicate that changes in psychological variables might indeed occur when assessing people early on (Carstens et al., 2013). Hence, the time lag might have given room for movement between profiles between screening and treatment start. In this study, we were seeking to explore the profiles used to allocate participants to treatment.

Aim
The aim was to investigate the process of determining participant’s psychological profile and allocating them to treatment. Two research questions were posed:
1. Were the simple profiles used for subgroup assignment stable over time?
2. How did the simple profiles used for subgroup assignment and treatment allocation correspond with more thorough assessment and profiling using fully validated questionnaires?

Design
The design was cross-sectional as well as prospective, as is shown in Figure 9. In Study II, the psychological profiles were determined when the person was screened for inclusion in the study. These profiles were the basis for matching into one of the three treatments. To study the stability and the validity of the profiles, we compared these profiles with two new sets of profiles created at treatment start typically seven weeks later. At this later time point, we used two different means of subgrouping the par-
participants. Hence, we ended up with three sets of subgroups, each comprising three different profiles, at two time points.

![Figure 9. Design of the study. In the original study treatment allocation was determined by profiles created at screening, typically seven weeks before treatment start. The profiles were based on three items from a brief screening questionnaire. To investigate stability of the profiles these original profiles were compared with a new set of profiles created at treatment start using the same three items. Then, to investigate concurrent validity the profiles created at treatment start with three items were compared with a third set of subgroups based on two longer psychometric questionnaires.]

**Participants**

The ninety-five participants who returned complete measurements in Study II were included in this follow-up study. The mean age was 48.6 years, and 80.0% were female.

**Measurements**

All participants filled out the Örebro Musculoskeletal Pain Screening Questionnaire (ÖMPSQ; Linton & Halldén, 1998) before inclusion in the study. Immediately prior to treatment start they then filled out pretreatment questionnaires. For the purpose of this study, we included three items from the ÖMPSQ filled out at screening along with the same three items filled out prior to treatment start. Moreover, we included the Tampa
Scale of Kinesiophobia (TSK; Kori et al., 1990) measuring fear and avoidance beliefs and the depression subscale of the Hospital Anxiety and Depression Scale (HADS-D; Zigmond & Snaith, 1983) measuring depressive symptoms.

**Statistical analyses**

The analysis took off in the subgroups and psychological profiles used in Study II to allocate participants to a matched or an unmatched treatment. First, we created subgroups at treatment start using the same items as the subgroups used for treatment allocation. The new set of subgroups had the same psychological profiles; one medium risk profile, one fear and avoidance profile, and one emotional distress profile.

Then, we created a third set of subgroups using an empirical approach. We used the TSK and the depression subscale from the HADS, and performed cluster analysis based on these two scales. We started with a hierarchical cluster analysis, using squared Euclidian distance as the similarity measure and Ward method to minimize within-cluster variance. The cluster solution explaining over 67% of the total error sum of squares was selected, resulting in four clusters. Thereafter, we performed k-means cluster analysis using the centroids determined by the hierarchical cluster analysis. This method allows people to move to a better fitting cluster if that leads to a reduction in the total error sum of squares. Finally, we added the two clusters with elevated scores of depressive symptoms together, ending up with three subgroups similar to the ones used for treatment allocation.

We investigated stability and concurrent validity of the subgrouping with EXACON analyses (Bergman & El-Khoury, 1987). The EXACON can be framed as an extended chi-square, comparing the number of observations in a cell to the expected number of cases if the distribution was random. The focus of the EXACON is on *typical* and *atypical* movements between cells (here: subgroups). If the profiles are stable, then it would be typical to belong in the same subgroup at two different time-points. If the profiles are valid, then it would be typical to belong in the same subgroup using different means of measurement.

**Results**

The analysis of stability in the profiles used for treatment allocation is summarized in Table 2. In the Table, each cell includes one number appearing above a line, and one number appearing below a line. The number
above the line is the observed frequency of people, and the number below the line is the expected number of people if the distribution was random. The first cell in Table 2 hence includes 12 people who had the medium risk profile at screening and also had the medium risk profile at treatment start. If the profiling at treatment start had been random, there would have been 7.83 people in that cell. Hence, there are a few people more than if it were random, but there is no statistical relationship between having the medium risk profile at screening and having the same profile at treatment start.

The same is true for all cells. There are no visible typical transitions between profile at screening and profile at treatment start. Hence, the profiles created at screening can be considered unstable.

Table 2.

*Analysis of stability in profiles using the ÖMPSQ at screening (n = 94).*

<table>
<thead>
<tr>
<th>ÖMPSQ</th>
<th>Treatment start</th>
<th>Medium risk</th>
<th>Fear and avoidance</th>
<th>Emotional distress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium risk</td>
<td></td>
<td>12</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.83</td>
<td>2.04</td>
<td>6.13</td>
</tr>
<tr>
<td>Fear and avoidance</td>
<td>11</td>
<td>3</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.28</td>
<td>2.68</td>
<td>8.04</td>
</tr>
<tr>
<td>Emotional distress</td>
<td>23</td>
<td>9</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>27.89</td>
<td>7.28</td>
<td>21.83</td>
</tr>
</tbody>
</table>

*Note.* Stability is determined by the screening profiles’ concordance with similar profiles at treatment start. The number appearing above the line in each cell is the observed frequency. The number appearing below the line is the expected frequency, if the distribution were random. **Boldface** font indicates expected typical movements, if profiles were stable. Normal print indicates expected atypical movements.

The analysis of concurrent validity between profiles determined using the brief screening questionnaire at treatment start and the empirically based profiles is shown in Table 3. As can be seen in the Table, the first cell includes 25 people who are considered to belong to the medium risk profile based on three items from the screening questionnaire, and who also are
considered to belong to the medium risk profile based on the HADS-D and the TSK. If the profiling with the three items from the screening questionnaire was random, there would have been 16.94 people in the cell, significantly less than the observed number. There is hence a relationship between the two means of subgrouping, and the transition is considered typical. The same is true for people considered to belong to the emotional distress profile according to the three items; they, to a larger extent than would be expected by chance, also are considered to belong to the emotional distress profile using the HADS-D and the TSK (22 people observed, as compared to 13.94 that would have been expected by chance). There is a tendency towards a similar typical transition for the fear and avoidance profile (6 people, as compared to 2.84 people that would have been expected by chance).

Table 3.

*Table 3. Analysis of concurrent validity for the profiles created using items from the ÖMPSQ at treatment start. (n = 93).*

<table>
<thead>
<tr>
<th></th>
<th>HADS-D and TSK treatment start</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium risk</td>
</tr>
<tr>
<td>Medium risk</td>
<td>25**</td>
</tr>
<tr>
<td></td>
<td>16.94</td>
</tr>
<tr>
<td>Fear and avoidance</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>10.65</td>
</tr>
<tr>
<td>Emotional distress</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>17.42</td>
</tr>
</tbody>
</table>

*Approaching significant typical transition, p = .07, **Significant typical transition, p < .01, #significant atypical transition.

Note. The ÖMPSQ profiles’ validity is determined by their concordance with profiles created using the HADS-D and the TSK at the same time point. The number appearing above the line in each cell is the observed frequency. The number appearing below the line is the expected frequency, if the distribution were random. Boldface font indicates expected typical movements, if profiles were stable. Normal print indicates expected atypical movements.
Moreover, there is an atypical transition from the medium risk profile to the emotional distress profile. People who are assigned the medium risk profile with the three items from the screening questionnaire are unlikely to be assigned the emotional distress profile by the HADS-D and the TSK. The same is true for people in the emotional distress profile according to the three items in the screening questionnaire, who are unlikely to be assigned the fear and avoidance profile by the HADS-D and the TSK. Hence, the profiling realized at treatment start based on three items from a brief screening questionnaire can be considered relatively valid when compared to more extended assessment and profiling.

**Discussion and conclusions**

The profiles used to allocate people to treatment were not stable over the time period of typically seven weeks until treatment start. When treatments started, people no longer presented the pattern of elevations associated with the profiles and consequently, people who were considered to be “matched” to treatments were in fact not. When the same questions were posed at treatment start, people responded differently. The transitions indicate that people’s levels of complaints had decreased, and the treatments were no longer customized for their psychological profiles. However, when compared to longer questionnaires with documented psychometric properties the profiles seem valid and the changes have likely occurred during the time lag of typically seven weeks between screening and treatment start. This finding is in line with recent studies, indicating that people at an early stage of problem development change over rather short time spans (Carstens et al., 2013). Moreover, pain problems have been described as cyclic and it is possible that some participants had a problematic episode when announcing interest and had spontaneously recovered from the episode when treatment started (Nicholas et al., 2011). It would indeed have been of great interest to explore matching using the profiles determined at baseline. However, unfortunately the subgroups were too small at that time point and no valid conclusions could be drawn.

In addition to the normal course of pain and pain-related complaints, there might be other explanations for the lack of stability in the profiles. First, the participants filled out the screening questionnaire with the hope of being included in a cost-free, evidence based treatment for their pain problem. The profiles were then based on their responses in the screening questionnaire. Possibly, this knowledge may have evoked other responses to the screening questionnaire than if the gain of filling it out was less
obvious and there might hence be an outcome expectancy bias in the participants’ responses. Second, common to studies of early intervention, the participants’ levels of the psychological variables were relatively low and transition from one profile to another was hence rather easy. This could be prevented by testing treatment matching in other populations, with more variance in the psychological variables.

In sum, a matching procedure is complex. Lessons to be learned are that the assessment and profiling should be realized closer to treatment start, and that a population of people with more variance in their complaints could allow more distinct subgroups. Hence, while the idea of matching needs to be investigated further, the treatments did indeed have an effect on important outcomes. The development of treatments could profit from more in-depth studies of treatment processes and their association to outcomes. How might we best produce favorable outcomes of early psychological interventions for pain problems?
Study IV
Both Early and Late Changes in Psychological Variables Relate to Treatment Outcome for Musculoskeletal Pain Patients at Risk for Disability

Introduction
In contrast to our hypothesis, matching did not enhance treatment outcomes but Study II shows that targeting important psychological mechanisms in treatment is associated with favorable outcomes. Early psychological interventions for pain-related disability are hence promising, but the knowledge about how treatments work is scarce (Vlaeyen & Morley, 2005). Psychological interventions aim to alter processes known to be related to long-term outcomes, often processes included in theoretical models such as the fear and avoidance model (Vlaeyen & Linton, 2000). Indeed, there is evidence suggesting that when treatments succeed in altering psychological processes such as pain catastrophizing and depressive mood, the outcome is better (Burns, Glenn, et al., 2003; Burns, Kubilus, et al., 2003). These findings are important for early interventions, when the main outcome variable (i.e. disability) is not yet problematic and it is crucial to identify key variables to target in treatment. Moreover, the timing of improvements, that is, when improvements occur during treatment has been suggested as an important factor for understanding who will improve and who will not. For example, early responders to treatment, that is, people who improve early in treatment have been found to have better treatment outcomes when treated for depression or other psychological complaints (Fennell & Teasdale, 1987; Haas et al., 2002; Ilardi & Craighead, 1994). Hence, understanding when and in terms of which psychological processes people improve is a key to understanding how effective treatments should be designed.

Aim
The aim of this study was to explore treatment changes in psychological variables in a population of people participating in early preventive interventions for pain-related disability. The investigation was directed both towards which processes change during treatment, and towards the timing of these changes (early or late in treatment.)

Design
This study was a secondary analysis of a randomized controlled trial (Study II). The original design involved people assigned three different
psychological profiles and matched or unmatched to three different customized psychological interventions. This study used a prospective design with three measure points, aiming to investigate changes from the first to the second time point, and from the second to the third time point.

**Participants**
The available literature concerns psychological treatments, and in line with these findings for the purpose of this study we excluded participants in the one treatment arm led by physical therapists. Hence, out of the 95 people who participated in the original study, 64 who participated in psychologist-led interventions were included in this study. Their mean age was 48.4 years, and 83.1% were female.

**Measurements**
The participants filled out measurements at screening, at treatment baseline, weekly throughout treatment, after treatment, and at follow up nine months after treatment finish. Data from treatment baseline, mid-treatment, and post-treatment were used in this study. The interventions were developed to affect outcome variables through targeting and altering a number of psychological process variables.

**Process variables**
As process variables, we included depressive symptoms, pain catastrophizing, back pain worry, fear avoidance beliefs and function. Depressive symptoms were measured with the depression subscale of the Hospital Anxiety and Depression Scale (HADS-D; Zigmond & Snaith, 1983) and pain catastrophizing with the Pain Catastrophizing Scale (PCS; Sullivan et al., 1995). Back pain worry was assessed with four questions referred to by Von Korff and colleagues (Von Korff et al., 1998). Fear avoidance beliefs (FA) was assessed with a composite score of two questions and function (ADL) was assessed with five questions, all from the Örebro Musculoskeletal Pain Screening Questionnaire (Linton & Halldén, 1998).

**Outcome variables**
Outcome variables were divided into primary outcomes and secondary outcomes. The primary outcome variable was disability, measured with the Quebec Back Pain Disability Scale (Kopec et al., 1995). The secondary outcome variables were health perception, measured with the EQ VAS
Scale of the EQ-5D (EuroQol Group, 1990) and pain intensity, rated for the past week on a scale from 0 to 10.

**Statistical analyses**

The statistical analyses were realized in two steps. First, we calculated early and late treatment change in process variables, in terms of standardized residual change to control for regression to the mean and random errors of measurement. Change in process variables from pre-treatment to week three was considered early change, and change from week four to post-treatment was considered late change. Then, we used the standardized residual change scores to predict outcome in terms of improvement in disability, health status, and pain intensity. We performed three stepwise regression analyses, one for each outcome variable. We entered pre-treatment score in the outcome in the first step, followed by early change in process variables in the second step, and late change in process variables in the third and final step.

**Results**

The initial descriptive analyses revealed that process variables as well as outcome variables changed from pre-treatment to post-treatment. The mean changes were small, but large standard deviations indicated that there was variation in the degree of change; some people changed more and some less. Simple correlations also revealed that change in process variables and change in outcome variables was related; people who reported change in process variables also reported change in outcomes and vice versa.

The main analyses targeting the relative contribution of early and late changes consistently showed that both early and late changes in process variables were able to predict improvement in outcome variables. Improvement in the primary outcome variable, disability was predicted by early change in function along with late change in depressive symptoms. Together, they explained 27% of the variance in post-treatment disability, above and beyond the variation explained by pre-treatment scores in disability (see Table 4). Improvement in health perception was predicted by early change in pain catastrophizing, and improvement in pain intensity was predicted by late change in function. Hence, people who improved in terms of psychological process variables throughout treatment, both early and late, also improved in terms of disability, health perception and pain intensity.
Table 4.

*Regression Analyses Predicting Post-Treatment Disability.*

<table>
<thead>
<tr>
<th>Step</th>
<th>Variable</th>
<th>β</th>
<th>$R^2$ change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quebec pre treatment</td>
<td>.61**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pain intensity pre treatment</td>
<td>.09</td>
<td>.51**</td>
</tr>
<tr>
<td>2</td>
<td>Early changes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Early change HADS-D</td>
<td>-.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Early change PCS</td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Early change Back pain worry</td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Early change ADL</td>
<td>-.41**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Early change FA</td>
<td>-.04</td>
<td>.16**</td>
</tr>
<tr>
<td>3</td>
<td>Late changes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Late change HADS-D</td>
<td>.21**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Late change PCS</td>
<td>-.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Late change Back pain worry</td>
<td>.21*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Late change ADL</td>
<td>-.11</td>
<td></td>
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<tr>
<td></td>
<td>Late change FA</td>
<td>-.03</td>
<td>.11**</td>
</tr>
</tbody>
</table>

*Note.* All change scores are standardized residuals. Standardized beta weights are from the final regression equation. Total amount of explained variance adjusted $R^2 = 79\%$. *p < .05, **p < .01.

**Discussion and conclusions**

The main finding of the study was that people who report improvements on emotional, cognitive, and behavioral process variables hypothesized to mediate outcome during treatment have better total treatment outcomes. Both early changes and late changes contribute to the explanation of variance in outcomes, and there was no support for the notion that changes occurring early are better predictors of outcome. An important conclusion is thus that treatments aimed at targeting psychological process variables that succeed in affecting them, can produce favorable treatment outcomes. Moreover, the variables suggested by the fear and avoidance model to be crucial drivers of long-term disability can function as important targets for intervention.

There are several important clinical implications of these findings. First, interventions targeting the psychological processes suggested by the fear and avoidance model can produce favorable outcomes and should be implemented. Second, improvements related to outcome can occur both early and late in treatment, and improvement in processes can be used as an
important signal of moving forward in treatment. And finally, fixed-schedule group formats offered in clinical settings could possibly benefit from a more flexible format where changes in psychological processes are monitored and used as cues for successful interventions.
General discussion

This dissertation has focused on individual variations in psychological mechanisms that are important for the development of long-term disabling pain problems. Moreover, it has focused on early interventions for people at risk for long-term problems, both in terms of treatment efficacy, enhancement of treatment effects, and change processes during treatment. Study I demonstrated that people who report elevations in either pain catastrophizing or depressive symptoms at baseline had worse treatment outcomes after physical therapy that people with no elevations. Moreover, a subgroup of people with elevations in both pain catastrophizing and depressive symptoms had even worse symptoms, indicating that the combination is even more problematic. In Study II, we extended the findings about distinct subgroups of people, and attempted to optimize treatment effects by matching treatments to psychological profiles of each subgroup. While the treatments produced effects in line with earlier studies of similar populations (e.g. Linton & Nordin, 2006), we did not see an improved effect for people who were matched to treatment and treatment matching needs further attention. Study III mapped out the complexity of a matching system, and brought forward the assessment and profiling as one issue that needs to be addressed in future investigations of matching. The final study, study IV, presented an in-depth investigation of which change processes during treatment that are related to treatment outcomes and lends further support to the idea that there are important psychological mechanisms that need to be successfully altered in order to produce favorable treatment outcomes.

Based on the theoretical models of pain psychology, the dissertation has demonstrated that psychological mechanisms are indeed important for the development towards problems as well as for the prevention of long-term disability. This knowledge can be used when developing interventions and when understanding why treatments are effective. Emotional, cognitive and behavioral variables suggested in the literature can alone and in combination be valuable targets for interventions, and while there is room for improvement in interventions, behavioral treatments offered at an early stage of problem development can successfully alter the prognosis for people suffering from pain problems.
Answers to the research questions

The findings of study I and IV demonstrate that the variables framed within the fear avoidance model of chronic pain are important and viable mechanisms in two ways. First, alone and not in the least in combination pain catastrophizing and depressive symptoms are clearly related to worse treatment prognosis. People with high levels of pain catastrophizing and depressive symptoms, either one of them or not in the least in both, have less favorable outcomes than people with no elevations. Second, if treatments succeed in altering these mechanisms outcome is better. People who report decreasing levels of pain catastrophizing, fear and avoidance beliefs, back pain worry, and depressive mood and increased function during treatment have larger improvements in disability, health perception and pain intensity. Put together, these findings indicate that the emotional, cognitive and behavioral variables included in the fear and avoidance model are indeed key processes to target in early interventions for pain. However, while the sequential relationship of the fear and avoidance model might be true for some people the findings also indicate that there are individual differences in terms of which variables are important for whom. Some people may express low mood and unwelcome negative emotions while others may express catastrophic predictions about how disabled they will become over time due to their pain problem. Hence, there is not only a need to target these variables in treatment but also to assess, determine psychological profile, and monitor changes for people participating in early psychological interventions. For the person with catastrophic predictions about future disability, we need to assess and monitor pain catastrophizing and make sure that the treatment offered produces change in the persons’ view of the future. For the person with low mood, we need to make sure that the level of depressive symptoms decreases before we terminate treatment.

The findings of study II and III demonstrate that while early interventions can successfully alter psychological processes related to outcomes, and prevent the route towards more disability, matching treatment to profile did not improve treatment effects further. However, being the first attempt to match treatment to processes suggested by the fear and avoidance model, there are feasibility issues such as psychological profiles being unstable over time that may have influenced the results and there is a need to explore matching strategies further. Matching needs to be investigated using other ways of profiling, in other populations with potentially more distinct subgroups, with other methodologies, and with interventions even
more clearly targeting the mechanisms suggested in the fear and avoidance model.

**Findings in relation to the theoretical framework**

Within the overarching theoretical framework of this dissertation, the psychology of pain, a number of psychological mechanisms have been suggested as important for pain experience. These mechanisms have been further specified in the fear and avoidance model of pain, which focuses on pain catastrophizing, fear and avoidance, and depression. The findings in this dissertation have relevance for the clinical application of the fear and avoidance model, as well as for theoretical refinement of the model. First of all, the findings are in line with earlier suggestions that while the mechanisms suggested by the model are valuable predictors and targets for treatment, the sequential relationship suggested in the fear and avoidance is not necessarily true for all people (Wideman et al., 2009). Study I shows that there seem to be differential pathways between painful experiences, through psychological processing, towards long-term disabling pain problems. Not all people at risk for long-term problems report pain catastrophizing as a precursor to the vicious circle, and not all people at risk report depression. Indeed, the model is argued to be a theory-based heuristic and rather a suggested caption of the knowledge so far than an established truth (Vlaeyen et al., 2009). Possibly, the model could profit from a flexible outline, allowing for individual differences in response to pain.

A more flexible outline of the fear and avoidance model that allows for differential pathways towards long-term disability is shown in Figure 10. First, a painful experience can immediately, for example through respondent and operant conditioning, elicit avoidance responses which are negatively reinforced when the immediate pain decreases. Hence, a person who reports a “weak back” and who repeatedly experiences low back pain may have learned that avoidance responses to the pain can effectively decrease pain in the short term (indicated by the first crosshatched arrow, between pain experience and avoidance). This pain-avoidance connection can occur without the activation of pain catastrophizing and pain-related fear, but repeated avoidance still has the potential of leading to lower mood and in the long term disability.
Figure 10. Theoretical implications of the dissertation for the fear and avoidance model of pain. The model and its pathways are more flexible, allowing for individual differences in response to painful experiences.

Other possible pathways towards pain-related disability involve pain catastrophizing in different ways. Indeed, pain catastrophizing has been shown to be closely linked to negative emotionality (e.g. Keogh & Asmundson, 2004) and it has even be suggested to be a form of avoidance rather than a precursor to avoidance (Flink, Boersma, & Linton, 2013). Hence, a person in pain who engages in catastrophic thinking about the pain may either also experience fear, but another pathway could be an immediate link to depressive mood (indicated by the second crosshatched arrow), and yet another pathway could be from pain catastrophizing to disability (the third crosshatched arrow).

Moreover, as was observed in Study I, people who report elevations in both pain catastrophizing and depressive symptoms seem worse off in terms of outcome than people with an elevation in one of them. It might be that these people experience pain problems within a wider frame of psychological ill-health. Possibly, they experience problems with emotions and emotion regulation related to their problems dealing with pain. In a recent theoretical review, Linton (2013b) summarized the knowledge on
emotion regulation and pain and proposed a transdiagnostic approach to co-occurring emotional and pain problems. In sum, the author proposed that repetitive thinking, avoidance, and thought suppression might function as transdiagnostic processes driving the problems with pain as well as emotional dysregulation. Successful identification of shared mechanisms between pain and emotional problems holds the promise of more precise understanding of the people reporting both and in the next step more effective treatments.

In sum, a more flexible take on the fear and avoidance model could emphasize its value in identifying important variables, while at the same time give room for individual differences in terms of psychological responses to painful experiences. Moreover, there seems to be a subgroup of people with emotional problems in association to the pain problem and these people need scientific attention. Integrating findings of individual differences into the theoretical framework would hence have implications for clinical implementation as well as for future research.

**Clinical implications of the findings**

The findings in this dissertation have a number of important clinical implications. First of all, the studies have underscored the importance of viewing people seeking health care for pain problems not as a homogeneous group but rather as a heterogeneous one. People at a higher risk for long-term disability differ from those who will improve with little or no intervention, and also those at a higher risk differ from one another. Some show a pattern of elevation in pain catastrophizing and thus repeatedly engage in visualizing catastrophic consequences of their pain, while some report low mood and others report both catastrophizing and emotional distress. The clinical application is that people, already at their first contact with a caregiver, should be assessed for psychological functioning. Moreover, it should be taken into account that “people with a psychological risk” are a diverse population and that their specific profile of psychological functioning is determined and taken into account when planning interventions.

Second, and most importantly, the studies in this dissertation have given further strength to the notion that psychological variables are not only valuable as predictors of outcome but also as targets for treatment. The findings in Study II show that treatments aimed at altering pain catastrophizing, fear and avoidance beliefs, avoidance behavior, and depressive symptoms indeed have an effect on disability. Moreover, the findings in
Study IV demonstrate how changes in these mechanisms are able to predict total treatment outcome. Hence, if variables such as pain catastrophizing, depressive mood and worry are articulated and targeted in treatment the outcomes are likely to be better. Moreover, these variables should be monitored throughout treatment and used as indications for a successful outcome; if they improve so will the outcome. An issue for future research is to develop interventions that clearly target the key variables, and monitor the effect of such treatments on the variables in question through repeated measurement.

While we have contributed to the field by demonstrating that treatments targeting psychological variables are indeed effective, the dissertation did not clearly support treatment matching. It might indeed be the case that matching specific and distinct interventions to clearly separated subgroups of people is not a feasible way of enhancing treatment effects and this question needs further investigation before any clinical application of matching and customizing can be recommended. However, we can conclude that successful targeting of pain catastrophizing, fear and avoidance beliefs, avoidance behavior, and depressive mood, are effective components in treatments. Hence, the recommendation is to choose interventions that aim to alter the patient’s levels of these risk factors. The findings in this dissertation clearly point to what needs to be done in treatment to produce effects, but the format for optimally meeting needs and demands of people seeking care needs to be investigated further. Hence, there are things that we have rather good empirical support for, such as early identification of people at risk and that these people differ in terms of psychological variables. Moreover, we have cues as to what needs to be done in treatment in order to produce effect. This knowledge needs to be translated to work in clinical settings.

Consequently, a recommended clinical flow chart integrating our findings with earlier research (Westman, 2010) is presented in Figure 11. Worth noting is that the main focus of the flow chart is on the psychological aspects of assessment and treatment and that other procedures need to be taken into account when it comes to e.g. assessment of red flags. As can be seen in the figure, the process from the point when the person seeks care to the administration of an effective psychological intervention is split in three main parts: Assessment, treatment targets, and optimizing of treatments.

The first part of the flow chart hence concerns assessment of people seeking care. Numerous studies have investigated the early identification
of people at risk (see e.g. Hill et al., 2010; Hockings et al., 2008), and these findings put together can be considered a basis for strong empirical support. There are ways that clinicians can determine each patient’s risk for long-term problems, and these strategies should be golden standard in clinical practice.

The second part of the flow chart concerns choosing targets for treatment. There is some empirical data suggesting that targeting psychological mechanisms in treatment is related to better outcomes (Nicholas et al., 2011). The studies included in this dissertation have provided more knowledge about the processes of change during early psychological interventions for pain problems. In sum, there seems to be moderate empirical support for the suggestion of pain catastrophizing, fear and avoidance beliefs, depressive mood, and avoidance behaviors as viable targets of treatment.

The final part of the flow chart concerns treatment optimization, and how treatments should best be developed in the future. Is it feasible to develop and administer distinct and specific interventions, customized to fit individual problem profiles? Or would it be more efficient to develop broad cognitive-behavioral treatments targeting psychological risk factors that to some extent can be tailored to individuals? This area is the one with the least empirical support, and only more research can determine the optimal format for early psychological interventions in the pain field. There are likely major contributing factors, such as the risk factors, that can be targeted more directly in treatment. In our matching investigation, we matched the emotional distress subgroup with a rather broad CBT approach. We aimed to target emotional distress with for example problem solving techniques and mindfulness. However, since the importance of emotions for pain has been emphasized in recent years (Linton, 2013b; Lumley et al., 2011) we might learn how to successfully target unwelcome and problematic emotions from other psychological treatments working directly with emotions such as dialectical behavior therapy (e.g. Dimeff & Koerner, 2007; Linton, 2010) or emotion-focused therapy (e.g. Greenberg, 2004). The specific impact of such treatments on disability and other outcomes for the subgroup of people reporting emotional distress is an area to investigate further.

In sum, our findings underscore the importance of assessing at an early stage, targeting important variables in treatment and monitoring the effect of treatment on key process variables. This would have the potential of distributing effective treatments to the people who need it.
Figure 11. Clinical Flow Chart, showing a recommended clinical approach to people seeking health care for pain problems. The psychological approach is realized in conjunction with medical screening ruling out red flags. Assessment and screening procedures have strong empirical support. More research is needed concerning what to target in treatment and how treatments can be optimized.
Directions for future research

The findings from study I, II and IV all demonstrate the crucial importance of psychological variables on treatment outcomes. Study I indicates that psychologically informed physical therapy is insufficient for decreasing levels of pain catastrophizing and depressive mood, and that outcome is worse for people with elevations in these variables. Moreover, elevations in both pain catastrophizing and depressive mood is related to even worse outcomes, indicating a possible role of emotion regulation problems. Study II demonstrates that treatments targeting these variables are effective, and study IV demonstrate that when treatments succeed in altering these variables treatment outcome is better. However, interventions are still suboptimal; some people still suffer at the end of treatment. Moreover, the interventions have similar effects independent of the profile of psychological risk. Hence, one goal for future research should be to further develop interventions. Through identifying treatment components that directly and effectively target the psychological variables, interventions can be more distinct and more customized towards the key variables. Future research can learn from not only the presence of risk factors but also their qualities– and aim to alter them in treatments.

Another area for further research is the process of matching. Matching and customizing treatment could be approached in different ways. One way could be to replicate the design of the matching study presented in this dissertation, but aim to identify more stable psychological profiles, for example through the use of longer questionnaires with good psychometric qualities. The profiling needs careful assessment at the right time point, as a suggestion immediately prior to treatment start. Moreover, the interventions could be more distinct and even more clearly directed towards targeting important mechanisms. Another way of testing the process of matching could be to implement other research designs. When, for example, using replicated single subject research designs (e.g. Kazdin, 2010b) the researcher is allowed a close and detailed look at treatment progress, and the design facilitates sharpening of treatment interventions throughout the process.

Matching treatment to subgroups is still in its infancy, and matching needs to be tested with other populations, with other ways of subgrouping people, and with other treatment interventions. The main point, however, is to not only identify presence of risk factors but to learn from what they tell us– and use risk factors as cues as to what needs to be obtained in an effective intervention for people with or at risk for pain problems. A per-
son with elevated levels of pain catastrophizing needs an intervention targeting pain catastrophizing, and a person with elevated levels of depressive mood needs an intervention targeting depressive mood. Only when these risk factors are successfully altered in treatment the outcomes will be good. Whether this targeting should be realized within customized and matched treatments or within a broader framework needs to be investigated further.

**Methodological limitations**

The studies included in this dissertation have some methodological limitations worth taking into account in the interpretation of the findings. One has already been brought up in the studies, very pronounced in study II and III: The system used for matching participants to treatments. Being a first attempt at a theoretically informed matching procedure, we based the profiles on earlier research demonstrating subgroups of people with different levels of elevations in psychological risk factors. We then matched the profiles with already existing, evidence based, early interventions. The profiles turned out to be unstable over time, leading to treatments not being matched in the end and obstructing our possibilities of drawing conclusions regarding the effects of matching. Moreover, the treatments included may have been less distinct than anticipated, and in fact targeting in some cases the same mechanisms, obstructing our possibilities of distinguishing treatment effects. These limitations, while constraining the conclusions, also generated ideas of what is important to look out for in future studies investigating matching. Hence, methodological limitations can inform future studies and increase possibilities of important findings.

A second limitation, common and to some extent unavoidable in psychological research, is the exclusive use of subjective self-report measurements. Self-report measurement, while easy to administer and indeed valuable as a source of information, risk bringing about bias and distortions from the person responding to them, for example out of social desirability (Kazdin, 2010a). Although we have strived to include instruments of good quality, with well-established psychometric properties objective measures would give further strength to conclusions. However, most concepts included in the studies are by definition subjective and difficult to measure in objective ways and the subjective experience is in fact what we are aiming to capture.

A third limitation concerns the recruitment of participants in the matching study. While all eligible patients at the occupational health care clinic
received information about the project and were encouraged by their healthcare providers to declare their interest, nonetheless the recruitment was based on self-selection. In addition to this self-selection, a number of included participants declined to participate before treatment start. They reported various reasons for declining, including that they had another ongoing treatment and/or lack of time. The question is how this selection bias might influence our results, and whether the results are possible to generalize to the population of people with pain complaints seeking occupational health care. Those who after inclusion declined participation did not differ from those who commenced treatment in any one of the important variables including pain severity, duration of problem or level of disability. However, we have not had access to data concerning those who did not announce interest. It is thus reason to assume that the results are generalizable to people volunteering to participate in psychological interventions for pain within occupational health care, but some caution is needed before extending the findings to the whole population.

A fourth methodological limitation is that the participants included in the matching study were rather well-functioning and not yet disabled by their pain problem, leaving little room for improvements (i.e. ceiling effect). Again, this is to some extent unavoidable when investigating early, preventive interventions. However, despite that the participants’ level of psychological as well as physical functioning was rather high we could still observe significant improvements in hypothesized process variables and in outcomes. We can thus conclude that while the participants were included in the study rather early in their pain problem development we could offer effective interventions that seem to have had the capacity of altering their prognosis.

A final methodological limitation is the lack of a no-treatment control group in Study II. We had two main research questions, one using the unmatched participants as control group and the other one lacking control group, and it might indeed be problematic to draw conclusions regarding treatment effects without control group. However, we calculated within-groups effect sizes and when compared with similar treatment outcome studies (e.g. Leeuw et al., 2008; Linton et al., 2008) our effects are well in line with others.

In sum, there are reasons to be cautious about generalizing findings to the whole population of people at risk for long-term pain problems. Nevertheless, this dissertation was conducted in an actual clinical situation
and underscores the advantages as well as the problems in developing a sustainable early detection and treatment program.

Summary and concluding remarks
In summary, this dissertation shows that psychological mechanisms are important for the prediction of outcomes. The dissertation has added to the knowledge about individual differences in terms of psychological responses to pain, and supports the notion that the population of people seeking care for pain is a heterogeneous one. Seemingly, people have different pathways of psychological responses that can all lead to long-term disability. Some report elevations in pain catastrophizing, others report depressive mood, and some describe elevations in both while a rather large group do not have elevations in either one. These individual differences might be important to take into account when developing treatment interventions aiming to prevent long-term suffering due to musculoskeletal pain. Moreover, it seems as if these psychological mechanisms have an additional value; they are well-chosen targets for treatment. If pain catastrophizing, fear and avoidance beliefs, pain-related worry, depressive mood, and avoidance behavior are elevated when people seek care for pain problems, these variables have to be targeted and altered in order to achieve good outcomes of treatment. And finally, the dissertation has investigated a matching process attempting to optimize psychological treatments for the prevention of long-term pain-related disability. The findings do not support matching treatment to psychological profiles, but bring about issues that are valuable to take into account when investigating matching in the future. Hence, while the dissertation has contributed to the understanding of psychological processes and their importance for how pain can interrupt daily functioning and become a major burden for the individual as well as for society, the mystery of pain needs a lot more attention both in research and in the clinic.

Conclusions
- People with musculoskeletal pain problems differ in terms of psychological mechanisms. It is possible to identify subgroups of people with different patterns of psychological mechanisms such as pain catastrophizing and depressive mood.
- People belonging to a subgroup with elevations in either pain catastrophizing or depressive mood, or both, have less favorable
outcomes of psychologically informed physical therapy, than people with no elevations. These psychological profiles can thus be valuable predictors of treatment outcome.

- Early interventions can successfully alter pain catastrophizing, fear and avoidance beliefs, avoidance behaviors, pain-related worry, and depressive mood. Therefore, these psychological mechanisms are potential targets for treatment.

- If psychological mechanisms are successfully targeted in treatment, outcome in terms of disability, perceived health, and pain intensity is better.

- Effects of three different evidence-based psychological treatments were comparable, and were not related to risk profile. Independent of subgroup belonging, treatments were effective and matching did not improve outcomes further.

- BUT it was difficult to identify stable profiles and a feasible matching system, and matching needs further scientific attention.

- Future research should focus on two areas: Development of effective interventions targeting psychological variables, and the investigation of how treatments can be optimized e.g. through matching.
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