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Factorial Validity and Gender Invariance of the Beck Depression Inventory – Second Edition
(BDI–II) and the Multidimensional Pain Inventory (MPI) in Individuals with Chronic Pain

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Factorial Validity and Gender Invariance of the
Beck Depression Inventory – Second Edition (BDI-II) and the
Multidimensional Pain Inventory (MPI) in Individuals with Chronic Pain

Cheryl A. Harris

Dissertation submitted to the Faculty of Graduate and Postdoctoral Studies in partial
fulfillment of the requirements for the Doctor of Philosophy in Clinical Psychology

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In memory of my dearly loved sister

Lisa Louise Harris

*who encouraged me to live life to the fullest
and taught me to appreciate each and every moment.*

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Thesis Format

This dissertation begins with a general introduction including an overall literature review and the goals of the dissertation. The two studies comprising the dissertation are then presented in article format, each with separate introduction, methods, results, discussion, acknowledgements, and references sections. The articles are presented in their entirety and in the format required by the journal to which they have been submitted. Article I has been accepted for publication in *Pain* and Article II is currently under review for publication in the *European Journal of Pain*. A general discussion of the dissertation then follows, including integration of the results and their implications, research strengths and limitations, and directions for future research. The references specific to the general introduction and the general discussion appear at the end of the dissertation.

Abstract

The factorial validity and gender invariance of the Beck Depression Inventory – Second Edition (BDI-II) and the Multidimensional Pain Inventory (MPI) were examined in large samples of women and men with chronic pain. These measures are commonly employed in the assessment of individuals with chronic pain. Moreover, the BDI and the MPI Interference subscale are recommended by the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) committee for use in pain research. In Article I, four competing models of the BDI-II factor structure were examined and confirmatory factor analysis supported the conceptualization of depression as a singular latent construct, within a hierarchical factor structure consisting of three first-order factors – Negative Attitude, Performance Difficulty, and Somatic Elements. Factor structure, item-total correlations, and correlations between subscale means and subjective pain experience, support the inclusion of somatic items despite concerns regarding their overlap with pain symptoms. Given partial measurement gender invariance, an examination of mean gender differences was warranted. The scores of women and men were similar. In Article II, models of the MPI factor structure [Kerns et al., 1985 with amendments by Rudy, 1989 and Deisinger et al., 2001] were examined. The Interference factor was cross-validated except for one problematic item, and is gender invariant. When configured according to the Deisinger Model, the Punishing Responses and Pain Severity factors provide valid, gender equivalent, information. The Support, Solicitous and Distracting Responses factors operated differently by gender. Although neither model is optimal for Section III, the Kerns Model is best. The Activities Away From Home and Social Activities factors are gender invariant, but Outdoor Work and

Household Chores are not. Revisions to Sections II and III are recommended. With its focus on construct validity and gender equivalence, this dissertation complements recent calls for empirically supported measurement and is consistent with gender-fair research initiatives. Results impact chronic pain clinicians and researchers.

Factorial Validity and Gender Invariance of the
Beck-Depression Inventory – Second Edition (BDI-II) and the
Multidimensional Pain Inventory (MPI) in Individuals with Chronic Pain

Empirically Supported Measurement in Psychology

Psychological testing has figured prominently in the history of psychology (Anastasi & Urbina, 1996). Given this foundation and its continuing importance, the more recent focus on empirically supported measurement, with its emphasis on employing assessment measures with demonstrated psychometric strength, is welcomed. Although assessment and treatment research are often viewed as more interesting than psychometric investigations, the meaningfulness of empirically-based psychological research hinges on the psychometric strength of the measures employed.

Recently, for example, the need to direct greater attention to empirically supported measurement in the area of pain has been noted (Turk & Melzack, 2001). With the goal of obtaining comprehensive assessment information, the breadth and complexity of pain has resulted in the development of multiple instruments designed to assess different facets of this subjective experience. Comprehensive assessment is imperative; however, insufficient evaluation of the psychometric properties of the measures developed for this purpose has been observed (Turk & Melzack, 2001). As a result, the quality and accuracy of the information that these measures provide is unclear. In turn, this can have negative implications for the accuracy of treatment decisions that are based on these measures and for the meaningfulness of research conclusions that are drawn from them.

Psychometrics in Psychology

Psychology has been defined as the scientific study of mental processes and behaviour (Reber, 1995). In the context of mental processes, psychology involves the measurement of attributes, termed constructs, that are not directly observable (e.g., intelligence, attitudes, beliefs, personality traits, psychopathology). These psychological constructs must therefore be inferred from observable data that are hypothesized manifestations of the particular attribute under investigation. As such, the accurate measurement of constructs in psychology is imperative to understanding these subjective phenomena.

Psychometrics is the field of study pertaining to psychological measurement (Reber, 1995). It involves the development, evaluation, and refinement of psychological measures that are designed to assess constructs. For example, a questionnaire could be developed to measure the construct of depression quantitatively by assessing the degree to which an individual endorses symptoms that are hypothesized, on the basis of theory, to be manifestations of depression (e.g., sadness, loss of pleasure etc.). Once developed, such a questionnaire would need to be evaluated to determine how well it actually measures the depression construct.

The concepts of reliability and validity are central to psychometrics. Reliability refers to consistent measurement, whereas validity refers to actually measuring what is claimed to be measured (Nunnally & Burnstein, 1994). In order to be valid, a questionnaire must be reliable; however, a questionnaire can be reliable without being valid if it measures an unintended construct in a consistent way. Reliability and validity are both assessed mathematically. Even when established, these properties are not

deemed to be inherent to the measure itself, rather they vary depending on the situation (e.g., population, specific purpose) in which the measure is used (Hunsley & Mash, 2007; Nunnally & Bernstein, 1994).

Three major types of reliability and three major types of validity have been outlined (Sax, 1999). In regard to reliability, internal consistency reliability refers to the extent to which items measure the same underlying construct(s). Stability reliability is the consistency in measurement over time. Equivalence reliability is the consistency of measurement across two or more parallel or alternate forms of a questionnaire.

In regard to validity, content validity reflects the extent to which questionnaire items are an appropriate sample of the entire pool of content that is required to be measured. Criterion validity refers to the degree to which questionnaire scores correlate in the hypothesized manner with an external criterion. Finally, construct validity refers to how well the questionnaire items account for the construct of interest. Establishing reliability and validity is an ongoing process. Results of reliability and validity analyses may result in refinement of the measure itself and/or the theory upon which it is based.

Contribution of Confirmatory Factor Analysis to Measurement and Theory

Cronbach and Meehl (1955) stated that evaluating the construct validity of a measure involves developing a theory about the observable variables that underlie the construct, developing a way to assess the observable variables, and then empirically evaluating the proposed associations between the construct and its observable variables. Factor analysis, which involves examining the associations between observed variables (e.g., questionnaire items) and the factors (i.e., constructs) that they measure, is commonly employed in the final step suggested by Cronbach and Meehl (1955). This

approach to construct validation is referred to as factorial validation. It makes explicit the interdependence of theory and measurement by incorporating both observed variables (i.e., items on a questionnaire) and latent theoretical variables (i.e., the construct(s) that are assumed to be measured) (Donaldson, 1989; Kline, 1998).

There are two major methods employed in factorial validation. Exploratory factor analysis (EFA) is generally used in the early stages of measure development to determine factor structure, whereas confirmatory factor analysis (CFA) requires that associations between items and factors be stated in advance, and is therefore effectively employed when a measure is being further evaluated and/or refined, perhaps in a new population (Byrne, 2005). Using CFA, it is possible to test whether a proposed factor structure fits the observed data by imposing theoretically driven constraints on the data and then performing statistical tests to evaluate the degree of fit between the observed data and the proposed model (Byrne, 2006). Similarly, when several equally reasonable models of factor structure are suggested by theory and research, CFA can be used to evaluate which model is most relevant in the given sample (Byrne, 2006; Kline, 1998).

CFA belongs to the class of statistical methods known as structural equation modeling (SEM). CFA has several advantages over EFA, which does not use the SEM approach (Byrne, 2005). EFA is descriptive in nature, whereas CFA takes a hypothesis-testing (thus confirmatory) approach to the data in which the degree of fit of a proposed model is evaluated. When a proposed model renders a poor fit to the observed data, post-hoc model fitting can then be conducted in an exploratory fashion, to determine the sources of model misfit and develop a more optimally fitting model. In EFA it is not possible to correct for measurement error that can lead to inaccurate conclusions being

drawn about the results, whereas error is explicitly estimated in SEM and because it can be evaluated and separated from the variables of interest, is less likely to contaminate the CFA results, which are therefore clearer. Finally, while both EFA and CFA examine associations between observed and unobserved variables (i.e., latent constructs), CFA also allows for the modeling of associations between unobserved variables (i.e., latent constructs). As a result, the associations between constructs (i.e., higher-order factor structure) can be examined using CFA within the context of the SEM methodology.

The use of CFA to test the fit of a higher-order factor structure is important when a more general construct is hypothesized to subsume several more specific constructs. For example, ‘Catastrophizing’ about pain, as measured by the Pain Catastrophizing Scale (Sullivan, Bishop, & Pivik, 1995; PCS), is best conceptualized as a higher-order (i.e., more general) construct that is comprised of three lower-order (i.e., more specific) constructs including ‘Rumination’, ‘Magnification’, and ‘Helplessness’ (D’Eon, Harris, & Ellis, 2004). Of the 13 items on the questionnaire, four assess rumination about pain, three assess magnification of pain, and six assess helplessness with regard to pain; however, all 13 items combined are required to adequately assess the more general construct of ‘pain catastrophizing’.

The Impact of Gender Invariance on Measurement and Theory

Although historically gender has not always been considered an important variable by investigators conducting psychological or health research, its importance has grown in the past 25 years with the movement toward gender-fair research and assessment (Denmark, Russo, Frieze, & Sechzer, 1988; Grady, 1981; Hyde, 1996; McHugh, Koeske, & Freize, 1986; Rollman, 2003). Characteristics of gender-fair

research include selecting balanced samples so as to avoid overgeneralization from one gender to both genders, and ensuring that measuring instruments are equally applicable to both women and men (Canadian Psychological Association, 1992; CPA Section on Women and Psychology, 2007; Denmark et al., 1988; Grady, 1981; Hyde, 1996; McHugh et al., 1986). As noted, in the development of a measure the optimal factor structure must first be determined. However, this alone does not ensure adequate measurement. Once the optimal factor structure of an assessment measure is determined, it is also important to evaluate the factor structure for gender invariance (i.e., applicability to both men and women).

The assumption of gender invariance includes three components: 1) that the number of underlying factors is equivalent, 2) that the item content is interpreted similarly across gender, and 3) that the theoretical structure is equivalent (Byrne, Baron, & Campbell, 1994). In other words, tests of gender invariance evaluate whether the factor structure is configurally the same for women and men and if so, whether questionnaire scores of women and men are comparable on the same measurement scale (Widaman & Reise, 1997). Establishing gender invariance demonstrates that a measure is tapping the same construct(s) in exactly the same way for men and women. Such a determination provides evidence that the measure is free of gender bias, which can arise as a result of construct bias (i.e., the construct measured is not the same for men and women), method bias (i.e., characteristics of the measure and its administration are not the same for men and women), and/or item bias (i.e., items function differently for women and men) (van de Vijver & Leung, 1997). Therefore, gender invariance must be established before mean gender differences can be examined meaningfully.

The importance of empirically establishing the gender invariance of factor structure is illustrated by research on the PCS (Sullivan, Bishop, & Pivik, 1995). Higher scores on the PCS predict more negative outcomes for individuals experiencing pain, and women tend to score higher on the PCS than do men (e.g., Sullivan et al., 1995; Sullivan et al., 2001). Prior to accepting these mean differences as genuine gender differences, it was important that the PCS be shown to be gender invariant (D'Eon et al., 2004). After establishing gender invariance, gender bias was deemed an improbable source of the mean gender differences. In other words, these analyses showed that gender differences in catastrophizing are most likely due to gender and are not a function of construct, method, or item bias in the measurement. Questions examining the origins and implications of these gender differences in catastrophizing can now be explored with confidence that the PCS provides equivalent measurement of catastrophizing in both women and men (D'Eon et al., 2004).

Pain

Pain is a common experience. It is the primary symptom that motivates individuals to seek medical attention and it can seriously compromise one's quality of life (Turk & Melzack, 2001). Pain is currently defined by the International Association for the Study of Pain (IASP) as: "An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (Merskey & Bogduk, 1994, p. 210). This definition reflects the complex and multidimensional nature of pain, which is always subjective and is by nature both a sensory and a psychological experience.

Pain as defined above, can be broadly classified as either acute or chronic. Pain that is of relatively brief duration is frequently referred to as acute pain (Nielson, 2001). Acute pain typically serves as a warning signal of physical injury. It performs the adaptive role of motivating an individual experiencing it to guard against further harm. Healing through time or treatment usually resolves the underlying pathology, and therefore the pain (Nielson, 2001). Acute pain can be the result of injury, it can occur following surgery, during and following medical interventions, and it can be induced in a laboratory setting for the purpose of conducting research (Turk & Melzack, 2001).

Chronic pain is commonly defined as pain that persists for an extended period of time (i.e., typically 3 months or more) or pain that persists beyond the normal time of healing (Melzack & Wall, 1999; Merskey & Bogduk, 1994; Turk & Melzack, 2001). In the case of chronic pain, pain no longer serves as an adaptive warning signal. Individuals must therefore learn to manage it as a part of daily life (Nielson, 2001). Chronic pain can be categorized into several types (Turk, Meichenbaum, & Genest, 1983). *Chronic, periodic pain* refers to pain conditions that are characterized by intense episodes of pain interspersed with periods of being free of pain (e.g., migraine headache pain). *Chronic, progressive pain* refers to pain that is the result of a medical condition and is usually associated with tissue damage (e.g., rheumatoid arthritis, cancer). *Chronic, intractable, benign pain* refers to what is commonly labelled “chronic pain” in accordance with the IASP definition quoted above. The term intractable denotes longstanding pain that is likely to continue throughout a patient’s lifetime, and the term benign denotes pain that is not associated with cancer (Turk, Meichenbaum, & Genest, 1983; Turk & Melzack, 2001).

The Prevalence and Complexity of Chronic Pain

Chronic pain is markedly prevalent. In a review of epidemiological studies conducted around the world examining chronic pain among adults, researchers reported a prevalence rate of 10% in the general population (Verhaak, Kerssens, Joost, Marjolijn, & Bensing, 1998). In Canada, there have been three epidemiological studies of the prevalence of chronic pain. In a telephone survey in which 827 individuals were asked if they were "often troubled with pain", 11% reported that they were (Crook, Rideout, & Brown, 1984). The Statistics Canada National Population Health Survey of 1994 to 1995 revealed a chronic pain prevalence rate of 15% in men and 20% in women (Millar, 1996). Most recently, a stratified random sample of 2012 adult Canadians (weighted by gender, age, and region) determined that chronic pain, defined as intractable, benign pain or periodic pain present for at least six months, was reported by 29% of respondents (Moulin, Clark, Speechley, & Morley-Forster, 2002). In this sample, the mean number of days that respondents reported being unable to work during the past year due to chronic pain was 9.3 for those with mild to moderate pain, and 16 for those with severe pain (Moulin et al., 2002). In addition, 49% of the respondents experiencing chronic pain reported great difficulty attending social events, 61% reported being unable to participate in their usual recreational activities, and 58% were unable to carry out typical daily activities at home. Using data from the Canadian Community Health Survey, Currie and Wang (2004) estimated the prevalence of chronic back pain at 9% of individuals 12 years and older. In British Columbia in the year 2000 alone, it was estimated that the Insurance Corporation of British Columbia paid out \$108,532,000 for past wage loss claims and \$127,108,000 for future wage loss claims due to pain and suffering related solely to

automobile accidents (Harder & Potts, 2003). Clearly, chronic pain is a pervasive personal and societal problem.

Many aspects of chronic pain are not thoroughly understood. In some cases, chronic pain develops following an acute episode of pain that fails to resolve. Consistent with this, research has shown that uncontrolled and prolonged pain can become a medical condition of its own. This occurs through a process of neural plasticity and central sensitization that may result in alteration of both the peripheral and central nervous systems (Basbaum & Bushnell, 2002;Coderre & Katz, 1991; Coderre, Katz, Vaccarino, & Melzack, 1993). In other instances, the cause of the pain is unknown (e.g., fibromyalgia). The IASP has published a taxonomy of chronic pain, which includes a definition, clinical description, prognosis, and probable etiology for each of the numerous chronic pain conditions that had been identified at the time of publication (Merskey & Bogduk, 1994).

Despite significant scientific advances in understanding the physiology of pain, there is no available pharmacological treatment that consistently and permanently alleviates pain (Merskey & Moulin, 1999; Turk & Monarch, 2002). Nonsteroidal anti-inflammatory drugs (NSAIDs) are the class of drugs that are most commonly prescribed for chronic pain in Canada (Moulin et al., 2002). Although these drugs do provide some pain relief, in Canada they also account for approximately 4000 hospitalizations and 400 deaths per year (Tamblyn et al., 1997). There is growing recognition that opioid analgesics (e.g., morphine) are safe and effective in the management of moderate to severe chronic pain (Moulin et al., 2002); however, clinical trials have indicated reductions in pain intensity of 20%-50%, which means that individuals still need to

manage pain (Arkininstall et al., 1995; Caldwell et al., 1999; Harati et al., 1998; Roth et al., 2000; Watson & Babul, 1998; Watson, Watt-Watson, & Chipman, 2004). Moreover, statistics show that individuals with chronic pain are not likely to be comfortable taking opioid analgesics. Of 340 individuals with chronic pain who were taking prescription medications for their pain (mostly NSAIDs), 69% of those sampled by Moulin et al. (2002) felt that opioids were addictive, 52% felt that they were too strong for their pain, and 29% said that they should be reserved for terminal illness like advanced cancer. Thus, for a variety of reasons, drug therapy cannot effectively alleviate chronic pain in many individuals.

Clinicians and researchers have found that individuals with chronic pain benefit when a more holistic approach is taken toward helping them manage their pain (Polatin & Gajraj, 2002). Chronic pain is currently viewed from a biopsychosocial perspective, in which a reciprocal interplay among biological, psychological, and social factors is assumed (Dworkin & Sherman, 2001; Turk & Monarch, 2002). Psychological and social factors are not viewed as mere consequences to pain, but are known to influence the experience of pain and therefore represent opportunities for improved pain management. As such, a substantial amount of research into the psychological and social components of the pain experience is being conducted (e.g., Grant, Long, & Willms, 2002; Keogh, McCracken, & Eccleston, 2006; Morley & Williams, 2002; Turner, Jensen, & Romano, 2000).

Assessing the Multiple Dimensions of Chronic Pain

Given that pain is influenced by multiple variables and its consequences are multifaceted, it has been argued that the pain construct is best inferred from multiple

indicators (Dworkin & Sherman, 2001; Feuerstein, Papciak, & Hoon, 1987; Jamison, Rudy, Penzien, & Mosley, 1994; Jensen & Karoly, 2001; Naliboff, Cohen, Swanson, Bonebakker, & McArthur, 1985; Turk, 1989). Valid and reliable assessment of the multiple dimensions associated with chronic pain in both men and women is important for accurate diagnosis, effective rehabilitation, theory development, and program evaluation. Given the subjective nature of the pain experience, researchers and clinicians have relied predominantly on self-report measures in the assessment of its cognitive, affective, and behavioural components (Dworkin & Sherman, 2001). For example, the Multidimensional Pain Inventory is a self-report questionnaire that was developed to assess psychosocial and behavioural components of the pain experience (Kerns, Turk, & Rudy, 1985).

Recently, pain specialists from academia, government agencies, and the pharmaceutical industry met under the auspices of the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) with the goals of determining outcome domains that should be considered in clinical trials of pain treatments and how best to assess the domains once identified (Dworkin et al., 2005; Turk et al., 2003). A total of six core domains and corresponding recommendations for outcome measures to assess each of them were delineated as follows: 1) pain assessed via an 11-point numerical rating scale of pain intensity or a categorical rating (none, mild, moderate, severe) and by the use of analgesics; 2) physical functioning assessed via the Multidimensional Pain Inventory Interference subscale or the Brief Pain Inventory interference items; 3) emotional functioning assessed via the Beck Depression Inventory and/or the Profile of Mood States; 4) participant ratings of global improvement and

satisfaction with treatment assessed via the Patient Global Impression of Change; 5) adverse events and symptoms assessed by recording any spontaneously reported adverse events or symptoms and by openly asking about the same; and 6) participant disposition assessed via detailed information regarding participant recruitment and progress throughout the research study. By outlining a consistent battery of assessment measures to be employed, the recommendations of the IMMPACT committee will facilitate the interpretation of research results and comparisons of results across studies.

As noted, the emphasis on empirically supported measurement has had an impact on many areas of research. The IMMPACT recommendations are in keeping with this focus, and point to the importance of investigating the psychometric properties of measures used in the area of chronic pain in general, and for the recommended measures in particular.

Depression in Chronic Pain

Major Depressive Disorder (MDD) is one of the most common mental health problems in the general population, in which its prevalence is approximately 5-8% (Blazer, Kessler, McGonagle, & Swartz, 1994; Kessler et al., 2003). MDD is also prevalent among individuals with chronic pain, and estimates in this population are significantly higher. Rates of MDD in patients seeking treatment at pain clinics have ranged from 30 to 54% (Banks & Kerns, 1996; Geisser, Roth, Theisen, Robinson, & Riley, 2000; Sullivan, Reesor, Mikail, & Fisher, 1992; Wilson, Eriksson, D'Eon, Mikail, & Emery, 2002). A recent epidemiological study examining the co-occurrence of chronic back pain and major depression in the general Canadian population indicated that 19.8%

of individuals with chronic back pain also met criteria for major depression (Currie & Wang, 2004).

Researchers have acknowledged that the prevalence of depression in individuals with chronic pain may be inflated due to the overlap of chronic pain symptoms (e.g., sleep disturbance, loss of energy) with the symptoms of MDD (Banks & Kerns, 1996; Currie & Wang, 2004; Sullivan et al., 1992; Wilson, Mikail, D'Eon, & Minns, 2001). However, the rates of MDD in individuals with other chronic medical conditions, including arthritis, diabetes, heart disease, high blood pressure, and chronic lung conditions, in which symptom overlap is also problematic, are substantially lower, ranging from 5-27%. (Katon & Ciechanowski, 2002; Katon & Schulberg, 1992; Robinson, Starr, Kubos, & Price, 1983; Wells, Golding, & Burnam, 1989). Such a comparison demonstrates that rates of MDD in the chronic pain population are remarkably high given that one-third to one-half of this population experiences depression.

Given its prevalence, the importance of routinely assessing the level of depressive symptomatology experienced by women and men with chronic pain is clear. Moreover, studies have consistently shown that individuals diagnosed with chronic pain and depression have poorer outcomes than those who are diagnosed with chronic pain alone (Arnow et al., 2006; Doan & Wadden, 1989; Geisser, Robinson, Keefe, & Weiner, 1994; Geisser et al., 2000; Haythornthwaite et al., 1991; Keefe, Wilkins, Cook, Crisson, & Muhlbaier, 1986; Kerns & Haythornthwaite, 1988). For example, individuals with comorbid chronic pain and depression have been found to report higher pain intensity and disability, tend to be less active, display more pain behaviours (e.g., holding, rubbing,

wincing), experience poorer pain management treatment outcome, and are less likely to complete pain management treatment programs (Arnow et al., 2006; Doan & Wadden, 1989; Geisser et al., 1994, 2000; Haythornthwaite et al., 1991; Keef et al., 1986; Kerns & Haythornthwaite, 1988). Thus, depression has damaging consequences for individuals in pain both in terms of suffering and impact on treatment for depression and chronic pain.

Gender Differences and Chronic Pain

Research indicates that women and men experience pain differently.

In epidemiological, clinical, and experimental research, women have generally been found to report more frequent, varied, and intense pain experiences than do men (Filligim, 2000; Keogh & Herdenfeldt, 2002; Riley, Robinson, Wise, Myers, & Filligim, 1998; Rollman, 2003; Unruh, 1996). Women also report pain that persists for a longer duration, and lower levels of pain tolerance and pain threshold (Filligim, 2000; Keogh & Herdenfeldt, 2002; Riley et al., 1998; Unruh, 1996). Gender differences in response to interdisciplinary pain management treatment have also been identified, with men maintaining post-treatment reductions in pain severity and pain-related distress at 3-month follow up and women showing no difference from pre-treatment scores (Keogh, McCracken, & Eccleston, 2005).

Various influences, including biological (e.g., hormone variation, differences in brain chemistry), sociological (e.g., role expectations), and psychological (e.g., differences in appraisals of the meaning of pain, coping strategies), have been proposed to explain these gender differences (LeResche, 2000; Rollman, 2003; Rollman, Abdel-Shaheed, Gillespie, & Jones, 2004; Rollman & Lautenbacher, 2001; Unruh, 1996). It is likely that they are due to some combination of biological, psychological, and

sociological variability. Clinicians and researchers must be cognizant of gender differences and consider how they might impact the assessment and management of pain and its associated constructs (Unruh, 1996).

Gender, depression, and chronic pain.

Epidemiological research has shown that in the general population women are twice as likely as men to suffer from depression (Boyd & Weissman, 1981; Nolen-Hoeksema, 1987; Weissman & Klerman, 1977). Although surprisingly few studies in the area of chronic pain have examined gender prevalence ratios of depression, those that have yield inconsistent findings. Some report that, as in the general population, women are more likely to be depressed than men (Fishbain, Goldberg, Meagher, Steele, & Rosomoff, 1986; Magni, Caldiernon, Rigatti-Luchini, & Merskey, 1990; Turk & Okifunji, 1999). In others, no gender differences have been found (Haley, Turner, & Romano, 1985; Haythornthwaite, Sieber, & Kerns, 1991; Keogh et al., 2006; Kraemlinger, Swanson, & Maruta, 1983; Novy, Nelson, Averill, & Berry, 1996). It is possible that these inconsistencies relate to the various methods used to assess depressive symptoms in these studies and differences in sample characteristics.

Of the three studies that found gender differences in depression in samples of individuals with chronic pain, one involved surveying a community sample (Magni et al., 1990) and the other two identified depression in clinic samples through diagnostic interviews (Fishbain et al., 1986; Turk & Okifunji, 1999), although Turk and Okifunji (1999) also reported mean gender differences on the Centre for Epidemiologic Studies Depression Scale (CDS-D). Studies reporting no gender differences have all employed

clinical samples and have used diagnostic interviews and/or self-report (i.e., the Beck Depression Inventory) to measure depression. Thus, no clear pattern of results is evident.

It is also possible that gender bias in the assessment of depressive symptoms may be contributing to inconsistencies in the gender difference results. Self-report measures of depressive symptoms in chronic pain have not been examined for gender bias. There is some evidence to suggest that clinical diagnosis can be gender biased, with professionals being more likely to consider psychological components of an illness if the patient is a woman (Verbrugge, 1985; Unruh, 1996). Research is required to rule out the possibility of gender bias in the assessment of depression in chronic pain, and then to further examine gender differences in the prevalence of depression via clinical diagnosis and in the prevalence of depressive symptoms via self-report. It seems reasonable to hypothesize that gender differences in depression are less likely to be found in individuals who seek specialized chronic pain treatment, in which pain duration is likely to be longer and its severity greater, than in community samples of individuals with chronic pain, regardless of the method of assessment. However, this remains to be determined.

One study to date has examined the influence of gender on the expression of depressive symptoms in individuals with chronic pain (Novy et al., 1996). Although these researchers did not find gender differences in Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) total scores, gender differences at the item level were found via discriminant function analyses. Women were reported to endorse significantly higher levels of body image distortion and fatigue than were men (Novy et al., 1996). However, as demonstrated in the example with the Pain

Catashrophizing Scale, it is important that the BDI be examined for gender invariance before these mean gender differences can be interpreted as genuine gender differences with confidence that the measure is not gender biased.

Relevance and Research Objectives

In selecting measures to be used in research and practice, the psychometric properties of potential instruments need to be examined carefully. With the recent movement toward empirical support for the clinical-effectiveness and cost-effectiveness of psychological services (Hunsley, 2003; Turk & Melzack, 2001), a related shift toward empirically supported assessment has also emerged (Antony & Barlow, 2002; Hunsley & Mash, 2007). In all areas of psychology, researchers and clinicians are being called upon to justify decisions about the assessment tools that they use. The area of chronic pain is no exception. As discussed, chronic pain is a common problem that can have significant personal and social consequences. Assessment based on psychometrically sound measures, that are equally applicable to women and men, is required to ensure that individuals with chronic pain are assessed properly and therefore offered appropriate treatment, and so that the results of research studies can be interpreted with confidence in the measures employed.

Although there is consensus that thorough evaluation of the pain experience must include multiple dimensions, the psychometric properties of self-report measures employed in such assessment have not been given sufficient attention (Turk & Melzack, 2001; Bradley & McKendree-Smith, 2001). In order to assess psychosocial factors in individuals with chronic pain some measures have been developed specifically for individuals experiencing pain (e.g., West Haven-Yale Multidimensional Pain Inventory,

Pain Stages of Change Questionnaire, Pain Anxiety Symptoms Scale) (Bradley & McKendree-Smith). In other instances measures not specifically developed for chronic pain samples have been used (e.g., Beck Depression Inventory-II, Minnesota Multiphasic Personality Inventory-2, Symptom Checklist-90-R). Reliance on measures that have not been validated in the chronic pain population is problematic because a measure that has demonstrated adequate psychometric properties in one population cannot be assumed to demonstrate adequate psychometric properties in another population (Hunsley & Mash, 2007; Turk & Melzack, 2001). Moreover, even when a measure has been developed or validated using a sample of individuals with chronic pain, adequate psychometric properties must be replicated in several pain samples before clinicians and researchers can have confidence in the results obtained (Byrne, 1994; Smith & McCarthy, 1995). In addition, research suggests that men and women experience pain differently. It is therefore possible that different theoretical models apply when evaluating their pain and its related constructs. Thus, the examination of measures for gender invariance is also critical in order to ensure valid assessment.

The primary purpose of this research is to examine the factorial validity and gender invariance of two widely used assessment measures in the area of chronic pain: the Beck Depression Inventory – Second Edition (BDI-II; Beck, Steer, & Brown, 1996), and the Multidimensional Pain Inventory (MPI; Kerns et al., 1985). In an empirical investigation of nine measures commonly used to assess individuals with chronic pain, the Beck Depression Inventory (BDI) and MPI were found to be part of a three-measure assessment battery (also including the McGill Pain Questionnaire) that captures the pain experience with minimal overlap (Mikail, DuBrueil, & D'Eon, 1993). The utility of this

three-measure assessment battery in capturing the multifaceted nature of the chronic pain experience has also been demonstrated (De Gagné, Mikail, & D'Eon, 1995). Clinical assessment and decision making is frequently influenced by these measures (e.g., Geisser, Roth, & Robinson, 1997; Piotrowski, 1998; Turner & Romano, 1984). Furthermore, the BDI-II and the MPI are commonly used in chronic pain research (e.g., Currie, Wilson, & Curran, 2002; Okifuji, Turk, & Eveleigh, 1999; Wilson et al., 2002) and, as noted, the IMMPACT committee recently recommended the BDI and MPI Interference subscale for use within the context of the multidimensional assessment of core outcome domains in pain treatment research (Dworkin et al., 2005).

Overview of Articles and Hypotheses

This dissertation comprises two articles. In Article I, the factorial validity and gender invariance of the BDI-II is evaluated in a large, heterogeneous sample of men ($n = 202$) and women ($n = 279$) with chronic pain. To date, only one study has examined the factor structure of the BDI-II in a sample of individuals with chronic pain (Poole, Bramwell, & Murphy, 2006). The Poole et al. study resulted in only 18 of the 21 BDI-II items being retained and no test of gender invariance was conducted. In Article I, the Poole et al. model and three other competing models of BDI-II factor structure are tested using CFA (i.e., Arnau et al., 2001; Beck et al., 1996; Byrne, Stewart, & Lee, 2004; Poole et al., 2006). A second-order CFA model, based on the best fitting model from the initial CFA analyses is then tested for gender invariance. The influence of gender on item and total scores, and the issue of symptom overlap between depression and chronic pain are also examined. Thus, Article I extends the psychometric research of the BDI-II through the use of first- and second-order CFA with a large heterogeneous chronic pain sample,

by evaluating gender invariance of the measure, and by investigating the potential confound between chronic pain and the BDI-II somatic items.

Given similarities between a methodologically sound model of BDI-II factor structure derived by Byrne et al. (2004) and the factor structure found to provide an adequate fit to the data of chronic pain patients measured using the original BDI (Novy, Nelson, Berry, & Averill, 1995), it is hypothesized that the Byrne et al. (2004) model will provide the best fit to the data of women and men with chronic pain. With regard to gender invariance, it is hypothesized that the best fitting BDI-II factor structure will be invariant across gender. This hypothesis is based on BDI gender invariant findings in samples of individuals without pain (Byrne, Baron, & Campbell, 1993; Byrne et al., 1994).

In Article II, the factorial validity and gender invariance of the MPI is evaluated in a large, heterogeneous sample of men ($n = 256$) and women ($n = 356$) with chronic pain. Researchers have questioned the factorial validity of the MPI (Bernstein, Jaremko, & Hinkley, 1995; De Gagné et al., 1995; Riley, Zawacki, Robinson, & Geisser, 1999; Deisinger, Cassisi, Lofland, Cole, & Bruehl, 2001) and the influence of gender in responses to it (Bernstein et al., 1995; De Gagné et al., 1995; Riley et al., 1999). Despite this, only three studies have examined the factor structure of the MPI since its original development (Bernstein et al., 1995; Riley et al., 1999; Deisinger et al., 2001), and it has never been tested for gender invariance.

Article II extends the psychometric research of the MPI by investigating the factor structure in a large sample and evaluating the generalizability of the measure to women. The MPI factor structure derived by Kerns et al. (1985; with amendments by Rudy,

1989), and the factor structure derived by Deisinger et al. (2001) are examined separately, by gender, using CFA to determine which model is statistically optimal. To further evaluate the influence of gender, tests of gender invariance are then conducted when appropriate, based on the best fitting model for each gender.

Deisinger et al. (2001) addressed limitations of the original study by Kerns et al. (1985) by employing a large sample composed of an approximately equal number of women and men, and conducting an EFA on all 61 items in Version 2 of the MPI. As such, it is hypothesized that the Deisinger et al. model will provide a more optimal fit to the observed data in the present research. With regard to gender invariance, it is hypothesized that the MPI factor structure will vary with gender, and that this will be particularly evident in Section III (activity section). This hypothesis is based on past research that has shown Section III to be particularly problematic (Bernstein et al., 1995; De Gagné et al., 1995; Jensen & Karoly, 1991; Riley et al., 1999) and on research suggesting that the types of activities men and women engage in on a regular basis vary by gender (Vallerand, 1998).

Results of these studies will allow clinicians and researchers to base interpretations of the BDI-II and the MPI on the optimal factor structure for the chronic pain population and will provide valuable information about the applicability of these measures to women and men with chronic pain. Given the importance of valid and reliable assessment to clinical practice (i.e., for accurate diagnosis and appropriate treatment) and research (i.e., theory development and program evaluation), these studies will make a substantive contribution to the chronic pain literature.

Article I

Psychometric Properties of the Beck Depression Inventory – Second Edition (BDI-II)
in Individuals with Chronic Pain

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depression; psychometrics; assessment; gender; confirmatory factor analysis

Abstract

Given the high prevalence of depression in individuals with chronic pain and the negative outcomes associated with such comorbidity, the importance of assessing depressive symptoms is widely acknowledged by chronic pain specialists. The BDI-II is a commonly employed measure of depressive symptomatology at pain centres; however, little is known about its psychometric properties in this population. This study evaluated factorial validity, internal consistency, and gender invariance of the BDI-II in 481 patients with chronic pain. Four competing models of the BDI-II factor structure were examined and confirmatory factor analysis supported the conceptualization of depression as a singular latent construct, within a hierarchical factor structure consisting of three first-order factors – Negative Attitude, Performance Difficulty, and Somatic Elements. Factor structure, item-total correlations, and correlations between subscale means and subjective pain experience, support the inclusion of somatic items despite concerns regarding their overlap with pain symptoms. Internal consistency was good. Mean total scores were in the moderately severe range. Given evidence of partial measurement invariance, an examination of mean gender differences was warranted. In contrast to the general population, the average scores of women and men were similar. Overall, results support the construct validity and internal consistency of the BDI-II for assessing depressive symptoms in both women and men with chronic pain. Results support the appropriateness of computing a total score and/or subscale scores. By providing evidence of the reliability and validity of the BDI-II in individuals with chronic pain, these results impact chronic pain researchers and clinicians, particularly given current trends toward empirically supported assessment.

Psychometric Properties of the Beck Depression Inventory – Second Edition (BDI-II)
in Individuals with Chronic Pain

1. Introduction

The high prevalence of depression among individuals with chronic pain is well documented (Banks & Kerns, 1996; Wilson et al., 2001), as are the negative outcomes associated with such comorbidity (Keefe et al., 1986; Kerns & Haythornthwaite, 1988). Given its prevalence and negative implications, the importance of routinely assessing depression is acknowledged by chronic pain specialists.

The original Beck Depression Inventory (BDI; Beck et al., 1961) is one of the most commonly used measures of depressive symptomatology in individuals with chronic pain (Wesley et al., 1999; Morley et al., 2002); however, varied conclusions have been drawn regarding its utility in this population. In support of the BDI, authors reported adequate sensitivity and specificity of the measure to discriminate between chronic pain patients with and without major depression (Turner & Romano, 1984; Geisser et al., 1997). A study of factorial validity supported the conceptualization of depression as a singular latent construct within a hierarchical factor structure consisting of three first-order factors – Negative Attitudes/Suicide, Performance Difficulty, and Physiological Manifestations (Novy et al., 1995). In contrast, others have concluded that the BDI items do not tap a singular latent construct and that the total score should therefore not be interpreted (Williams & Richardson, 1993; Miles et al., 2001; Morley et al., 2002). These authors argued that the total score likely overestimates depression given that the somatic items, which may be due to chronic pain, are most highly endorsed.

In 1996, Beck et al. developed the Beck Depression Inventory-Second Edition (BDI-II) to correspond with diagnostic criteria for major depressive disorders described in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 1994). This measure replaced the original version and is commonly used at pain centres. One study to date examined the BDI-II factor structure in chronic pain patients, and two factors labelled Negative Thoughts and Behaviour, which included 18 of the 21 items, were supported (Poole et al., 2006). Further evaluation of the BDI-II in this population is warranted, especially given the discrepant conclusions drawn regarding the original measure. Moreover, assessing gender invariance of the BDI-II is important in this population given that gender variations are reported to be pervasive (Unruh, 1996).

In addition to the BDI-II factor structure reported by Poole et al. (2006), this study empirically examined three other models deemed most likely to generalize to chronic pain (i.e., Beck et al., 1996; Arnau et al., 2001; Byrne et al., 2004). Each model was evaluated separately by gender using confirmatory factor analysis. Based on the best fitting first-order model, a second-order structure was evaluated and tested for gender invariance. Descriptive and comparative statistics required to examine the influence of gender and of somatic items on the BDI-II were also computed. Thus, this study extends the psychometric research of the BDI-II through the use of first- and second-order CFA with a large heterogeneous chronic pain sample, by evaluating gender invariance of the measure, and by investigating the potential confound between chronic pain and the BDI-II somatic items.

2. Methods

2.1. Participants

From January 1997 to December 2002, chronic pain patients referred to The Rehabilitation Centre in Ottawa, Ontario completed the English version of the BDI-II. Of 575 patients, 8 did not consent to their data being used for research purposes, 12 completed only one side of the questionnaire, and 74 provided data with one or more random items missing. The present study is comprised of BDI-II responses from the remaining 481 patients with chronic pain (279 women, 202 men).

The average age of participants was 43.25 years ($SD = 8.71$), with women being slightly older on average ($M = 44.25$, $SD = 8.76$) than men ($M = 41.87$, $SD = 8.48$) [$t(479) = 2.97$, $p < .01$, $d = 0.3$]. The average pain duration in years was 7.32 ($SD = 7.07$), with no significant difference between women ($M = 7.38$, $SD = 7.10$) and men ($M = 7.23$, $SD = 7.05$) [$t(467) = 0.22$, $p = .83$]. There was no significant difference between the scores of women ($M = 35.47$, $SD = 13.79$) and men ($M = 36.46$, $SD = 12.97$) [$t(388) = 0.72$, $p = .47$] on the Pain Rating Index (PRI) of the McGill Pain Questionnaire (MPQ), a measure of subjective pain experience. Other relevant sample demographics and chi-square statistics are summarized in Table 1. No significant association was found between gender and ethnicity, income, or education. There was a significant association between gender and primary pain site. The standardized residuals indicated that women were more likely than men to report neck/shoulder pain and less likely than men to report joint pain. There was also a significant association between gender and current marital status, with women being more likely than men to report widowed, separated, or divorced status.

This sample is similar to the Poole et al. (2006) sample, although the average age of participants in this study is somewhat lower than that reported by Poole et al. ($M = 46.73$, $SD = 11.30$) [$t(1706) = 6.08$, $p < .01$, $d = 0.3$] as is the average pain duration ($M = 8.8$, $SD = 7.8$) [$t(1706) = 3.62$, $p < .01$, $d = 0.2$]. A comparison by gender is not possible because Poole et al. did not report a breakdown of data by gender.

INSERT Table 1 ABOUT HERE

2.2. Measures

2.2.1 Pain History Questionnaire (PHQ).

The PHQ (D'Eon et al., 2000) is a self-report questionnaire designed to solicit a consistent history from every patient prior to assessment. The questionnaire was developed from a modified version of an inventory designed by Monks and Taenzer (1983) and the International Association for the Study of Pain (IASP) Task Force on Records and Data Retrieval (1996). The questionnaire provides demographic information on each patient as well as information about pain, medical and work history, activities, family circumstances, and treatment expectations. Information such as age, pain duration, education etc. was used for descriptive purposes in this study.

2.2.2 McGill Pain Questionnaire (MPQ).

The MPQ (Melzack, 1975) consists of 20 subclasses of words that describe different qualities of the pain experience. Within each subclass, words are ordered along an intensity dimension. Three inter-related yet distinct dimensions of the pain experience (sensory, affective, and evaluative) are derived from the first 16 sets of descriptors. The remaining 4 sets of descriptors comprise a miscellaneous dimension. The rank values of

the words chosen are summed to yield a total Pain Rating Index (PRI), which represents a measure of subjective pain experience. In addition, the measure has a Present Pain Intensity (PPI) rating scale. Factor analytic studies have supported the three-factor structure, however due to high intercorrelations it has been suggested that the total score of the PRI be used in pain evaluation (Turk et al., 1985). The reliability of the groupings of adjectives has been demonstrated by replicating the construction of the measure using different statistical techniques than those initially used in its creation (Reading et al., 1982). Adequate test-retest reliability ($r = .83$) for the PRI has also been reported (Love et al., 1989).

2.2.3 Beck Depression Inventory-Second Edition (BDI-II).

The BDI-II (Beck et al., 1996) is a 21-item self-report measure designed to assess DSM-IV depressive symptomatology in adolescents and adults. It is a revised version of the amended BDI (BDI-IA; Beck & Steer, 1993). Respondents are asked to rate each of the depressive symptoms, ranging from 0 (not present) to 3 (severe), in terms of how they have been feeling during the past two weeks, including the date of questionnaire completion. The BDI-II is designed to provide a single overall score that can range from 0 to 63. The following cut-score guidelines are suggested for patients diagnosed with major depression: minimal (0-13); mild (14-19); moderate (20-28); and severe (29-63). Beck et al. (1996) reported convergent validity (e.g., $r = .93$ with the BDI-IA, $r = .71$ with the Hamilton Psychiatric Rating Scale for Depression), and excellent internal consistency ($\alpha = .91$ among psychiatric outpatients, $\alpha = .93$ among undergraduate students). The correlation between the BDI-IA and BDI-II is .93, although mean BDI-II scores are usually higher than those of the BDI-IA (Beck et al., 1996).

The initial BDI-II comprised 27-items that resulted from changes in the BDI-IA wording and item content (Beck et al., 1996). After administering these items to 193 psychiatric outpatients, Beck et al. (1996) performed a series of item analyses that resulted in 21-items being retained. The factor structure of the 21-item measure was then examined through exploratory factor analysis (EFA) in a sample of 120 undergraduate students and in a sample of 500 psychiatric outpatients. A different two-factor structure emerged in each sample. In the sample of undergraduates, cognitive symptoms (e.g., self-criticalness) and affective symptoms (e.g., loss of pleasure) contributed to one factor and somatic symptoms (e.g., loss of energy) contributed to the second factor. In the sample of psychiatric outpatients, the cognitive items loaded together to form one factor and the somatic and affective items loaded together to form the second factor. Given that the factor on which the affective symptoms loaded varied by sample, Beck et al. (1996) speculated that affective symptoms must be more sensitive than non-affective symptoms to the background characteristics of the sample being considered.

Since its original development, researchers have examined the factor structure of the BDI-II in samples of adolescents (Steer et al., 1998; Osman et al., 2004; Byrne & Stewart, 2006), undergraduate students (Osman et al., 1997; Steer & Clark, 1997; Dozois et al., 1998; Whisman et al., 2000; Storch et al., 2004; Carmody, 2005), psychiatric patients (Steer et al., 1999; Steer et al., 2000; Bedi et al., 2001; Cole et al., 2003), family medicine patients (Arnau et al., 2001; Viljoen et al., 2003; Grothe et al., 2005), individuals with traumatic brain injury (Rowland et al., 2005), chemically dependent individuals (Buckley et al., 2001), and individuals with chronic pain (Poole et al., 2006). Translated versions of the measure have also been evaluated (Al-Musawi, 2001; Kojima

et al., 2002; Penley et al., 2003; Byrne et al., 2004; Ghassemzadeh et al., 2005). Results have frequently been consistent with the two factor models originally reported by Beck et al. (1996); however, a number of three-factor models have also been reported (Osman et al., 1997; Steer et al., 1998; Al-Musawi, 2001; Buckley et al., 2001; Byrne et al., 2004; Carmody, 2005; Rowland et al., 2005; Byrne & Stewart, 2006).

2.3. Procedure

Patients with chronic pain referred to The Rehabilitation Centre for chronic pain assessment were assessed if they had experienced constant pain for more than six months (i.e., chronic musculoskeletal pain), surgery was not an option, and they had undergone a trial of treatments without success (e.g., physiotherapy, injection/nerve block therapies). Individuals with complex pain problems or concomitant problems (e.g., with impaired physical functioning, sleep disturbance, medication use, clinically depressed, difficulty coping, concentration/memory problems) were included. Patients with unresolved alcohol and drug abuse issues, significant head injury, and/or acute mental health conditions, which would significantly interfere with treatment, were referred to other services. Patients deemed suitable for consultation completed the BDI-II as part of a questionnaire package routinely used for clinical purposes. Patients were asked to complete a consent form indicating whether they agreed to their responses being used for research purposes and only those who agreed were included in the research (i.e., 98.6%). The study was approved by the Research Ethics Board at The Rehabilitation Centre.

2.4. Analytic strategy

The data analyses were conducted using EQS 6.1 software (Bentler, 2004). The data were screened to ensure that the assumptions underlying the CFA model, which

include multivariate normality, linearity, absence of multicollinearity, absence of singularity, and analyzability of covariances, were met. Given evidence of some multivariate kurtosis, the Satorra-Bentler Chi-square and associated robust statistics were employed in all CFA analyses as recommended by Bentler (2004). The analyses proceeded in stages as described below.

2.4.1 CFA of four competing first-order models of BDI-II factor structure separately for women and men with chronic pain.

Four first-order models of BDI-II factor structure were examined (i.e., Beck et al., 1996; Arnau et al., 2001; Byrne et al., 2004, Poole et al., 2006). Criteria considered when selecting these models included the generalizability of the sample to individuals with chronic pain, methodology (e.g., appropriate sample size, tests of assumptions), overall model fit, and cross-validation of findings in other samples. Each model was analyzed using maximum likelihood CFA. CFA is considered the appropriate factor analytic technique when the goal of analysis is to determine whether a model, or which of several models, specified a priori fits well with the observed data (Byrne, 1994). To examine the influence of gender on BDI-II factor structure, the models were tested separately for women and men.

The first model tested was that of Poole et al. (2006), the only model to date derived with a sample of chronic pain patients. Eighteen of the 21 BDI-II items were hypothesized to load onto one of two first-order latent factors labelled Negative Thoughts and Behaviour.

The second model tested was derived with a sample of psychiatric outpatients (Beck et al., 1996). In this model, each of the 21 BDI-II items was hypothesized to load onto one of two first-order latent factors labelled Somatic-Affective and Cognitive.

The third model tested was based on the results of Arnau et al. (2001) in a sample of patients awaiting an appointment with their primary care physician. The labels and item composition of the first-order latent factors were identical to those of Beck et al. (1996), with the exception of two items: Sadness was hypothesized to load on the Somatic-Affective rather than the Cognitive factor, and Crying was hypothesized to load on the Cognitive rather than the Somatic-Affective factor. In the original study, the Self-Criticalness item failed to make a significant contribution to either factor. On the basis of conceptual considerations and the results of other studies (Beck et al., 1996; Viljoen et al., 2003), this item was hypothesised to load on the Cognitive factor for the purposes of the present research.

The fourth model tested was that of Byrne et al. (2004) who validated a Chinese version of the BDI-II in a sample of Hong Kong community adolescents. These authors reported a three-factor structure with factors labelled Negative Attitude, Performance Difficulty, and Somatic Elements. This factor structure was also supported in American nonclinical adolescents who completed the BDI-II in English (Byrne & Stewart, 2006). Although generalizability to individuals with chronic pain may seem unlikely, this factor structure was selected because of its similarity to the optimal factor structure of the original BDI in patients with chronic pain (Novy et al., 1995). In the Byrne et al. (2004, 2006) studies, the Loss of Interest in Sex item was not included in the analyses. On the basis of conceptual considerations and the results of other studies reporting a similar

solution (Osman et al., 1997), this item was hypothesized to load on the Somatic Elements factor for the purposes of the present research.

For each model tested, the first-order factors were assumed to be intercorrelated and error terms were assumed to be uncorrelated. For the purposes of statistical identification, the first factor loading from each of the first-order factors was fixed to 1.00. The assessment of CFA model fit was based on the Satorra-Bentler scaled Chi-Square Likelihood Ratio statistic ($SB\chi^2$), the robust Comparative Fit Index (*CFI), the robust Root Mean Square Error of Approximation (*RMSEA), the 90% confidence interval provided for the *RMSEA, and the Standardized Root Mean Squared Residual (SRMR). Criteria for determining adequate model fit were: *CFI \geq .95, *RMSEA \leq .06, and SRMR \leq .08 (Hu & Bentler, 1999).

2.4.2 Post-hoc model fitting of the first-order model that resulted in the best initial fit, and evaluation of the second-order structure separately for women and men with chronic pain.

Post-hoc model fitting then proceeded in an exploratory fashion. Sources of misfit between the best fitting first-order model, from the step described above, and the observed data were examined. Criteria considered in determining sources of model misfit included the Z-values (parameter estimates divided by their standard error), which were inspected for significance ($p < .05$), and modification indices, which were examined to determine the expected decrease in the χ^2 value if the corresponding fixed parameter was free to be estimated. Prior to any change, the theoretical meaningfulness of each modification was also considered.

Under conditions of multivariate normality, the extent to which a modified model exhibits improvement over the prior model is determined by calculating the simple difference between the two χ^2 values and testing this difference for significance (Bentler, 2004; Byrne et al., 2004). When the Satorra-Bentler scaled statistic is employed to correct for multivariate kurtosis, as in the present study, the simple difference between S-B χ^2 values is not χ^2 distributed, and a correction is required (Satorra & Bentler, 2001; Bentler, 2004). In this research, the extent to which a modified model exhibited improvement over the prior model was therefore determined by calculating the corrected Δ S-B χ^2 and testing it for significance.

Once the best fitting model for women and men was established, a second-order model was tested. In this model, the correlation between the first-order factors was assumed to be fully explained by their regression onto a second-order latent factor called depression.

2.4.3 Testing for gender invariance.

The second-order model established for women was then tested simultaneously with the second-order model established for men under the constraint that the common model parameters be held equal across the groups (Byrne et al., 1989). A series of nested models were tested to evaluate the various levels of measurement and structural invariance within a mean and covariance structures (MACS) framework (Cheung & Rensvold, 2002; Byrne & Stewart, 2006). In this step, adequate model fit was based on a non-significant change in S-B χ^2 (Δ S-B χ^2), a decrease in $*CFI \leq .01$ ($\Delta*CFI \leq .01$)¹, and

¹ Cheung and Rensvold (2002) examined the properties of several indices of fit under constraints of invariance in multivariate normal data distributions. These authors proposed the $\Delta CFI \leq .01$ criterion as an alternative to the χ^2 difference test. Given the kurtotic nature of the distributions in the present study, the $\Delta*CFI \leq .01$ criterion is examined in conjunction with the S-B χ^2 difference test.

non-significant probability levels of the equality constraints obtained with the Lagrange Multiplier test (LM) (Cheung & Rensvold, 2002; Byrne, 2006; French & Finch, 2006).

2.4.4 Descriptive and comparative statistics.

The severity of depressive symptomatology in this sample is reported according to cut-score guidelines recommended by Beck et al. (1996). Item means, standard deviations, percentage symptomatic, and corrected item-total correlations are reported separately for women and men. Subscale scores were calculated, based on the best fitting factor model, by summing the items comprising each first-order factor. T-tests were conducted to evaluate gender differences on BDI-II items, subscale scores, and the total score. Subscale means, mean subscale scores corrected for differences in subscale length, mean total scores, mean inter-item correlations, and internal consistency reliability (α) are reported. The association between BDI-II subscale means, the BDI-II mean total score and subjective pain experience is also reported.

3. Results

3.1 CFA of four competing first-order models of BDI-II factor structure separately for women and men with chronic pain

The results of the first-order CFA analyses are summarized in Table 2. All fit indices suggest that the three-factor model of Byrne et al. (2004) provided the best fit to the data of both women and men with chronic pain. The *CFI for both groups was less than the recommended .95 criterion, which indicated some misfit in the model.

INSERT Table 2 ABOUT HERE

3.2 Post-hoc model fitting of the first-order model that resulted in the best initial fit, and evaluation of the second-order structure separately for women and men with chronic pain

Given the results in the step above, sources of misfit between the Byrne et al. (2004) model and the data of women and men with chronic pain were examined. In both groups, all parameter estimates and their corresponding standard errors fell within an acceptable range and were statistically significant. The modification indices for both women and men suggested that the measurement error terms associated with the Tiredness or Fatigue and Loss of Energy items should be correlated. Correlated errors are often the result of redundancy in item content (Byrne, 1994). Given that this explanation is theoretically plausible, the models of women and men were respecified. Results of these analyses are summarized in Table 3.

As is evident from the $\Delta S-B\chi^2$ for both women and men, the second model yielded a statistically significant improvement over the first. Also in support of the modification, the newly specified parameter was statistically significant in both groups and the standardized solution revealed that the correlation between the two error terms was moderately high. In the case of women, the *CFI met the .95 criterion and post hoc model fitting therefore ceased. In the case of men, the modification indices suggested that the measurement error terms associated with the Concentration Difficulty and Indecisiveness items should be correlated. Because this modification was also theoretically plausible, the model was respecified. As shown in Table 3, the third model for men resulted in a statistically significant improvement over the second. As with the previous modification, the newly specified parameter was statistically significant and the

correlation between the two error terms was moderately high. Moreover, the *CFI met the .95 criterion.

Having established the best fitting model for women and men, a second-order model was tested. To ensure overidentification of the higher-order structure, the variance of the disturbance terms for the second and third first-order factors were equated (Byrne, 1994; Bentler, 2004). This decision was based on prior analyses, which showed that these parameters were small and almost equal in value. Although the $\Delta S-B\chi^2$ was significant, as indicated in Table 3, it like the S-B χ^2 statistic is sensitive to sample size such that its value is often significant even when there are only inconsequential discrepancies between models. Given that the *CFI, *RMSEA, and SRMR remained unchanged, it was concluded that the second-order model provided an equally adequate fit to the data.

INSERT Table 3 ABOUT HERE

3.3 Testing for gender invariance

The second-order factor structure was then tested for its equivalence across gender. Table 4 provides a summary of increasingly stringent tests of measurement and structural invariance within a MACS framework. A comparison of Model 1, in which no constraints were imposed, and Model 2, in which equality constraints were placed on all lower order factor loadings, revealed a non-significant $\Delta S-B\chi^2$ and a $\Delta *CFI < .01$, each of which suggest invariance; however, the probability level of the equality constraint associated with the Concentration Difficulty item was significant, indicating that this

factor loading may vary by gender. In Model 3, the equality constraint associated with the loading of the Concentration Difficulty item onto the Performance Difficulty factor was therefore released. As evidenced by the ΔCFI , this modification resulted in a slight improvement in model fit. Moreover, the $\Delta S-B\chi^2$, ΔCFI , and LM results all indicated invariance across gender.

In Model 4, all lower order intercepts were constrained equal. The significant $\Delta S-B\chi^2$ suggested noninvariance associated with this step. The probability level of the equality constraints associated with eight intercepts (i.e., those associated with Guilty Feelings, Crying, Loss of Pleasure, Loss of Interest, Loss of Energy, Changes in Sleep, Tiredness or Fatigue, and Loss of Interest in Sex) and three additional factor loadings (i.e., those associated with Guilty Feelings, Punishment Feelings, and Crying) were significant. In Model 5, the equality constraints associated with these parameters were released. This resulted in a non-significant $\Delta S-B\chi^2$, a $\Delta CFI < .01$, and non-significant LM results, indicating a measurement model that was invariant across gender.

In a final test of measurement invariance, the equality of the error covariance between the Tiredness or Fatigue and Loss of Energy items was assessed. Although testing for the equality of error variances across groups is generally considered to be excessively stringent (Byrne, 1994; Byrne et al., 2004), the covariance between these error terms was large for both men and women and it therefore seemed useful to determine whether this parameter held across gender. Comparison of this Model (Model 6) with Model 1 resulted in a non-significant $\Delta S-B\chi^2$, a $\Delta CFI < .01$, and non-significant LM results supporting gender invariance.

Having established an invariant measurement model, the equality of the structural model was examined. All lower order factor loadings and intercepts except those released in the steps above were constrained equal in Model 7, along with the higher order factor loadings. Results indicated a non-significant $\Delta S-B\chi^2$, a $\Delta*CFI < .01$, and non-significant LM results, each of which provide evidence of invariance.

In the final test of structural invariance, the higher order intercepts were tested for equivalence across gender. To ensure an over-identified model in this step, the three lower order intercepts associated with the reference variables (i.e., those with factor loadings fixed to 1.0) for men were constrained equal to those of women as recommended by Byrne (2006). As in the step above, results from Model 8 indicated a non-significant $\Delta S-B\chi^2$, a $\Delta*CFI < .01$, and non-significant LM results, each of which provided evidence of an invariant structural model. The standardized parameter estimates associated with the final model structure for women and men with chronic pain are presented in Figures 1 and 2 respectively.

INSERT Table 4, Figure 1, AND Figure 2 ABOUT HERE

3.4 Descriptive and comparative statistics

3.4.1 Severity of depressive symptomatology.

The severity of BDI-II depressive symptomatology reported by women and men according to the scores and interpretive labels provided by Beck et al. (1996) is reported in Table 5. No significant association was found between gender and category of

severity. Over 70% of the sample reported Moderate or Severe depressive symptomatology.

INSERT Table 5 ABOUT HERE

3.4.2 Influence of gender on BDI-II items.

T-tests were conducted to evaluate gender differences on the BDI-II items. As can be seen in Table 6, effect sizes ranged from $d = 0.2$ to 0.3 . Women reported significantly higher scores on Guilty Feelings, Crying, Tiredness or Fatigue, and Loss of Interest in Sex than men. Men reported significantly higher scores on Loss of Pleasure and Loss of Interest than women.

INSERT Table 6 ABOUT HERE

3.4.3 BDI-II item means, standard deviations, % symptomatic, and corrected item-total correlations.

Given the above reported gender differences, the means, standard deviations, percentages of individuals endorsing the symptom options 1, 2, or 3, and the corrected item-total correlations of each of the BDI-II items are presented separately for women in Table 7 and for men in Table 8. The percentage of individuals endorsing at least some difficulty with Punishment Feelings or at least some difficulty with Suicidal Thoughts or Wishes was lowest of all the BDI-II items for both women (35.8% and 47.0% respectively) and men (35.6% and 47.0% respectively). The percentage of individuals

endorsing at least some difficulty with Loss of Energy, at least some difficulty with Changes in Sleeping Pattern, and at least some difficulty with Tiredness or Fatigue was highest of all the BDI-II items for both women (98.6%, 94.6%, and 97.1% respectively) and men (97.5%, 97.5%, and 96.5% respectively). These results are consistent with those reported by Poole et al. (2006).

As can be seen in Table 7, the corrected item-total correlations of the 21 BDI-II items for women ranged from 0.34 (Changes in Sleeping Pattern) to 0.73 (Indecisiveness). A similar range from 0.34 (Changes in Sleeping Pattern) to 0.67 (Loss of Interest) emerged for men as seen in Table 8. This range indicates good internal consistency given the generally accepted minimum standard of 0.3 (Nunnally & Bernstein, 1994, p 305). Moreover, results suggested that deletion of any of the 21 items would result in a reduction in coefficient alpha.

INSERT Table 7 AND Table 8 ABOUT HERE

3.4.4 Influence of gender on BDI-II subscale means (computed based on the best fitting factor model), mean subscale scores corrected for differences in subscale length, mean total scores, and internal consistency reliability (α).

BDI-II subscale means (computed based on the best fitting factor model), mean total scores, mean inter-item correlations, and internal consistency reliability (α) are reported in Table 9. T-tests were conducted to evaluate gender differences on the BDI-II subscale means and the mean total score. No significant gender differences were found

on scores of Negative Attitude, Performance Difficulty, Somatic Elements, or the total score.

To correct for differences in subscale length (i.e., the number of items contributing to each subscale), mean item values within each subscale were also computed for women and men. These analyses revealed no significant gender differences and indicated that both women and men scored highest on the Somatic Elements subscale ($M = 1.73$, $SD = 0.61$ and $M = 1.64$, $SD = 0.55$ respectively), followed by Performance Difficulty ($M = 1.41$, $SD = 0.69$ and $M = 1.53$, $SD = 0.61$ respectively), and Negative Attitude ($M = 0.99$, $SD = 0.64$ and $M = 0.95$, $SD = 0.61$ respectively).

Coefficient alpha for the BDI-II total scale was 0.92. Internal consistency for the Somatic Elements factor was somewhat weaker than for the Negative Attitude and Performance Difficulty factors, although all factors exhibited good reliability (Robinson et al., 1991). Because coefficient alpha is influenced by the number of items included in a particular scale, the mean inter-item correlation, which is a purer measure of internal consistency, is also reported. These results also provide evidence of good reliability given the range of 0.15 - 0.50 recommended by Clark and Watson (1995).

Participants in the present study scored higher BDI-II totals on average ($M = 26.94$, $SD = 11.65$) than did chronic pain patients in the Poole et al. (2006) study ($M = 24.66$, $SD = 11.62$) [$t(1706) = 3.64$, $p < .001$, $d = 0.2$], primary care medical patients (Arnau et al., 2001; $M = 8.74$, $SD = 9.7$) [$t(812) = 23.43$, $p < .001$, $d = 1.7$], and psychiatric outpatients (Beck et al., 1996; $M = 22.45$, $SD = 12.75$) [$t(979) = 5.75$, $p < .001$, $d = 0.4$].

INSERT Table 9 ABOUT HERE

3.4.5 Association between BDI-II subscale means (computed based on the best fitting factor model), mean total score, and subjective pain experience.

Correlations were conducted to examine the association between the BDI-II subscale means (computed based on the best fitting factor model), the BDI-II mean total score, and subjective pain experience as measured by the MPQ PRI. Subjective pain experience was associated with 7.3% of the variance in Negative Attitude ($r = 0.27, p < .001$), 9.0% of the variance in Performance Difficulties ($r = 0.30, p < .001$), 8.4% of the variance in Somatic Elements ($r = 0.29, p < .001$), and 10.2% of the variance in the BDI-II total score ($r = 0.32, p < .001$).

4. Discussion

This study involved a comprehensive psychometric evaluation of the BDI-II with a large heterogeneous sample of chronic pain patients. Results support the theoretical conceptualization of depression, as measured by the BDI-II, as a singular second-order latent construct consisting of three interrelated but independent first-order factors – Negative Attitude, Performance Difficulty, and Somatic Elements, for individuals with chronic pain. These findings are consistent with those reported by Novy et al. (1995) in regard to the factor structure of the original BDI in chronic pain patients. The model derived by Poole et al. (2006) was tested in the present study, along with three other competing models of the BDI-II factor structure. Although the Poole et al. (2006) model fit was adequate, it did not provide the best account of the data. These results highlight a methodological strength associated with CFA in that it is possible to determine which of several theoretically plausible factor analytic models is statistically optimal.

Tests of gender invariance indicate that the BDI-II factor structure is fundamentally the same for women and men with chronic pain. Four factor loadings (i.e., those associated with Concentration Difficulty, Guilty Feelings, Punishment Feelings, and Crying) failed to demonstrate equivalent measurement across gender. Variance of a factor loading indicates that the factor is not on the same measurement scale for both groups (i.e., a one-unit change in the factor does not lead to the same change in the other group) (Bollen, 1989). As such, variant factor loadings can have adverse consequences for construct validity. However, when the majority of factor loadings are invariant, and the loadings that define the latent metric for the purposes of statistical identification are invariant, as was the case in this research, the criterion of partial measurement invariance is met and meaningful across-group comparisons can be made with confidence in the construct validity of the measure (Byrne et al., 1989; Reise et al., 1993).

Eight intercepts (i.e., those associated with Guilty Feelings, Crying, Loss of Pleasure, Loss of Interest, Loss of Energy, Changes in Sleep, Tiredness or Fatigue, and Loss of Interest in Sex) failed to demonstrate equivalent measurement across gender. Variance of an intercept does not necessarily suggest that the corresponding item is a poor indicator, nor does it preclude meaningful across-group comparisons (Byrne & Stewart, 2006). Rather, it indicates that the item overestimates the corresponding factor for one group (Chan, 2000). In this study, the Guilty Feelings, Crying, Loss of Energy, Tiredness or Fatigue, and Loss of Interest in Sex items overestimated their respective factors for women, whereas the Loss of Pleasure, Indecisiveness, and Changes in Sleep items overestimated their respective factors for men.

A correlated error between the Tiredness or Fatigue and Loss of Energy items operated equivalently across gender. Correlated errors are most often a result of perceived redundancy in item content (Byrne, 1994). As both items can be perceived to measure some aspect of fatigue, both men and women with chronic pain appear to interpret these items as asking about the same symptom. A correlated error between the Concentration Difficulty and Indecisiveness items was indicated for men only. It appears that these items elicit responses reflective of the same mental set, perhaps general cognitive difficulty, in men, whereas women perceive the items as tapping distinct symptoms of depression.

Having established that the BDI-II factor structure is fundamentally the same for men and women with chronic pain (i.e., partial measurement invariance), it was possible to conduct item and mean level gender comparisons with confidence that any gender differences that emerged were true differences, and not due to measurement error associated with gender bias in the instrument itself. Item level analyses revealed gender differences in the expression of six symptoms of depression. Women reported more Guilty Feelings, Crying, Tiredness or Fatigue and Loss of Interest in Sex than did men, whereas men reported more Loss of Pleasure and Loss of Interest than did women.

Results for both men and women indicated that three somatic items were the items most likely to be endorsed to at least some degree, whereas two cognitive items were the items least likely to be endorsed to at least some degree. The same pattern held when mean item values within each subscale were computed to correct for differences in subscale length. This pattern is consistent with previous findings (Poole et al., 2006) and research suggesting that depressed individuals with chronic pain are less likely to endorse

cognitive symptoms of depression than depressed individuals without chronic pain (see Pincus & Morley, 2001).

No gender differences were found with regard to Negative Attitude, Performance Difficulty, Somatic Elements, or the BDI-II total score. The similarity of scores across gender is consistent with findings in other samples of men and women with chronic pain (Kraemlinger et al., 1983; Haley et al., 1985; Haythornthwaite et al., 1991; Novy et al., 1996).

Corrected item-total correlations, the mean inter-item correlation, and coefficient alpha all provided evidence of good BDI-II internal consistency in individuals with chronic pain. High levels of internal consistency have also been reported in other studies of the BDI-II (e.g., Beck et al., 1996; Arnau et al., 2001; Byrne et al., 2004; Poole et al., 2006). All factors exhibited good reliability, although consistent with results reported by Byrne et al. (2004), internal consistency for the Somatic Elements factor was somewhat weaker than for the Negative Attitude and Performance Difficulty factors.

Despite the relatively high endorsement of somatic items in this study, several lines of evidence support the inclusion of somatic symptoms of depression in the calculation of a BDI-II total score, notwithstanding the association between somatic symptoms and chronic pain. A hierarchical factor structure was confirmed in the present study. This indicates that the somatic items covary with the cognitive and affective items, and are required to provide an optimal explanation of the overall depression construct. In addition, the item-total correlations suggested that the somatic items are valid indicators of the depression construct. With the exception of changes in sleep, which contributed to adequate internal consistency, but demonstrated the lowest item-

total correlation, somatic items correlated as highly with the total score as any of the other BDI-II items.

Additionally, the three BDI-II subscale means were equally associated with subjective pain experience as measured by the MPQ PRI. Somatic items were not more highly associated with the experience of pain as would be expected if these items resulted in an inflation of the total score. Consistent with evidence provided by the present results, other studies of individuals with chronic pain supported the inclusion of somatic items when assessing depression (Turk & Okifuji, 1994; Geisser et al., 1997; Wilson et al., 2001).

In this study, both men and women with chronic pain endorsed a high degree of depressive symptoms. Over 70% of the sample reported moderate or severe depressive symptomatology. These results are consistent with those of Poole et al. (2006) who found that 62% of their sample of chronic pain patients reported symptoms in the moderate or severe range. The severity of depressive symptoms reported by both men and women in the present study is higher than what has been reported by psychiatric outpatients (Beck et al., 1996) and primary care medical patients (Arnau et al., 2001). There was no association between gender and category of severity and, as noted above, no significant gender difference on the mean subscale or total scores. This similarity of men and women with regard to depressive symptoms contrasts with reports in the general population, where women report higher levels of depressive symptomatology than men (e.g., Beck et al., 1996).

Multiple influences, including biological, sociological, and psychological have been proposed to explain the higher probability of women to experience depression in the

general population (see Bebbington, 1996 for a review). Results of this study suggest that chronic pain of long duration (i.e., years) and its associated consequences (e.g., work interference, relationship and financial strain, behavioral deactivation), may counter the effect of any biological, social, and/or psychological resilience that men without chronic pain exhibit in regard to depressive symptoms.

These results are important for researchers and clinicians who work with the chronic pain population, particularly in light of current trends toward empirically supported assessment (Hunsley & Mash, 2007). This research supports the construct validity and internal consistency reliability of the BDI-II in assessing depressive symptomatology in women and men with chronic pain. Valid assessment is the cornerstone of accurate diagnosis, effective treatment, theory development, program evaluation, and research. Interpretations of the BDI-II scores need to be based on the optimal factor structure for the chronic pain population. Results of this study indicate that computation of a BDI-II total score and/or three subscale scores (Negative Attitude, Performance Difficulty, Somatic Elements) is warranted. As with all research, replication in other chronic pain samples will add credibility to these findings.

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Table 1. Sample demographics

Variable	Women (n = 279) n (%)	Men (n = 202) n (%)	Total (N = 481) N (%)	χ^2_a	df	p ^b
Primary pain site				14.08*	6	0.17
Head	13 (5%)	9 (5%)	22 (5%)			
Neck/shoulders	67 (24%)	28 (14%)	95 (20%)			
Back	117 (42%)	104 (51%)	221 (46%)			
Legs	23 (8%)	19 (9%)	42 (9%)			
Multiple sites	44 (16%)	25 (12%)	69 (14%)			
Joints	3 (1%)	8 (4%)	11 (2%)			
Total body pain	9 (3%)	5 (3%)	14 (3%)			
Not reported	3 (1%)	4 (2%)	7 (2%)			
Ethnicity				2.23	3	-
English Canadian	149 (53%)	114 (56%)	263 (55%)			
French Canadian	21 (8%)	13 (6%)	34 (7%)			
Aboriginal	5 (2%)	6 (3%)	11 (2%)			
Other	29 (10%)	15 (7%)	44 (9%)			
Not reported	75 (27%)	54 (28%)	129 (27%)			
Marital status				11.06*	3	0.15
Single	37 (13%)	35 (17%)	72 (15%)			
Widowed	5 (2%)	0 (0%)	5 (1%)			
Married/common-law	157 (56%)	125 (62%)	282 (59%)			
Separated/divorced	76 (27%)	34 (17%)	110 (23%)			
Not reported	4 (2%)	8 (4%)	12 (2%)			

	0.56	3	-
Total income per year			
Under \$10,000	88 (32%)	64 (32%)	152 (32%)
10,001-30,000	98 (35%)	74 (37%)	172 (36%)
30,001-50,000	43 (15%)	36 (18%)	79 (16%)
over 50,000	12 (4%)	7 (3%)	19 (4%)
Not reported	38 (14%)	21 (10%)	59 (12%)
Highest education level			
Some high school or less	56 (20%)	43 (21%)	99 (20%)
Completed high school	51 (18%)	40 (20%)	91 (19%)
Some college/university	76 (27%)	62 (31%)	138 (29%)
College/university grad.	86 (31%)	48 (24%)	134 (28%)
Not reported	10 (4%)	9 (4%)	19 (4%)
	3.69	3	-

^a cases with missing data (i.e., not reported) were excluded from these analyses

^b $V = \text{Cramér's } V$ (ranges from 0 to +1 with higher values indicating stronger degrees of association)

* $p < .05$

Table 2. Goodness-of-fit statistics of BDI-II models for women and men with chronic pain

Model	S-B χ^2	df	*CFI	*RMSEA	90%*RMSEA CI	SRMR
Women						
Beck et al., 1996	378.70	188	.92	.06	.05, .07	.06
Arnau et al., 2001 ^a	376.36	188	.92	.06	.05, .07	.06
Byrne et al., 2004 ^b	315.03	186	.94	.05	.04, .06	.05
Poole et al., 2006	280.06	134	.93	.06	.05, .07	.05
Men						
Beck et al., 1996	303.54	188	.91	.06	.04, .07	.06
Arnau et al., 2001 ^a	301.07	188	.91	.06	.04, .07	.06
Byrne et al., 2004 ^b	283.15	186	.93	.05	.04, .06	.06
Poole et al., 2006	228.48	134	.92	.06	.05, .07	.06

S-B χ^2 = Satorra-Bentler scaled Chi-Square Likelihood Ratio statistic; *CFI = robust Comparative Fit Index; *RMSEA = robust Root Mean Square Error of Approximation; CI = confidence interval; SRMR = Standardized Root Mean Squared Residual

Criteria for determining adequate model fit were: *CFI \geq .95, *RMSEA \leq .06, and SRMR \leq .08

(Hu & Bentler, 1999)

^a with Self-Criticalness on the Cognitive factor

^b with Loss of Interest in Sex on the Somatic Elements factor

Table 3. Goodness-of-fit and comparative statistics of Byrne et al. (2004) BDI-II model for women and men with chronic pain

Model	χ^2	df	S-B χ^2	Δ S-B χ^2 ^a	Δ df	*CFI	*RMSEA	90%*RMSEA CI	SRMR
Women									
1. Byrne et al., 2004	351.98	186	315.03	---	---	.94	.05	.04, .06	.05
2. Correlated error (Tiredness/Fatigue with Loss of Energy)	325.00	185	290.34	36.12***	1	.95	.05	.04, .06	.05
3. Second-order with correlated error	335.71	186 ^b	300.51	14.34***	1	.95	.05	.04, .06	.05
Men									
1. Byrne et al., 2004	327.00	186	283.15	---	---	.93	.05	.04, .06	.06
2. Correlated error (Tiredness/Fatigue with Loss of Energy)	305.46	185	265.73	10.36**	1	.94	.05	.03, .06	.06
3. Correlated error (Concentration Difficulty with Indecisiveness)	288.74	184	251.73	20.23***	2	.95	.04	.03, .06	.06
4. Second-order with correlated errors	292.56	185 ^b	255.46	4.92*	1	.95	.04	.03, .06	.06

S-B χ^2 = Satorra-Bentler scaled Chi-Square Likelihood Ratio statistic; *CFI = robust Comparative Fit Index; *RMSEA = robust Root Mean Square Error of Approximation; CI = confidence interval; SRMR = Standardized Root Mean Squared Residual

Criteria for determining adequate model fit were: *CFI \geq .95, *RMSEA \leq .06, and SRMR \leq .08 (Hu & Bentler, 1999)

^a the corrected value is reported as required when the S-B χ^2 statistic is employed

^b variance of disturbance terms for F2 and F3 equated

* $p < .05$

** $p < .005$

*** $p < .001$

Table 4. Goodness-of-fit and comparative statistics for BDI-II second-order factor structure tests of gender invariance

Model	χ^2	df	S-B χ^2	*CFI	Δ S-B χ^2 ^a	Δ df	Δ *CFI
1. No constraints	628.26	371	555.43	.948	---	---	---
2. All lower order factor loadings constrained equal	639.87	389	569.26	.949	12.70	18	.001
3. All lower order factor loadings except Concentration Difficulty constrained equal	636.18	388	566.05	.950	8.78	17	.001
4. Model 3 and lower order intercepts constrained equal	709.20	407	644.46	.951	102.33***	36	.003
5. Model 3 with constraints on Guilty Feelings, Punishment Feelings, and Crying factor loadings and 8 intercepts released	628.92	397	561.72	.952	0.68	26	.004
6. Model 5 and correlated error (Tiredness/ Fatigue with Loss of Energy) constrained equal	629.10	398	561.49	.953	0.85	27	.005
7. Model 6 and higher order factor loadings constrained equal	646.66	403	579.57	.949	18.40	32	.001
8. Model 7 and higher order intercepts constrained equal	652.09	402 ^b	584.65	.963	23.83	31	.015

S-B χ^2 = Satorra-Bentler scaled Chi-Square Likelihood Ratio statistic; *CFI = robust Comparative Fit Index

^a the corrected value is reported as required when the S-B χ^2 statistic is employed

^b df decreased by one because although the three higher order factor intercepts were constrained equal, three additional constraints were placed on lower order intercepts to ensure an over-identified model (Byrne, 2006)

* $p < .05$

** $p < .01$

*** $p < .001$

Table 5. Severity of BDI-II depressive symptomatology reported by women and men with chronic pain

Variable	Women (<i>n</i> = 279) <i>n</i> (%)	Men (<i>n</i> = 202) <i>n</i> (%)	Total (<i>N</i> = 481) <i>N</i> (%)	χ^2	<i>df</i>	<i>p</i>
Minimal (0-13)	39 (14.0%)	26 (12.9%)	65 (13.5%)	0.71	3	0.87
Mild (14-19)	40 (14.3%)	33 (16.3%)	73 (15.2%)			
Moderate (20-28)	84 (30.1%)	56 (27.7%)	140 (29.1%)			
Severe (29-63)	116 (41.6%)	87 (43.1%)	203 (42.2%)			

Table 6. Significant gender differences on BDI-II items

Variable	Women (<i>n</i> = 279)		Men (<i>n</i> = 202)		<i>t</i>	<i>df</i>	<i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Loss of Pleasure (Item 4)	1.56	0.87	1.74	0.86	-2.22*	479	0.2
Guilty Feelings (Item 5)	0.87	0.87	0.69	0.81	2.22*	479	0.2
Crying (Item 10)	1.22	0.89	0.98	1.03	2.75**	479	0.2
Loss of Interest (Item 12)	1.48	1.07	1.73	1.04	-2.57**	479	0.2
Tiredness or Fatigue (Item 20)	2.05	0.86	1.79	0.85	3.29***	479	0.3
Loss of Interest in Sex (Item 21)	1.64	1.05	1.34	0.96	3.25***	479	0.3

* *p* < .05

** *p* < .01

*** *p* < .001

Table 7. Means, standard deviations, percentages symptomatic, and corrected item-total correlations of the BDI-II items in women with chronic pain

Symptom	<i>M</i>	<i>SD</i>	%	<i>r</i> _{tot}
Sadness	1.01	0.81	76.7	0.63
Pessimism	1.36	0.91	87.8	0.58
Past Failure	0.91	1.01	53.4	0.54
Loss of Pleasure	1.56	0.87	90.7	0.64
Guilty Feelings	0.87	0.87	59.5	0.58
Punishment Feelings	0.79	1.20	35.8	0.57
Self-Dislike	1.16	0.91	74.2	0.68
Self-Criticalness	0.92	0.95	60.9	0.61
Suicidal Thoughts or Wishes	0.54	0.64	47.0	0.53
Crying	1.22	0.89	79.9	0.54
Agitation	1.05	0.84	74.9	0.49
Loss of Interest	1.48	1.07	79.2	0.71
Indecisiveness	1.38	1.06	74.6	0.73
Worthlessness	1.12	0.95	70.3	0.69
Loss of Energy	1.80	0.68	98.6	0.58
Changes in Sleeping Pattern	1.77	0.77	94.6	0.34
Irritability	1.42	0.83	86.4	0.66
Changes in Appetite	1.38	1.02	77.4	0.49
Concentration Difficulty	1.58	0.80	90.7	0.63
Tiredness or Fatigue	2.05	0.86	97.1	0.56
Loss of Interest in Sex	1.64	1.05	82.1	0.51

n = 279

% = total percentage endorsing response choices 1, 2, or 3

*r*_{tot} = corrected item-total correlation

Table 8. Means, standard deviations, percentages symptomatic, and corrected item-total correlations of the BDI-II items in men with chronic pain

Symptom	<i>M</i>	<i>SD</i>	%	<i>r</i> _{tot}
Sadness	0.96	0.76	75.7	0.62
Pessimism	1.39	0.86	92.1	0.59
Past Failure	0.92	1.00	54.5	0.48
Loss of Pleasure	1.74	0.86	94.1	0.58
Guilty Feelings	0.69	0.81	49.5	0.56
Punishment Feelings	0.81	1.23	35.6	0.63
Self-Dislike	1.14	0.86	76.2	0.56
Self-Criticalness	0.90	0.89	63.4	0.62
Suicidal Thoughts or Wishes	0.52	0.61	47.0	0.51
Crying	0.98	1.03	61.9	0.53
Agitation	1.18	0.91	77.7	0.40
Loss of Interest	1.73	1.04	86.6	0.67
Indecisiveness	1.37	1.00	77.7	0.61
Worthlessness	1.17	0.93	72.8	0.64
Loss of Energy	1.69	0.67	97.5	0.53
Changes in Sleeping Pattern	1.95	0.76	97.5	0.34
Irritability	1.53	0.79	91.6	0.57
Changes in Appetite	1.41	0.91	83.2	0.45
Concentration Difficulty	1.62	0.72	93.6	0.51
Tiredness or Fatigue	1.79	0.85	96.5	0.51
Loss of Interest in Sex	1.34	0.96	77.7	0.43

n = 202

% = total percentage endorsing response choices 1, 2, or 3

*r*_{tot} = corrected item-total correlation

Table 9. BDI-II means, standard deviations, mean inter-item correlations, and standardized α indices for women and men with chronic pain

Variable	Women ($n = 279$)				Men ($n = 202$)				Total ($N = 481$)			
	<i>M</i>	<i>SD</i>	r_{mit}	α	<i>M</i>	<i>SD</i>	r_{mit}	α	<i>M</i>	<i>SD</i>	r_{mit}	α
Negative attitude	9.91	6.40	0.43	0.88	9.49	6.09	0.39	0.87	9.73	6.27	0.41	0.88
Performance difficulty	8.46	4.15	0.48	0.85	9.17	3.66	0.36	0.77	8.76	3.96	0.43	0.82
Somatic elements	8.65	3.06	0.36	0.74	8.18	2.75	0.30	0.68	8.45	2.94	0.33	0.71
BDI-II total score	27.02	12.09	0.37	0.93	26.84	11.05	0.32	0.91	26.94	11.65	0.35	0.92

r_{mit} = mean inter-item correlation

Figure Captions

Fig. 1. Standardized estimates for the final model of BDI-II factor structure for women with chronic pain. A single asterisk (*) denotes a parameter that was freely estimated.

Fig. 2. Standardized estimates for the final model of BDI-II factor structure for men with chronic pain. A single asterisk (*) denotes a parameter that was freely estimated.

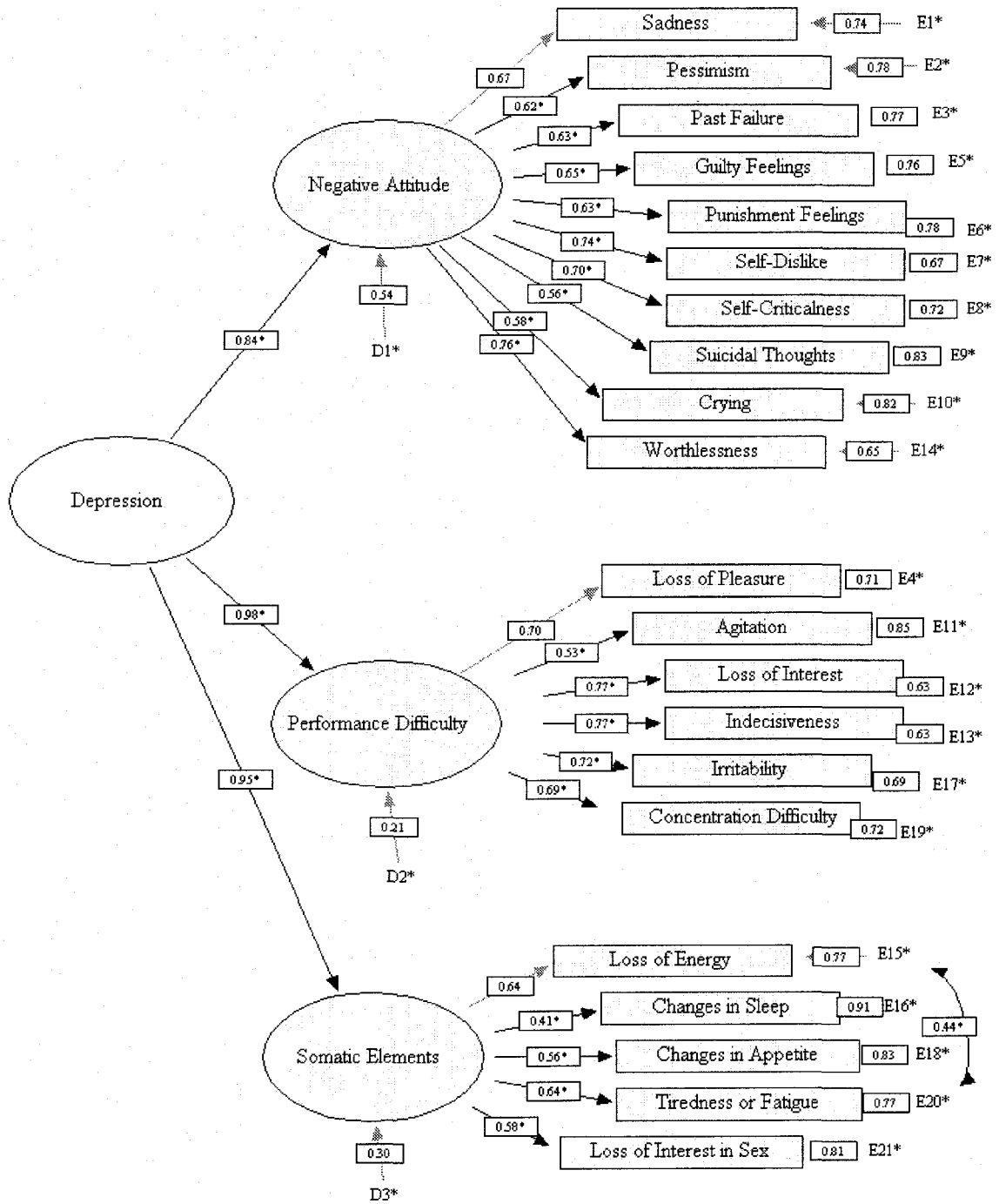


Fig. 1.

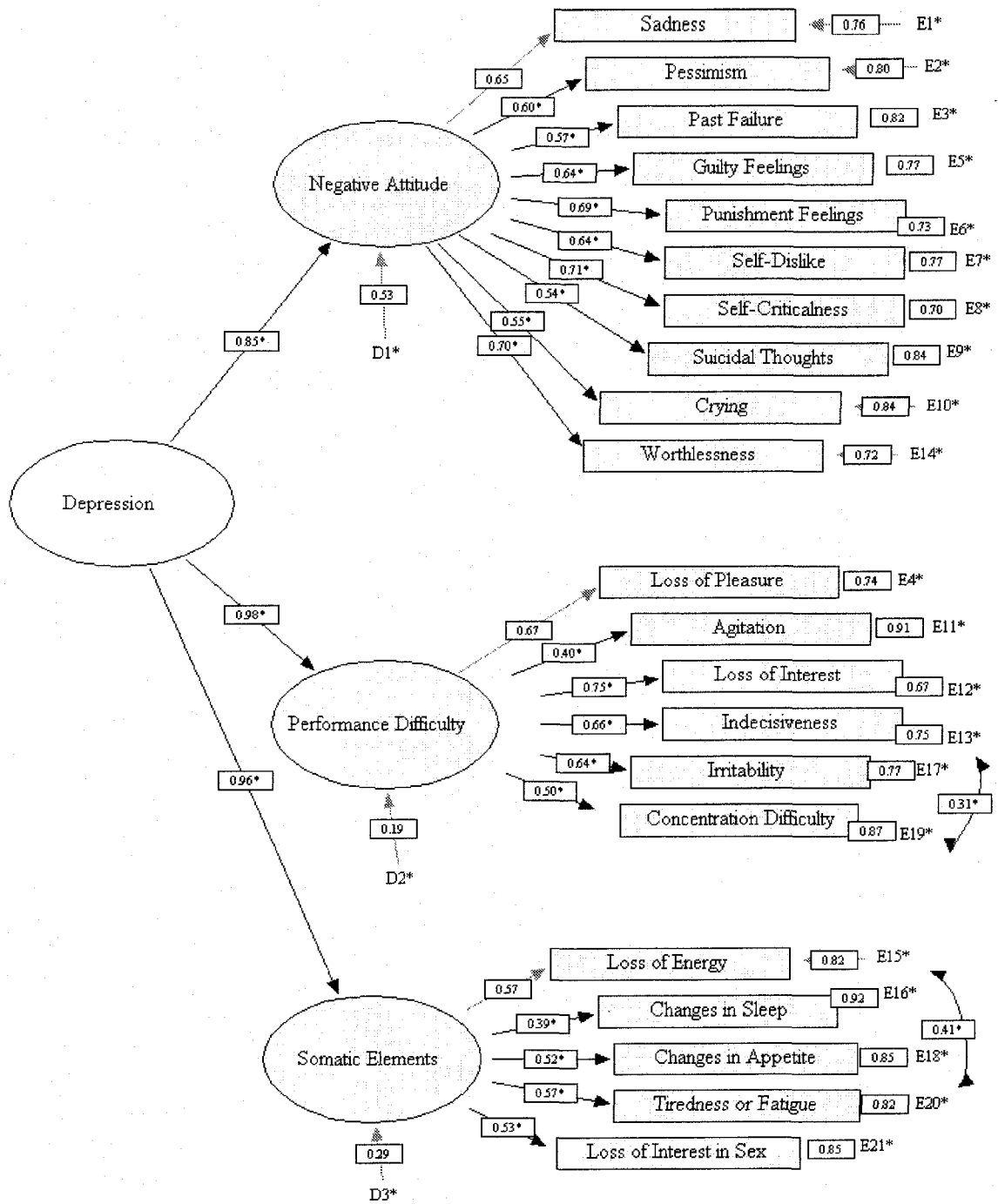


Fig. 2.

Article II

Factorial Validity and Gender Invariance of the Multidimensional Pain Inventory (MPI)
in Individuals with Chronic Pain

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Keywords: Multidimensional Pain Inventory; MPI; chronic pain; factorial validity;
psychometrics; assessment; gender

Abstract

The West Haven-Yale Multidimensional Pain Inventory (MPI) is a widely used self-report measure developed to evaluate psychosocial and behavioral components of the pain experience. While acknowledging the unique contribution of this measure, researchers have noted that the MPI was derived using a small, predominately male sample, which has led to questions about its factorial validity and generalizability to women. This study examined two different models of the MPI factor structure [Kerns et al., 1985 and Deisinger et al., 2001] in a large sample of women ($n=356$) and men ($n=256$) with chronic pain. Gender invariance (i.e., equivalence) was examined where appropriate. The Interference factor was cross-validated except for one problematic item, and is gender invariant, providing further support of its validity. When configured according to the Deisinger Model, the Punishing Responses and Pain Severity factors provide valid, gender equivalent, information. The Support, Solicitous and Distracting Responses factors operated differently by gender. Research aimed at assessing these constructs in a gender equivalent manner is suggested. Although neither model is optimal for Section III, the Kerns Model is best. The Activities Away From Home and Social Activities factors are gender invariant, but Outdoor Work and Household Chores are not. The challenge of attaining an optimal fitting model in this section suggests that the development of new activity scales specific to women and men is warranted. Given the importance of gender in the chronic pain experience and current trends toward empirically supported assessment, these results are relevant for clinicians and researchers using the MPI.

Factorial Validity and Gender Invariance of the Multidimensional Pain Inventory
(MPI) in Individuals with Chronic Pain

1. Introduction

Given the complex and subjective nature of pain, the West Haven-Yale Multidimensional Pain Inventory (MPI) was developed to evaluate the psychosocial and behavioural components of the pain experience (Kerns et al., 1985). The MPI is a self-report measure, theoretically founded in a cognitive-behavioural approach, that examines individual perception and appraisal of pain and its consequences for daily life. In 1989, amendments by Rudy resulted in Version 2 of the measure.

In a survey of practicing clinicians, the MPI was identified as one of the six most frequently used inventories in the assessment of individuals with pain (Piotrowski, 1998). The MPI is unique in its breadth (Tyrer, 1992; Mikail et al., 1993; Bradley & McKendree-Smith, 2001) and the utility of including it in an assessment battery designed to capture the multifaceted nature of the chronic pain experience has been noted (De Gagné et al., 1995). The MPI has been translated into seven languages (Rudy, 1989), and has been used in numerous published studies (Okifuji et al., 1999). The MPI Interference subscale was recently recommended by the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) committee for use within the context of the multidimensional assessment of core outcome domains in pain treatment research (Dworkin et al., 2005).

While acknowledging the important contribution of this unique measure, researchers have also raised psychometric concerns. The MPI was derived using a small ($n = 120$), predominately male sample (81.5%), which has led to questions about its

factorial validity and generalizability to women (Bernstein et al., 1995; De Gagné et al., 1995; Williamson et al., 1997; Bergström et al., 1998; Riley et al., 1999; Deisinger et al., 2001). Three studies have examined the factor structure of the MPI since its original development. Bernstein et al. (1995) and Riley et al. (1999) evaluated the MPI and, while identifying some problematic items, subscales and/or sections, concluded that the original structure be retained. Deisinger et al. (2001) published the only evaluation of the MPI Version 2, and identified factor compositions that differed from those reported by Kerns et al. (1985). Deviations from the original factor structure may be due to gender variance (Bernstein et al., 1995; De Gagné et al., 1995). Bernstein et al. (1995) reported a large multiple correlation of the MPI subscales with gender and recommended that the influence of gender be investigated further.

This study extends the psychometric research of the MPI by using confirmatory factor analysis (CFA) to investigate the factor structure and equivalence of the measure across gender in a large heterogeneous sample of men and women with chronic pain. The MPI factor structure derived by Kerns et al. (1985; with amendments by Rudy, 1989) labelled the Kerns Model, and the factor structure derived by Deisinger et al. (2001), labelled the Deisinger Model, were examined separately, by each Section for men and women, to determine which of these unique models is statistically optimal. Tests of gender invariance were conducted when appropriate, based on the best fitting models in each Section.

2. Methods

2.1 Participants

From January 1997 to December 2002, chronic pain patients referred to The Rehabilitation Centre in Ottawa, Ontario completed Version 2 of the MPI in English (Kerns et al., 1985; with amendments by Rudy, 1989). Of 620 patients, 8 did not consent to their data being used for research purposes. The present study comprises MPI responses from the remaining 612 patients with chronic pain (356 women, 256 men). Additional data from this sample, focused on the psychometric properties of the Beck Depression Inventory – Second Edition (BDI-II) has been reported in Harris and D'Eon (in press).

The average age of participants was 43.53 years ($SD = 8.74$), with no significant difference between women ($M = 43.95$, $SD = 8.81$) and men ($M = 42.94$, $SD = 8.62$) [$t(610) = 1.42$, $p = .16$]. The average pain duration in years was 7.84 ($SD = 7.46$), with men having experienced pain slightly longer on average ($M = 8.68$, $SD = 7.92$) than women ($M = 7.25$, $SD = 7.06$) [$t(595) = 2.32$, $p < .05$, $d = 0.2$]. Other relevant sample demographics and chi-square statistics are summarized in Table 1. No significant association was found between gender and ethnicity or income. There was a significant association between gender and primary pain site. The standardized residuals indicated that women were more likely than men to report neck/shoulder pain and less likely than men to report back pain. There was also a significant association between gender and current marital status, with women being more likely than men to report widowed, separated, or divorced status. The significant association between gender and education indicated that women were more likely than men to be college/university graduates.

This sample is similar to the Kerns et al. (1985) and Deisinger et al. (2001) samples, although the average age of participants in the present study is lower than that reported by Kerns et al. (1985; $M = 50.80$, $SD = 14.50$) [$t(730) = 7.35$, $p < .001$, $d = 0.7$] and higher than that reported by Deisinger et al. (2001; $M = 41.73$, $SD = 11.88$) [$t(1062) = 2.88$, $p < .01$, $d = 0.2$]. Individuals in this study reported a shorter average pain duration than those in the Kerns et al. study (1985; $M = 10.20$, $SD =$ not reported) and a longer average pain duration than those in the Deisinger et al. study (2001; $M = 3.35$, $SD = 5.41$) [$t(1047) = 10.82$, $p < .001$, $d = 0.7$]. A comparison by gender is not possible because neither Kerns et al. (1985) nor Deisinger et al. (2001) reported a breakdown of data by gender.

INSERT Table 1 ABOUT HERE

2.2 Measures

2.2.1 Pain History Questionnaire (PHQ)

The PHQ (D'Eon et al., 2000) is a self-report questionnaire designed to solicit a consistent history from every patient prior to assessment. The questionnaire was developed from a modified version of an inventory designed by Monks and Taenzer (1983) and the International Association for the Study of Pain (IASP) Task Force on Records and Data Retrieval (1996). The questionnaire provides demographic information on each patient as well as information about pain, medical and work history, activities, family circumstances, and treatment expectations. Information such as age, pain duration, income, education etc. was used for descriptive purposes in this study.

2.2.2 Multidimensional Pain Inventory

The MPI (Kerns et al., 1985) is a 52 item self-report measure comprising 12 subscales organized into three Sections. Section I includes five subscales (Pain Severity, Interference, Life Control, Affective Distress, and Support) that explore the psychosocial component of the pain experience by examining the perceived severity and impact of pain on the respondent's life. Section II includes three subscales (Punishing Responses, Solicitous Responses, and Distracting Responses) that evaluate the respondent's perception of how significant others respond to his/her displays of pain. Section III includes four subscales (Household Chores, Outdoor Work, Activities Away From Home, and Social Activities) that assess behavioural components of the pain experience. Respondents are required to rate the degree to which each item applies to them by indicating their responses on a 7-point scale ranging from 0 to 6. The verbal anchors associated with the scale vary according to item content. The score for each subscale is calculated by averaging the corresponding items.

The factor structure was derived using data from a sample of 120 chronic pain patients (81.5% male) who were heterogeneous with regard to primary pain site. Confirmatory Factor Analyses (CFA) were used to examine the factor structure of Section I, which was based on six subscales that were determined a priori. The factor structure of Sections II and III were evaluated using exploratory factor analysis (EFA). The authors reported adequate internal consistency and stability of the measure, indicated by Cronbach's alpha coefficients ranging from .70 to .90 and test-retest correlations ranging from .62 to .91. A correlation matrix was derived from the 12 MPI subscales and 9 scales from previously validated instruments of anxiety, depression, marital

satisfaction, pain severity, and health locus of control. Factor analyses of this constellation of measures provided converging evidence for both the internal and external validity of the MPI scales.

In 1989, MPI Version 2 was developed (Rudy, 1989). A new General Activity subscale was created by computing the mean of the four Section III activity subscales, and nine items were added to improve the psychometric properties of the measure resulting in a 61-item questionnaire. Eight questions were added to Section I to address perceived control and predictability of pain as well as questions related to sleep, resulting in 28 questions in this Section. Section II remained the same with 14 questions. One question related to sexual functioning was added to Section III, resulting in 19 questions. Unpublished psychometric analyses of Version 2 revealed that 4 of the 8 questions added to Section I did not load on their intended factors and were therefore not included in the scoring (#s 7, 9, 15, 17). This was also the case for the question added to Section III (#19) (T. E. Rudy, personal communication, January 26, 2004). Thus, although Version 2 consists of 61 items, only 56 are actually scored.

As noted, of the three studies that have examined the factor structure of the MPI since its original development, only Deisinger et al. (2001) identified factor compositions that differed significantly from those reported by Kerns et al. (1985). Deisinger et al. (2001) conducted an EFA of all 61 items of Version 2 of the MPI at once, using a sample of 452 patients at a multidisciplinary pain clinic. A summary of the derived model, including the Sections, subscales, and items, is shown in Table 2. The EFA revealed three Sections, which were labelled Suffering, Social Support, and Activity. Three of the items originally conceptualized by Kerns et al. (1985) as belonging in Section I of the

measure (i.e., items 5, 13, & 20 from the Support Subscale) were most strongly related to Section II (Social Support) in the Deisinger et al. (2001) model. Similarly, three items originally conceptualized by Kerns et al. (1985) as belonging in Section II (i.e., items 4, 7, & 10, from the Punishing Response Subscale) shared the most variance with other Section I (Suffering) items in the Deisinger et al. (2001) model. After conducting the initial overall EFA, Deisinger et al. (2001) then used EFA to examine each of the three newly derived Sections. Section I (Suffering) included Interference, Punishing Responses, and Pain Severity subscales; Section II (Social Support) comprised Support, Solicitous Responses, and Distracting Responses subscales; and Section III (Activity), included Recreation, Household Chores, and Outdoor Work subscales. In total, Deisinger et al. (2001) recommended that 12 of the 61 items be discarded due to their contribution to low internal consistency. The item composition of the Interference subscale was the only subscale from the Kerns et al. (1985) study to be replicated in its entirety (Deisinger et al., 2001).

Translated versions of the measure have also been evaluated (Bergström et al., 1998, 1999; Lousberg et al., 1999; Ferrari et al., 2000; Kuusinen, 2000; Andreu et al., 2006; Jakobsson & Horstmann, 2006), as has an English version developed specifically to assess chronic pain related to spinal cord injury (Widerström-Noga et al., 2006). In these studies, problematic items and/or factors have been reported.

INSERT Table 2 ABOUT HERE

2.3 Procedure

Patients with chronic pain referred to The Rehabilitation Centre for chronic pain assessment were assessed if they had experienced constant pain for more than six months (i.e., chronic musculoskeletal pain), surgery was not an option, and they had undergone a trial of treatment without success (e.g., physiotherapy, injection/nerve block therapies). Individuals with complex pain problems or concomitant problems (e.g., with impaired physical functioning, sleep disturbance, medication use, clinically depressed, difficulty coping, concentration/memory problems) were included. Patients with unresolved alcohol and drug abuse issues, significant head injury, and/or acute mental health conditions, which would significantly interfere with treatment, were referred to other services. Patients deemed suitable for consultation completed the MPI as part of a questionnaire package routinely used for clinical purposes. Patients were asked to complete a consent form indicating whether they agreed to their responses being used for research purposes and only those who agreed were included in the research (i.e., 98.7%). The study was approved by the Research Ethics Board at The Rehabilitation Centre.

2.4 Analytic strategy

The data analyses were conducted using EQS 6.1 software (Bentler, 2006). The data were screened to ensure that the assumptions underlying the CFA model, which include multivariate normality, linearity, absence of multicollinearity, absence of singularity, and analyzability of covariances, were met. Given evidence of some multivariate kurtosis, the appropriate robust Chi-square and associated robust statistics were employed in all CFA analyses as recommended by Bentler (2006). The three Sections of the MPI derived by Kerns et al. (1985; with amendments by Rudy, 1989)

were analysed separately, for men and women, as were the three distinct Sections derived by Deisinger et al. (2001).

Recent research indicates that the required sample size in CFA is a function of construct reliability, which is a measure of model quality that is computed based on the number of indicators per factor and the magnitude of factor loadings in a particular measurement model (Gagné & Hancock, 2006). On the basis of factor loadings obtained in previous research on the MPI, sample sizes of 200 were deemed sufficient for all models tested in this study.

To ensure adequate sample sizes for the Section I analyses, the responses of women and men with two or fewer random responses missing (i.e., < 7% missing) were imputed based on case-wise maximum likelihood estimation with Yuan-Bentler corrections for multivariate kurtosis, as recommended by Bentler (2006). The data of 71 women and 31 men who left three or more random items missing were not included in the analyses. Therefore, the Section 1 sample was comprised of 285 women and 225 men to examine the Kerns et al. (1985; with amendments by Rudy, 1989) and the Deisinger et al. (2001) models.

Section II analyses relied on complete cases with Satorra-Bentler corrections for multivariate kurtosis. The data of 39 women and 14 men with one or more random responses missing were not used. A total of 71 women and 38 men failed to complete the MPI Version 2, Section II. Women who did not complete Section II were older ($M = 45.81$, $SD = 8.63$) than those whose data were analysed ($M = 43.15$, $SD = 8.69$) [$t(315) = 2.28$, $p < .05$, $d = 0.3$], had experienced pain longer ($M = 9.76$, $SD = 8.46$ and $M = 6.58$, $SD = 6.41$ respectively; $t(309) = 3.36$, $p < .01$, $d = 0.5$), and were more likely to report a

marital status of single, separated, or divorced [$\chi^2(3, N = 312) = 120.26, p < .001$, *Cramér's V* = 0.62]. Men who did not complete Section II had experienced pain longer ($M = 11.45, SD = 9.39$) than those whose data were analysed ($M = 8.14, SD = 7.69$) [$t(231) = 2.27, p < .05, d = 0.4$], were more heterogeneous with regard to their primary pain site [$\chi^2(6, N = 233) = 14.13, p < .05, Cramér's V = 0.25$], had higher levels of education [$\chi^2(3, N = 222) = 10.56, p < .05, Cramér's V = 0.22$], lower income [$\chi^2(3, N = 205) = 12.56, p < .01, Cramér's V = 0.25$], and were more likely to report a marital status of single, separated, or divorced [$\chi^2(3, N = 230) = 73.97, p < .001, Cramér's V = 0.57$]. Thus, the Section II sample consisted of 246 women and 204 men in the investigation of the Kerns et al. (1985; with amendments by Rudy, 1989) model. In the investigation of the Deisinger et al. (2001) Section II model, 225 women and 187² men were included. This smaller sample size occurred due to cases that were excluded because of random missing data on the three items in this model that were originally conceptualized by Kerns et al. (1985) as belonging in Section I.

Section III analyses also relied on complete cases with Satorra-Bentler corrections for multivariate kurtosis. The data of 55 women and 32 men had one or more random items missing and were therefore excluded. Thus, the Section III sample included 301 women and 224 men in the investigation of the Kerns et al. (1985; with amendments by Rudy, 1989) and the Deisinger et al. (2001) Section II models.

The analyses proceeded in stages as described below.

² Although less than 200, this sample size was deemed sufficient based on model quality (Gagné & Hancock, 2006).

2.4.1 CFA of two models of MPI factor structure, by Section, separately for women and men

CFA is considered the appropriate factor analytic technique when the goal of analysis is to determine whether a model, or which of several models, specified a priori, fits well with the observed data (Byrne, 1994; Kline, 1998). The MPI factor structure derived by Kerns et al. (1985; with amendments by Rudy, 1989) and the factor structure of Deisinger et al. (2001) were examined by each Section for overall model fit using maximum likelihood CFA. To determine the influence of gender on these two MPI factor structures, the two models were tested separately for women and men.

For each model tested, the first-order factors were assumed to be intercorrelated and error terms were assumed to be uncorrelated. For the purposes of statistical identification, the first factor loading from each of the first-order factors was fixed to 1.00. The assessment of CFA model fit was based on the appropriate Chi Square statistic (i.e., the Yuan-Bentler scaled Chi-Square Likelihood Ratio statistic ($Y-B\chi^2$) for Section I and the Satorra-Bentler scaled Chi-Square Likelihood Ratio statistic ($S-B\chi^2$) for Sections II and III), the robust Comparative Fit Index (*CFI), the robust Root Mean Square Error of Approximation (*RMSEA), the 90% confidence interval provided for the *RMSEA, and the Standardized Root Mean Squared Residual (SRMR). Criteria for determining adequate model fit were: *CFI \geq .95, *RMSEA \leq .06, and SRMR \leq .08 (Hu & Bentler, 1999).

2.4.2 Post-hoc model fitting of the model that resulted in the best initial fit, in each Section, for women and men

Post-hoc model fitting then proceeded in an exploratory fashion. Sources of misfit between the best fitting first-order model, from the step described above, and the observed data were examined. Criteria considered in determining sources of model misfit included the Z-values (parameter estimates divided by their standard error), which were inspected for significance ($p < .05$), and modification indices, which were examined to determine the expected decrease in the χ^2 value if the corresponding fixed parameter was free to be estimated. Prior to any change, the conceptual meaningfulness of each modification was also considered.

Under conditions of multivariate normality, the extent to which a modified model exhibits improvement over the prior model is determined by calculating the simple difference between the two χ^2 values and testing this difference for significance (Bentler, 2006). When the Y-B χ^2 or S-B χ^2 scaled statistic is employed to correct for multivariate kurtosis, as in the present study, the simple difference between Y-B χ^2 or S-B χ^2 values is not χ^2 distributed, and a correction is required (Satorra & Bentler, 2001; P. M. Bentler, personal communication, June 10, 2007). In this research, the extent to which a modified model exhibited improvement over the prior model was therefore determined by calculating the corrected Δ Y-B χ^2 or Δ S-B χ^2 and testing it for significance.

2.4.3 Testing for gender invariance

When the criteria of configural invariance was met in a Section (i.e., when the number of factors and the items loading on each factor was the same for women and men), the model established for women was then tested simultaneously with the model

established for men under the constraint that the common model parameters be held equal across the groups (Byrne et al., 1989). A series of nested models were tested to evaluate the various levels of measurement and structural invariance within a mean and covariance structures (MACS) framework (Cheung & Rensvold, 2002). In this step, adequate model fit was based on a non-significant increase in $Y-B\chi^2$ ($\Delta Y-B\chi^2$) or $S-B\chi^2$ ($\Delta S-B\chi^2$), a non-significant decrease in $*CFI$ ($\Delta *CFI \leq .01$)³, and non-significant probability levels of the equality constraints obtained with the Lagrange Multiplier test (LM).

2.4.4 Mean gender differences and internal consistency

Subscale scores were calculated, based on the best fitting factor model, by averaging the items comprising each first-order factor. Subscale means, mean inter-item correlations, and internal consistency reliability (α) are reported separately for women and men. When the criterion of partial measurement invariance was met for a factor (Byrne et al., 1989; Chan, 2000), t-tests were conducted to evaluate gender differences on the corresponding subscale means.

3. Results

3.1 CFA of two models of MPI factor structure, by Section, separately for women and men

The results of the CFA analyses are summarized in Table 3. The Deisinger Section I Model, consisting of Interference, Punishing Responses, and Pain Severity subscales, provided the best fit to the data of both women and men with chronic pain. The Deisinger Section II Model, consisting of Support, Solicitous Responses, and

³ Cheung and Rensvold (2002) examined the properties of several indices of fit under constraints of invariance in multivariate normal data distributions. These authors proposed the $\Delta CFI \leq .01$ criterion as an alternative to the χ^2 difference test. Given the kurtotic nature of the distributions in the present study, the $\Delta *CFI \leq .01$ criterion is examined in conjunction with the $Y-B\chi^2$ or $S-B\chi^2$ difference test.

Distracting Responses subscales, was optimal for women. Based on the majority of fit indices, the Kerns Section II Model, consisting of Punishing Responses, Solicitous Responses, and Distracting Responses subscales, provided the best fit for men. The Kerns Section III Model, consisting of Household Chores, Outdoor Work, Activities Away From Home, and Social Activities subscales, provided the best fit to the data of both women and men. However, in all models but one (i.e., the Deisinger Section II Model for women), the *CFI was less than the recommended .95 criterion, which indicated some misfit in the models.

INSERT Table 3 ABOUT HERE

3.2 Post-hoc model fitting for women and men

3.2.1 Section I post-hoc model fitting: The Deisinger Model

Given the results of the CFAs, indicating that the Deisinger Section I Model provided the best fit for women and men, post-hoc model fitting was conducted for this model (see Table 4). In both groups, parameter estimates and their corresponding standard errors fell within an acceptable range and were statistically significant except for those corresponding to Item 19 (change in satisfaction from work due to pain). This item was therefore dropped.

In the case of women, the modification indices suggested that a cross loading of Item 2 (extent to which pain interferes with daily activities) onto the Pain Severity factor would improve the model fit. This modification was conceptually sound, and the model was therefore respecified. As is evident from the $\Delta Y-B\chi^2$ and the improvement in fit

indices, the third model yielded a statistically significant improvement over the second. Also in support of the modification, the newly specified parameter was statistically significant. The modification indices then identified two large correlated errors between the measurement error terms associated with Items 4 (extent to which pain affects satisfaction from social activities) and 10 (extent to which pain affects ability to participate in social activities), and with Items 1 (interference of pain with daily activities) and 8 (pain severity during past week). Correlated errors are often the result of redundancy in item content (Byrne, 1994). Given that this explanation is conceptually plausible, the model was respecified incorporating one correlated error at a time. In both cases, the $\Delta Y-B\chi^2$ supported a statistically significant improvement, there was improvement in fit indices, the newly specified parameters were statistically significant, and the standardized solution revealed that the correlation between each set of error terms was moderately high. Post hoc model fitting ceased, having met the appropriate criteria for all fit indices.

The modification indices for men were similar to those of women. A correlation between the measurement error terms associated with Items 4 (extent to which pain affects satisfaction from social activities) and 10 (extent to which pain affects ability to participate in social activities) was suggested, as was a cross loading of Item 2 (extent to which pain interferes with daily activities) onto the Pain Severity factor. As shown in Table 4, both modifications resulted in a statistically significant improvement to the model ($\Delta Y-B\chi^2$). As was the case for women, the correlation between the two error terms was moderately high, and both of the newly specified parameters were statistically

significant. Moreover, the improvement in fit indices resulted in the corresponding criteria for model fit being met.

INSERT Table 4 ABOUT HERE

3.2.2 Section II post-hoc model fitting: The Deisinger Model for women and the Kerns Model for men

For women, all recommended model fit criteria were met for the Deisinger Section II Model. For men, post-hoc model fitting of the Kerns Section II Model was required (see Table 5). The modification indices indicated that a cross loading of Item 6 (my significant other talks to me to take my mind off the pain) onto the Solicitous Responses factor would improve the model fit. Given the logic of this modification, the model was respecified. The modification was supported by a statistically significant $\Delta S-B\chi^2$, improvement in fit indices, and a significant parameter estimate. At this point, post hoc model fitting ceased despite failure to meet the *CFI and *RMSEA cut-off criteria because subsequent modifications identified statistically could not be supported conceptually.

INSERT Table 5 ABOUT HERE

3.2.3 Section III post-hoc model fitting: The Kerns Model

The results of post-hoc model fitting for the Kerns Section III Model are shown in Table 6. Changes suggested on the basis of the modification indices related to the data of

women were not conceptually coherent (e.g., correlated error between Item 6 – ‘work in the garden’ and Item 10 – ‘work on the car’, and between Item 6 and Item 14 – ‘wash the car’) so the model was not respecified. The correlated error indicated for men, however, was substantively reasonable (Item 10 – ‘work on the car’, and Item 14 – ‘wash the car’) and the model was therefore respecified. This resulted in a statistically significant $\Delta S-B\chi^2$, improvement in fit indices, a significant parameter estimate, and a moderate correlation between the two error terms. As with women, post-hoc model fitting for men ceased despite failure to meet the *CFI cut-off criterion because subsequent modifications identified statistically could not be supported conceptually.

INSERT Table 6 ABOUT HERE

3.3 Testing for gender invariance

3.3.1 Section I: The Deisinger Model

Table 7 provides a summary of increasingly stringent tests of measurement and structural invariance within a MACS framework, corresponding to the Deisinger Section I Model. A comparison of Model 1, in which no constraints were imposed, and Model 2, in which equality constraints were placed on all lower order factor loadings, revealed a $\Delta^*CFI = .01$, the exact cut-off value suggested by Cheung and Rensvold (2002) to indicate invariance. However, the significant $\Delta Y-B\chi^2$ suggested noninvariance, as did the probability levels of the equality constraints associated with Item 12 (change in satisfaction from family-related activities due to pain), Item 16 (suffering experienced

because of pain), and Section II Item 10⁴ (significant other gets angry with me when I am in pain). In Model 3, the equality constraint for each of these items was released. LM results indicated noninvariance of the factor loading associated with Item 18 (degree to which pain has changed relationships with spouse, family, or significant other). This constraint was released in Model 4 and all model fit criteria indicated an invariant model.

In Models 5 and 6, the cross loading of Item 2 (extent to which pain interferes with daily activities) with the Pain Severity factor and the correlated error associated with Items 4 (extent to which pain affects satisfaction from social activities) and 10 (extent to which pain affects ability to participate in social activities) were constrained equal. Given the configural invariance of these post-hoc parameters, it seemed useful to determine whether they operated equivalently across gender. Comparison of these Models with Model 1 resulted in a non-significant $\Delta Y-B\chi^2$, $\Delta*CFI < .01$, and non-significant LM results indicative of invariance.

In Model 7, constraints were placed on the intercepts associated with all Section I items. LM results suggested that the intercepts associated with Section I Items 11 (extent to which activities are limited to keep pain from getting worse), 12 (change in satisfaction from family-related activities due to pain), and 23 (change in ability to do household chores due to pain) varied by gender. After releasing these constraints in Model 8, LM results identified an additional invariant intercept associated with Section II Item 10 (significant other gets angry with me when I am in pain). This constraint was released in Model 9, resulting in a non-significant $\Delta Y-B\chi^2$, a $\Delta*CFI < .01$, and non-significant LM results indicative of an invariant measurement model.

⁴ As noted, the Deisinger Section I Model incorporates three items that are included in the Kerns Section II Model.

The equality of the structural model was examined next. All factor variances and covariances were constrained equal in Model 10. LM results indicated invariance associated with two factor covariances (i.e., Interference, Punishing Responses and Interference, Pain Severity). These constraints were released in Model 11. A non-significant $\Delta Y-B\chi^2$, $\Delta*CFI < .01$ and non-significant LM results provided evidence of an invariant structural model. The standardized parameter estimates associated with the final Section I model structure for women and men with chronic pain are presented in Figs. 1 and 2 respectively.

INSERT Table 7, Figure 1, and Figure 2 ABOUT HERE

3.3.2 Section II: The Deisinger Model for women and the Kerns Model for men

Gender invariance analyses were not conducted for Section II because the prerequisite of configural invariance was not met. The standardized parameter estimates associated with the final Deisinger Section II Model for women, and the final Kerns Section II Model for men are presented in Figs. 3 and 4 respectively.

INSERT Figure 3 and Figure 4 ABOUT HERE

3.3.3 Section III: The Kerns Model

Table 8 provides a summary of increasingly stringent tests of measurement and structural invariance corresponding to the Kerns Section III Model. A comparison of Model 1, in which no constraints were imposed, and Model 2, in which equality

constraints were placed on all lower order factor loadings, revealed a significant $\Delta S-B\chi^2$ and a $\Delta^*CFI > .01$ indicative of noninvariance. LM results indicated that the equality constraints placed on the factor loadings associated with Items 6 (work in the garden), 9 (help with the house cleaning), 10 (work on the car), 14 (wash the car) and 18 (work on a needed household repair) should be released. In Model 3 these constraints were released providing support for invariance evidenced by a non-significant $\Delta S-B\chi^2$, $\Delta^*CFI < .01$, and non-significant LM results.

In Model 4, constraints were placed on the intercepts associated with all items. LM results indicated that the intercepts associated with Items 1 (wash dishes), 2 (mow the lawn), 3 (go out to eat), 5 (go grocery shopping), 6 (work in the garden), 7 (go to a movie), 9 (help with the housecleaning), 10 (work on the car), 13 (prepare a meal), 14 (wash the car), 17 (do the laundry), and 18 (work on a needed household repair) varied by gender. After releasing these constraints in Model 5, a non-significant $\Delta S-B\chi^2$, $\Delta^*CFI < .01$, and non-significant LM results supported the gender invariance of the measurement model.

The equality of the structural model was examined next. All factor variances and covariances were constrained equal in Model 6. This model provided evidence of noninvariance associated with a factor variance (Outdoor Work) and a factor covariance (Outdoor Work, Activities Away From Home). Release of these constraints in Model 7 resulted in little improvement in model fit. LM results indicated noninvariance associated with the remaining covariances involving Outdoor Work (i.e., Outdoor Work, Household Chores; Outdoor Work, Social Activities). Release of these constraints resulted in an invariant structural model evidenced by a non-significant $\Delta S-B\chi^2$, $\Delta^*CFI <$

.01, and non-significant LM results. The standardized parameter estimates associated with the final Section III model structure for women and men with chronic pain are presented in Figs. 5 and 6 respectively.

INSERT Table 8, Figure 5, and Figure 6 ABOUT HERE

3.4 Mean gender differences and internal consistency

MPI subscale means, computed based on the best fitting factor models, mean inter-item correlations, and internal consistency reliability (α) are reported for women and men in Table 9. The criterion of partial measurement invariance (Byrne et al., 1989; Chan, 2000) was met for all of the Deisinger Model Section I factors, enabling meaningful tests of gender differences of all three subscale means in this model. No significant difference was found for Interference or Pain Severity; however, men scored significantly higher than women on Punishing Responses [$t(506) = -2.87, p < .001, d = 0.3$]. For Section II, different factor models provided the best fit to the data of women (i.e., The Deisinger Model) and men (i.e., The Kerns Model). An analysis of mean gender differences was therefore impossible for this Section given that the number of factors and the pattern of factor loadings varied by gender. The Kerns Section III Model provided the best fit for men and women. Tests of gender differences were conducted on two of the four subscale means in this model. The criterion of partial measurement invariance was not met for Outdoor Work, and given that all items associated with the Household Chores factor were found to overestimate the factor for women, mean gender differences were not tested for these factors. No significant difference was found for

Social Activities. Women scored significantly higher than men on Activities Away From Home [$t(523) = 2.98, p < .01, d = 0.3$].

For the majority of subscales that were computed based on the best fitting factor models, the mean inter-item correlations and alpha indices indicated good internal consistency. The coefficient alpha for the Kerns Model Section III Activities Away From Home and Social Activities subscales is somewhat low for both women and men (Robinson et al., 1991). Because coefficient alpha is influenced by the number of items included in a particular scale, the mean inter-item correlation, which is a purer measure of internal consistency, is also reported. These results indicate adequate reliability for the Activities Away From Home and Social Activities subscales given the range of 0.15 - 0.50 recommended by Clark and Watson (1995). The mean inter-item correlation is considerably higher than ideal for the Deisinger Model Section I Punishing Responses subscale in both men and women, suggesting that the items underlying this subscale may be highly redundant.

INSERT Table 9 ABOUT HERE

4. Discussion

This study extends psychometric research of the MPI by separately testing two different models of the MPI factor structure in a large sample of individuals with chronic pain. Tests of gender invariance were conducted when appropriate, based on the best fitting model in each Section.

Analyses of the Section I models indicated that the Deisinger Model (i.e., Interference, Punishing Responses, Pain Severity) provides a better fit to the data of both genders than the five factor Kerns Model. The factor loading associated with the Interference factor Item 19 (change in work satisfaction due to pain) was non-significant and therefore dropped from the analyses. Approximately 60% of both genders reported no change because they were not working. This may be a function of the long pain duration in this sample. The MPI scoring program (Rudy, 1989) omits missing items or ones that are not applicable. Clark and Watson (1995) argued that skewed items are problematic because they provide little information and contribute to correlational instability. As such, the Interference subscale would be strengthened for individuals with longstanding chronic pain if Item 19 was dropped.

Tests of gender invariance for the Deisinger Section I Model indicated that it is fundamentally the same for women and men with chronic pain. Four items in Section I (i.e., Items 12, 16, 18 & Section II Item 10⁵) failed to demonstrate equivalent measurement across gender. Variance of a factor loading indicates that the factor is not on the same measurement scale for both groups (i.e., a one-unit change in the factor does not lead to the same change in the other group) (Bollen, 1989). As such, variant factor loadings can have adverse consequences for construct validity. However, when the majority of factor loadings are invariant for a particular factor, as in this Section, the criterion of partial measurement invariance is met and meaningful across-group comparisons can be made (Byrne et al., 1989; Reise et al., 1993).

⁵ As noted, the Deisinger Section I Model incorporates three items that are included in the Kerns Section II Model.

Additionally, four intercepts (i.e., those associated with Section I Items 11, 12, 23 & Section II Item 10) failed to demonstrate equivalent measurement across gender. Variance of an intercept does not necessarily suggest that the corresponding item is a poor indicator, nor does it preclude meaningful across-group comparisons (Byrne & Stewart, 2006). Rather, it indicates that the particular item overestimates the corresponding factor to some degree for one group (Chan, 2000). Results indicated that the interference of pain with enjoyment from family activities and ability to do housework items overestimate their respective factors for women, whereas the degree to which activities are limited to prevent exacerbations in pain and the perception of angry responses from significant others due to pain items overestimate their respective factors for men.

Having established that the Deisinger Section I Model is fundamentally the same for men and women (i.e., partial measurement invariance), it was possible to conduct mean level gender comparisons with confidence that any emerging gender differences were genuine differences and not due to measurement error associated with gender bias in the instrument. These analyses revealed that men reported a higher level of perceived punishing responses from their significant others than women, although only about 2% of the variance in the subscale was explained by gender.

Analyses of the Section II models indicated that the Deisinger Model (i.e., Support, Solicitous Responses, Distracting Responses) is optimal for women, whereas the Kerns Model (i.e., Punishing Responses, Solicitous Responses, Distracting Responses) is best for men. Although two of the three factor labels from these models are identical, the items comprising them are not. These gender differences may relate to the predominately

male sample employed by Kerns et al. (1985), but the model fit for men was not optimal even after post hoc model fitting procedures were conducted, suggesting that neither model provides an adequate explanation of the male data⁶. Because the least stringent test of equivalence (i.e., configural invariance) failed in this Section, further tests of gender invariance could not be completed and mean comparisons by gender are not meaningful and would be misleading.

Analyses of the Section III models indicated that the Kerns Model (i.e., Household Chores, Outdoor Work, Activities Away From Home, Social Activities) provides a better fit to the data of both genders than the three factor Deisinger Model. However, as for men in Section II, model fit was not optimal for either gender in Section III. Gender invariance analyses revealed that all Outdoor Work factor loadings, intercepts (all items overestimate the factor for men except for 'work in the garden'), variances, and covariances varied with gender. On the Household Chores factor, one factor loading and all intercepts (all items overestimate the factor for women) were noninvariant. Additionally, two noninvariant intercepts were associated with the Activities Away From Home factor ('go out to eat' and 'go to a movie' overestimate the factor for women). Given the noninvariance of all factor loadings for Outdoor Work, and the noninvariance of all intercepts indicating an overestimation of the Household Chores factor for women, tests of mean gender differences were conducted for only two subscales. There was no gender difference on Social Activities and women reported higher scores on Activities Away From Home than men, although only about 2% of the variance in the subscale was explained by gender.

⁶ Hu & Bentler (1999) recommend $*CFI \geq .95$ as evidence of good model fit; however, some argue that this may be excessively stringent (Marsh et al., 2004).

The lack of optimal model fit in Section III suggests that although two factors exhibit gender invariance, all of the relevant domains of the activity construct may not be tapped for either gender. This could be due to gender differences in activity prior to the onset of pain (De Gagné et al., 1995). Accordingly, Vallerand (1998) noted that activity measures assume that the given list of activities is equally applicable to both genders, and has suggested that different activity measures be devised for women and men, to avoid the complexity of creating a measure applicable to both genders.

This study demonstrates that significant portions of the MPI operate differently for men and women. Variance in the factor structures has implications for optimal scoring of the measure, which should be based on the corresponding best fitting factor model for each gender in each Section. The Deisinger Section I Model is best for both genders, indicating that the data of men and women are most optimally scored according to this factor model. Importantly, given recent recommendations by the IMMPACT committee (Dworkin et al., 2005), the item composition of the Interference factor in this model is the same as that proposed in the Kerns Model. Moreover, results indicated that this factor is gender invariant providing further evidence of its validity, although excluding Item 19 would strengthen it. Women and men conceptualize the constructs tapped in Section II differently. Thus, scoring of this Section should be based on different models for men (i.e., the Kerns Model) and women (i.e., the Deisinger Model). The Kerns Section III Model is best for both genders, indicating that scoring should correspond with this model; however, only the Activities Away From Home and Social Activities subscales should be interpreted.

These results suggest that more optimal models should be developed to account for the Section II data of men and the Section III data of both genders. Furthermore, several constructs the MPI measures operate differently by gender. When items on a questionnaire measure the same construct in a different way for each gender, or when the same items measure different constructs in each gender, the measure is said to evidence gender bias (van de Vijver & Leung, 1997). Gender bias is complex (Byrne & Watkins, 2003), and why it occurs in Sections of the MPI requires some speculation. The issues raised by this study (i.e., lack of optimal model fit in Sections II and III, and gender variance of several subscales) suggest that construct bias most likely accounts for gender bias in the MPI. According to van de Vijver and Leung (1997), the most common causes of construct bias include one or more of the following: 1) attempting to measure a construct defined differently in each group using the same items, 2) including items that measure qualities not belonging to the repertoire of one group, and/or 3) failure to sample all relevant domains to ensure complete coverage of the construct being measured.

In summary, the MPI was developed with the important goal of providing information about psychosocial and behavioural facets of the pain experience. The Interference factor was cross-validated except for one problematic item, and is gender invariant, providing further support of its validity. When scored according to the Deisinger Model, the Punishing Responses and Pain Severity factors provide valid, gender equivalent, information. Research aimed at assessing the Support, Solicitous Responses and Distracting Responses factors in a gender equivalent manner is suggested. The development of new activity scales specific to men and women is also suggested by the challenge of attaining an optimal Section III model. These results have implications

for the use and interpretation of the MPI in clinical practice with men and women with chronic pain and for clinical and psychometric research involving this measure.

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Table 1. Sample demographics

Variable	Women ($n = 279$) n (%)	Men ($n = 202$) n (%)	Total ($N = 481$) N (%)	χ^2 ^a	df	p ^b
Primary pain site				19.83**	6	0.18
Head	13 (4%)	7 (3%)	20 (3%)			
Neck/shoulders	81 (23%)	35 (14%)	116 (19%)			
Back	162 (45%)	145 (57%)	307 (50%)			
Legs	29 (8%)	24 (9%)	53 (9%)			
Multiple sites	51 (14%)	25 (10%)	76 (12%)			
Joints	4 (1%)	8 (3%)	12 (2%)			
Total body pain	13 (4%)	3 (1%)	16 (3%)			
Not reported	3 (1%)	9 (3%)	12 (2%)			
Ethnicity				0.73	3	-
English Canadian	163 (46%)	111 (43%)	274 (45%)			
French Canadian	25 (7%)	22 (9%)	47 (8%)			
Aboriginal	5 (1%)	3 (1%)	8 (1%)			
Other	43 (12%)	29 (11%)	72 (12%)			
Not Reported	120 (34%)	91 (36%)	211 (34%)			
Marital status				15.57**	3	0.16
Single	41 (12%)	42 (16%)	83 (14%)			
Widowed	8 (2%)	2 (1%)	10 (1%)			
Married/common-law	201 (56%)	159 (62%)	360 (59%)			
Separated/divorced	98 (28%)	41 (16%)	139 (23%)			
Not reported	8 (2%)	12 (5%)	20 (3%)			

Total income per year		1.85	3	-
Under \$10,000	87 (24%)	74 (29%)	161 (26%)	
10,001-30,000	130 (37%)	93 (37%)	223 (37%)	
30,001-50,000	54 (15%)	34 (13%)	88 (14%)	
over 50,000	27 (8%)	16 (6%)	43 (7%)	
Not reported	58 (16%)	39 (15%)	97 (16%)	
Highest education level			19.18***	3 0.18
Some high school or less	75 (21%)	71 (28%)	146 (24%)	
Completed high school	60 (17%)	49 (19%)	109 (18%)	
Some college/university	95 (27%)	77 (30%)	172 (28%)	
College/university grad.	109 (30%)	38 (15%)	147 (24%)	
Not reported	17 (5%)	21 (8%)	38 (6%)	

^a cases with missing data (i.e., not reported) were excluded from these analyses

^b V = Cramér's V (ranges from 0 to +1 with higher values indicating stronger degrees of association)

* $p < .05$

** $p < .01$

*** $p < .001$

Table 2. Item composition of the MPI Sections and subscales derived by Deisinger and colleagues (2001)

The Deisinger Model	Original MPI Section and Item Number (The Kerns Model)
Section I (Suffering)	
Interference	I: 2, 3, 4, 10, 11, 12, 18, 19, 23, 25, 27
Punishing Responses	II: 4, 7, 10
Pain Severity	I: 1, 7, 8, 16
Section II (Social Support)	
Support	I: 5, 13, 20; II: 2
Solicitous Responses	II: 5, 8, 11, 13, 14
Distracting Responses	II: 6, 9, 12
Section III (Activity)	
Recreation	III: 3, 4, 7, 8, 11, 12, 15, 16, 19
Household Chores	III: 1, 5, 9, 13, 17
Outdoor Work	III: 2, 6, 10, 14, 18

The content of this table is taken from Table 3 in Deisinger et al. (2001).
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Table 3. Goodness-of-fit statistics of MPI models by Section for women and men

Model	* χ^2	df	*CFI	*RMSEA	90% *RMSEA CI	SRMR
The Kerns Model						
Section I (PS, I, LC, AD, S)						
Women (n = 285)	507.29	242	.87	.06	.05, .07	.08
Men (n = 225)	482.59	242	.84	.07	.06, .07	.08
Section II (PR, SR, DR)						
Women (n = 246)	201.21	74	.92	.08	.07, .10	.08
Men (n = 204)	168.53	74	.91	.08	.06, .10	.08
Section III (HC, OW, AH, SA)						
Women (n = 301)	223.71	129	.90	.05	.04, .06	.06
Men (n = 224)	231.39	129	.89	.06	.05, .07	.07
The Desinger Model						
Section I (I, PR, PS)						
Women (n = 285)	269.68	132	.90	.06	.05, .07	.07
Men (n = 225)	277.54	132	.88	.07	.06, .08	.07
Section II (S, SR, DR)						
Women (n = 225) ^a	95.65	51	.96	.06	.04, .08	.05
Men (n = 187) ^a	128.66	51	.88	.09	.07, .11	.07
Section III (R, HC, OW)						
Women (n = 301)	274.57	149	.87	.05	.04, .06	.06
Men (n = 224)	261.83	149	.88	.06	.05, .07	.07

* χ^2 =robust Chi-Square Likelihood Ratio statistic; Yuan-Bentler (Y-B χ^2) for Section I, Satorra-Bentler (S-B χ^2) for Sections II and III; *CFI = robust Comparative Fit Index; *RMSEA = robust Root Mean Squared Error of Approximation; CI = confidence interval; SRMR = Standardized Root Mean Squared Residual; PS = Pain Severity, I = Interference; LC = Life Control; AD = Affective Distress; S = Support; PR = Punishing Responses; SR = Solicitous Responses; DR = Distracting Responses; HC = Household Chores; OW = Outdoor Work; AH = Activities Away From Home; SA = Social Activities; R = Recreation

Criteria for determining adequate model fit were: *CFI \geq .95, *RMSEA \leq .06, and SRMR \leq .08 (Hu & Bentler, 1999)
a sample size smaller than for the Kerns Section II Model due to cases excluded because of random missing data on Section I items included in this model

Table 4. MPI Section I: Goodness-of-fit and comparative statistics for post-hoc model fitting of the Deisinger Model for women and men

Model	χ^2	df	Y-B χ^2	$\Delta Y-B\chi^2$ ^a	Δdf	CFI	RMSEA	90% RMSEA CI	SRMR
Women									
1. The Deisinger Model	301.47	132	269.68	---	---	.90	.06	.05, .07	.07
2. Item 19 dropped	285.52	116	251.19	16.36	16	.90	.06	.05, .07	.07
3. Cross loading Item 2 onto Pain Severity	251.22	115	221.76	47.77***	17	.93	.06	.04, .07	.06
4. Correlated error (Items 4 & 10)	226.59	114	200.82	70.84***	18	.94	.05	.04, .06	.06
5. Correlated error (Items 1 & 8)	221.32	113	187.79	105.05***	19	.95	.05	.03, .06	.06
Men									
1. The Deisinger Model	307.02	132	277.54	---	---	.88	.07	.06, .08	.07
2. Item 19 dropped	295.31	116	261.71	12.13	16	.88	.07	.06, .09	.07
3. Correlated error (Items 4 & 10)	243.99	115	217.17	60.49***	17	.92	.06	.05, .07	.07
4. Cross loading Item 2 onto Pain Severity	203.55	114	182.60	93.22***	18	.95	.05	.03, .06	.07

Y-B χ^2 = Yuan-Bentler scaled Chi-Square Likelihood Ratio statistic; *CFI = robust Comparative Fit Index; *RMSEA = robust Root Mean Square Error of Approximation; CI = confidence interval; SRMR = Standardized Root Mean Squared Residual

Criteria for determining adequate model fit were: *CFI \geq .95, *RMSEA \leq .06, and SRMR \leq .08 (Hu & Bentler, 1999)

^a the corrected value is reported as required when the Y-B χ^2 statistic is employed

*** $p < .001$

Table 5. MPI Section II: Goodness-of-fit and comparative statistics for post-hoc model fitting of the best fitting models for women and men

Model	χ^2	df	S-B χ^2	Δ S-B χ^2 ^a	Δ df	*CFI	*RMSEA	90% *RMSEA CI	SRMR
Women									
1. The Deisinger Model	116.72	51	95.65	---	---	.96	.06	.04, .08	.05
Men									
1. The Kerns Model	188.37	74	168.53	---	---	.91	.08	.06, .10	.08
2. Cross loading Item 6 onto Solicitous Responses	169.68	73	154.72	7.05**	1	.92	.07	.06, .09	.08

S-B χ^2 = Satorra-Bentler scaled Chi-Square Likelihood Ratio statistic; *CFI = robust Comparative Fit Index; *RMSEA = robust Root Mean Square Error of Approximation; CI = confidence interval; SRMR = Standardized Root Mean Squared Residual

Criteria for determining adequate model fit were: *CFI \geq .95, *RMSEA \leq .06, and SRMR \leq .08 (Hu & Bentler, 1999)

^a the corrected value is reported as required when the S-B χ^2 statistic is employed

** $p < .01$

Table 6. MPI Section III: Goodness-of-fit and comparative statistics for post-hoc model fitting of the Kerns Model for women and men

Model	χ^2	df	S-B χ^2	Δ S-B χ^2 ^a	Δ df	*CFI	*RMSEA	90% *RMSEA CI	SRMR
Women									
1. The Kerns Model	277.73	129	223.71	---	---	.90	.05	.04, .06	.06
Men									
1. The Kerns Model	281.08	129	231.39	---	---	.89	.06	.05, .07	.07
2. Correlated error (Items 10 & 14)	251.89	128	207.71	19.85***	1	.92	.05	.04, .07	.06

S-B χ^2 = Satorra-Bentler scaled Chi-Square Likelihood Ratio statistic; *CFI = robust Comparative Fit Index; *RMSEA = robust Root Mean Square Error of Approximation; CI = confidence interval; SRMR = Standardized Root Mean Squared Residual

Criteria for determining adequate model fit were: *CFI \geq .95, *RMSEA \leq .06, and SRMR \leq .08 (Hu & Bentler, 1999)

^a the corrected value is reported as required when the S-B χ^2 statistic is employed

*** $p < .001$

Table 7. MPI Section I: Goodness-of-fit and comparative statistics for the Deisinger Model tests of gender invariance

Model	χ^2	df	Y-B χ^2	*CFI	$\Delta Y-B\chi^{2a}$	Δdf	$\Delta *CFI$
1. No constraints	413.15	227	367.34	.948	---	---	---
2. All factor loadings constrained equal	465.37	241	410.61	.937	42.80***	14	.011
3. All but three factor loadings (Section I Items 12 & 16; Section II Item 10) constrained equal	433.63	238	383.59	.946	16.52	11	.002
4. All but four factor loadings (Section I Items 12, 16, & 18; Section II Item 10) constrained equal	427.27	237	378.57	.947	11.30	10	.001
5. Model 4 and Item 2 with Pain Severity cross loading constrained equal	427.51	238	378.98	.948	11.58	11	.000
6. Model 5 and correlated error (Section I items 4 & 10) constrained equal	432.84	239	382.71	.947	16.01	12	.001
7. Model 6 and all intercepts constrained equal	481.75	256	428.40	.947	63.52***	29	.001
8. Model 7 and all but three intercepts (Section I Items 11, 12, & 23) constrained equal	451.75	253	400.81	.947	32.71	26	.001
9. Model 7 and all but four intercepts (Section I Items 11, 12, & 23; Section II Item 10) constrained equal	446.90	252	396.94	.947	28.60	25	.001
10. Model 9 and all factor variances and covariances constrained equal	459.89	258	408.73	.945	39.95	31	.003
11. Model 9 and all but two factor covariances (Interference, Punishing Responses & Interference, Pain Severity) constrained equal	452.09	256	401.55	.947	33.28	29	.001

Y-B χ^2 = Yuan-Bentler scaled Chi-Square Likelihood Ratio statistic; *CFI = robust Comparative Fit Index

^a the corrected value is reported as required when the Y-B χ^2 statistic is employed
*** $p < .001$

Table 8. MPI Section III: Goodness-of-fit and comparative statistics of the Kermes Model tests of gender invariance

Model	χ^2	df	S-B χ^2	*CFI	Δ S-B χ^2 ^a	Δ df	Δ *CFI
1. No constraints	529.62	257	431.58	.907	---	---	---
2. All factor loadings constrained equal	586.23	271	477.24	.890	54.43***	14	.017
3. All but five factor loadings (Items 6, 9, 10, 14, 18) constrained equal	535.23	266	437.39	.909	6.03	9	.002
4. Model 3 and all intercepts constrained equal	761.17	284	653.35	.903	385.92***	27	.004
5. Model 4 and twelve intercept constraints released (Items 1, 2, 3, 5, 6, 7, 9, 10, 13, 14, 17, 18)	540.31	272	443.66	.908	10.18	15	.001
6. Model 5 and all factor variances and covariances constrained equal	601.70	282	494.29	.887	64.36***	25	.020
7. Model 5 and one variance (Outdoor Work) and one covariance (Outdoor Work, Activities Away From Home) constraint released	592.14	280	491.46	.887	72.70***	23	.020
8. Model 7 and two additional covariance (Outdoor Work, Household Chores; Outdoor Work, Social Activities) constraints released	543.59	278	447.73	.909	14.40	21	.002

S-B χ^2 = Satorra-Bentler scaled Chi-Square Likelihood Ratio statistic; *CFI = robust Comparative Fit Index

^a the corrected value is reported as required when the S-B χ^2 statistic is employed

*** $p < .001$

Table 9. MPI means, standard deviations, mean inter-item correlations, and standardized α indices of the best fitting models, by Section, for women and men

Variable	Women			Men				
	M	SD	r_{mit}	α	M	SD	r_{mit}	α
Section I: The Deisinger Model (n = 285, 225)								
Interference	4.98	0.80	0.38	0.86	5.01	0.82	0.38	0.86
Punishing Responses	2.14	1.86	0.79	0.92	2.63	1.98	0.82	0.93
Pain Severity	4.89	0.78	0.44	0.76	4.90	0.76	0.44	0.75
Section II: The Deisinger Model (n = 225)								
Support	4.15	1.61	0.65	0.88				
Sollicitous Responses	3.46	1.68	0.48	0.82				
Distracting Responses	2.99	1.66	0.44	0.70				
Section II: The Kerns Model (n = 204)								
Punishing Responses					2.42	1.75	0.62	0.87
Sollicitous Responses					3.45	1.45	0.39	0.79
Distracting Responses					2.68	1.34	0.33	0.66
Section III: The Kerns Model (n = 301, 224)								
Household Chores	3.38	1.41	0.46	0.81	2.40	1.45	0.50	0.84
Outdoor Work	0.57	0.74	0.38	0.75	1.07	1.20	0.47	0.82
Activities Away From Home	1.97	0.97	0.30	0.63	1.72	0.92	0.26	0.59
Social Activities	1.79	1.08	0.26	0.59	1.68	1.03	0.28	0.61

r_{mit} = mean inter-item correlation

Figure Captions

Fig. 1. MPI Section I: Standardized estimates for the final Deisinger Model for women with chronic pain. A single asterisk (*) denotes a parameter that was freely estimated. The rectangle located at right centre of the model is a constant and is required given the use of ML estimation in the treatment of missing data (Bentler, 2006). I = Interference, PR = Punishing Responses, PS = Pain Severity.

Fig. 2. MPI Section I: Standardized estimates for the final Deisinger Model for men with chronic pain. A single asterisk (*) denotes a parameter that was freely estimated. The rectangle located at right centre of the model is a constant and is required given the use of ML estimation in the treatment of missing data (Bentler, 2006). I = Interference, PR = Punishing Responses, PS = Pain Severity.

Fig. 3. MPI Section II: Standardized estimates for the final Deisinger Model for women with chronic pain. A single asterisk (*) denotes a parameter that was freely estimated. S = Support, SR = Solicitous Responses, DR = Distracting Responses.

Fig. 4. MPI Section II: Standardized estimates for the final Kerns Model for men with chronic pain. A single asterisk (*) denotes a parameter that was freely estimated. PR = Punishing Responses, SR = Solicitous Responses, DR = Distracting Responses.

Fig. 5. MPI Section III: Standardized estimates for the final Kerns Model for women with chronic pain. A single asterisk (*) denotes a parameter that was freely estimated. HC = Household Chores, OW = Outdoor Work, AH = Activities Away From Home, SA = Social Activities.

Fig. 6. MPI Section III: Standardized estimates for the final Kerns Model for men with chronic pain. A single asterisk (*) denotes a parameter that was freely estimated. HC =

Household Chores, OW = Outdoor Work, AH = Activities Away From Home, SA =
Social Activities.

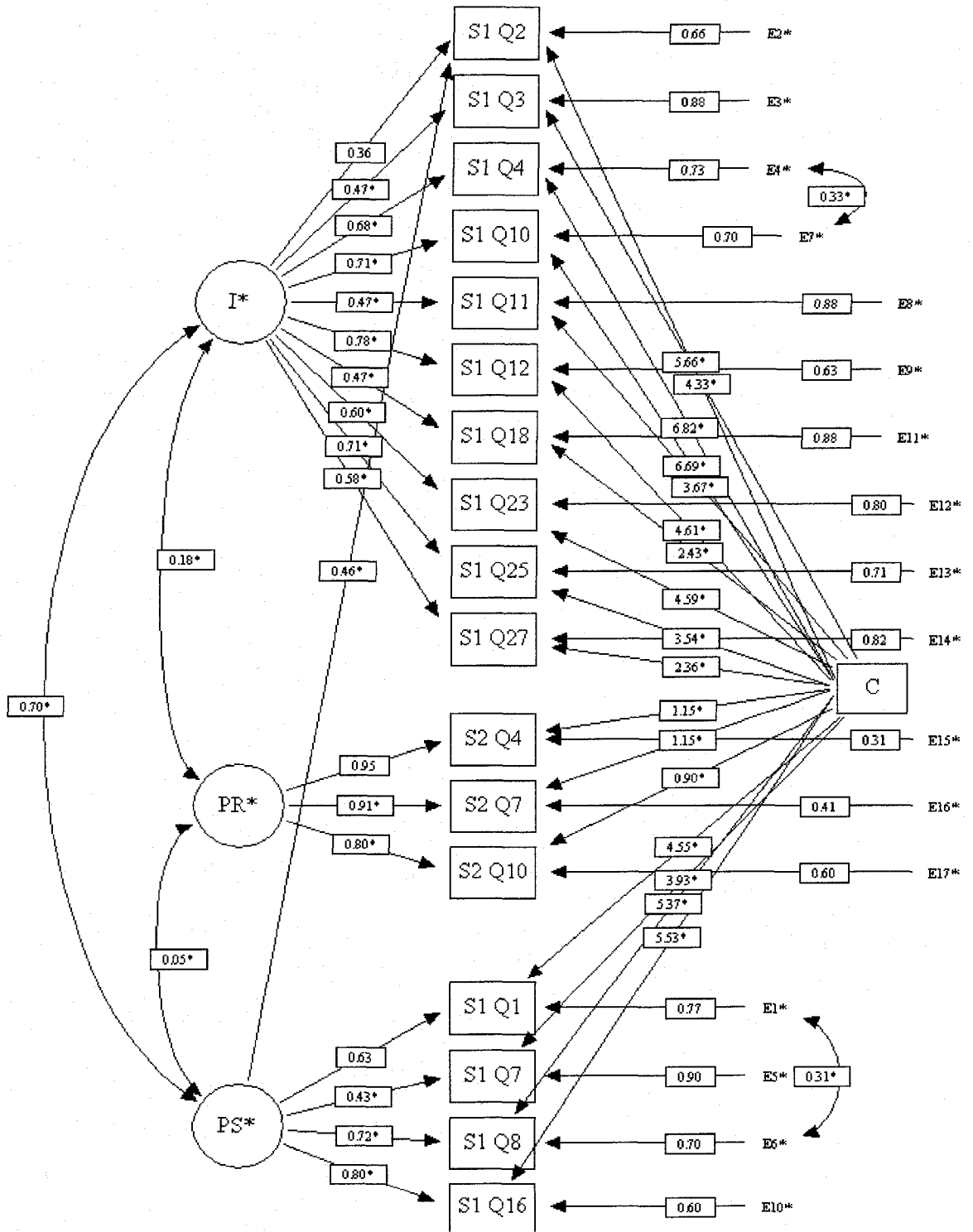


Fig. 1.

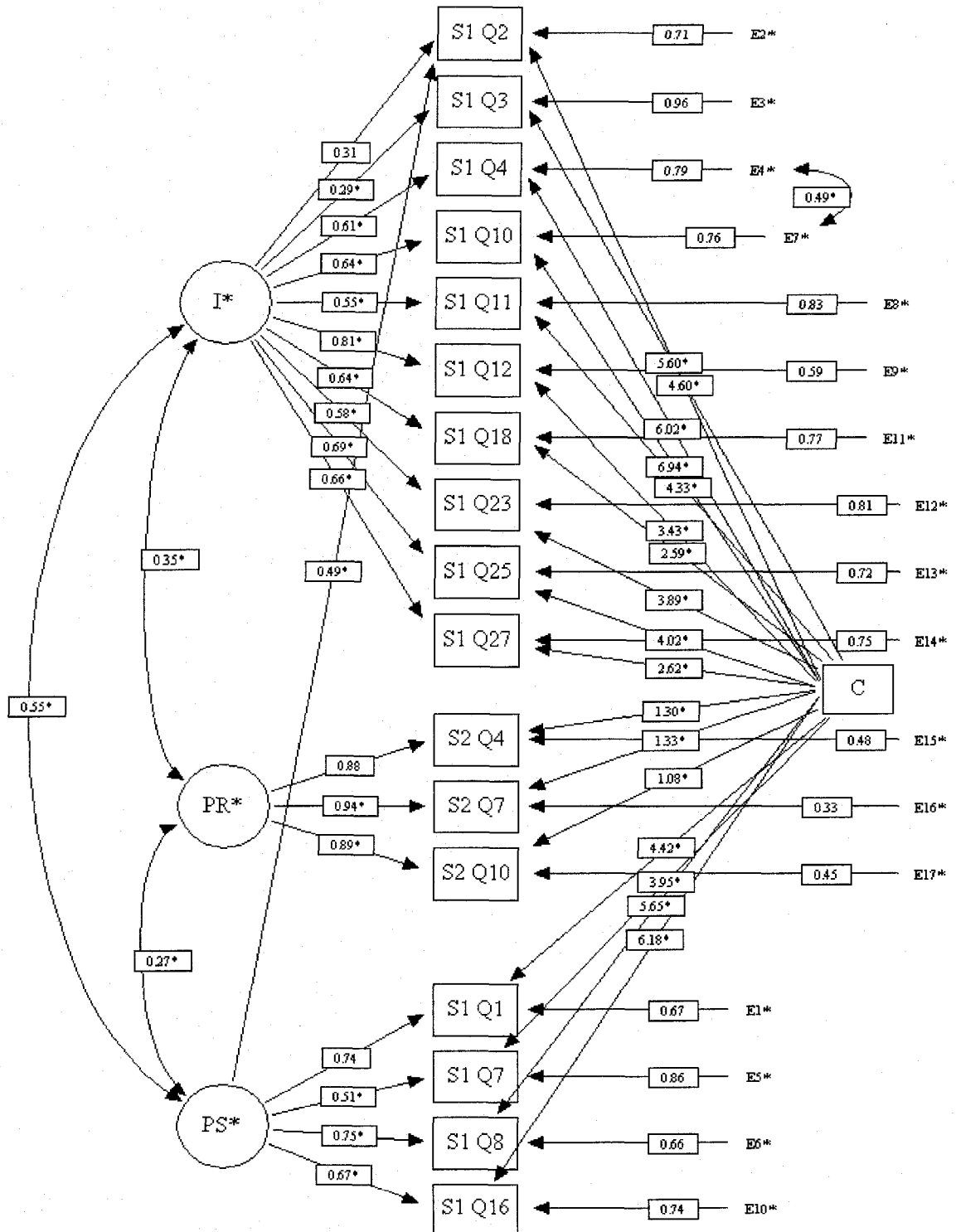


Fig. 2.

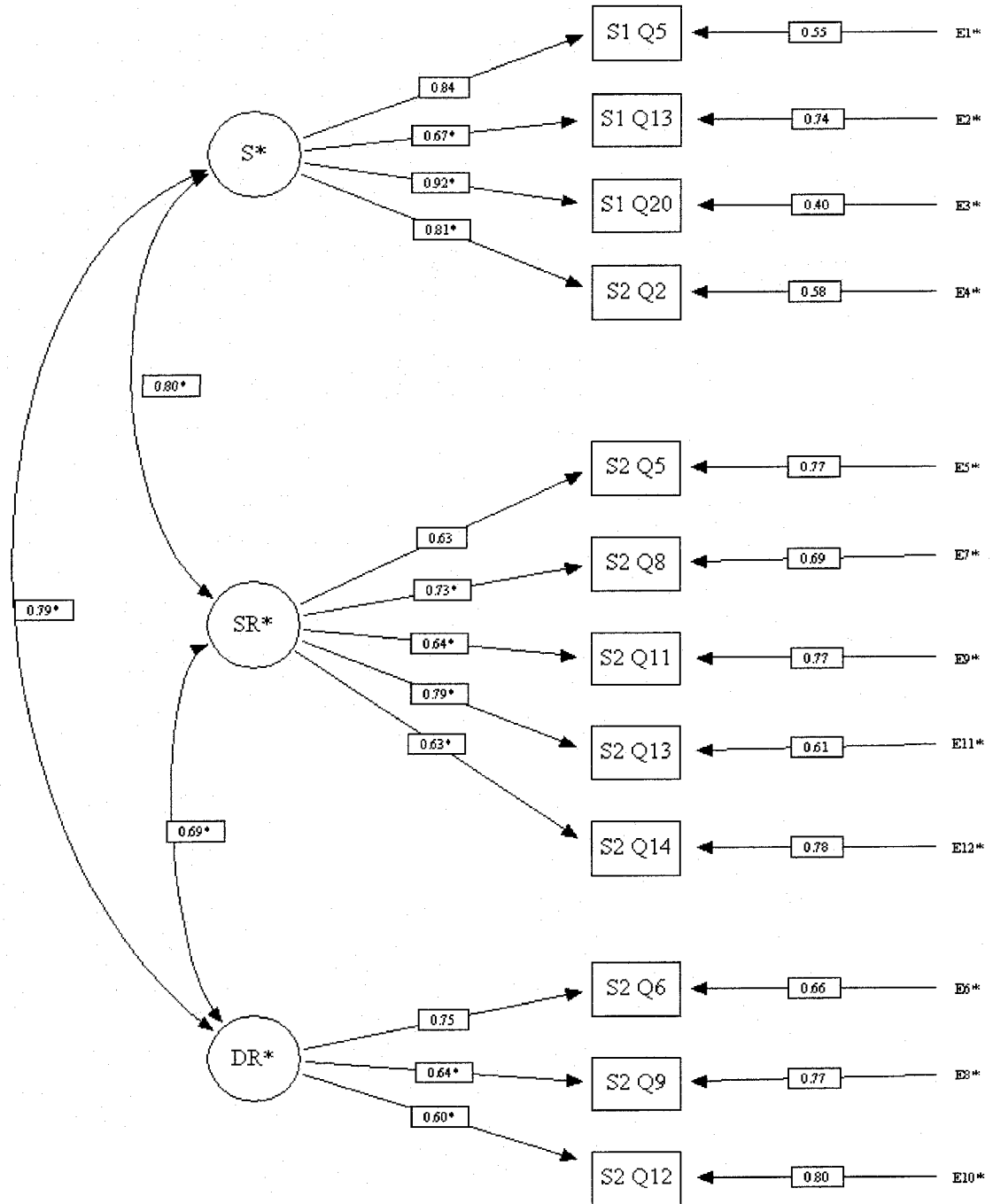


Fig. 3.

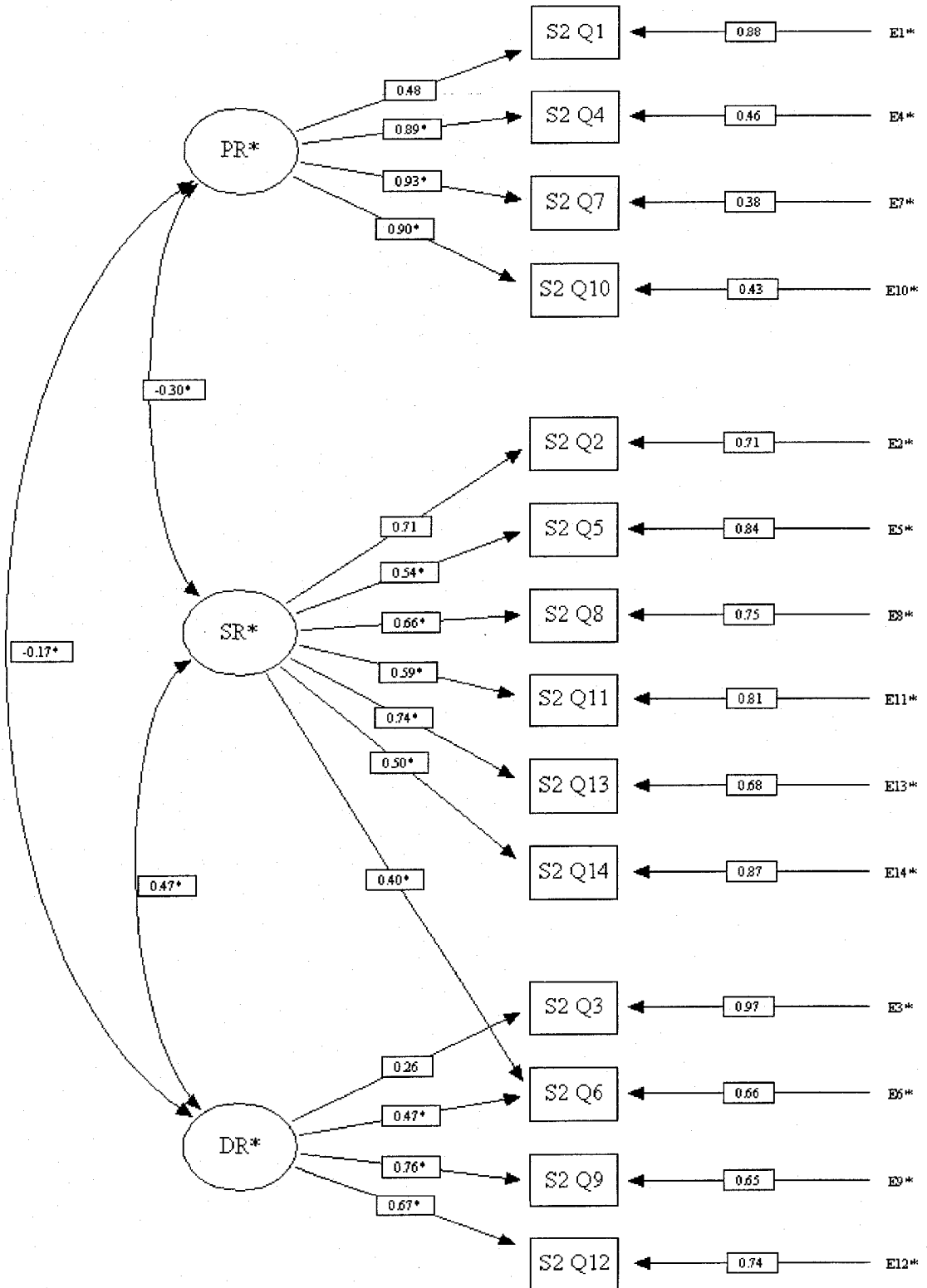


Fig. 4.

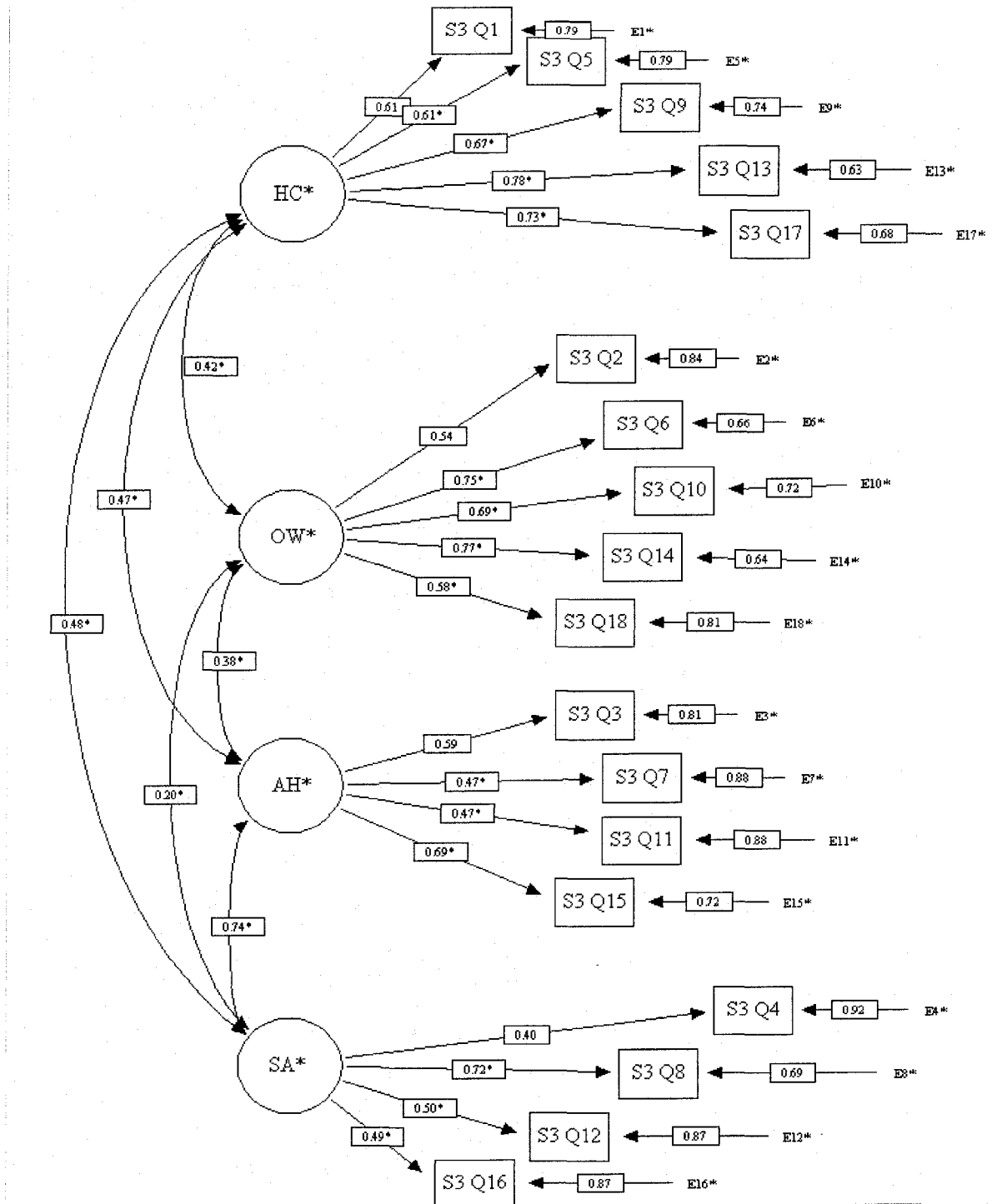


Fig. 5.

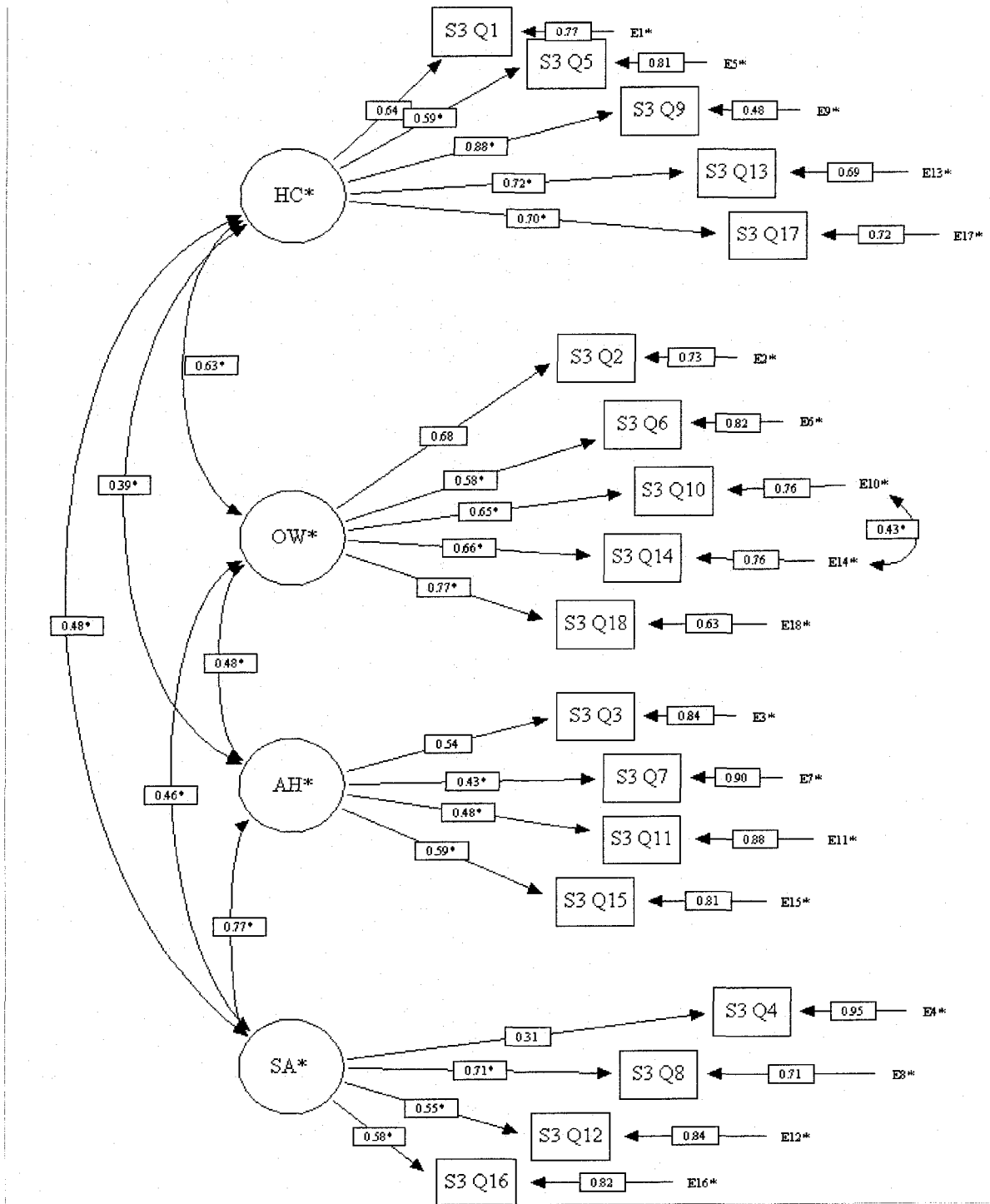


Fig. 6.

General Discussion

This dissertation examined the factorial validity and gender invariance of the BDI-II and the MPI in individuals with chronic pain. Both of the measures investigated are commonly employed in the assessment of women and men with chronic pain and the BDI and the Interference subscale of the MPI have been recommended by the IMMPACT committee for use within the context of multidimensional assessment in pain treatment research. With its focus on construct validity and the examination of possible gender bias, this dissertation complements the recent calls for empirically supported measurement, not only in psychology in general but in the area of chronic pain in particular, and is consistent with gender-fair research initiatives.

Contribution of Confirmatory Factor Analysis and Tests of Gender Invariance to Measurement and Theory

As hypothesized, results of Article I support the theoretical conceptualization of depression, as measured by the BDI-II, as a singular second-order latent construct consisting of three interrelated but independent first-order factors – Negative Attitude, Performance Difficulty, and Somatic Elements, for individuals with chronic pain. The hierarchical factor structure that was confirmed indicates that somatic, affective, and cognitive indicators of depression covary and are all required to provide an optimal explanation of the overall depression construct. This supports the inclusion of somatic symptoms of depression in the calculation of a BDI-II total score, despite the association between somatic symptoms and chronic pain.

The BDI-II also evidenced partial measurement gender invariance, indicating that the factor structure of the BDI-II is configurally the same for women and men, and that

the questionnaire scores of both genders are comparable on the same measurement scale (Widaman & Reise, 1997). Meaningful mean gender comparisons can now be made with confidence that the BDI-II is free of gender bias. Consistent use of the BDI-II in research examining gender prevalence ratios of depressive symptoms in men and women with chronic pain will help clarify the inconsistent results that have been reported in this area.

Hypotheses relating to the MPI factor structures tested in Article II were supported in part. As expected, analyses of the Section I models indicated that the Deisinger Model (Deisinger, et al. 2001) provides the best fit to the data of both genders. This indicates that Section I of the MPI is best conceptualized as assessing Pain Severity, Interference due to pain, and Punishing Responses, as derived by Deisinger et al. (2001). Moreover, these constructs are measured in fundamentally the same way for women and men with chronic pain, indicating that meaningful mean gender comparisons can be made.

As hypothesized, the Section II Deisinger Model is optimal for women. In contrast, and contrary to expectations, the Section II Kerns Model (Kerns et al., 1985) is best for men. Although this finding is understandable given that Kerns et al. (1985) employed a predominately male sample, the model fit for men was not optimal even after post hoc model fitting procedures were conducted, indicating that neither model provides an adequate explanation of the male data. These results suggest that men and women with chronic pain conceptualize social support and its related constructs differently. Research examining the impact of social support on adaptation to chronic pain suggests a significant and positive association between these variables (Karoly & Ruehlman, 2006; Li & Moore, 1998) with one study indicating that sharing important matters with a

significant other is more salient to the adaptation of men with chronic pain than women (Weir, Browne, Tunks, Gafni, & Roberts, 1996). This finding supports the importance of developing a better fitting support model for men.

Contrary to expectations, analyses of the Section III models indicated that the Kerns Model provides a better fit to the data of both genders. However, consistent with hypotheses, model fit was not optimal for either gender in Section III. There is considerable gender variance in the Outdoor Work and Household Chores factors. As a result, mean gender differences were only conducted for the Activities Away From Home and Social Activities subscales. The challenge of attaining an optimal fitting model in this Section suggests that the development of new activity scales specific to each gender is warranted given differences in the types of activities in which men and women engage (Campbell & Friedman, 2007; De Gagné et al., 1995; Vallerand, 1998).

When the same items on a questionnaire measure different constructs in each gender, or when those items measure the same construct in a different way for each gender, the measure is said to evidence gender bias (Byrne & Watkins, 2003; van de Vijver & Leung, 1997). Gender variance in factorial validity most frequently points to construct bias, which can arise due to one or more of the following: 1) attempting to measure a construct that is defined differently in each group using the same items, 2) including items that measure qualities not belonging to the repertoire of one of the groups, and/or 3) failure to sample all of the relevant domains to ensure complete coverage of the construct being measured (van de Vijver & Leung). CFA tests of gender invariance are therefore instrumental in identifying issues of gender bias related to particular items and/or constructs, and pointing to the possible origin of these issues.

This dissertation has identified constructs that are problematic within the MPI (i.e., Support, Solicitous Responses, Distracting Responses, Household Chores, and Outdoor Work) and indicates that Sections II and III must be refined. Having identified these problematic areas, additional research is required to determine how best to assess these constructs in a way that eliminates gender bias.

Relevance

To ensure valid and reliable assessment, interpretations of psychological measures must be based on the optimal factor structure for the particular population in which they are being used. Results of Article I indicated that computation of a BDI-II total score and/or three subscale scores (Performance Difficulty, Negative Attitude, Somatic Elements) is warranted in the chronic pain population. Such knowledge of the optimal, gender invariant, factor structure for the BDI-II in this population has important implications for research and clinical practice.

Depending on the particular research question being addressed, investigators may choose to utilize the BDI-II total score or each of the subscale scores. For example, it would be interesting to investigate gender as a potential moderator of the associations between the depression factors and pain severity. The results would determine if the strength of one or more of these associations is stronger for men or women with chronic pain, and could ultimately have implications for the optimal treatment of depression in this population, which may or may not vary by gender. Clinicians treating individual patients with chronic pain would also be wise to consider the BDI-II subscale scores in addition to the overall depressive symptomatology score. By consulting normative data on the subscales, it would be possible to determine which subtypes of depressive

symptoms are most problematic for individual patients. This could help focus and advance treatment in an area of tremendous importance given the prevalence and negative outcomes associated with comorbid chronic pain and depression.

Similarly, knowledge of the MPI factor structure has implications for research and practice. The results of Article II suggest that researchers and clinicians can have confidence in Section I scores obtained for men and women with chronic pain if this Section is scored according to the Deisinger Model (i.e., Interference, Punishing Responses, Pain Severity). Results indicate that revisions are needed in Sections II and III. In the meantime, interpretations of Section II should be based on the Deisinger Model for women and the Kerns Model for men. Until Section III is revised, scoring is best based on the Kerns Model; however, only the Activities Away From Home and Social Activities subscales should be interpreted.

Past research in the area of chronic pain that has employed either the BDI-II or the MPI must be considered in light of the results of this dissertation. Conclusions drawn on the basis of the BDI-II total score are likely to be sound given the results of Article I, whereas conclusions based on the use of the MPI as a predictor or outcome measure require substantiation given the results of Article II. With regard to future research, the recommendations recently put forth by the IMMPACT committee are likely to have significant influence. The BDI and the MPI Interference subscale are among the measures endorsed for use in clinical trials of pain treatments (Dworkin et al., 2005; Turk et al., 2003). Results of this dissertation reinforce the appropriateness of both the BDI-II, as discussed above, and the MPI Interference subscale. As noted, the MPI Interference factor was the only factor in the Kerns Model to be replicated in its entirety by Desinger

et al (2001). Results of Article II also suggest that this factor is gender invariant, further supporting its validity.

Research Strengths

This dissertation provides crucial information about the construct validity, internal consistency, and gender invariance of the BDI-II and the MPI in individuals with chronic pain. The samples of women and men were sufficiently large to allow for sound application of CFA methodology with tests of gender invariance. This is particularly relevant given current trends toward empirically supported assessment (Antony & Barlow, 2002; Hunsley & Mash, 2007) and gender-fair research (Canadian Psychological Association, 1992; CPA Section on Women and Psychology, 2007; Denmark et al., 1988; Grady, 1981; Hyde, 1996; McHugh et al., 1986; Rollman, 2003).

The sample demographics in this research are similar to those seen in other multidisciplinary pain rehabilitation centres and therefore highly generalizable to individuals seeking speciality treatment for chronic pain. In keeping with the conceptualization of chronic pain as a general phenomenon, the sample was heterogeneous with regard to primary pain site (Addison, 1984; Sanders, 1985). This conceptualization of chronic pain is based on research showing that similarities between chronic pain conditions with regard to the experience of pain and its consequences outweigh any differences (e.g., Wessely, Nimnuan, & Sharpe, 1999). Multidisciplinary pain management programs are based on this understanding of chronic pain, which allows for the development of common prevention strategies and intervention programs.

The use of CFA to evaluate competing models of factor structure is another significant strength of this dissertation. Because CFA is a type of SEM, it has several

advantages over EFA and is considered a more rigorous method of examining factorial validity (Byrne, 2006). Examining competing models of CFA factor structure adds to the methodological strength of the approach. In doing so, it was possible to determine which of the theoretically plausible BDI-II and MPI factor analytic models is statistically optimal.

Research Limitations

The results of this dissertation must be interpreted within the context of its methodological and theoretical limitations. The most significant limitation is the lack of cross-validation of the results in an independent sample. The replication of findings in new samples adds credibility to the results and permits increased confidence in the conclusions drawn from them by providing evidence that the factor structure is stable and not merely an artifact of a particular sample. Within the context of CFA, the issue of replication is particularly relevant to results obtained via post-hoc model fitting. To some extent these modifications are data-driven, although adjustments were made to models in this dissertation only when they could be justified conceptually. Nonetheless, the large number of additional participants that were required precluded cross-validation and this is an important area of future research.

The results of CFA analyses are only as strong as the models that are tested. This research was rigorous in that it involved tests of several competing models of factor structure; however, it is possible that another, as of yet untested model could provide a more optimal fit to the data. An attempt was made to minimize this possibility in both articles by testing all models deemed likely to generalize to the chronic pain population. Criteria considered when evaluating potential models included the methodology with

which they were derived (e.g., appropriate sample size, tests of assumptions), overall model fit reported in previous research, and cross-validation of findings in independent samples.

Future Research

In keeping with the limitation noted above, future research aimed at cross-validation of the present findings is required. Such studies would necessarily require large samples of women and men with chronic pain. Replication of the BDI-II results will strengthen the already strong support for its psychometric properties in this population. Future research evaluating the stability of the BDI-II subscale and total scores over time and the criterion validity of the measure in chronic pain are required.

The need for significant revision to Sections II and III of the MPI is indicated by gender variance of factors in these Sections and the lack of optimal model fit for men in Section II and both genders in Section III. New items that better tap the pain constructs being assessed for both women and men will need to be developed for these Sections and then evaluated in large representative samples of individuals with pain. It is possible that a male and female version of Section III may need to be developed to account for differences in the daily activities of men and women.

Conclusion

Results of this dissertation indicate that the BDI-II demonstrates good construct validity and internal consistency in patients with chronic pain. Moreover, data indicated that it operates equivalently across gender. The MPI was developed with the important goal of providing valuable information about various psychosocial and behavioural aspects of the pain experience. Results indicate that its utility in achieving this goal will

be enhanced through revisions to Section II and Section III. As new items and factors are developed, additional research examining the psychometric properties of the measure will be required.

This dissertation illustrates the importance of psychometric research.

Measurement figures prominently in all areas of psychology, including chronic pain.

Research investigating the psychometric properties of psychological measures is imperative because the quality of treatment decisions and research conclusions based on these measures depends on their psychometric properties in the particular population in which they are being used. This dissertation responds to recent calls for empirically supported measurement in the area of pain (Turk & Melzack, 2001) and is consistent with gender-fair research initiatives. There is more work to be done. Chronic pain and its associated constructs are complex. Further psychometric research is required to ensure that this subjective and multifaceted experience is assessed and treated optimally.

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Appendix A

Pain History Questionnaire Information

Information from Pain History Questionnaire

Patient ID _____ **DOB** (day/month/year) ___/___/_____

Pg1 Ethnicity [1] Canadian [2] French Canadian **(ethnic)** ___
 [3] Aboriginal [4] Other
 [99] Missing

Pg2 Q 1 Primary Pain Location (primpain) ___
 [00] HEAD
 [10] NECK
 [20] SHOULDERS/ARMS
 [30] THORACIC REGION
 [40] ABDOMINAL
 [50] BACK
 [60] LEGS
 [70] PELVIC
 [80] GENITAL
 [90] MULTIPLE SITES- Four or more sites listed in total
 [91] **JOINTS** (i.e. shoulders, elbows, wrists, hand, hips, knees, ankles - not spine)
 [94] Total body pain
 [98] **No other site** [99] Missing

Q 2a) Pain began?(Month/Year) (paindur) ___/___
Number of years (calculated automatically by running syntax file)

Q 3 Pain Constancy (describe) ___
 [1] Always present - same intensity
 [2] Always present - Intensity varies
 [3] Often present - short periods without pain
 [4] Often present - pain-free periods lasting 1 to 6 hours
 [5] Often present - pain-free periods lasting over 6 hours
 [6] Occasionally present - pain daily, lasting a few seconds
 [7] Occasionally present- pain daily, a few seconds to an hour
 [8] Rarely present - Have pain every few days or weeks
 [99] Missing

Pg 5 Q17 Medication
 [1] yes [2] no **(med)** ___

Type
 [1] analgesic [2] psychotropic
 [3] other (medtype) __

Pg 8 Q30 Marital Status (marital) __
 [1] Never Married [2] Widowed
 [3] Married or Common-law [4] Separated or divorced
 [99] Missing

How long widowed, married or separated (in years) (length) __
 [88] Not applicable [99] Missing

Pg 9 Q33b Relationship Rating (relation) __
 [Code 01 to 10 - Poor to Excellent]
 [88] Not applicable
 [99] Missing

Pg10 Q36 Employment Status (allow for 2 codes) (employ) __
 (employ2) __
 [1] Working- use only if [2] [3] not completed
 [2] full-time [3] part-time
 [4] Student- use only if [5] [6] not completed
 [5] full-time [6] part-time
 [7] Homemaker/parenting- use only if [8] [9] not completed
 [8] full-time [9] part-time
 [10] Unemployed
 [11] Retired
 [12] Sick leave/Vacation leave
 [13] Disability leave - unspecified type
 [14] permanent [15] temporary
 [99] Missing
 [88] Not applicable (for employ2 only)

Pg11 Q45 Compensation/Insurance Status (finance) __
 [1] No [2] Yes
 [88] Not applicable [99] Missing

Appendix B

Beck Depression Inventory – Second Edition (BDI-II)

Beck Depression Inventory – Second Edition (BDI-II)

The BDI-II is a 21-item self-report measure based on the diagnostic criteria for depressive disorders outlined in the DSM-IV (American Psychiatric Association, 1994). For each item, respondents are asked to choose the one statement, of 4 to 7 available for each item, that best describes their cognitive, affective, or physical state during the previous 2-week period, including the day of testing. If more than one statement is relevant for any item, respondents are instructed to circle the statement with the highest score.

Each item on the inventory requires respondents to endorse one of four graded sentences reflecting the severity of different depressive symptoms. For example, the item on Guilty Feelings requires respondents to endorse any one of four sentences ranging from “I don’t feel particularly guilty” to “I feel guilty all of the time”. Scores from zero to three are applied to each sentence within the items. Higher scores are related to more severe symptoms. The questionnaire is scored by adding the numbers corresponding to each of the statements circled by the respondent. For items concerning sleep and appetite (items 16 and 18), alternative statements allow respondents to indicate increases (statements 1a, 2a, 3a, respectively) or decreases (statements 1b, 2b, 3b, respectively) for the second, third, and fourth graded statements.

Appendix C

The McGill Pain Questionnaire

McGill Pain Questionnaire

° R. Melzack, 1975

Name: _____

Date: _____

Read each group of words below and put a check beside the word in each group that best describes your present pain. Check only one word in each group, if it describes your pain. If none of the words in a group apply, do not check any - move on to consider the next group.

- 1 Flickering
 Quivering
 Pulsing
 Throbbing
 Beating
 Pounding
- 2 Jumping
 Flashing
 Shooting
- 3 Pricking
 Boring
 Drilling
 Stabbing
 Lancinating
- 4 Sharp
 Cutting
 Lacerating
- 5 Pinching
 Pressing
 Gnawing
 Cramping
 Crushing
- 6 Tugging
 Pulling
 Wrenching
- 7 Hot
 Burning
 Scalding
 Searing
- 8 Tingling
 Itchy
 Smarting
 Stinging

- 9 Dull
 Sore
 Hurting
 Aching
 Heavy
- 10 Tender
 Taut
 Rasping
 Splitting

- 11 Tiring
 Exhausting

- 12 Sickening
 Suffocating

- 13 Fearful
 Frightful

- 14 Punishing
 Gruelling
 Cruel
 Vicious
 Killing

- 15 Wretched
 Blinding

- 16 Annoying
 Troublesome
 Miserable

- 17 Spreading
 Radiating
 Penetrating
 Piercing

- 18 Tight
 Numb
 Drawing
 Squeezing
 Tearing

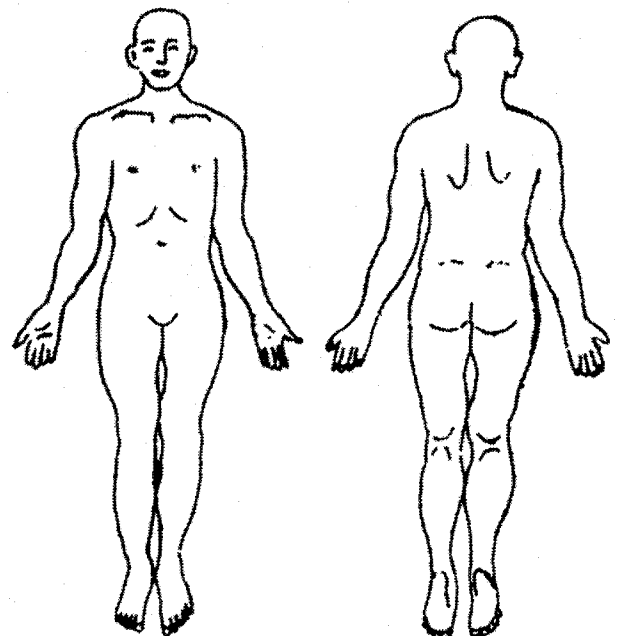
- 19 Cool
 Cold
 Freezing

- 20 Nagging
 Nauseating
 Agonizing
 Dreadful
 Torturing

Self-Rating of Pain: Please circle the appropriate rating at this time.

- 0 - No Pain
- 1 - Mild
- 2 - Discomforting
- 3 - Horrible
- 4 - Excruciating

Please note on the diagram below where you experience pain.



Appendix D

The Multidimensional Pain Inventory

Section 1

1. Rate the level of your pain at the present moment.

0 1 2 3 4 5 6
 No Pain Very Intense Pain

2. In general, how much does your pain interfere with your day-to-day activities?

0 1 2 3 4 5 6
 No Interference Extreme Interference

3. Since the time your pain began, how much has your pain changed your ability to work?

(____ Check here, if you have retired for reasons other than your pain).

0 1 2 3 4 5 6
 No Change Extreme Change

4. How much has your pain changed the amount of satisfaction or enjoyment you get from taking part in social and recreational activities?

0 1 2 3 4 5 6
 No Change Extreme Change

5. How supportive or helpful is your spouse (significant other) to you in relation to your pain?

0 1 2 3 4 5 6
 Not at all Supportive Extremely Supportive

6. Rate your overall mood during the past week.

0 1 2 3 4 5 6
 Extremely Low Extremely High

7. How much has your pain interfered with your ability to get enough sleep?

0 1 2 3 4 5 6
 No Interference Extreme Interference

8. On the average, how severe has your pain been during the last week?

0 1 2 3 4 5 6
 Not at all Severe Extremely Severe

9. How able are you to predict when your pain will start, get better, or get worse?

0 1 2 3 4 5 6
 Not at all able to predict Very able to predict

10. How much has your pain changed your ability to take part in recreational and other social activities?

0 1 2 3 4 5 6
 No Change Extreme Change

11. How much do you limit your activities in order to keep your pain from getting worse?

0 1 2 3 4 5 6
 Not at all Very Much

12. How much has your pain changed the amount of satisfaction or enjoyment you get from family-related activities?

0 1 2 3 4 5 6
 No Change Extreme Change

13. How worried is your spouse (significant other) about you because of your pain?

0 1 2 3 4 5 6
 Not at all Worried Extremely Worried

14. During the past week how much control do you feel that you have had over your life?

0 1 2 3 4 5 6
 No Control Extreme Control

15. On an average day, how much does your pain vary (increase or decrease)?

0 1 2 3 4 5 6
 Remains the Same Changes a lot

16. How much suffering do you experience because of your pain?

0 1 2 3 4 5 6
 No Suffering Extreme Suffering

17. How often are you able to do something that helps to reduce your pain?
- 0 1 2 3 4 5 6
Never Very Often
18. How much has your pain changed your relationship with your spouse, family, or significant other?
- 0 1 2 3 4 5 6
No Change Extreme Change
19. How much has your pain changed the amount of satisfaction or enjoyment you get from work? (____ Check here, if you are not presently working)
- 0 1 2 3 4 5 6
No Change Extreme Change
20. How attentive is your spouse (significant other) to you because of your pain?
- 0 1 2 3 4 5 6
Not at all Attentive Extremely Attentive
21. During the past week how much do you feel that you've been able to deal with your problems?
- 0 1 2 3 4 5 6
Not at all Extremely Well
22. How much control do you feel that you have over your pain?
- 0 1 2 3 4 5 6
No Control at all A Great Deal of Control
23. How much has your pain changed your ability to do household chores?
- 0 1 2 3 4 5 6
No Change Extreme Change
24. During the past week, how successful were you in coping with stressful situations in your life?
- 0 1 2 3 4 5 6
Not at all Successful Extremely Successful

25. How much has your pain interfered with your ability to plan activities?

0 1 2 3 4 5 6
 No Change Extreme Change

26. During the past week how irritable have you been?

0 1 2 3 4 5 6
 Not at All Irritable Extremely Irritable

27. How much has your pain changed or interfered with your friendships with people other than your family?

0 1 2 3 4 5 6
 No Change Extreme Change

28. During the past week how tense or anxious have you been?

0 1 2 3 4 5 6
 Not at All Tense or Anxious Extremely Tense and Anxious

Section II

In this section, we are interested in knowing how your spouse (or significant other) responds to you when he or she knows that you are in pain. On the scale listed below each question, circle a number to indicate how often your spouse (or significant other) responds to you in that particular way when you are in pain. Please answer all of the 14 questions.

1. Ignores me.

0 1 2 3 4 5 6
 Never Very Often

2. Asks me what he/she can do to help.

0 1 2 3 4 5 6
 Never Very Often

3. Reads to me.

0 1 2 3 4 5 6
 Never Very Often

4. Gets irritated with me.

0 1 2 3 4 5 6
 Never Very Often

5. Takes over my jobs or duties.

0 1 2 3 4 5 6
Never Very Often

6. Talks to me about something else to take my mind off the pain.

0 1 2 3 4 5 6
Never Very Often

7. Gets frustrated with me.

0 1 2 3 4 5 6
Never Very Often

8. Tries to get me to rest.

0 1 2 3 4 5 6
Never Very Often

9. Tries to involve me in some activity.

0 1 2 3 4 5 6
Never Very Often

10. Gets angry with me.

0 1 2 3 4 5 6
Never Very Often

11. Gets me pain medication.

0 1 2 3 4 5 6
Never Very Often

12. Encourages me to work on a hobby.

0 1 2 3 4 5 6
Never Very Often

13. Gets me something to eat or drink.

0 1 2 3 4 5 6
Never Very Often

14. Turns on the T.V. to take my mind off my pain.

0 1 2 3 4 5 6
Never Very Often

Section III

Listed below are 19 daily activities. Please indicate how often you do each of these by circling a number on the scale listed below each activity. Please complete all 19 questions.

1. Wash dishes.

0 1 2 3 4 5 6
Never Very Often

2. Mow the lawn. (____ Check here, if you do not have a lawn to mow.)

0 1 2 3 4 5 6
Never Very Often

3. Go out to eat.

0 1 2 3 4 5 6
Never Very Often

4. Play cards or other games.

0 1 2 3 4 5 6
Never Very Often

5. Go grocery shopping.

0 1 2 3 4 5 6
Never Very Often

6. Work in the garden. (____ Check here, if you do not have a garden.)

0 1 2 3 4 5 6
Never Very Often

7. Go to a movie.

0 1 2 3 4 5 6
Never Very Often

8. Visit friends.

0 1 2 3 4 5 6
Never Very Often

9. Help with the house cleaning.

0 1 2 3 4 5 6
Never Very Often

10. Work on the car. (____ Check here, if you do not have a car.)

0 1 2 3 4 5 6
Never Very Often

11. Take a ride in a car or bus.

0 1 2 3 4 5 6
Never Very Often

12. Visit relatives (____ Check here, if you do not have relatives within 100 miles.)

0 1 2 3 4 5 6
Never Very Often

13. Prepare a meal.

0 1 2 3 4 5 6
Never Very Often

14. Wash the car. (____ Check here, if you do not have a car.)

0 1 2 3 4 5 6
Never Very Often

15. Take a trip.

0 1 2 3 4 5 6
Never Very Often

16. Go to a park or beach.

0 1 2 3 4 5 6
Never Very Often

17. Do the laundry.

0 1 2 3 4 5 6
Never Very Often

18. Work on a needed household repair.

0 1 2 3 4 5 6
Never Very Often

19. Engage in sexual activities.

0 1 2 3 4 5 6
Never Very Often

Appendix E

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