Chronic Pain and Cognition: Effects of Pain Intensity on Tasks of Attention and Memory

by

Laurel A. Townsend
B.Sc., University of Victoria, 1989
M.A., University of Victoria, 1992

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In the Department of Psychology

We accept this dissertation as conforming to the required standard

Dr. C. M. Mateer, Supervisor (Department of Psychology)

Dr. P. Duncan, Departmental Member (Department of Psychology)

Dr. M. Ehrenberg, Departmental Member (Department of Psychology)

Dr. J. Walsh, Outside Member (Department of Educational Psychology)

Dr. D. Patterson, External Examiner (University of Washington)

Supervisor: Dr. C. M. Mateer

ABSTRACT

The impact of pain intensity upon tasks of attention and memory was investigated, with the specific aim of evaluating differences in effortful versus automatic processing, implicit versus explicit memory, and right versus left hemisphere measures. All research participants in the study had been diagnosed with chronic pain conditions and each person completed memory and attention tasks, measures of intelligence, emotional functioning, and cognitive failures, and provided pain intensity ratings. Ratings regarding level of fatigue, quality of sleep, perceived control over pain, and perceived effect of pain on attention and memory were also obtained. With age, education, fatigue, and self-efficacy controlled, performance on the cognitive tasks was used to predict pain intensity through a series of hierarchical multiple regressions. Performance on the cognitive tasks was not able to account for a significant amount of the variance in pain intensity. Self-efficacy and fatigue were also noted as strong predictors of pain intensity among this sample. Implications are discussed in view of rehabilitation and neuropsychological assessment of persons with chronic pain, as well as clinical interventions with this population.

Examiners:

Dr. C. M. Mateer, Supervisor (Department of Psychology)

Dr. P. Duncan, Departmental Member (Department of Psychology)

Dr. M. Ehrenberg, Departmental Member (Department of Psychology)

Dr. J. Walsh, Outside Member (Department of Educational Psychology)

Dr. D. Patterson, External Examiner (University of Washington)

TABLE OF CONTENTS

List of Tables

List of Figures

ACKNOWLEDGMENTS

There are many people who have directly or indirectly been a support to me during the duration of this study. I would like to thank the Sara Spencer Research Foundation for their generous financial support of the costs associated with this project, and the Victoria Arthritis Centre for their endless assistance with the difficult task of participant recruitment.

I would like to thank the members of my dissertation committee for their suggestions, positive feedback, and complete support of a research topic of personal significance to myself. I also wish to thank my family, my parents Mike and Sue Townsend, and my sisters Carolyn and Sheryl, for their faith in my ability to reach this goal.

Last I would like to thank the best friends a person could ever have: Theresa Van Domselaar, Diane Fox, and Linnea Nelson. All you have provided encouragement in immeasurable ways. Theresa - thank you for always being able to challenge my thinking and for all your "stats" guidance. Diane - your support and ability to help me see the "big picture" has been wonderful. Linnea - your insight into what all of this meant at a clinical level was invaluable.

DEDICATION

I dedicate this dissertation to my husband Edward
who has always been there for me with a hot cup of tea,
a delicious gourmet meal, and a never ending ability to listen.

CHAPTER 1

Introduction

Chronic pain is a problem that affects millions of North Americans and disrupts family dynamics, social functioning, and ability to perform tasks at work (Miller, 1990). A new area of interest regarding this complex problem is the impact chronic pain may have upon attention and memory. Given that deficits in these areas are often very subtle, persons with chronic pain may demonstrate appropriate intellectual and social functioning, yet have tremendous difficulty coping with situations involving time or performance pressure, divided attention, unpredictability, and challenge (Schwartz, Barth, Dane, Drenan, DeGood, & Rowlingson, 1987). Despite the fact that chronic pain patients frequently report disturbances of attention and memory, few studies to date have investigated the degree to which these complaints can be explained by the presence or absence of pain, or pain intensity.

The Importance of Understanding the Relationship Between Pain and Cognitive Functioning

The idea that pain impacts cognitive functioning is not new to persons who live with pain on a daily basis. In a study of nursing home residents with chronic pain ($N = 97$) 12% of the respondents indicated a direct relationship between their pain and memory abilities. Further, 54% of the residents reported that pain impaired their ability to visit with others and engage in social activities (Ferrell, Ferrell, and Osterweil, 1990).

Numerous respondents to a questionnaire distributed by the Chronic Pain Task Force of the Arthritis Society (1994) spontaneously reported memory disturbances as a consequence of their pain; these same patients, in response to the question "do you have pain with your arthritis?" answered "yes" 76.7% of the time. A remaining 21.4% indicated "sometimes", while only 1.9% responded with "no". With such a high prevalence of pain among these patients, the impact upon "mental" activities of everyday living is an issue that warrants further investigation. Pain patients often report being unable to read, watch television, or complete a simple task because of difficulty attending to the material or activity (Jamison, Sbrocco & Parris, 1988). These difficulties have consequences in the everyday functioning of many patients, particularly with the maintenance of full-time employment.

For example, persons with chronic pain who must avoid jobs requiring strenuous physical activity may find they have difficulty coping with a mentally demanding job because of problems with attention (Jamison, Sbrocco & Parris, 1988). This may be especially problematic for patients injured at a previous employment site and seeking retraining in a different vocation, and thus, may need to be a consideration in this retraining. Attention and memory problems in chronic pain patients may also extend to difficulties learning an exercise regime, following complex medication schedules, or adhering to complicated treatment recommendations (Kewman, Vaishampayan, Zald, & Han, 1991).

A further issue arises from our limited understanding of the impact chronic pain has upon intellectual and neuropsychological assessment. Chronic pain often occurs concomitantly with head injury and other neurological disorders (Miller, 1990). Since these populations are frequently seen in clinic settings, the need exists for knowledge of the relationship between pain intensity and cognitive performance. If pain does account, to some degree, for measured neuropsychological deficits or weak areas of performance, treatment recommendations may be affected. Rather than targeting weak areas with compensation strategies, it may be more beneficial (in terms of improving attention and memory performance) to teach the client pain control techniques.

The Neurophysiology of Pain

The multiplicity of terms and definitions used in the literature concerning chronic pain has been a source of confusion for many practitioners (Workers Compensation Board [WCB] of British Columbia, 1991). Mersky and Spear (1967) define pain as resulting from damage to nerve endings, or nerves, or else due to a lesion of the central nervous system. More general definitions describe pain as an unpleasant sensation, occurring in varying degrees as a result of injury, disease, or emotional disorder. More recently, efforts have been made to distinguish between pain due to organic pathology and pain due to psychological factors. The WCB task force on pain suggests that the term chronic pain be used for conditions with an organic cause in which the disability is proportionate to the organic impairment, and that the term somatoform pain disorder be considered when there is self-reported disability grossly in excess of the physical findings. Chronic pain, for the purposes of this study, is defined as organically based and supported by physical findings, with an additional criterion: duration of greater than six months.

Pain is still less well understood than any other sensory system (WCB, 1991). The neurological representation of pain is extremely complex and the anatomy of the pain-responsive nervous system is still being mapped (Talbot, Marrett, Evans, Meyer, Bushnell, & Duncan, 1991). Historically, the pain system was conceptualized by Descartes in 1664 as a straight-through channel from pain receptors in the skin to a pain center in the brain. Descartes' theory has evolved considerably during the past three centuries, and contemporary views of pain now recognize the interactionary nature of its sensory, affective, and cognitive features (Gallie, 1994).

Pain receptors in humans, though primarily located just below the outer layer of skin, are also found in the cornea, internal organs, and membranes surrounding bones and muscles. Damage to these tissues activates receptors of painful stimuli (referred to as nociceptors), free nerve endings that respond to direct stimulation or chemical products associated with injury. Three types of receptors contribute uniquely to the quality and intensity of pain: mechanosensitive nociceptors with A-delta fibers, mechanothermal nociceptors with A-delta fibers, and polymodal nociceptors with C-fibers. Nerve impulses from injured tissue travel via these fibers to excite dorsal horn neurons in the spinal cord (Melzack & Wall, 1988) and are subsequently transmitted to the brain by ascending systems.

Two major ascending pathway systems are involved with pain: a lateral pain system which is newer and courses laterally through the brainstem, and a phylogenetically older medial pain system which courses medially through the brainstem. The lateral system is composed of the following sequence: A-delta (myelinated) neurons of peripheral nerves, dorsal horn and spinal nucleus of nerve V, lateral spinothalamic tract and trigeminothalamic tract, ventral posterior thalamic nucleus, and somatosensory cortex. This system conducts signals rapidly and is functionally associated with sharp, suddenly felt, and discriminating aspects of pain. The lateral system accounts for most sensory qualities associated with pain and has been described as the sensory-discriminative system (Melzack & Casey, 1968).

The medial pain system is composed of the following sequence: C-fiber (unmyelinated) neurons of peripheral nerves, dorsal horn and spinal nucleus of nerve V, spinoreticulothalamic pathway and trigeminoreticulothalamic pathway, intralaminar thalamic nuclei, and widespread areas of the cerebral cortex. This system also has connections with structures of the limbic system and thus, is probably associated with actions and reactions to pain. Jones, Brown, Friston, Qi, and Frackowiak (1991) indicate that the cingulate cortex plays a major role in attributing emotional significance to painful stimuli. The medial system conducts signals slowly through a multineuronal pathway and is functionally involved with persistent pain and diffuse unpleasant feelings for some time after an injury has occurred. This system has also been described as the motivational-affective system due to its role in motivation to act (i.e. remove oneself from the noxious stimulus) when experiencing pain.

A third pain system of descending fibers has been referred to as the endogenous pain control system (Basbaum & Fields, 1978). Fibers in this system descend from the brain (specifically the pons and medulla) to regulate sensory input, and inhibit pain signals through the release of endorphins and enkephalins. These descending projections terminate in the dorsal horn of the spinal cord and act to inhibit the response of dorsal horn neurons to injury. This system receives inputs from multiple areas of the brain and can act to modify information transmission at almost all levels of the ascending projection systems (Melzack & Wall, 1988).

The significance of these ascending and descending projections, or pain systems, lies in their ability to demonstrate a dynamic, adjustable model of pain whereby sensory input signals interact with cortical activities that underlie past experience, attention, and other cognitive determinants of pain. Thus, the input patterns evoked by injury can be modified by other sensory inputs or descending influences, which may then serve to determine the quality and intensity of the pain experience for that particular individual (Melzack & Wall, 1988). This model has been extensively described by Melzack and Wall (1988) as the Gate Control Theory of pain.

The location for "conscious" awareness of a painful sensation is believed to be centered in the thalamus. Lesions of the dorsomedial nucleus have been shown to decrease the intensity or anguish of the pain experience, while lesions of the ventral posterior and intralaminar nuclei may provide relief from intractable pain. Further evidence for the role of the thalamus is derived from studies that demonstrate a dissociation between perception and tolerance of pain with lobotomy of prefrontal cortex or lesions of the dorsomedial and anterior thalamic nuclei. Patients in these instances still report pain but do not appear bothered by it. The sensory cortex has also been hypothesized to play a role in pain awareness, however, ablation of the somatosensory systems (S I and S II) does not appear to decrease chronic pain (Nobeck, Strominger, &

Demarest, 1991). The sensory cortex is more involved with the localization of a pain source (WCB, 1991).

A clear understanding of the impact chronic pain may have upon cognitive processes at the neurophysiological level has yet to be obtained. All three of the systems described previously project to the motor system. Whether they also project to systems involved in cognitive processes such as attention and memory is unknown. What remains to be determined is if activation of these pain pathways, in one or both hemispheres, acts to decrease the available resources necessary for activities requiring attention and memory.

CHAPTER 2

Literature Review

A huge body of research is available regarding the issue of pain, as numerous researchers have sought over the years to refine both the assessment and treatment of this very complex problem. Survey data suggest that most persons in the general population are at risk of developing either a temporary or permanent pain problem during the course of their lifetime (Waddell, 1987). While the emotional, social, and occupational sequelae of living with pain are fairly well understood, the impact of pain, particularly severe and chronic pain, upon cognitive functioning is not.

This chapter will examine the relationships between mood, general cognitive functioning, and pain through a review of the literature published to date in these areas. Research involving nonclinical research participants, persons with mood disorders, chronic pain patients, and neurological patients will be included. The discussion of cognitive functioning will also specifically incorporate studies on effortful and automatic processing, implicit and explicit memory, and interhemispheric differences. Finally, a brief review of the literature on fatigue, and self-efficacy and coping skills among persons with chronic pain will be discussed.

Affective Processing, Cognitive Functioning, and Pain.

Past research has shown a strong association between attention/concentration difficulties, memory impairment, and affective disorders. Depression and anxiety in particular, have been demonstrated to affect memory and concentration abilities (Coyne & Gotlib, 1983; McAllister, 1981). Watts and Sherrock (1985) had depressed clients complete a concentration task following a full clinical interview and found that concentration deficits were not related to general intelligence but instead, were associated with self-reports of "mind wandering" and decreased affect. Thus, depression was found to affect the client's capacity to attend to a task. Others have found that the ability to perform a task successfully is significantly impaired when research participants are experiencing anxiety (see Hamilton, 1980; Wine, 1971).

Research in the area of emotion and cognition has demonstrated that emotional state can strongly effect the selective encoding and retrieval of information (see Bower, Gilligan, & Monteiro, 1981; Isen & Shalker, 1982). Numerous investigations have suggested that recall of an event is optimized when the persons' emotional state is congruent with the emotional tone of the material to be recalled (e.g. Fiedler & Stroehm, 1986; McDowell, 1984; Teasdale & Russell, 1983). Bower (1981) suggests that people not only attend to and encode more about situations or information congruent with their emotional state, but also that subsequent recall of this information is enhanced when the emotional state during retrieval matches that present during the encoding process. Selzer and Yarczower (1991) hypothesized that the emotional component of the pain experience may produce effects on memory analogous to those of emotions.

To assess this hypothesis, the impact of acute pain on the encoding and retrieval of affective words was examined by Selzer and Yarczower (1991). Research participants (40 female undergraduates) were presented positive, negative, and neutral words during one of two conditions: a pain condition (involving immersion of the forearm in an ice water bath, i.e. the cold pressor method), and a "no-pain" condition (involving immersion of the forearm in a room temperature water bath). During the recall phase of this experiment, half of the research participants from each of the above two groups were exposed to the cold pressor task, while the other half received the warm water bath. The difference between the total number of words correctly recalled by research participants in the pain and no-pain groups at the time of word exposure, approached, but did not meet, the criteria for significance. Pain experienced during recall did not appear to impact significantly the number of words correctly remembered.

Post hoc analyses did reveal, however, a trend towards decreased recall of positive words when pain was experienced during word exposure, and increased memory for negative words when pain was experienced during recall. Some of the limitations of this study include the small sample size of each group (n = 10), the exclusion of male participants, and the use of only acute pain. Given the trend towards poorer recall by persons in the pain condition, as compared to those persons who were in the no-pain condition, better methodology may have produced significant findings.

Edwards, Pearce, Collett, and Pugh (1992) investigated selective memory for sensory and affective pain-related information in depressed chronic pain patients (n = 16), non-depressed chronic pain patients (n = 19), and depressed psychiatric patients (n = 18). Comparison of the three patient groups with normal research participants (n = 19) on word-list recall and recognition tasks was undertaken. While the primary aim of this study was to evaluate the interaction between recall bias, and pain and depression, several results are of particular relevance. All of the nondepressed chronic pain patients were in pain at the time of testing (as measured by a 0-100 mm Visual Analog Scale), while the depressed psychiatric patients and control research participants generally were not. The authors reported that the total number of words recalled by the control group was greater than that of the other three groups.

One interpretation of this decreased level of recall shown by the non-depressed chronic pain group is the pain they were experiencing at the time of testing limited their ability to concentrate on the task at hand and store list words in memory. Results on the recognition task suggested that research participants in the chronic pain and depression groups had poorer overall 'true memory' than the control research participants (Edwards et al., 1992). The nature of these differences in true memory (i.e. dissimilarities in encoding, storage, or retrieval) was not evaluated, nor was the presence or absence of differences in recall versus recognition memory (i.e. explicit versus implicit memory).

Studies that specifically address the impact of pain upon cognition are limited, although the influence of cognition on pain is well documented. Numerous studies have addressed the relationship between focus of attention and pain intensity (Arntz & de Jong, 1993; Gardner & Licklider, 1959; Melzack & Wall, 1988). When a person is instructed to focus his/her attention on a potentially painful experience (such as electric shock or burning heat), it is typical to find that his/her reported pain intensity is higher than normal. On the other hand, research participants instructed to direct their concentration toward other events, such as games, books, or films, report a diminished pain intensity (Melzack & Wall, 1988).

Memory for Pain

Memory for pain has also been an area of research interest to emerge in the last two decades (Erskine, Morley, & Pearce, 1990). Eich, Reeves, Jaeger, and Graff-Radford (1985) examined the effect of current pain state on the accuracy of recall for previous pain intensity. Headache patients asked to estimate pain intensity ratings they had previously recorded in their diaries tended to overestimate significantly these ratings when their current pain level was high. The reverse was seen when patients were experiencing little or no pain at the time of recall. The authors concluded that current pain state may affect recall for prior pain intensities. Whether this finding can be extended to conditions other than memory for chronic episodic pain is unclear (Erskine, Morley, & Pearce, 1990).

Hunter, Philips, and Rachman (1979) examined the accuracy of recall in patients experiencing acute head pain following neurosurgical investigations that included lumbar puncture. Research participants completed the McGill Pain Questionnaire at the time of their head pain and again five days later. Recall for pain intensity was fairly accurate; however, research participants had difficulty recalling their use of sensory and affective descriptors of their pain. These authors also attempted to assess memory for non-pain material by testing recall of incidental information (the researcher's name and profession, and a prepared comment she made regarding the weather) over this same five day period. Unfortunately, the small number of research participants evaluated (N=16) limited further testing of these findings for statistical significance.

The Cognitive Functioning of Persons Experiencing Pain

As suggested earlier, the specific effect of pain on processes involved in attention and memory has received little consideration in the literature. Many suggest such a relationship but provide only tangential evidence that it exists. Sargent and Solbach (1988) note that "tension headaches cause difficulty in reading and thinking, poor concentration, and decreased energy, all of which contribute to poor work output". Dufton (1989) notes that cognitive inefficiencies are frequently reported by persons with pain but that the relationship between the two is unclear. Other studies have assessed pain intensity or the cognitive performance of pain patients in isolation, and have not addressed a potential link between the two.

One study does provide some evidence for the role of pain in decreased cognitive functioning (Kewman, Vaishampayan, Zald, & Han, 1991). Outpatients with musculoskeletal pain were recruited through a rehabilitation medicine clinic and assessed using the McGill Pain Questionnaire and Neurobehavioral Cognitive Status Examination. Patients with previous diagnoses of neurological problems or those who had ingested narcotic analgesics within the 24 hour period prior to testing were not included. The authors found that 32% of the research participants demonstrated performance in the "impaired" range on one or more of the cognitive domains (orientation, attention, language functioning, memory, constructional abilities, arithmetic calculation, and reasoning), with memory the domain most frequently affected.

Interestingly, those research participants who performed the most poorly on this measure also tended to report higher levels of pain. This relationship remained significant even after level of education was statistically controlled. Confounded with this, however, was the fact that psychological distress also contributed to poorer performance overall, and when this was partialled out of the findings a nonsignificant correlation between pain and cognitive scores emerged.

One difficulty with use of the Neurobehavioral Cognitive Status Exam in this study is that it may have underestimated the prevalence of cognitive difficulties for this sample. Pain patients with higher premorbid intelligence are likely to have better compensatory strategies than others, and thus appear unimpaired on this measure (despite a change in their functioning). An additional issue inherent in this research is the difficulty assessing what factors are contributing to the cognitive dysfunction seen in these pain patients. Whether their reported psychological distress is caused by their pain or whether it acts to amplify its intensity remains unknown. Kewman et al. (1991) suggest that regardless of the answer to this question, the high rate of concentration and attention difficulties seen in this study suggests a need to adapt instructional techniques to help persons with pain compensate for these problems. They further suggest that vocational, educational, and independent living arrangements for persons with chronic pain need to consider limitations as a result of not only their physical disability, but the limitations imposed by their cognitive difficulties as well.

Other studies lending support to the role of pain in cognitive impairment among chronic pain clients are those by Astrand (1987) and Westin (1973). Astrand (1987) found that mill workers with back pain performed more poorly on measures of arithmetic, synonyms, and general intelligence than a non-pain control group. Westin (1973) reported a higher incidence of self-reported concentration and memory difficulties among his sample of back pain patients than a group of matched control research participants. A difficulty with both of these studies, however, is that the results obtained by these authors were not interpreted in the context of clinically meaningful normative data. The occurrence of true "impaired" cognitive performance by these patients is not clear because there was no comparison made to a normative group.

Duggleby and Lander (1994) examined the relationship between postoperative pain and cognitive status among sixty older adults (aged 50 to 80 years) who had undergone total hip replacement surgery. All research participants were screened preoperatively for mental status deficits. Research participants rated their pain, distress, and sleep disturbance from pain using 100 millimeter visual analog scales, and completed the Mini-Mental Status Questionnaire (MMSQ), on days two to five postoperatively. Information regarding intake of analgesics was obtained from patient charts and matched for time of day to the pain intensity ratings. These authors found the strongest predictor of mental status decline postoperatively was pain, not analgesic intake. Patients with higher pain intensity ratings demonstrated poorer performance on the MMSQ than those with lower pain intensity ratings. Age was unrelated to both pain and mental status in this group of patients.

There were several limitations of this study, however. The effect of anesthetic agents upon mental status is unknown and may have been a factor for these patients. Fatigue was also a common complaint of study participants but was not formally assessed by the researchers. The MMSQ provides a global assessment of cognitive status but does not allow assessment of specific domains of cognitive functioning; thus the effects of pain experienced by these patients on concentration and memory is unknown. Last, amount of sleep the night before research participants completed the MMSQ was not measured. Duggleby and Lander (1994) suggest that future studies on cognitive status of postoperative patients should include measurements of fatigue and sleep loss.

Dufton (1989) did not demonstrate support for a relationship between pain and cognition. Pain patients completed the McGill Pain Questionnaire, the Beck Depression Inventory, and the Cognitive Failures Questionnaire (CFQ). Results indicated a significant relationship between self-reported cognitive errors and emotional difficulties. However, pain intensity, duration, and location did not differ between a low and high cognitive failures group.

Two criticisms of this research are offered. Since the CFQ only provides a measure of participants' perceived frequency of cognitive errors and not their actual cognitive performance (as assessed by standardized neuropsychological measures), it is not known if these research participants would have performed on such measures in a manner discrepant from their self-report. Dufton (1989) also used the Beck Depression Inventory (BDI) with his chronic pain sample, a measure that has been shown to elevate depression scores artificially in pain patients (see Pincus & Callahan, 1993). If one is to consider the Beck scores for this sample as more reflective of their disability and physical symptoms than emotional functioning, then a significant relationship between cognitive performance and pain is demonstrated.

This same argument regarding the Beck Depression Inventory holds true for a study by Sprock, Braff, Saccuzzo, and Atkinson (1983) that examined the relationships between depression, pain, and cognitive performance among chronic pain outpatients (N = 40). Those pain patients who reported high depression levels on the BDI were also found to have significant deficits in the areas of abstraction and speed of processing. When the contributions of depression (as measured by the BDI) were controlled, these authors found nonsignificant correlations between pain and cognitive performance. However, as noted previously, if these 'depression' scores are interpreted as more reflective of pain and disability than changes in affect, pain may have been a factor in the cognitive performance of these patients after all. Re-analysis of this data controlling only those BDI items tapping physical functioning would provide further understanding of this relationship. Interestingly, patients classified as 'depressed' also had significantly higher pain ratings than those classified as nondepressed.

These same authors reported in their manuscript "we wished to include pain during the testing session .... since pain may act as a distractor, causing poor performance on tests of abstraction". Despite the conclusions of Sprock et al. (1983) concerning a nonsignificant relationship between pain intensity and test performance, this statement suggests a belief on their part regarding the potential impact of pain upon cognitive functioning.

The presence of cognitive impairment among persons with rheumatoid arthritis was reported by Kutner, Busch, Mahmood, Racis, and Krey (1988). When compared to a group of control research participants, the arthritis group demonstrated significantly poorer performance on several neuropsychological measures, including Block Design and Vocabulary from the WAIS-R, total time on the Tactual Performance Test, and Immediate and Delayed Recall on Logical Memory from the WMS-R. Pain intensity was not assessed among the rheumatoid arthritis patients; thus, the relationship of their pain to performance is unknown. The small sample size of this group (n = 10) and the motor component inherent in tasks such as the TPT and Block Design also limits interpretation of these findings. Musculoskeletal problems associated with arthritis frequently produce motor limitations. Of interest, however, is the finding that measures of verbal memory, which have no motor component, were performed at a level below that of the control group.

Jamison, Sbrocco, and Parris (1988) examined self-reported concentration and memory difficulties in chronic pain patients (N = 363) as they corresponded to emotional disturbance and interruption of daily activity. Their results indicated that the concentration and memory problems reported by research participants were related to emotional stress, inadequate family support and interference with daily activity. Of interest is the finding that over half of the research participants in this same study reported having moderate to extreme concentration and memory problems. This was assessed by their rating on the following items of the Symptom Checklist (SCL-90): How much are you bothered by trouble concentrating? How much are you bothered by trouble remembering things? Ratings of two or greater (on a zero to four scale) were given by 198 of the 363 chronic pain patients.

Swanson, Maruta, and Wolff (1986) also reported cognitive difficulties among their sample of forty-five chronic pain patients. These authors described decreased intellectual efficiency among persons in their sample on the Shipley Verbal and Abstract scales; however, they did not offer any interpretations of this finding. Pain intensity was also not assessed among the participants in this study.

Support for the potential impact of pain on attention and memory is also seen in research that examines performance of persons with chronic pain conditions on measures such as the MMPI-2. Townsend (1992, unpublished) obtained significant differences between control group and chronic pain research participants on the clinical scales of Psychasthenia, Schizophrenia, and Hypomania on the MMPI-2, and postulated that this may be a reflection of the pain group endorsing items concerning difficulties with attention and concentration. Causal factors of these differences were not evaluated due to the limited sample size in this study (N=36).

Almay (1987) compared two groups of pain patients (64 identified as having idiopathic and 22 with neuropathic pain syndromes) on several indices, including concentration difficulties and memory disturbances. Research participants indicated their ratings for concentration and memory problems on separate visual analog scales. The idiopathic pain group reported significantly more memory and concentration disturbances than the neurogenic group, suggesting that undefined pain may involve greater cognitive problems. Although the author did not postulate potential explanations for this finding, one possibility is that those patients with pain of no known etiology may have been presenting with a variant of depressive disorders. This hypothesis would need further testing to determine whether depression was in fact a confound in this study. Of interest is the finding that both groups reported higher ratings of concentration and memory disturbances than those given by a normal control group. Almay (1987) obtained pain intensity scores for all three groups but did not compare these with the memory and concentration ratings research participants reported.

Bruera, Fainsinger, Miller, and Kuehn (1992) examined the relationship between pain intensity and cognitive failure among patients with cancer pain. In three patients who developed a "nonagitiated cognitive failure episode" (defined as a score of zero on the Mini-Mental State Questionnaire; a description of the patient's experience during this episode was not provided by the authors) no difference was found between pain intensity ratings prior to and following the episode, and those made by the nursing staff during the episode. For the 11 research participants who developed an episode of cognitive failure involving agitation, pain intensity ratings made by a nurse during its occurrence were higher than the patient's assessment prior to and following the episode. The contributions of narcotic analgesics and neurological factors among these patients, however, cannot be ruled out, and the effect of pain, if any, on cognitive functioning is not clear.

Bruera, Macmillan, Hanson, and MacDonald (1989) examined the relationship between cognitive performance and narcotic analgesic administration among forty cancer pain patients. Participants completed tests of finger tapping speed, arithmetic, memory for digits, and visual memory, just prior to and 45 minutes following their scheduled dose of analgesics. Pain intensity was also measured (using a 0-100 mm VAS) at each testing session. The authors reported a significant decrease in pain intensity after drug administration but failed to find any significant changes in test performance. Tapping speed, arithmetic, and memory for digits and objects were stable between the two assessments. Confounded with this decrease in pain intensity, however, was a significant increase in drowsiness reported by the research participants. Thus, it is difficult to establish the impact that decreased pain may have had upon cognitive performance for research participants in this study.

Another pharmacological study of relevance is that by Szekely et al. (1986). These authors examined the effects of an enkephalin analog on pain tolerance and cognitive function. Pain threshold was determined using the submaximum effort tourniquet technique. With the tourniquet in place, eight research participants completed baseline measures of pain intensity, attention (a symbol cancellation test), and memory (digits forwards and backwards). Subsequent to administration of the analgesic, research participants were again asked to complete the pain intensity, attention, and memory measures. Szekely et al. (1986) found that concurrent with decreases in pain intensity, were slight improvements in performance on the symbol cancellation and digit span tasks. Although the aim of this study was to examine the effectiveness of an enkelphin analog, the results offer some support for the idea that decreased pain intensity may have played a role in the improved cognitive performances seen among research participants.

Taken together, these studies provide support for the occurance of self-reported cognitive complaints across a wide variety of pain populations. Deficits in attention/ concentration, memory, abstract visual-spatial analysis, and general intellectual functioning have also been demonstrated through psychometric testing. Further, these deficits have been reported among headache patients, persons with musculoskeletal and chronic back pain, and arthritis and postoperative patients. A difficulty with the majority of studies cited, however, is the frequent occurance of confounds such as use of narcotic analgesics, concomittant emotional disorders, and employment of measures involving a motor component or items of a somatic nature.

Pain and Cognitive Functioning Among Neurological Populations

Studies regarding the cognitive functioning of whiplash patients have suggested that attentional deficits may contribute to the 'disability' of these patients. Radanov, Di Stefano, Schnidrig, and Sturzenegger (1993) examined the predictive relationships between psychosocial factors, cognitive performance, and disability, in recently injured common whiplash patients. All research participants (N = 97) rated their pain on a scale from 0 (no pain) to 10 (pain as bad as it could be) points and completed the following attentional measures: Digit Span; Corsi Block Tapping test; Number Connection Test; Trail Making Test, Parts A and B; and the Paced Auditory Serial Addition Task (a more complete description of these measures is provided by Radanov et al., 1993). Some of the strongest predictors of disability (these authors considered those research participants who had not returned to work or had only returned part-time as disabled, while research participants who had returned to full-time employment were considered non disabled) six months after injury were back pain and initial neck pain intensity. The authors noted that the disturbances in attention revealed by whiplash patients in this study may be attributed to symptoms such as pain. Inter-test performance differences were not evaluated in this investigation.

Schwartz et al. (1987) examined the incidence of cognitive deficits in chronic pain patients with and without a history of head/neck injury ($N = 42$). All research participants completed the Paced Auditory Serial Addition Task, Trails A and B, and Controlled Word Association (using the letters C, F, and L). Although the mean scores for each subtest did not significantly differ between groups, a higher number of the head/neck injury group were considered to demonstrate cognitive deficits. Of interest, however, is the finding that 26% of the chronic pain patients without a history of trauma to the head or neck were also rated as demonstrating cognitive deficits. These deficits were centered on the areas of attention and concentration. Also of interest was the authors' report that, although the majority of participants did not indicate problems with intellectual functioning, many did acknowledge difficulty with attention and concentration, and considered these difficulties to be a consequence of their pain (Schwartz et al., 1987). The relationship between their pain and cognitive performance, however, was not addressed in this study, and was considered by these authors as misattribution on the part of the research participants.

Examination of the literature on headache patients reveals that loss of concentration and poor memory are frequent sequelae in both acute and chronic sufferers. Covelli, Antonaci, and Puca (1984) studied the relationship between headache and memory impairment in twenty-six adult headache patients. They found that short-term memory performance of their clinical sample, as compared to a sample of healthy research participants, was the most affected cognitive function. Logical memory, visual reproduction and associative learning were also affected.

Others have reported poorer performance by migraine research participants, as compared to non-headache control subjects, on measures such as the Stroop Color Word Test, the Wechsler Memory Scale, and reaction times (see Sepe et al., 1993; Zeitlan & Oddy, 1984). Silberstein (1992) suggests that the concentration and memory disturbances seen in migraine patients indicates involvement of higher cortical centers. Currently, the mechanisms underlying these cognitive complaints are poorly understood, and their relationship to pain intensity is unknown.

Effortful and Automatic Processing

Tasks requiring automatic processing are considered to require insignificant attentional resources, while tasks involving effortful processing require most of one's attentional capacity if they are to be performed successfully. More specifically, automatic processes are typically defined to include the following criteria: (a) the processes take place without requiring attention or conscious awareness; (b) automatic processes occur in parallel and do not interfere with other operations or stress the capacity limitations of the cognitive system; and (c) automatic processes occur without intention or control. Effortful processes, on the other hand, are characterized by the following: (a) they require attention, inhibit other pathways, and are influenced by cognitive capacity limitations; (b) effortful processes are used in learning; and (c) people are consciously aware of these operations.

The impact of pain upon effortful and automatic processing has yet to be directly evaluated. A direct relationship has been demonstrated between severity of depression and degree of interference in effortful processing (Hartlage, Alloy, Vazquez, & Dykman, 1993). Tasks of automatic processing, however, are only minimally affected by changes in level of depression. Other studies have evaluated effortful and automatic processing differences among closed head injury research participants and patients with multiple sclerosis (see Grafman, Rao, Bernardin, & Leo, 1991; Levin, Goldstein, High, & Williams, 1988). Support has also been found for the negative impact of narcotic administration on tests of both automatic (e.g. finger tapping or simple arithmetic) and effortful (e.g. reverse digits) processing (see Bruera et al., 1989; Hasher & Zacks, 1979).

In McCaul, Monson, and Maki (1992), forty male and thirty-four female college students underwent the cold pressor test while they completed tasks requiring varying degrees of mental processing. Research participants in the "easy" task group simply indicated whether a number had appeared on a computer screen by moving a joystick to the right. The "medium-difficulty" task group were instructed to move the joystick left for odd numbers and right for even numbers. The "difficult" task group were instructed to move the joystick left for high-odd numbers (e.g. 53) and low-even numbers (e.g. 20), or to the right for all others (McCaul et al., 1992). Attentional capacity during the cold pressor test was measured by performance accuracy and reaction time.

These authors found that the "difficult" task group demonstrated significantly more errors than the other two groups and took considerably longer to respond. Self-report ratings of distress during the cold pressor test did not reveal any differences among the easy, medium-difficult, and difficult task groups. Thus, a possible explanation of these results would be that the pain research participants experienced in the cold-pressor test impacted more upon the task requiring effortful processing than it did upon that requiring only automatic processing.

Ellis, Woodley, Dulaney, and Palmer (1989) suggest that the Stroop Color and Word Test provides a measure of both effortful and automatic processing. They hypothesize that the ability to minimize the interference effect seen on the third trial of this test requires success in control (i.e. effortful) processing, which is needed to suppress the automatic reading responses. Mentally disabled participants in their study demonstrated significantly greater interference on this measure than a control group of college students. The impact of pain upon control processing is not known.

Research demonstrates that normal participants receiving moderately painful electrical stimulation during distractor tasks report a lower pain intensity than those receiving electrical stimulation alone (Arntz & De Jong, 1993). Just as the work of Miller (1956) and Broadbent (1958) established limits on human memory capacity, the same findings can now be extended to processing ability. McCaul and Malott (1984) suggest that attentional capacity is limited. Thus, the need exists to examine whether or not the experience of being in pain may tax attentional capacity and limit the resources available for cognitive endeavors (such as attention and memory).

The further difficulty with studies published to date is that none of them have specifically examined the relationship between pain intensity and level of processing, despite the fact that the subjective experiences of many chronic pain patients would support the notion that activities requiring effortful processing are often more difficult than those requiring only automatic processing (e.g. reading complex materials, remembering a list with numerous tasks on it).

Implicit and Explicit Memory

The implicit and explicit memory distinction views explicit memory as being declarative in nature and involving facts and events which are available to conscious awareness. Implicit memory is seen as non-declarative and including memory abilities that are not available to conscious awareness such as skills and habits, priming, and simple conditioning (Squire, 1992). Explicit memory processes are felt to be more effortful than implicit memory processes (Hartlage, Alloy, Vasquez, & Dykman, 1993). The explicit/implicit memory paradigm has typically been measured using free recall, and word-stem completion or recognition tasks following presentation of word lists.

Numerous studies have demonstrated the differential sensitivity of explicit and implicit memory processes to brain damage ensued as a consequence of anterior communicating artery aneurysm rupture, Alzheimer's disease, or Amnestic syndromes (Bondi, Kaszniak, Rapcsak, & Butters, 1993; Carlesimo & Oscar-Berman, 1992). Typically, implicit memory has been spared, while explicit memory has been affected severely. Further evidence for the explicit/implicit dichotomy is found in studies assessing the effects of anxiety and depression on measures of explicit and implicit memory.

Mueller, Esler, and Rollack (1993) classified a sample of college students as low or high test-anxious on the basis of Test Anxiety Inventory scores. Students classified as high-anxiety recalled less on a direct recall test of explicit memory than those classified as low-anxiety. Both groups performed similarly on a stem-completion test of implicit memory. In a review of four studies addressing the relationship between depression and implicit memory, Roediger and McDermott (1992) found that depressed mood had a far more significant effect on performance of explicit memory tasks than it did on performance of implicit memory tests.

Free recall , as a measure of explicit memory, is considered more effortful than recognition or cued recall conditions (Hartlage et al., 1993). Depression has been associated with poorer memory performance on word-learning tests, the Wechsler Memory Scale, recall of nonsense syllables and visual retention tests, and spared performance on measures of word recognition (see review by Hartlage et al., 1993).

A number of studies have also examined the relationship between level of processing and explicit and implicit memory retention. Jelicic and Bonke (1991) reported that high school students instructed to remember a word list using semantic cues demonstrated better explicit and implicit recall than those given nonsemantic instructions. Semantic encoding is felt to require greater cognitive capacity or attention, and is thus more effortful in nature. The negative effect of depression on semantic encoding has been demonstrated. A study of depressed patients by Weingartner et al. (1981) found that these research participants exhibited significantly more deficits in recall of semantically processed words than a normal control group.

In another study of a related nature, Parkin and Russo (1990) had research participants undertake a picture completion task of fragmented pictures under conditions of either divided or focused attention. Subsequent recall of pictures presented in the original completion task was significantly impaired in the divided attention group. Both groups demonstrated substantial savings, regardless of their attention condition, on picture completion when re-tested the next day with the original sequences. What these studies demonstrate is that conditions, be it test or positive emotional state, allowing a deeper level of processing enhance the subsequent free recall of information by research participants.

Since level of processing has been shown to affect performance on explicit memory tasks more so than implicit memory tasks (Hamann, 1990), and various emotional states (e.g. depression) can alter processing level, one might predict that pain can have this same effect. If the experience of being in pain serves to lower the depth to which a person can process material presented to him/her, then the potential exists for chronic pain to affect explicit memory more so than implicit memory.

Interhemispheric Effects of Pain

The question of whether pain differentially affects the cognitive processes of the left or right hemispheres (i.e. verbal versus nonverbal tasks) is not known. Evidence supports the unique contributions of the right and left hemispheres to memory and attention. Lezak (1983) indicates that the left hemisphere is responsible for verbal functions including reading, writing, understanding and speaking, verbal memory, the numerical symbol system, and time-bound relationships of sequence and order. The right hemisphere, on the other hand, plays more of a role in the processing and storage of visual information, perception for spatial orientation and perspective, and aspects of musical ability and the ability to recognize and discriminate nonverbal sounds.

Support for these interhemispheric differences comes from numerous studies involving lobectomy patients and research participants with focal neurological damage (i.e. damage from head injuries or cerebrovascular accidents). Removal of the right temporal lobe has produced deficits on tasks that involve processing of nonverbal patterned stimuli, and difficulty in recognition of tonal patterns after a short delay (Butters & Miliotis, 1985). Removal of the left temporal lobe produces verbal memory deficits, regardless of whether the information is presented in a visual or auditory mode.

A preliminary investigation by Chen and Dworkin (1985) noted that right hemisphere activity (as measured by brain evoked potentials or BEP) was significantly greater during periods of headache pain than left hemisphere activity, regardless of the location of the pain. Thus, an extension of this finding is that some pain-related processing may be selective to the right hemisphere. Whether pain-related processing in the right hemisphere is at the expense of other right hemisphere activity remains to be determined. Covelli, Antonaci, and Puca (1984) provide weak support for this hypothesis with the finding that their sample of headache patients had significant impairments on measures such as the Rey-Osterreith, Benton Visual Retention Test, and Visual Reproduction from the Wechsler Memory Scale - Revised, compared to control research participants. These measures have been typically been considered "right hemisphere" tasks.

McArthur, Cohen, Gottlieb, Naliboff, and Schandler (1987) administered the Wechsler Adult Intelligence Scale (WAIS) to a large sample of chronic low back pain patients (N = 702) admitted to an inpatient treatment program. The subgroup of cases with the lowest performance scale scores on the WAIS were those patients with the lowest behavioral score profiles at admission (i.e. lowest scores on measures of physical capabilities such as endurance, strength, flexibility, pain behavior, and tolerance for sitting). Comparison of this group with another subgroup of patients with better physical functioning revealed a performance score averaging 4% lower, a reduction of 11% on picture arrangement, and object assembly and digit symbol scores that were both 7% lower. Differences among the verbal subtests were insignificant.

The authors interpreted these results as indicative of a general motor slowing among the low performance group. It is possible, however, that any pain that research participants were experiencing during administration of these subtests may have decreased their ability to process actively information presented to them on these timed measures. Also of interest is that these decreased scores are found on measures considered to reflect right hemisphere activity. Without further information, however, the impact of pain on test performance in this study is difficult to assess, and confounded with these findings is the possibility that these patients had disabilities which impaired their ability to perform fully tasks involving a motor component.

<u>Pain and Fatigue</u>

A concomitant of pain among many persons who experience discomfort on a daily basis is fatigue. Many persons with chronic pain report high levels of fatigue, both as a consequence of their pain during the day and due to poor sleep quality from pain experienced during the night. Several studies have established this link between pain and fatigue. Devins et al. (1993) compared the frequency of restless sleep among patients with rheumatoid arthritis, renal-disease, and multiple sclerosis, and found that the reported frequencies were highest among the patients with arthritis. Moffitt et al. (1991) found pain to be the strongest predictor of sleep disturbance in a sample of clients from a large community health survey; among the respondents, arthritis was the disability/disease most strongly associated with pain.

Tack (1990) also found that fatigue was a significant problem in patients with rheumatoid arthritis, and this was positively associated with pain. Hitchcock, Ferrell, and

McCaffery (1994) found in a survey of persons with chronic pain (N = 204) that fatigue was reported as one of the worst problems caused by their pain. Fatigue among persons with chronic low back pain has also been linked to the pain experienced during a pain episode (Feuerstein, Carter, & Papciak, 1987). Self-reported levels of anxiety and fatigue were found to increase in the 24 hour period following a worsening of the patient's pain intensity.

Research addressing the link between fatigue and pain perception has found increased pain ratings among research participants fatigued by tasks involving a high level of concentration. Marek, Noworol, and Karwowski (1988) applied high-intensity pressure to the index finger of computer operators following completion of either a demanding or less effortful task. Fatigue following performance of the more demanding task was associated with an increased pain intensity rating, while a decrease in pain ratings was seen among those persons completing the task of lower difficulty.

The impact of fatigue upon cognitive functioning has yet to be clearly delineated among persons with chronic pain conditions. Typically, the research has focused on work/task performance as a function of either physical or mental fatigue among 'normal' study participants. Kreuger (1989) noted that fatigue due to sleep loss resulted in decreased reaction time, reduced vigilance, and perceptual distortions in employment situations involving sustained work.

Soetens, Hueting and Wauters (1992) examined the impact of physical fatigue on a visual perception task. Fatigued and nonfatigued research participants (N = 20) were presented random groups of 3-12 dots through a tachistoscope and asked to indicate how many they had seen. Persons reporting fatigue during the task demonstrated fewer correct responses than those who were not fatigued. Reaction times between the two groups did not differ. The authors also noted that among the fatigued research participants, error rates increased for those trials with larger groups of dots. They suggested that the fatigued research participants were avoiding the controlled processing demands of these more difficult trials in favor of the automatic processing required by trials with only a few dots.

Sandroni, Walker, and Starr (1992) addressed the cognitive effects of mental fatigue in a clinical population. Patients with multiple sclerosis completed tasks of auditory short-term memory and reaction time while in rested and fatigued states. Research participants demonstrated poorer performance and increased reaction times when fatigued. These results were obtained despite insignificant central motor conduction times between states, and a nonsignificant correlation between motor conduction times and reaction times.

A meta-analysis of the literature addressing the impact of fatigue on cognitive processes, conducted by Tomporowski and Ellis (1986), concluded that clear data has yet to be obtained. Positive, negative, and neutral effects of mental and physical fatigue on the ability to process information have been reported. Numerous differences in methodology (e.g. timing between physical and mental tasks, variations in the types of mental tasks administered) are evidenced in the research to date; thus further investigation of this issue is warranted before any firm conclusions can be drawn.

Self-Efficacy and Coping Skills Among Persons with Chronic Pain

Bandura, O'Leary, Taylor, Gauthier, and Gossard (1987) defined perceived self-efficacy as one's judgment of his or her ability to attain a given level of performance and to exert control over events. Judgments of self-efficacy can influence the choices a person will make with regard to problem solving or coping, the degree of effort he/she will employ in a given activity, how long he/she will persist in difficult situations, whether his/her thought patterns will produce positive or negative effects, and the degree of stress he/she will experience in response to environmental demands (Bandura, 1986).

Bandura et al. (1987) extend these ideas further to the ways in which perceived self-efficacy can assist in the management of pain. They suggest that patients who feel a sense of control over their pain experience will likely use the skills they have learned and persist in these efforts. This strong sense of coping efficacy may also reduce the stress and anxiety associated with pain and avoid exacerbation of the condition. Further, these authors hypothesize that perceived self-efficacy may decrease pain intensity by providing a diversion to other activities and away from the pain sensations.

Tremendous support can be found in the literature for the positive impact of perceived self-efficacy on an individual's pain experience. Dolce, Crocker, and Doleys (1986) reported that posttreatment self-efficacy expectancies among chronic pain patients completing a multidisciplinary pain management program were related to work status, exercise level, and medication use at follow-up. Widner and Zeichner (1993) also found among their sample of elderly chronic pain patients that self-efficacy covaried with treatment success. Those persons with greater perceived sense of control over their pain tended to benefit more from intervention than those who did not report such a level of control.

Nicholas, Wilson, and Goyen (1992) found that patients who employed active coping strategies and reported high self-efficacy beliefs demonstrated significantly greater improvement following cognitive-behavioral treatment of chronic low back pain when compared to attention-control and physiotherapy-control groups. Similarly, patients' beliefs regarding their ability to manage their pain have been shown to influence the type of coping efforts they employ (Jensen, Turner, and Romano, 1991). These authors stress the importance of actual rehearsal and application of adaptive coping strategies in the treatment of chronic pain rather than providing purely educational interventions.

Spinhoven, ter Kuile, Linssen and Gazendam (1989) note that persons who feel helpless to do anything about their pain will report higher levels of pain, functional impairment, anxiety, and depression, while those with higher perceived control will report lower levels of pain and functional impairment and higher activity levels. Support is also found for increased utilization of health care services among persons who view their pain as catastrophic and beyond their control. Coping styles have also predicted pain treatment and surgical outcome among chronic pain patients (Kleinke & Spangler, 1988; Smith & Duerksen, 1979; Villard, Imbeault & Duguay, 1986). Poor surgical outcome among chronic pain patients was predicted by characteristics of passivity and dependency, and difficulty perceiving and expressing one's concerns.

The relationship between coping skills and health status has been further supported with Rheumatoid Arthritis (RA) patients whose pain is of a known organic origin yet can be modified by psychological factors. Active coping among RA patients is associated with less pain, depression, and functional impairment and with higher self-efficacy. Passive coping is correlated with greater pain, depression, and functional impairment as well as lower self-efficacy (Brown & Nicassio, 1987).

Summary

Directed attentional abilities are necessary for many activities in daily living that involve thinking clearly, planning, problem solving, storage of information, and maintaining a cognitive set. Cimprich (1992) notes that the physical discomfort that frequently accompanies illness often restricts normal functioning. Theoretically, the ability to focus attention (and thus, encode information into memory) involves a global neural inhibitory mechanism that acts to block competing stimuli during purposeful activity (Posner & Presti, 1987). The impact of pain upon this system is unknown.

Research supports a relationship between affective functioning and cognitive abilities. Concentration and memory disturbances are commonly seen among persons experiencing symptoms of depression and anxiety. Further, acute emotional state has been demonstrated to impact encoding and subsequent retrieval of information. Extension of these findings to the pain experience has met with inconclusive results. Depressed chronic pain patients have been found to show this effect; however, distinguishing between the impact of mood and pain intensities has been difficult. Current pain state has been shown to affect recall for previous pain intensities, however, recall for non-pain information has not been fully examined.

There is much discussion among medical and mental health professionals, as well as chronic pain patients themselves, regarding the presence of concentration and memory impairments among persons experiencing both acute and chronic pain. Studies seeking to bring this relationship to light have been marred by methodological problems (e.g. small sample sizes, nonspecific measures of cognition, use of tasks with a motor component) and confounds such as concomitant emotional, medical, and neurological disorders among participants. Further, many studies have examined cognitive functioning and pain intensity among persons with acute or chronic pain but failed to address the potential link between the two.

The differential impact of depression and neurological conditions upon tasks of automatic and effortful processing and implicit and explicit memory has been demonstrated. Automatic and implicit memory processes are typically spared among depressed patients and persons with dementia or amnesia, while effortful and explicit memory processes typically are not. The impact of pain upon these same processes is unknown and requires investigation. Further, the differential impact of pain upon right or left hemisphere processes remains unaddressed.

It is felt that information processing theory provides support for the idea that pain may differentially affect various processing and memory functions. It is now understood that pain perception is more of a controlled, than an automatic process, because it involves active processing of both sensory and affective components of a noxious stimulus (McCaul & Malott, 1984). Thus, pain draws on attentional resources. When a painful stimulus reaches some intensity level, it follows from this theory that one's capacity for controlled (or effortful) processing of other information will be decreased. Because tasks of an automatic nature do not require significant attentional resources, it follows that pain may not act to decrease the ability to perform successfully such tasks. Automatic processes are felt to be relatively unaffected by differences in motivation and mood, while effortful processes are frequently compromised (Hasher & Zacks, 1979).

Information processing theory also extends to performance of memory tasks. Hasher and Zacks (1979) suggest that factors impacting effortful processing, such as depression, decrease one's ability to perform memory tasks requiring attentional capacity and control. As discussed previously, this is well supported in the depression literature. The tasks typically affected can be thought of as those involving explicit memory. As noted, effortful processes are often a necessary prerequisite for learning and direct recall of information. Extension of these findings to the phenomenon of pain intensity is proposed.

Thus, the need remains for research free of methodological and subject sampling problems so the potential relationship between pain intensity and cognitive performance can be properly addressed. As with any research that seeks to involve persons with chronic pain conditions, non-pain factors often pose as potential confounds and need also to be better understood. Strong links between pain, quality of sleep, and fatigue have been established. Persons with chronic pain often describe fatigue as the primary difficulty produced by their pain. The impact of fatigue upon cognitive functioning also remains unclear among persons with chronic pain. In fact, research examining the impact of fatigue on work/task performance among 'normal' research participants is inconclusive. Finally, the self-efficacy literature supports the positive impact of efficacy beliefs on pain intensity, treatment success, choice of coping strategies, level of functional impairment, and mood. The potential role of fatigue and self-efficacy among pain intensity and cognitive abilities of persons with chronic pain will be briefly addressed by this study.

Hypotheses

This study is an initial attempt to begin to unravel the relationship between pain and cognition. Based on the above review of current pain research and the principles of information processing theory, two main hypotheses were addressed in this study. A third hypothesis is put forth more as a question on the basis of limited findings in the headache and pain literature. These hypotheses were as follows: 1) Performance on tasks requiring effortful processing is expected to be more correlated with pain intensity than those requiring passive processing. 2) Pain intensity will be more related to performance on tasks of explicit memory than tasks of implicit memory. 3) Are nonverbal (right hemisphere) measures of attention performed more poorly than verbal (left hemisphere) measures in patients experiencing pain at the time of testing? Due to the support in previous studies for the high incidence of fatigue in persons with chronic pain, the relationships between pain, fatigue, and cognition are also addressed.

CHAPTER 3

Procedures

Method

Participants

All participants in this study (N = 65; 50 women and 15 men) had chronic pain conditions (i.e. organically based, supported by physical findings, and duration greater than six months) and had previously received a diagnosis of arthritis from a qualified rheumatologist. These participants were recruited as volunteers through local support groups for arthritis patients and the local arthritis centre. Participants from a previous chronic pain study who agreed to participate in future research were also re-contacted to determine if they still wished to do so. All volunteers were paid fifteen dollars for their participation and were treated in accordance with the "Canadian Code of Ethics for Psychologists" (Canadian Psychological Association, 1988). Demographic and medical characteristics for this sample are presented in Table 1. Participants also reported a mean pain intensity of 7.8 (SD = 4.9) and a mean fatigue level of 9.7 (SD = 4.8) at the time of testing.

Arthritis is an autoimmune disease involving chronic inflammation and/or degeneration in the joints and surrounding tissues, and is one of the most common causes of pain. Typical symptoms include stiff, sore, and swollen joints. Joints are innervated by a multitude of nerve branches which are assumed to fire when their endings are activated by the pressure a swollen joint exerts. The tissue destruction and associated inflammation that occur in arthritis produce a drop in the thresholds of innervating fibers such that minor changes in pressure can cause severe pain (Melzack & Wall, 1988). Over a period of time, bony growths may also occur within these joints causing decreased and painful movement.

Although there are over a hundred forms of arthritis, the majority of persons who receive such a diagnosis fall into one or more of the following categories: rheumatoid arthritis (RA), osteoarthritis (OA), ankylosing spondalitis (AS), and scoriatic arthritis (SA). Of the participants in this study, 54 percent had been diagnosed with RA, 42 percent had OA, 11 percent had AS, 5 percent had SA, and 15 percent had received diagnoses of lesser known forms of arthritis. Twenty percent of the participants had received diagnoses of more than one form of the disease.

The majority of participants in this study (94 percent) were taking medications to control their pain and the underlying disease processes. Figure 1 indicates the number of participants using each of the major medication groups for treatment of their arthritis. Figure 2 provides a summary of the number of medications reported per person. Among those participants who were using medication on a daily basis for treatment of their arthritis (n = 48), the average amount of time between their last dose and the commencement of their testing session was 4.21 hours (SD = 3.21). The remaining participants reported use of analgesics for pain control on an as needed basis. None of the participants had taken any narcotic analgesics in the 24 hour period prior to their testing, and among those participants prescribed such analgesics (n = 12), use was reported as infrequent and for severe pain only. Time since medication intake was not significantly correlated with any of the variables in this study.

Forty percent of the participants were in the work force (18 full-time and 8 part-time). Of those remaining participants, 25 percent were retired and 35 percent were either at home or receiving long term disability benefits. The demographic and disease characteristics of the research participants in this study are consistent with those reported for a sample of arthritis patients who participated in a recent survey carried out by the Chronic Pain Task Force of the BC Division of the Arthritis Society.

Table 1

Demographic and Medical Characteristics of Participants (N=65)

	M	Range	SD
Age	50.9	26.0-79.0	13.3
Education (in years) a	13.9	8.0-21.0	2.7
Duration of Condition (in years)	12.2	0.5-47.0	11.1
Time Since Medication b (in hours)	4.2	1.0-14.0	3.2
Number of Medications	2.2	0-6.0	1.3

Note: a) Education was measured in years starting with grade one.

b) n = 48; includes all medications used on a daily basis for treatment of arthritis.

Figure 1

Types of Medications Used by Participants for Treatment of Arthritis

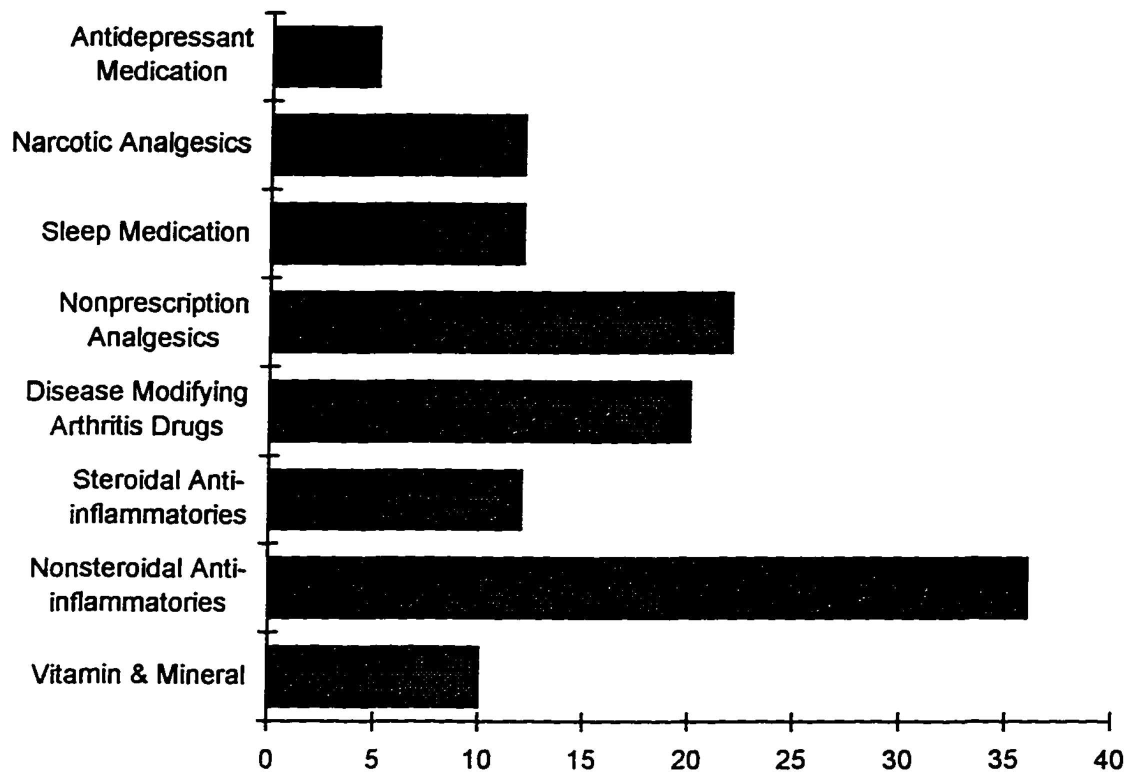
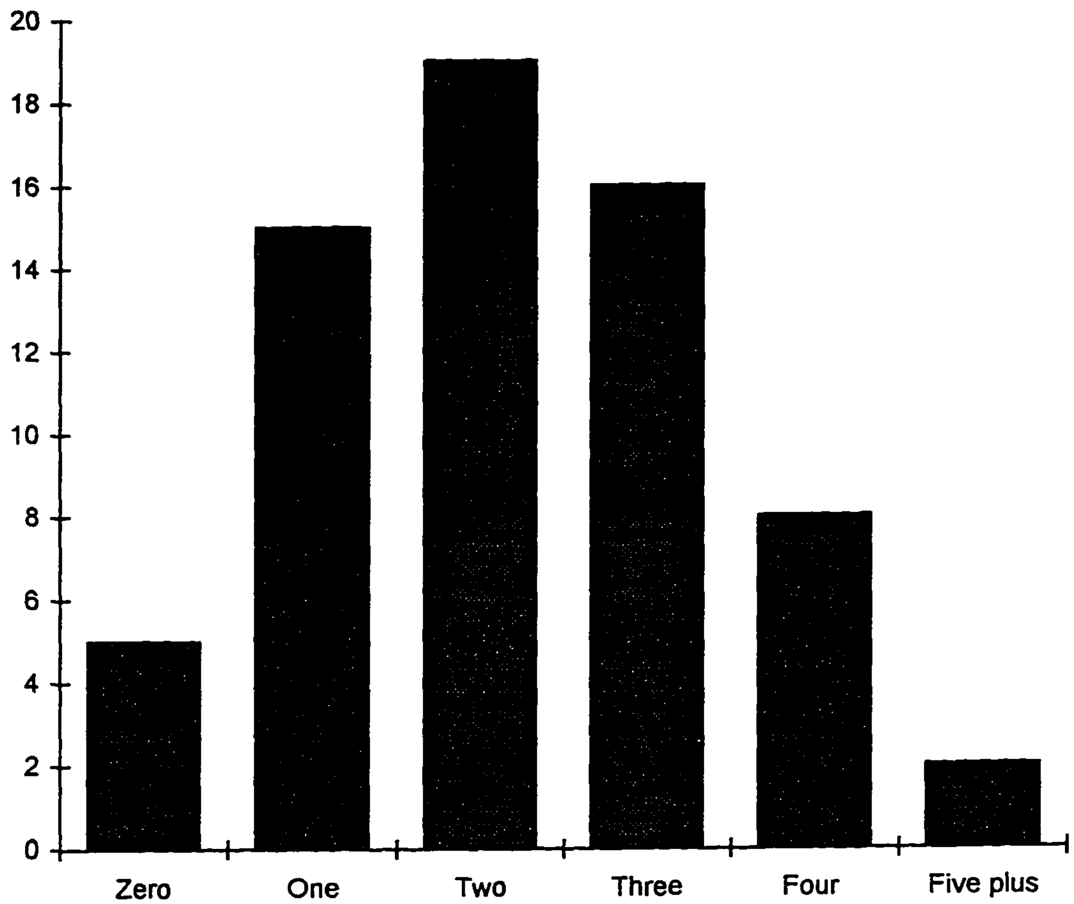


Figure 2

Number of Medications Per Person Used in Treatment of Arthritis



Procedure

The study was approved by the Ethics Committee for Research Involving Human Participants at the University of Victoria. Subjects participated in the study as volunteers and each person attended an individual session with the researcher. Participants were told the purpose of the study was to examine the relationships between pain intensity, quality of sleep, level of fatigue, and memory and concentration abilities. During this session, participants completed the following measures: The North American Adult Reading Test (NAART), The Mood Assessment Scale (MAS); The Paced Auditory Serial Addition Task (PASAT); the Stroop Test, parts D and C, Digit Span from the WMS-R, Visual Memory Span from the WMS-R, The California Verbal Learning Test (CVLT), a computerized lexical decision task followed by word recall and stem completion, the Cognitive Failures Questionnaire (CFQ), parts of the Coping Strategies Questionnaire (CSQ), and visual analog scales as measures of pain intensity, quality of sleep the night previous to testing, level of fatigue, and perceived effect of pain on tasks of everyday living involving concentration and memory.

Participants also provided information regarding their demographics, type of arthritis, length of time since diagnosis, and current medication use (i.e. type, time last taken, time on the medication). Qualitative information regarding troublesome mental activities in every day life and participant use of coping strategies was also gathered. In order to control for any effects stemming from a fixed order of test administration, half of the participants completed the measures in one order while the other half received the reverse order (see Appendix I). The duration of this session was approximately ninety minutes.

Measures

North American Adult Reading Test (NAART; Blair & Spreen, 1989).

The NAART was included as an estimate of intelligence. Research participants were asked to read a list of 61 words aloud and their errors were recorded by the examiner (see Appendix II for word list). Each mispronunciation of a word counted as one error, and the total number of errors was entered into a regression equation that estimates IQ. Empirical support for the reliability and validity of the NAART as an estimate of intelligence has been demonstrated. Blair and Spreen (1989) found a correlation of $r = .75$ between NAART scores and Full Scale IQ (FSIQ) scores from the Wechsler Adult Intelligence Scale - Revised (WAIS-R). Coefficient alpha, a measure of internal consistency, was reported at .94 by these same authors. A test-retest reliability of $r = .98$ has also been reported (Crawford et al., 1989). Cross-validation by Wiens, Bryan, and Crossen (1992) found a somewhat smaller, although statistically significant, correlation of $r = -.46$ between NAART errors and obtained WAIS-R FSIQ among 302 healthy civil service job applicants.

Mood Assessment Scale (MAS; Yesavage et al., 1983).

The MAS is a self-report measure designed to evaluate depression in the elderly. Research participants responded with either Yes or No to thirty statements regarding their mood and feelings (see Appendix III). The MAS was included as a depression measure because it controls for items involving somatic content, items that chronic pain patients frequently endorse as true on the basis of their condition. Other screening measures such as the Beck Depression Inventory have been reported to measure somatic complaints in medical populations (Cavenaugh, et al., 1983). Pincus and Callahan (1993) found that items concerning symptoms of fatigue, pain, and inability to work, on several depression measures, were more a reflection of disability than depression among a sample of rheumatoid arthritis patients. Depression has been reported as a common concomitant in patients with chronic pain conditions, with estimates of its prevalence ranging from 10% to 100% (Brown, 1990; Keefe, et al., 1986), thus the inclusion of a more "pure" measure is warranted.

Numerous studies have established the reliability and validity of this instrument among hospitalized and community dwelling elderly persons. Concurrent validity of the MAS has been demonstrated by correlations with the Depression Symptom Checklist (r = .82; Dunn and Sacco, 1989), Beck Depression Inventory (r = .73; Heyer & Blount, 1984), Hamilton Depression Rating Scale (r = .83), and Zung Depression Scale (r = .84; Yesavage et al., 1986). Internal consistencies of .93 and .94 have been reported and test-retest reliability after one to two weeks is good (r = .98; see Lyons et al., 1986; Koenig et al., 1988;). Reliable and valid use of the MAS is also supported with younger adults. Among a sample of 17-55 year olds (N = 193), internal consistency was .85, while split-half reliability was .84 (Rule, Harvey, & Dobbs, 1989). This same study found a correlation of r = .67 between the Zung scale and the MAS. Support for the single factor structure of the MAS has also been demonstrated (see Parmalee, Lawton, & Katz, 1989).

For the purposes of this study, only the Full Scale IQ estimate from the NAART and the depression score from the MAS were to be used in the analyses (as estimates of intellectual functioning and depression). These scores were included to ensure that differences in cognitive performance were due to differences in pain and not general mental abilities, or depression (should these variables demonstrate significant correlations with the cognitive measures). Performance on measures such as the Stroop Test and the subtests of the Wechsler Memory Scale - Revised have been shown to correlate with intellectual level (Spreen & Strauss, 1991).

Stroop Test (Regard, 1981).

The Victoria version of the Stroop Test was also used. This version consists of three cards, each containing 24 items (six rows, four items per row). In part D, the subject is asked to name the color of 24 dots that are printed in either blue, green, red, or yellow. The colors are arranged randomly in each row, with each appearing once. Part D of the Stroop Test is considered a measure of passive processing. In part C, the items are the color names of "blue, green, red, and yellow" are printed in lower case and the subject is asked to name the color in which the words are printed. The printed color does not correspond to the color name for any item. Part C was included as a measure of effortful processing. Both parts of the Stroop Test were scored for total time per trial.

Test-retest reliability for the Stroop Test is good. Spreen and Strauss (1991) report correlations of $r = .90$ for Part D and $r = .91$ for Part C of the Stroop Test. Factor analytic studies conducted by Graf, Uttl, and Tuokko (1995) suggest that processing speed and efficiency contribute to performance on Part C of the Stroop Test. Performance on Stroop color-words loaded on the same factor as Digit Symbol and Block Design from the WAIS-R, the Cancel H test, and a card sorting task (see Graf, Uttl, & Tuokko, 1995). Sherman et al. (in press) found a correlation of $r = .29$ between time on Part C and the Freedom from Distractibility factor of the WAIS-R.

Wechsler Memory Scale - Revised, Visual Memory Span Subtest (WMS-R; Wechsler, 1987).

The Visual Memory Span subtest of the WMS - R can be described as the spatial analog of digit span, and is a nonverbal, visual-spatial task. The two parts of this subtest, tapping forward and tapping backward, were administered independently. Using a card printed with colored squares, the examiner taps the squares in sequences of increasing length. The subject repeats each span in the same order for the tapping forward portion of this measure and reverse order for the tapping backward trials. This measure was scored for total number of items correct.

The Visual Memory Span Test was included as a measure of attention and concentration that is thought to rely more heavily upon right hemisphere than left hemisphere functioning. Milner (1971) reported that lobectomy patients demonstrated no impairment on a visual span measure after a left temporal lobectomy and impaired reproduction of longer spans among right temporal lobectomy patients.

A split-half reliability coefficient of .81 (using the WMS-R standardization sample of 308 persons) was reported by Wechsler (1987) for the Visual Memory Span subtest. Test-retest reliability, with a four to six week interval between testing, was reported as r = .81. Principle components analyses of WMS-R subtests performed with the entire WMS-R standardization sample and mixed clinical samples yield an attention-concentration factor. Scores for Visual Memory Span load on this factor (r = .65; Wechsler, 1987).

Wechsler Memory Scale - Revised, Digit Span Subtest (WMS-R; Wechsler, 1987).

Digit Span (forwards and backwards) from the WMS-R was also included. The sum of total correct for both trials was used. Performance of digits forwards is considered to be primarily a measure of attention that requires only passive processing, while digits backwards is considered more effortful because of its requirement to store information in working memory while simultaneously reversing the sequence of this material (Hayslip & Kennelly, 1980). Digits forwards and digits backwards are both more vulnerable to left hemisphere damage than right hemisphere damage (Weinberg et al., 1972). The PASAT and Digit Span were included to assess left hemisphere attention and concentration. See Appendix IV for score sheets of the Stroop Test, Visual Memory Span subtest and Digit Span subtest.

A split-half reliability coefficient of .88 was reported by Wechsler (1987) for the Digit Span subtest. Test-retest reliability, over a four to six week interval, was reported as r = .84. Digit Span scores have been demonstrated to load on the attention-concentration factor yielded by principle components analyses of WMS-R subtests (r = .75).

Implicit and Explicit Memory Measures (see Hultsch, Masson, & Small, 1991).

Due to the lack of widely used and well standardized tests of direct/indirect memory that are available, experimental measures of implicit and explicit memory were used. Research participants were presented with a list of 30 words and 30 non-words in the context of a lexical decision task in which they were to indicate whether the group of five to seven letters presented made up an English word or not. Explicit memory was assessed immediately following the lexical decision task by the number of "real" words correctly recalled by the research participants. This was followed by a stem-completion measure in which participants were asked to complete a sheet of three letter word stems with the first word that came to mind. This sheet contained sixty stems randomly presented. Thirty of these stems were of the words presented in the lexical decision task, and the total number of word-stems correctly completed from this list provided a measure of implicit memory. Appendices V and VI provide score sheets for the direct and indirect recall of these words.

Little information is available for these memory measures given their experimental nature. Hultsch, Masson, and Small (1991) had a large sample of community dwelling adults (N = 544) complete the stem-completion measure (following the lexical decision task) and three other measures of direct memory. Examination of the correlations between the indirect test and three direct tests of memory (fact recall, story recall, and word recall) revealed that none of these were significant. Thus, support for the stem-completion task as a measure of implicit memory was indicated.

Paced Auditory Serial Addition Task (PASAT; Gronwall, 1977).

The PASAT provides a measure of sustained attention and speed of processing. A tape of 60 randomly arranged numbers between one and nine was presented to the subject. Research participants were required to add pairs of numbers, such that each number was added to the one preceding it, and report their response verbally. Thus, the second number was added to the first number, the third to the second, the fourth to the third, and so on. For example, if given the numbers "1,9" the answer is "10"; if the next number is "4," this is added to the previous "9" to give "13"; and so on (Spreen & Strauss, 1991). These same 60 numbers can be presented across four different trials with increasing rates of presentation (see Appendix VII for PASAT scoring sheet). The total number of correct responses per trial is scored. For the purposes of this study, only trial one was administered, scored and analyzed.

Split-half reliability for the PASAT is .96, implying high internal consistency (Egan, 1988). Validity of the PASAT as a measure of attention and processing speed is supported. Deary et al. (1991) found that PASAT scores had a high loading on the freedom from distraction factor of the WAIS-R (r = .80) among healthy diabetic patients (N = 94). Loadings on the verbal and performance factors were not significant, suggesting the PASAT can in fact serve as an index of attention and concentration. O'Donnell et al. (1994) examined the construct validity of several neuropsychological measures among 117 community-living adults and found the PASAT loaded onto an attention/processing speed factor (r = .83) that included Trails B and a letter cancellation task.

California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987).

The CVLT is a multiple-trial, list learning measure. The ability to learn and recall verbal information is assessed, as well as use of memory strategies. List A, which includes 16 words equally distributed among four semantic categories (tools, fruit, clothing, &

herbs and spices), was presented to research participants five times. After each presentation of the list, research participants were asked to recall as many of the items they could remember. The participant's fifth recall was then followed by a single presentation of List B, which included 16 new words equally distributed among four semantic categories (fish, kitchen utensils, fruit, & spices and herbs). Delayed recall, cued recall, and recognition of the words from List A was undertaken subsequent to the participant's free recall of words from List B (see Appendix VIII for the word lists).

For the purposes of this study, the following CVLT scores were used: total number of words recalled over trials A1 to A5 (as a measure of explicit or direct memory), and a semantic cluster ratio (computed by CVLT software for the IBM computer; as a measure of the use of effortful versus passive memory strategies). This semantic cluster score involves the ratio of observed to expected reporting of two consecutive words from the same semantic category. A ratio of 1 indicates chance clustering performance, and a ratio of greater or less than 1 suggests above or below average clustering performance, respectively.

Delis et al. (1987) report reliability coefficients, for total score on trials A1 to A5, with both nonclinical (n = 286) and clinical samples (n = 113). With the nonclinical sample, split-half reliability for the total score on trials A1 to A5 was .92. Among clinical patients, the split-half correlation was r = .85. Test-retest reliability of CVLT scores after a one-year interval yields correlations of r = .59 for total recall across trials A1 to A5 and r = .49 for the semantic cluster ratio (Delis et al., 1987).

The validity of the CVLT has been established by correlations of different variables with scores on the WMS-R, and examination of score patterns that characterize individuals suffering from various disorders. Total recall across trials A1 to A5 is significantly correlated with both the General Memory Index (r = .66) and the Logical Memory I subtest from the WMS-R (r = .66; see Delis et al., 1987). The semantic cluster ratio is significantly correlated with learning and immediate recall of hard word associations on the WMS-R (r = .45). Factor analyses of normal research participants (N = 286) demonstrates that the total recall score for trials A1 to A5 loads on a general verbal learning factor (r = .91), while the semantic cluster ratio loads on a learning strategy factor (r = -.71). This same pattern and level of significance held for neurologically impaired patients (N = 113; see Delis, Freeland, Kramer, & Kaplan, 1988).

Visual Analog Scales (VAS).

Participants indicated their pain intensity at three points during the testing session (beginning, middle, and end) on a 10 centimeter vertical scale with the phrases "no pain" at the bottom end and "pain as bad as it could be" at the top end (see Appendix IX). This measure was scored using a 20 point grid. These three pain intensity ratings were averaged to provide a general pain intensity score for the session.

Visual analog scales have been widely used with pain populations and demonstrate strong reliability and validity as intensity measures. Test-retest correlations of r = .95 to r = .99 have been reported among patients asked to describe their pain intensity after an interval of 24 hours (Wewers & Lowe, 1990). Scott and Huskisson (1976) reported a correlation of r = .75 between a visual analog scale printed vertically and a four-point descriptive scale that rated pain as slight, moderate, severe, or agonizing. Further support for the validity of analog scales as measures of pain comes from studies that demonstrate strong correlations between the VAS and numerical rating scales (r = .92), the McGill Pain Questionnaire (r = .57; see Ahles et al., 1984), and simple descriptive scales (r = .78; see Downie et al., 1978).

These scales are easily administered and allow a high number of response categories, thereby potentially making them more sensitive to changes in pain intensity than other measures with limited response categories (Jensen & Karoly, 1992). Visual analog scales also demonstrate strong correlations with observed pain behavior, and are sensitive to treatment effects (see Jensen et al., 1989; Schachtel, Fillingim, Thoden, Lane,

& Baybutt, 1988; Teske, Daut, & Cleeland, 1983). The utility of visual analog scales as measures of other clinical phenomena has also been demonstrated. Lowe and Holm (1988) found correlations between VAS and questionnaire approaches to the measurement of anxiety ($r = .67$). Luria (1979) demonstrated that scores on a VAS assessing mood reliably classified patients into affective and nonaffective psychotic diagnostic categories.

Current level of fatigue was assessed using a 20-point visual analog scale with "no fatigue at all" anchored at the bottom and "fatigue as bad as it could be" anchored at the top (see Appendix X). Fatigue was defined to participants as their "subjective sensation of generalized tiredness or exhaustion" (Tack, 1990). These levels were gathered at the time of each pain intensity rating and averaged into a general fatigue score. Participants also rated the quality of their sleep the night previous to testing using a 20-point visual analog scale, with "sleep as good as it could be" anchored at the bottom and "sleep as bad as it could be" at the top (see Appendix XI). These measures were included as part of the study in order that the relationship between pain, sleep disturbance, fatigue, and cognitive abilities could be further delineated. Recent research has demonstrated strong links between sleep difficulties/fatigue and the pain associated with rheumatoid arthritis (see Devins et al., 1993; Moffitt et al., 1991; Nicassio & Wallston, 1992; Tack, 1990).

In order to gather information on participants' self-perceptions regarding the degree to which pain affects their ability to concentrate and remember information, a visual analog scale was again used, with "not at all affected" anchored at the top and "severely affected" anchored at the bottom (see Appendix VII). Participants were encouraged to think about a recent pain episode and then rate the impact this pain had on their ability to carry out tasks involving attention and memory. This scale was also scored using the 20-point grid.

Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, Fitzgerald, & Parkes, 1982).

The CFQ was developed to assess minor everyday slips or errors in functioning. Broadbent describes cognitive failures as cognitively based errors that occur during performance of a task which is typically executed successfully. Research participants respond to twenty-five items by indicating the frequency with which they make such mistakes, using a five-point scale ranging from "never" (0) to "very often" (4) (e.g. Do you find you forget why you went from one part of the house to the other?). Appendix XIII provides a copy of the test items. The CFQ has demonstrated sensitivity to everyday cognitive errors which are frequently not revealed in a laboratory setting, and appears to be uncorrelated with measured intelligence and educational level (Broadbent et al., 1982). It has demonstrated utility with elderly research participants, young adults, and chronic pain patients (see Dufton, 1989; Pollina et al., 1993; Pollina et al., 1992; and Scogin & Rohling, 1989). The CSQ was included in this study as a measure of self-reported failures in attention, perception, and memory.

Broadbent et al. (1982) reported an alpha coefficient of 0.89 for the CFQ among a sample of nonclinical research participants ($N = 98$). At 21 and 65 week intervals, test-retest reliability correlations were reported at $r = .82$ and $r = .80$, respectively. Reliability of the CFQ is suggested by its correlation with measures tapping absent-mindedness and errors in memory (e.g. Slips of Action Inventory and CFQ, $r = .58$; Absent-Mindedness Questionnaire and CFQ, $r = .62$; Short Inventory of Memory Experiences, $r = .59$).

Coping Strategy Questionnaire (CSQ; Rosenstiel & Keefe, 1983).

The CSQ consists of seven scales representing pain coping activity, and includes two pain control effectiveness scores of control over pain and ability to decrease pain. For the purposes of this study, participants were asked an open-ended question regarding techniques they currently use to cope with their pain and then provided two, seven-point rating scales from the CSQ that assessed their ability to control and decrease their pain using these techniques (see Appendix VIX). These two scores were then combined to provide a rating of outcome expectancy, an aspect of self-efficacy discussed by Bandura (1977). Outcome expectancy is defined as "the belief that a given behavior will or will not lead to a given outcome" (i.e. ability to control and decrease pain using one's coping techniques).

Rosenstiel and Keefe (1983) have demonstrated the internal reliability of the CSQ subscales (coefficient alpha ranges from .71 to .85 for the seven coping strategy scales) with chronic pain patients ($\underline{N} = 61$). Principle components analysis, conducted by these authors, of CSQ items demonstrated that the two pain control effectiveness scores load on the same factor (Control over pain, $\underline{r} = .83$; Ability to decrease pain, $\underline{r} = .75$). Patients high on this factor were significantly more depressed ($\underline{p} < .01$) and more anxious ($\underline{p} < .05$) than individuals low on this factor. Spinhoven et al. (1989) replicated the factor structure of the CSQ, finding that the two pain control effectiveness scores again loaded on the same factor (Control over pain, $\underline{r} = .94$; Ability to decrease pain, $\underline{r} = .93$). Turner and Clancy (1986) provide evidence for the stability of this factor structure with yet another patient sample, and also found associations between the types of coping strategies used and measures of physical and psychosocial impairment. Further, it has been found that treatment-related changes in the use of certain coping strategies are related to changes in pain intensity and disability (Turner & Clancy, 1986; Keefe et al., 1987b)

CHAPTER 4

Results

Analyses

The analysis of the data had two aims: to examine the degree of relationship between specific variables using Pearson correlation, and to address the three major questions of this study through a series of hierarchical multiple regression equations. To determine whether performance on the cognitive measures was related to pain intensity, even after the effects of noncognitive variables correlated with pain and test performance had been accounted for, three sets of hierarchical multiple regression analyses of pain intensity ratings were conducted, with the noncognitive and cognitive predictor variables entered in blocks. This method, which comprises forced entry into the regression equation, allows testing of the effects of a group of variables when the effects of other sets have already been partialled out and tested for predictive ability.

To evaluate the first hypothesis, whether performance on tasks of effortful processing is more related to pain than tasks of automatic processing, scores from part C of the Stroop Test and the semantic cluster ratio from the CVLT (as one block representing effortful processing), and the score for part D of the Stroop Test (as another block representing automatic processing) were entered into two different regression equations in order that the unique contribution of that variable block entered last could be determined through change in $\underline{R}$ squared. The semantic cluster ratio was included in the effortful processing block as an estimate of the degree to which participants used active/effortful memory strategies, and to determine whether or not this was related to pain intensity.

To determine the relationship between pain and explicit and implicit memory, the number of list words freely recalled after the lexical decision task and the number of words correctly recalled on trials A1 to A5 of the CVLT (as a block representing measures of explicit memory), and the number of correct stem-completions (considered the implicit memory block) were also assessed using two regression equations, such that each variable block was entered last for one of the equations.

In consideration of the third hypothesis/question, as to whether differences may occur between measures of right and left hemisphere processes among persons in pain, scores from Visual Memory Span (representing the right hemisphere block) and those from digit span and the PASAT (the left hemisphere block) were also entered into two separate regression equations. Change in R squared following entry of each variable block was evaluated. The unique contribution of each cognitive variable to explaining variance in pain intensity was evaluated by examination of the squared semi-partial correlation for that variable with pain intensity (i.e. the relationship between pain and performance on the cognitive measure with the effects of age and education, outcome expectancy, and fatigue removed from the dependent variables).

Qualitative Results

Participant responses to an open-ended question regarding tasks involving attention and memory disrupted by their pain were grouped into seven categories: decreased speed of thinking, decreased declarative memory, decreased reading comprehension, decreased comprehension of instructions/directions, problems with divided attention, problems with attention to detail, and decreased social functioning. Table 2 provides participant examples of activities and situations to illustrate the nature of these seven categories.

Decreased speed of thinking was defined as difficulty processing information rapidly and responding quickly to a question or situation. Decreased comprehension and retention of reading material was to include all responses indicating difficulty understanding and remembering written material, while decreased comprehension of instructions/directions was to include all complaints involving the understanding and carrying out of tasks involving a correct sequence of components. Divided attention was

Table 2

Self-reported Cognitive Complaints: Categories and Examples

Category	Examples
Speed of Thinking	"Adding numbers in my head is slower. I need to double check my accuracy" "I have trouble coming up with things quickly in response to a question"
Declarative Memory	"I can't remember any of my errands if I don't make a list first" "I sometimes forget if I've taken my meds" "I forget people's names and phone numbers all the time"
Reading Comprehension and Retention	"If I'm in pain I have a terrible time concentrating when I try to read something" "I often find that I'll have read something over and over and I'm still not getting it"
Following Instructions/Directions	"I may have trouble following a more complex recipe" "I notice that I have more trouble trying to follow a knitting pattern"
Divided Attention	"I can't work on a number of things at the same time" "Working the switchboard at work becomes more difficult"
Attention to Detail	"I have more trouble with the financial reports at work" "Doing my paperwork at home takes much longer because I make mistakes"
Social Functioning	"I'm not as socially adept when in pain" "I can't follow conversations very easily"

defined by Sohlberg and Mateer (1989) as the ability to respond simultaneously to multiple tasks or multiple task demands. Thus, any responses indicating primary difficulty with tasks of this nature were placed in this category. Problems with attention to detail included those complaints involving a decreased ability to take in relevant stimuli or produce accurate work involving detail. Finally, decreased social functioning was to include disruption of activities in which the primary focus was interaction with other people in a nonwork setting. This category was included to capture the concerns of participants regarding the impact of their pain on all aspects of living.

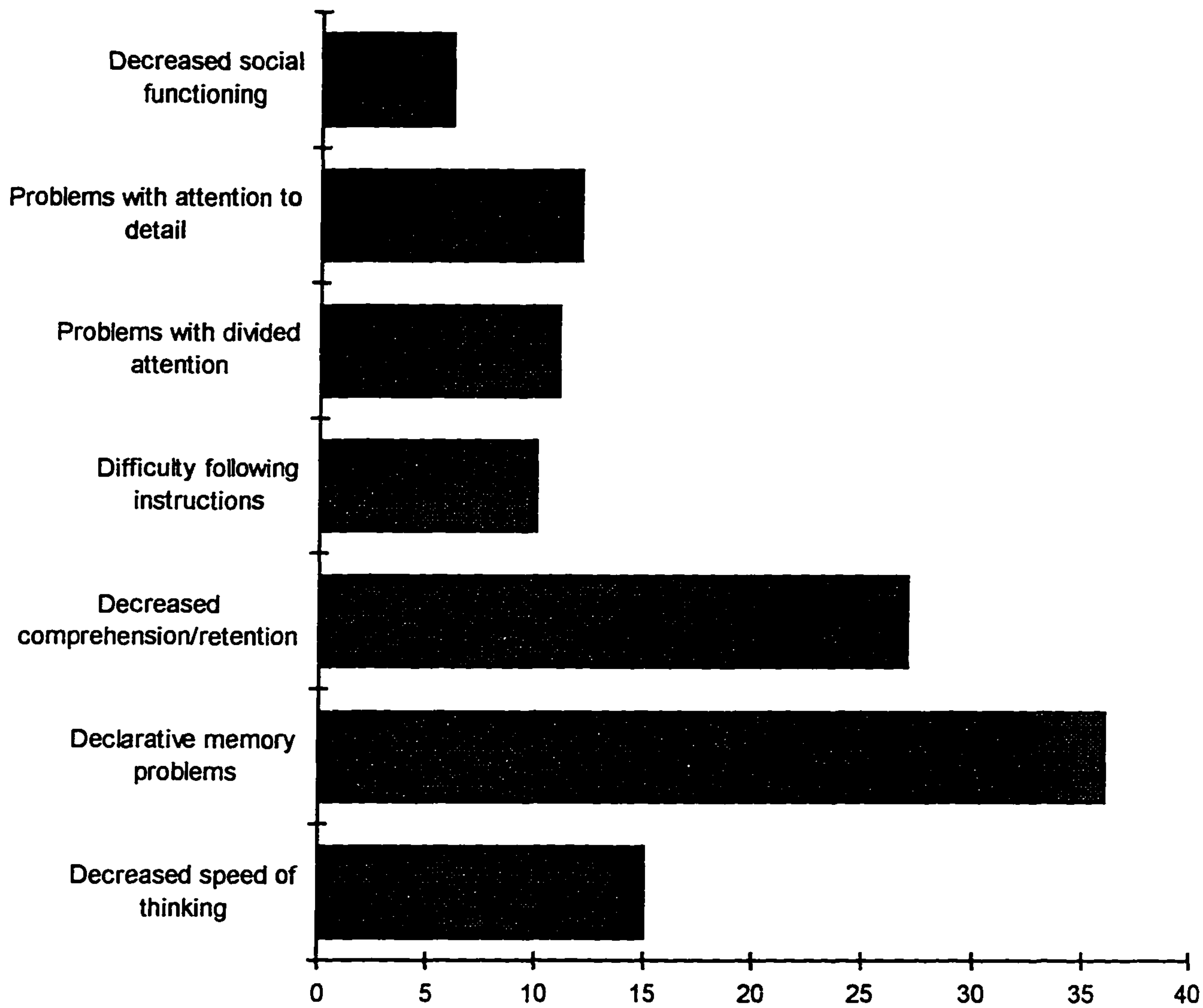
Placement of participant responses in the category best suited to the nature of each complaint was carried out by eight independent raters. This revealed a coefficient of concordance of .83 suggesting these complaints could be reliably categorized. All 65 participants were able to provide one or more examples of "mental" activities that are affected by their pain. See Figure 3 for the frequencies of these self-reported cognitive complaints among the research participants.

The most common cognitive complaints reported by participants involved the domain of declarative memory. Declarative memory is defined by Delis (1989) as memory that involves the acquisition of facts, knowledge and events that are directly available to conscious awareness. Declarative knowledge can be further broken into the areas of episodic and semantic memory; episodic memory refers to information learned at a particular time/place in one's life (e.g. asking a person what he/she ate for breakfast that day); semantic memory refers to one's general knowledge of the world and is not linked to a specific temporal-spatial context (e.g. asking a person to define breakfast). Participant responses recorded in this category included problems remembering names, phone numbers, appointments, and lists, difficulty remembering errands, and unreliable memory for medication intake.

Qualitative information was also gathered on the types of coping strategies participants commonly use to control and decrease their pain. These strategies were then

Figure 3

Frequency of Cognitive Complaints Across Participants

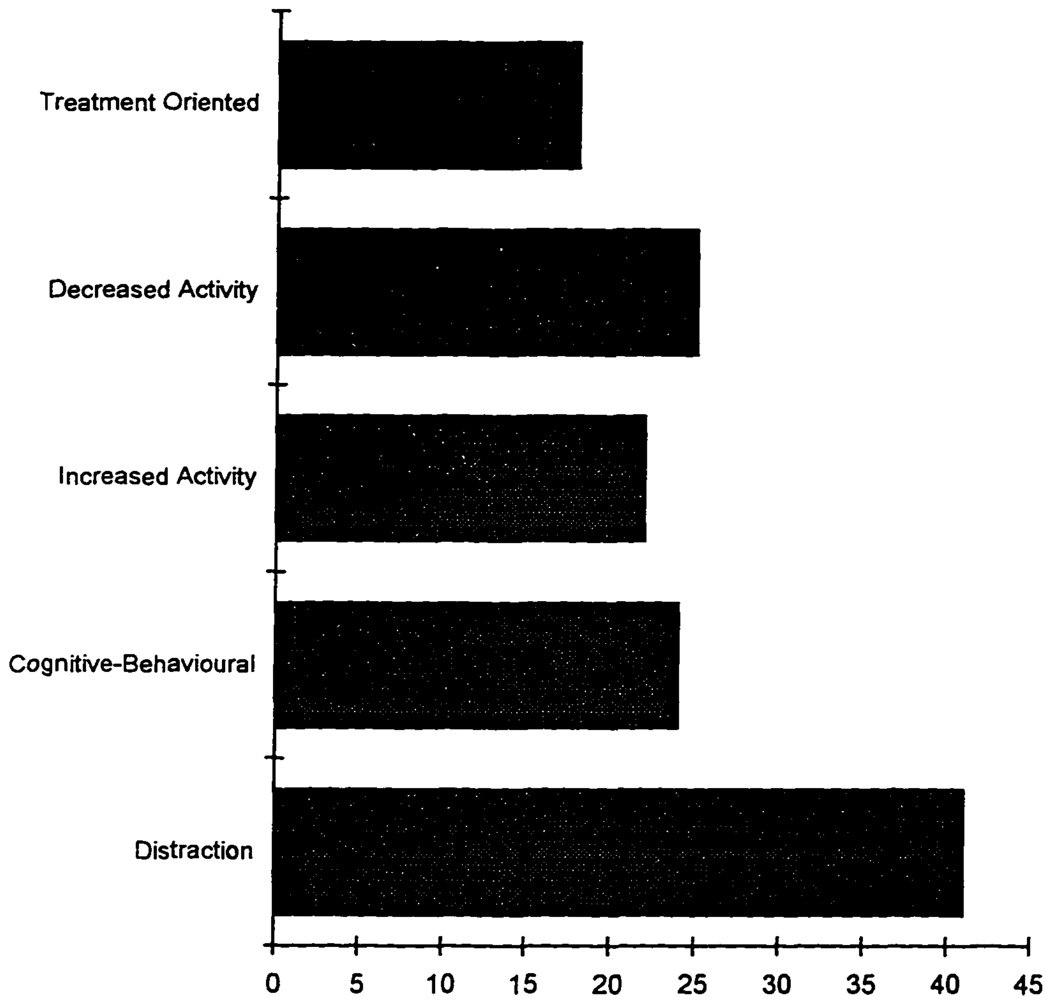


grouped into five main categories: distraction (e.g. reading, sewing, TV, music, phoning a friend, talking to someone); cognitive/behavioral (e.g. meditation, self-hypnosis, visualization, relaxation techniques, positive self-talk); increased activity (e.g. walk, exercise); decreased activity (e.g. rest, sleep, sitting down); and treatment-oriented (e.g. ice, heat, massage). See Figure 4 for a frequency distribution of these strategies among the participants.

The most common type of coping strategy reported was that of distraction, a technique employed by 41 of the 65 participants. Use of cognitive-behavioral techniques was reported by over one third of the participants. Treatment-oriented techniques was the coping strategy least frequently employed. Participants indicated an average outcome expectancy rating of 3.43 (SD = 0.85) when using all of these strategies for control of their pain. This mean score suggests a moderate level of perceived pain control on the part of these participants when they employ nonmedicinal coping strategies.

Figure 4

Frequency of Self-Reported Coping Strategies Among Participants with Chronic Pain



Correlational Analyses

As expected, a strong relationship was demonstrated between pain and fatigue among this sample of arthritis patients ($r = .55$, $p < .001$). Self-reported quality of sleep for the night previous to testing was also found to be correlated with fatigue ($r = .44$, $p < .001$), although less so with pain reported at the time of testing ($r = .26$, $p < .05$). This decreased strength of relationship between quality of sleep and pain is expected however, as a rating of pain during the night was not obtained.

The relationship between outcome expectancy, pain and depressed mood was also examined. As time since diagnosis increased, participants tended to report higher outcome expectancy ratings ($r = .32$ $p < .01$). Outcome expectancy also appeared related to self-reported pain intensity ($r = -.50$, $p < .005$) and depression ($r = -.57$ $p < .001$). Thus, the greater a person's level of self efficacious to deal with their pain or condition, the lower their subjective feelings of pain and depression.

Scores on the Cognitive Failures Questionnaire (CFQ) did not appear correlated with any of the memory or attention measures administered to the participants, with the exception of a somewhat weak relationship with part C from the Stroop Test ($r = .28$, $p < .05$). Self-reported cognitive errors among the participants were related, however, to both depression ($r = .59$, $p < .001$) and, to a lesser degree, fatigue ($r = .32$, $p < .01$). Participants experiencing higher levels of self-reported depression and fatigue were more likely to indicate minor mistakes of memory and attention in their activities of everyday living. The frequency of these cognitive "errors" was not related to pain intensity.

The degree to which participants rated the impact of their pain on concentration and memory ($X = 11.78$, $SD = 5.42$) was correlated with pain intensity ($r = .39$, $p < .001$). Thus, the higher the level of pain intensity experienced by a person the greater his/her rating of its impact on concentration and memory. This self-perception score was also related to depression ($r = .3559$, $p < .004$), although less so to cognitive failures ($r = .31$, $p < .013$), and outcome expectancy ($r = -.30$, $p < .015$).

Examination of the zero-order correlations between pain intensity and the cognitive variables revealed some support for the role of pain in direct recall of material. Scores from trials A1-A5 of the CVLT and digit span were negatively correlated with pain intensity, $r = -.35$, $p < .005$, and $r = -.27$, $p < .03$, respectively. Fatigue was not significantly correlated with performance on any of the memory and attention measures with the exception of a weak relationship with trials A1-A5 of the CVLT ($r = -.25$, $p < .05$). Quality of sleep for the night previous to testing did not demonstrate a relationship with performance on any of the cognitive measures. See Table 3 for a correlation matrix of these variables.

Table 3

Correlation Matrix of Key Variables

	Depr	Pain	Fatigue	Sleep	Selfperc	Outcome	CFQ	Stroop D	Stroop C	Explicit	Implicit	CVLT	Semclus	Digits	VMS	PASAT
Yrs Diag	-.30	-.02	-.02	.01	-.09	.32	-.25	-.13	-.12	-.17	.09	-.09	-.14	.10	-.01	-.10
Depr		.23	.38*	.10	.36*	-.57**	.59**	.12	.19	-.20	-.16	-.14	-.08	.00	.08	-.06
Pain			.55**	.26	.39**	-.50**	.13	-.05	.15	-.03	.24	-.35*	-.13	-.27	-.20	-.18
Fatigue				.44**	.44**	-.35*	.32*	.01	.01	.09	.09	-.25	-.16	-.11	.01	-.09
Sleep					.28	-.20	-.02	-.03	-.16	.09	.04	-.07	-.03	-.07	-.06	-.05
Selfperc						-.30	.31	.11	.19	-.16	-.10	-.19	.04	-.21	.02	-.15
Outcome							-.42**	-.14	-.39**	.18	-.07	.23	.04	.23	.15	.12
CFQ								.15	.28	-.22	-.10	-.01	.07	.00	.19	-.12
StroopD									.54**	-.03	-.16	-.19	-.00	-.08	-.43**	-.31
StroopC										-.22	.00	-.39**	-.09	-.21	-.41**	-.47**
Explicit											.01	.29	.06	.07	-.06	.08
Implicit												-.20	-.10	-.07	-.05	.07
CVLT													.61**	.28	.33*	.36*
Semclus														.09	.13	.27
Digits															.37*	.40**
VMS																.47**

* $p < .01$

** $p < .001$

Multiple Regression

Hierarchical regression was used to determine whether performance on the tasks of effortful processing and explicit memory predicted pain intensity beyond that accounted for by age, education, fatigue, and outcome expectancy, as well as tasks of automatic processing and implicit memory. Measures of right and left hemisphere processing were also evaluated through a set of two hierarchical regression equations, with age, education, outcome expectancy, and fatigue entered first. Since the estimates of Full Scale IQ and depression that were obtained did not correlate significantly with either pain intensity, or the cognitive measures, they were excluded from the analyses.

All variables were normally distributed. Inspection of histograms revealed no univariate outliers and with a $p < .001$ criterion for Mahalanobis distance (i.e. how much a case's values on the independent variables differ from the average of all cases), no multivariate outliers were detected. Data in all cases were complete and no suppressor variables were found.

Tables 4, 5, and 6 provide results for the three sets of regression analyses. Multiple R was significantly different from zero at the end of step five when pain was used as the criterion variable and tasks of automatic and effortful processing were added as the fourth and fifth blocks, F (57,7) = 6.60, $p < .001$. Taken together, the automatic and effortful processing variable blocks were able to account for only a small increase of approximately 2% of the explained variance in pain intensity over that accounted for by status variables (i.e. age and education), fatigue, and outcome expectancy. The effortful and automatic processing blocks were unable to increase significantly R squared when added as the last variable, $p > 0.8$ and $p > 0.2$, respectively (see Table 3). Thus, overall performance on tasks involving effortful processing did not appear to be significantly impacted by pain intensity in this sample.

Using pain as the criterion, and tasks of implicit and explicit memory as the fourth and fifth blocks entered, multiple R was again significantly different from zero at the end

Table 4

Results of Hierarchical Regression Analyses for Measures of Effortful and Automatic Processing

Criterion	Step	Predictor(s)	$R2$	$R2$ Change	F	F Change	Sig. of F Change
Pain	1	Status $_a$	.0890	.0890	3.027	3.027	.056
	2	Outcome expectancy	.2739	.1850	7.671*	15.538	.001
	3	Fatigue	.4321	.1582	11.415*	16.716	.001
	4	Effortful $_b$	.4340	.0019	7.413*	0.097	.908
	5	Automatic $_c$	.4476	.0136	6.599*	1.405	.241
Pain	1	Status	.0980	.0980	3.027	3.027	.056
	2	Outcome expectancy	.2739	.1850	7.671*	15.538	.001
	3	Fatigue	.4321	.1582	11.415*	16.716	.001
	4	Automatic	.4449	.0127	9.456*	1.354	.249
	5	Effortful	.4476	.0028	6.599*	0.143	.867

* significant at $p < .001$

Note: a = age and education
b = Stroop C and semantic cluster ratio
c = Stroop D

Table 5

Results of Hierarchical Regression Analyses for Measures of Explicit and Implicit Memory

Criterion	Step	Predictor(s)	$R2$	$R2$ Change	F	F Change	Sig. of F Change
Pain	1	Status a	.0890	.0890	3.027	3.027	.056
	2	Outcome expectancy	.2739	.1850	7.671*	15.538	.001
	3	Fatigue	.4321	.1582	11.415*	16.716	.001
	4	Explicit b	.4596	.0275	8.221*	1.473	.238
	5	Implicit	.4851	.0255	7.673*	2.828	.098
Pain	1	Status	.0890	.0890	3.027	3.027	.056
	2	Outcome expectancy	.2739	.1850	7.671*	15.538	.001
	3	Fatigue	.4321	.1582	11.415*	16.716	.001
	4	Implicit	.4675	.0354	10.361*	3.922	.052
	5	Explicit	.4851	.0176	7.673*	0.975	.384

* significant at $p < .001$

Note: a = age and education
b = free recall after lexical decision task and CVLT trials A1-A5

Table 6

Results of Hierarchical Regression Analyses for Measures of Right and Left Hemisphere Processing

Criterion	Step	Predictor(s)	R2	R2 Change	F	F Change	Sig. of F Change
Pain	1	Status $_a$	.0890	.0890	3.027	3.027	.056
	2	Outcome expectancy	.2739	.1850	7.671*	15.538	.001
	3	Fatigue	.4321	.1582	11.415*	16.716	.001
	4	Left $_b$	.4472	.0150	7.819*	0.788	.459
	5	Right $_c$	.4593	.0121	6.917*	1.279	.263
Pain	1	Status	.0980	.0980	3.027	3.027	.056
	2	Outcome expectancy	.2739	.1850	7.671	15.538	.001
	3	Fatigue	.4321	.1582	11.415	16.716	.001
	4	Right	.4532	.0211	9.780*	2.273	.137
	5	Left	.4593	.0061	6.917*	0.322	.726

* significant at $p < .001$

Note: a = age and education
b = digit span and PASAT
c = VMS

of step five, F (57,7) = 7.67, $p < .001$. The implicit and explicit memory blocks were able to account for an approximate increase of 6% of the explained variance in pain intensity over that accounted for by status variables, fatigue, and outcome expectancy. Entry of the explicit memory block last into the equation increased R squared by 2%, while entry of the implicit memory measure as the last step accounted for an increase of 3% in R squared (see Table 4). This represents a nonsignificant change in variance accounted for in both cases.

Finally, when left and right hemisphere measures of attention and memory were entered as the fourth and fifth blocks of the regression equation, multiple R remained significant at the end of step five, F (57,7) = 6.92, $p < .001$. These blocks of left and right hemisphere measures were able to account for an approximate increase of 3% of the variance in pain intensity over that accounted for by blocks one through three. Neither of the blocks on their own was able to increase significantly the size of R squared (the left hemisphere block accounted for less than one percent of the variance when entered last, while the right hemisphere block contributed 1% as the last variable entered). No support was indicated for interhemispheric processing differences among these chronic pain participants (see Table 5).

Examination of the individual squared semi-partial correlations for each variable entered into regression revealed that none of the cognitive measures, on an individual basis, were able to contribute significantly to the prediction of pain intensity. The stem-completion measure of implicit memory uniquely contributed approximately 3% of variance, and the total number of words recalled on trials A1-A5 on the CVLT contributed an additional 2% of unique variance. Performance on part D of the Stroop Test and the Visual Memory Scales each contributed an additional 1% of unique variance. Digit span scores, direct recall of words following the lexical decision task, performance on part C of the Stroop Test, and number correct on the PASAT did not account for any of the variance in pain intensity.

Altogether, only 7% of the total variance in pain intensity can be accounted for with knowledge of scores on the above measures. Table 7 provides the semi-partial and squared semi-partial correlations for each of the cognitive measures and pain intensity. Since the relative size of many of these correlations is small (range 1 - 3 percent) and do not reach statistical significance, they are not seen as providing support for the impact of pain on some aspects of cognitive functioning.

Table 7

Semi-Partial Correlations Between Performance on the Cognitive Measures and Pain Intensity (N = 65)

Independent Variable	sr	sr^2
Stem-completions	.173	.030
Explicit recall	.032	.001
CVLT trials A1-A5	.141	.020
Stroop D	.100	.010
Stroop C	.032	.001
Semantic Cluster	.032	.001
VMS	.100	.010
Digit span	.071	.005
PASAT	.011	.000

CHAPTER 5

Discussion and Conclusions

The results of this study did not offer support for the impact of pain intensity on performance of psychometric tasks of attention and memory. Extension of information processing theory principles to chronic pain was not supported. Scores on the cognitive measures were not able to account for a significant amount of the variance in pain intensity among these chronic pain participants. Differing levels of pain intensity did not appear to be related to performance on measures of effortful processing and explicit memory more than those involving automatic processing and implicit memory. In fact, performance on two of the measures considered to involve automatic processing and implicit memory demonstrated a weak, albeit statistically non-significant, relationship to pain intensity. Further, no significant differences were noted in performance of tasks tapping right and left hemisphere processes among these participants.

Despite the lack of statistical significance generated by the regression analyses in this study, some of the correlational findings can be taken as providing weak support for the idea that the experience of pain is related to a diminished capacity for concentration and memory. Examination of the measures on an individual basis revealed that performance on two memory tasks (the California Verbal Learning Test and Digit Span) was correlated with pain intensity. Further, the squared semi-partial correlations between pain intensity and each of the cognitive measures revealed findings in the expected direction although they did not reach a magnitude of significance.

The Weak Relationship Between Pain and Cognition

As with any research that examines issues previously unaddressed in the literature, it is frequently the case that while the foundation for future studies is provided, definitive conclusions are often not immediately established. Unequivocal support for a relationship between pain intensity and cognitive performance was not found. Several reasons are offered for the lack of significant empirical findings for an issue of clinical significance to persons with chronic pain.

It is likely that the reduced number of participants with pain in the upper range may have decreased the potential for finding such a relationship. Since the sample was mildly positively skewed for pain intensity, many of the research participants may not have reached a necessary threshold of pain that would be required before attention/ concentration and memory were affected. This is an issue that is difficult to circumvent, however, as many persons who were experiencing greater pain and disease activity during the data collection phase of the study would cancel their session on "bad" days. Given that many of the participants in this study were using analgesics for pain control, this sample was also likely a group for whom medication was successfully managing their pain.

It is also possible that the measures chosen did not truly capture the types of cognitive complaints reported by the participants. The majority of the neuropsychological tests included in this study were quite brief and could be administered in under ten minutes. It may be necessary in future studies addressing the issue of pain and cognitive abilities to include measures that require greater endurance and effort (e.g. all four trials of the PASAT). According to Schneider, Dumais, and Shiffrin (1984) many cognitive tasks involve a mixture of automatic and controlled processes. It is only when a task becomes more complex that it begins to shift the degree of processing to a more controlled or effortful level. Hartlage et al. (1993) suggest there has been limited examination of the attentional demands required by tasks used to assess psychological deficits. Thus, the tasks chosen in this study may not have achieved a balance towards requiring more controlled/effortful processing than automatic processing.

A further possibility is that summing the three pain intensity ratings and reporting a mean value resulted in the loss of higher pain effects during administration of specific measures. Having a pain intensity rating that corresponds to the time each measure is administered would allow for more direct comparisons between performance on these measures and actual pain at the time.

The adaptive and effective coping skills of the participants in this study may have also reduced the impact of their pain on cognitive functioning. The sample was a well-educated group with numerous coping skills. Several participants even remarked that they could block their pain when working on tasks involving attention and concentration. As time since diagnosis, was negatively correlated with depression, and since the majority of persons had experienced a period of time to adjust to their conditions since diagnosis and increase their outcome expectancy, this may have served to decrease the impact of their pain on cognitive functioning.

A final explanation is the complex nature of pain research, which often does not lend itself to clear cut methods and results. Given the multifaceted nature of the pain experience, it is difficult to truly assess "physical" pain and its relationship to cognitive functioning. The need to control for numerous non-neuropsychological variables (i.e. depression, fatigue, outcome expectancy) may have reduced the remaining variance to an amount that did not allow statistical power when conducting the analyses.

More recently, a growing body of research has begun to address the potential for pain to impact cognitive functioning. As discussed previously, these studies are few in number and often do not attempt to establish a link between pain intensity and performance on measures of attention, concentration and memory (see Almay, 1987; Jamison, Sbrocco, & Parris, 1988; and Kutner et al., 1988). Further, these studies often employ depression measures that contain items of a somatic nature, and which may inaccurately measure affect in persons with chronic pain. Thus, when the effect of "depression" on neuropsychological measures is controlled for, these researchers may in fact also be inadvertently controlling for pain and disability.

Despite the lack of studies designed to address such cognitive disturbances in pain patients and their relation to pain intensity, it is interesting to note that many of the questionnaires developed to assess the pain experience include items relating to cognitive functioning. Kinsmen et al. (1989) used the pain symptoms and experiences of a large sample of pain patients in their development of the Pain Symptom Checklist (PSC). Cluster analysis of subject responses indicated symptom categories that included affective states, sleep disturbance, fatigue, and cognitive dysfunction. Items endorsed in the cognitive dysfunction category included poor memory and forgetfulness, trouble concentrating, and mental confusion. Fourteen percent of the respondents in this study indicated the presence of cognitive difficulties when experiencing high pain intensity. The inclusion of such items in these questionnaires suggests that at some level, there is the belief that pain does impact upon one's mental abilities. What is required, however, is further research that specifically investigates this relationship.

The discussion of attention, concentration, and memory problems among chronic pain patients has also not been specific to one type of pain population. Cognitive disturbances have been reported in musculoskeletal pain patients, cancer pain patients, orthopedic patients undergoing total hip replacement, persons with different forms of arthritis, and mill workers with back pain (see Astrand, 1987; Bruera et al., 1992; Cathey, Wolfe, & Kleinkeksel, 1988; Duggleby & Lander, 1994; Kewman et al., 1991; and Kutner et al., 1988).

Further, the range of these cognitive disturbances has been evidenced by neuropsychological and cognitive measures, patient self-report, and task performance on the job. It is interesting to note both the variety and number of responses provided by the participants in this study regarding tasks involving attention/concentration and memory that they feel are disrupted by their pain. These included decreased speed of thinking, problems in the domain of declarative memory, decreased reading comprehension, decreased comprehension of written or spoken instructions/directions, problems with divided attention, problems with attention to detail, and decreased social functioning. These responses were provided freely and without prompting.

Despite the lack of studies that provide empirical support for the impact of pain upon effortful processing and explicit memory, an abundance of subjective evidence can be found. None of the troublesome activities reported by research participants in this study were considered to involve automatic processing or implicit memory. Decreased efficiency and accuracy on a task of effortful processing has been demonstrated among persons experiencing acute pain (see McCaul, Monson, & Maki, 1992); however, further research with chronic pain patients is still needed.

The clinical significance of these findings may, by some, be seen in the preliminary lack of support for the impact of pain upon "mental" activities involving functions such as attention and memory. To date, little research has addressed the potential for disturbance of these abilities among persons without some form of organic brain damage, despite the frequent discussion of this issue by pain patients and health care providers. Many would view this finding as good news. Unfortunately, these results do not provide validity to what persons with chronic pain have been reporting. In this study, participants indicated an overall impact of pain upon their cognitive functioning in the moderate range. The potential reasons for such a discrepancy between participant self-reports and the demonstration of weak to no support for this relationship in the study will now be discussed.

A Discussion of the Discrepancy Between Research Participants' Ratings Regarding the Impact of Their Pain Upon Cognition and The Actual Results of This Study

The possibility that these participants over estimated the impact of their pain upon attention and memory functioning is a further issue that warrants examination. Numerous studies have looked at judgment of cognitive abilities among neurological patients (e.g. multiple sclerosis, dementia, head injury) and found that damage to the frontal lobes of the brain impaired the ability to accurately estimate level of performance on measures of memory (see Beatty & Monson, 1991; Shimamura, 1989). Judgment of cognitive abilities among persons with chronic pain conditions has not previously been addressed.

Studies examining the impact of depression on metamemory provide some support for the possibility that participants in this study did not possess accurate judgment of the relationship between their pain and cognitive functioning. Self-perception scores regarding this relationship were correlated with both depression and outcome expectancy among this sample. Thus, those persons who were more depressed tended to indicate a stronger impact of pain upon attention and memory. This also held true for those participants who reported lower ratings of outcome expectancy. Scogin (1985) examined the relationship between memory complaints and actual memory performance among depressed and nondepressed research participants. Those research participants reporting higher levels of depressed mood also tended to demonstrate larger discrepancies between their self-reported memory disturbances and actual test performance.

Niederehe and Yoder (1989) also investigated the impact of depression on responses to a metamemory questionnaire and the correspondence to actual performance on a series of memory tests. These authors found that depressed research participants were more likely to indicate general and comprehensive memory problems, notably in the domain of recent memory. However, these same research participants did appear to have sufficient knowledge in basic metamemory. The research addressing metamemory among depressed patients is so far not conclusive, and judgment of one's cognitive abilities beyond the domain of memory has yet to be fully investigated. Thus, it is difficult to determine if such factors played a role in the self-perceptions of these participants.

A further confound can be seen among the perceptions of those research participants experiencing pain in the upper versus the lower ranges. Persons with high pain intensity were more likely to report a stronger impact of their pain upon activities involving concentration and memory. People with significantly less pain did not feel that it affected their memory as much; thus, the high pain intensity group may have unduly influenced the overall rating for all research participants.

Pain and Non-Neuropsychological Factors

The strong relationship noted between pain and fatigue among this sample of arthritis patients is consistent with previous research. Tack (1990) noted among her sample of rheumatoid arthritis patients (N = 20) that scores on the fatigue subscale of the Profile of Mood States were correlated with degree of pain intensity. Fatigue has also been reported as an extremely common complaint among persons with various forms of chronic pain (Devins et al., 1993).

Level of fatigue was not significantly correlated with performance on any of the memory and attention measures in this study, the only exception being demonstration of a weak relationship with a measure of verbal memory. Although many clinicians feel that fatigue influences performance on subsequent mental tasks (Soetens, Hueting & Wauters, 1992), research that addresses this issue has, to date, been inconsistent. As in the case of pain, fatigue is multifaceted and multidimensional, encompassing biological, psychological, social, and individual factors that affect its onset, impact, manifestation, duration, and severity. Further research of this issue will be required before any firm conclusions can be drawn.

The participants in this study indicated use of several common types of pain coping strategies (distraction; cognitive-behavioral; increased/decreased activity; and treatment-oriented) and felt these strategies had a moderate level of efficacy when it came to controlling and decreasing pain. The most common type of coping technique reported was distraction. The use of distraction as a means of coping with discomfort has demonstrated success with both acute and chronic pain populations.

Anderson, Baron, and Logan (1991) found that patients provided with distracting music during dental procedures reported less pain and increased levels of control over their discomfort than those in a no-treatment control group. Persons provided distraction techniques for coping with other forms of acute induced pain (e.g. the cold pressor method) also demonstrate enhanced pain tolerance (see Hodes, Howland, Lightfoot, and Cleeland, 1990; Williams and Kinney, 1991). Further, Davis, Cortez, and Rubin (1990) reported that adults with arthritis rated distraction as a useful management technique for their pain.

Shiffrin and Schneider (1977) suggest that the cognitive activity involved with use of distraction utilizes a portion of one's attentional capacity (which is limited) and reduces the amount of conscious "space" available for the processing of pain. Support for role of distraction in reducing pain was also demonstrated in this study. Over one third of the 65 participants reported a decrease in their pain intensity between the first and second ratings. Further, pain ratings for 33 of the participants either did not change or decreased between the second and third pain ratings, a time when the effects of fatigue and sitting for a period of time are likely to increase discomfort. Many of these participants commented that their involvement in performing the tests well, and their enjoyment of these tasks, had caused their pain to diminish since their arrival. Others reported a capacity to "block" their pain or separate themselves from it when required to partake in a mental activity.

This self-reported ability to block pain ties in with the suggestion that dissociation may act as an adaptive coping mechanism which allows persons with chronic pain to tolerate it better. Freischlag (1981) noted the ability of athletes, such as marathoners, to dissociate from their bodily sensations during a race. Spink (1988) investigated the effects of dissociation and analgesia suggestions on the pain ratings of students performing a muscular endurance task. Research participants in the dissociation groups were given instruction and training on how to focus on something unrelated to the endurance task such as planning a trip or what they were going to do on the weekend. Despite a lack of differences in pain ratings between the three groups (dissociation, dissociation/analgesia, and control), the dissociation/analgesia group demonstrated significantly greater endurance on the task.

Giolas and Sanders (1992) found that women scoring above 20 on the Dissociative Experiences Scale (DES) were able to tolerate ischemic pain (using the sub-maximum effort tourniquet method) significantly longer than those women who scored less than 20. The overall level of pain ratings did not differ between the two groups, and DES scores were negatively correlated with ratings of suffering. Further support for the view of dissociation as a positive pain coping technique is seen in the literature addressing the utility of cognitive-behavioral techniques such as hypnosis and meditation for pain control. Persons taught such techniques (and who are, therefore, able to "dissociate" to some extent) frequently report lower pain ratings, increased pain thresholds, and less psychological distress (Spink, 1983; Tenenbaum, Kurtz, & Bienias, 1990) than no-treatment control groups.

Despite the positive impact that adaptive coping strategies can have on the pain experience, it appears that above and beyond knowledge and skill in these techniques, there is a need to demonstrate self-efficacy beliefs with regard to control over one's pain condition if gains in physical and emotional functioning are to be maintained. Self-efficacy outcome expectancies in this study were strongly related to pain intensity and depression; thus, the greater a person's self-reported pain intensity and level of depression, the less perceived control he/she felt over his/her condition.

The strong relationship demonstrated between pain intensity and outcome expectancy in this study suggests major implications for the therapeutic and clinical treatment of pain. It seems that the greater efficacy a person feels that he/she has over his/her pain (which can be taught in the context of psychotherapy) the lower his/her pain, and the likelihood that he/she will see a decreased impact of his/her pain upon cognitive activities. The ramifications of this role for self-efficacy in the therapeutic treatment of chronic pain also extend to the relationship that was further verified in this study between pain intensity and level of fatigue. The teaching of self-care and techniques for controlling and reducing pain in the context of improving self-efficacy may serve to also decrease one's level of fatigue (or vise versa).

Several studies have demonstrated the impact of self-efficacy beliefs on acute and chronic pain tolerance (Dolce, 1987). Bandura et al. (1987) reported that greater perceived self-efficacy among research participants (36 male and 36 female undergraduates) taught cognitive pain control techniques was associated with greater endurance of increasing pain stimulation. This finding held even when pain medication conditions were manipulated. Research participants with a strong sense of efficacy to endure pain were able to tolerate it longer, regardless of whether or not they received placebo medication. Those research participants without this feeling of efficacy in the management of pain, demonstrated less tolerance of acute pain, in both the placebo medication and no medication conditions. These authors suggest that a sense of low self-efficacy may even serve to decrease the effectiveness of actual analgesics. Stevens and Turner (1993) also found that perceived efficacy of self-generated coping strategies increased pain tolerance among persons experiencing acute pain. Other studies have indicated a positive relationship between self-efficacy, treatment outcome and health status (Brown & Nicassio, 1987; Nicholas, Wilson, & Goyen, 1992).

Taken together, these numerous studies suggest that treatment programs designed for chronic pain patients may need to consider achievement of self-efficacy as the indicator of readiness to terminate. Typically, the success of pain clinic programs has been based upon the degree of physical improvement a client demonstrates (Hitchcock, Ferrell, & McCaffery). Jensen, Turner, and Romano (1994) examined the correlates of improved functioning and decreased use of health care services among pain patients completing an inpatient multidisciplinary pain program. The strongest predictors of maintained improvement over time were use of cognitive coping strategies, adaptive pain beliefs, and a strong sense of personal efficacy. Strategies such as increased physical exercise and use of rest were not associated with maintenance of treatment gains.

The lack of relationship between scores on the Cognitive Failures Questionnaire (CFQ) and the memory and attention measures used in this study is consistent with previous research examining the neuropsychological correlates of this instrument. The fact that it did, however, demonstrate a weak relationship with part C from the Stroop Test is supported by previous studies. Tipper and Baylis (1987) found that scores on the CFQ predicted efficiency of selective attention when normal research participants were required to respond to a target word in the presence of distracters that were either random letter sequences or words. The CFQ has been put forth as a measure of attention more than memory. Scores correlate with performance on divided attention tasks but do not predict performance on memory tasks (Wilkins and Baddeley, 1978).

Pollina, Greene, Tunick, and Puckett (1992, 1993) examined the self-reports of everyday memory among both young and old adults using the CFQ. These authors found that basic attention processes appeared to be the underlying mediator of many common memory failures reported by the research participants on this measure. Among the older men, illness and prescription drug use was associated with failure to encode information.

These attention-based, self-reported cognitive errors were related, however, to both depression and fatigue among the Pollina et al. (1992, 1993) samples. The increased incidence of minor errors of memory and attention found among the participants in this study experiencing higher levels of self-reported depression and fatigue is also consistent with what the literature says about the neuropsychological impact of affective disorders. King, Caine, and Cox (1993) compared the performance of patients with unipolar major depression and nondepressed control subjects on several measures of language, memory, and psychomotor functioning. These authors reported decreased scores among the depressed group on tests of verbal fluency and psychomotor speed. Others have found concentration problems, difficulty planning, and poorer memory for verbal information among depressed patients (see Watts, MacLeod, and Morris, 1988).

Scogin and Rohling (1989) found that self-reports of mental health functioning (using the SCL-90) were related to older adults' subjective assessments of their memory. Rabbitt and Abson (1990) demonstrated a positive relationship between scores on the Beck Depression Inventory and the CFQ among their sample of older adults. Research participants in their sample with higher self-reported depression also indicated a greater frequency of misplacing and losing objects. Dufton (1989) reported that among persons with chronic pain, the tendency to make cognitive errors was associated with emotional difficulties, not pain-related variables. The results of this study do not dispute this.

Other studies using chronic pain patients have noted the cognitive inefficiencies reported by these persons (e.g. disturbances of attention, concentration, and memory) but either failed to establish a link between these complaints and pain (see Sprock et al., 1983) or did not validate these complaints beyond self-report measures (see Almay, 1997; and Jamieson, Sbrocco, and Parris, 1988). This study did not find a relationship between pain intensity and frequency of cognitive errors; however, it is possible that differences in temporal context between these measures may have diminished the potential for establishing such a relationship (the pain intensity rating was based on pain being experienced during the session while the CFQ score was based on frequency of errors made during the previous six months).

Limitations of This Study

Though this study did not provide support for the impact of pain upon tasks involving effortful processing and explicit memory, several limitations are also apparent. The chronic pain participants in this study were limited to persons who had received previous diagnoses of arthritis. Since chronic pain conditions can vary in terms of cause and symptoms, applying these findings to persons without arthritis should be approached with caution. The gender imbalance of females to males, while ecologically valid for this population, also makes it difficult to generalize the findings to males with chronic pain conditions. Another sample-based shortcoming, typical of studies involving volunteer participants, was the educated, and middle to upper socioeconomic composition of the sample and their willingness to complete a fairly lengthy test protocol. This further limits generalization to persons outside of this range.

Limitations to clinical research with pain populations may also be imposed by the medication a person may be taking for his/her condition. While this may affect a subject's pain reports, it is an issue that is difficult to control ethically. No relationship was found in this study between time since medication intake, and either test performance or pain intensity; thus, no correction formula was felt necessary. The majority of participants reported use of non-steroidal anti-inflammatories for treatment of their arthritis. This class of drugs does not involve known side effects which would impact upon cognitive abilities. However, the potential impact of medication intake upon subsequent pain ratings and test performance can not be ignored.

Directions for Future Research

The findings of this study offer several suggestions for future research. Cross-validation of the procedures, with some modifications, with another organic chronic pain group is needed to ensure that the results obtained in this study are not merely an artifact of the sample. Further, a greater number of participants in the high pain intensity range may help to bring the potential relationship between pain and test performance to light. Given the difficult nature of research that employs clinical populations, and the reduced likelihood of persons with increased pain participating, the questions of this study may first need to be addressed using acute pain paradigms. Future samples should also incorporate a larger proportion of male research participants to provide for greater generalizability to both genders.

It may also be necessary in future studies to have a person report his/her pain level at the time that each measure is administered. This would allow a direct comparison between test scores and concurrent pain intensity. Last, more difficult measures may be required in order to ensure that the tasks truly involve effortful processing and explicit memory. The question of whether pain differentially affects processing of the right or left hemisphere remains unanswered. The development of neuro-imaging studies with this population may provide a window into the brain not previously available.

Conclusions

Although this study was not able to establish a relationship between pain intensity and attention and memory, the presence of a chronic pain condition in an individual may not allow opportunity for maximal cognitive performance. This has consequences for many aspects of daily living, both inside and outside of the home. The findings of this study, and those previously conducted, also suggest that rehabilitation and treatment plans should include intervention aimed at facilitating or increasing memory and concentration skills through pain control techniques or cognitive compensation strategies. Many patients seen in rehabilitation settings present with chronic pain injuries or conditions, yet the impact of these upon cognition are often ignored.

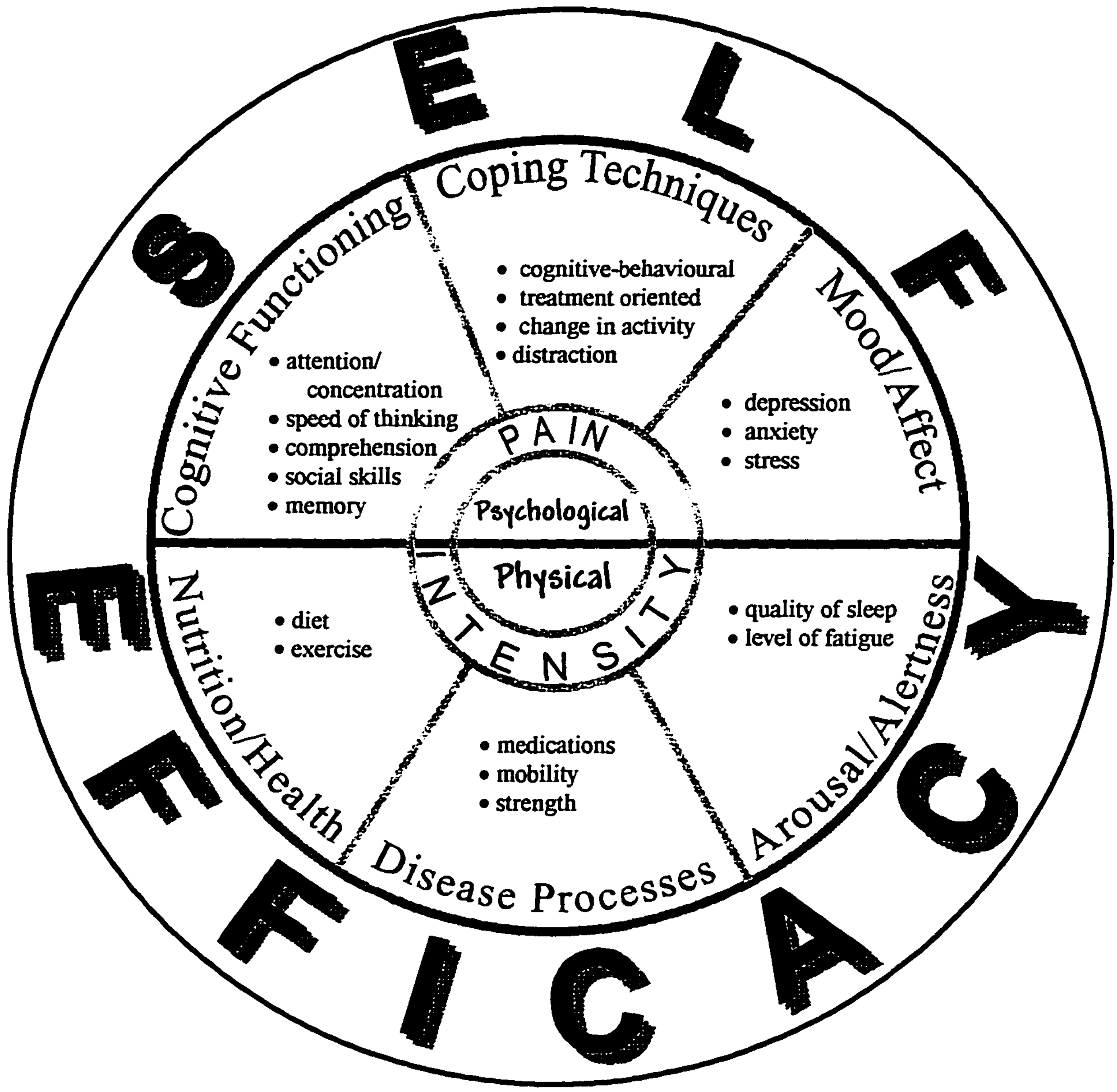
In those patients who demonstrate an absence of depression and other significant emotional factors that may exacerbate their pain, the focus may need to be on skills for enhancing attention, concentration and memory, and techniques for decreasing their pain intensity. For those persons who do demonstrate a strong emotional component to their pain condition (and subsequent cognitive difficulties), the therapist may first need to make emotional functioning and self-efficacy a focus in treatment. Knowledge of, and skill in, various pain control techniques does not appear on its own to be enough, however, as research has also demonstrated that the clients need to have a sense of self-efficacy with regard to themselves and these techniques. In this study, self-efficacy outcome expectancy, on its own, accounted for a significant amount of unique variance in pain intensity.

The strong relationship between pain intensity and level of fatigue seen among the participants in this study also suggests the need to make management of one's daily routine and activity level a focus of treatment. Again, the importance of pain control techniques, and one's self-efficacy, can not be overemphasized, as research has demonstrated a causal link between intensity and amount of pain, and consequent levels of fatigue. Further, persons with chronic pain who maintain a level of physical activity and nutritional balance, and perceive this to be an important part of their treatment, also tend to report fewer pain related problems.

Taken together, the results of this study and others, indicate the need for treatment of pain to be multidimensional and multifaceted. Figure 5 presents a model of proposed contributing factors to both perceived pain intensity and functional adaptation. This model provides a foundation for treatment of chronic pain that incorporates the findings of this study with that of previous research. What differs in this model, from others that have been suggested, is the role of self-efficacy with regard to the various physical and psychological treatment interventions. Self-efficacy has been demonstrated as a critical factor in the maintenance of gains for numerous types of treatment programs, including smoking cessation, weight loss, cardiovascular health, and chronic pain (see DiClemente, 1981; Fleury, 1992; Kores et al., 1990; and Weinberg et al., 1984), yet it is typically not used as an indicator of readiness to terminate.

Figure 5

Contributing Factors to Perceived Pain Intensity and Functional Adaptation



Last, it would seem warranted to assess pain intensity when conducting neuropsychological or intellectual assessments of client populations presenting with pain problems. Interpretation of cognitive performance would be cautioned for those patients experiencing pain at the time of the assessment, particularly on those measures involving explicit memory and effortful processing.

Despite the lack of unequivocal support for the impact of pain upon cognitive functioning, the results of this study do suggest the need for further research to understand the relationship of poor performance on cognitive tasks to the etiology, maintenance, and rehabilitation of pain problems (Kewman, Vaishampayan, Zald, & Han, 1991). This research represents the preliminary investigation of an issue important to pain patients that has not been previously addressed in the literature. As with any initial attempt to explore new areas of research, time and further study are often necessary to refine and modify the initial methodology and experimental procedures. Few people would dispute the potential for pain to impact one's ability to focus on a difficult task; however, further research is necessary before any firm conclusions can be drawn about this perplexing and complex problem.

References

Ahles, T. A., Ruckdeschel, J. C., & Blanchard, E. B. (1984). Cancer-related pain, II: Assessment with visual analogue scales. Journal of Psychosomatic Research, 28, 121-124.

Almay, B. C. (1987). Clinical characteristics of patients with idiopathic pain syndromes: Depressive symptomology and pain patient drawings. Pain, 29, 335-346.

Anderson, R. A., Baron, R. S., & Logan, H. (1991). Distraction, control, and dental stress. Journal of Applied Social Psychology, 21(2), 156-171.

Arntz, A. & de Jong, P. (1993). Anxiety, attention and pain. Journal of Psychosomatic Research, 37(4), 423-431.

Astrand, N. E. (1987). Medical, psychological, and social factors associated with back abnormalities and self-reported back pain: A cross-sectional study of male employees in a Swedish pulp and paper industry. British Journal of Industrial Medicine, 44, 327-336.

Bandura, A. (1977). Social learning theory. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A., O'Leary, A., Taylor, C. B., Gauthier, J., & Gossard, D. (1987). Perceived self-efficacy and pain control: Opiod and nonopiod mechanisms. Journal of Personality and Social Psychology, 53(3), 563-571.

Basbaum, A. I. & Fields, H. L. (1978). Endogenous pain control mechanisms: Review and hypothesis. Annals of Neurology, 4, 451-62.

Beatty, W. W. & Monson, N. (1991). Metamemory in multiple sclerosis. Journal of Clinical and Experimental Neuropsychology, 13(2), 309-327.

Blair, J. R. & Spreen, O. (1989). Predicting premorbid IQ: A revision of the National Adult Reading Test. Clinical Neuropsychologist, 3, 129-136.

Bondi, M. W., Kaszniak, A. W., Rapcsak, S. Z. & Butters, M. A. (1993). Implicit and explicit memory following anterior communicating artery aneurysm rupture. Brain and Cognition, 22, 213-229.

Bower, G. H. (1981). Mood and memory. American Psychologist, 36, 129-148.

Bower, G. H., Gilligan, S. G., & Monteiro, K. P. (1981). Selectivity of learning caused by affective states. Journal of Experimental Psychology, 110, 451-473.

Broadbent, D. E. (1958). Perception and communication. London: Pergamon Press.

Broadbent, D. E., Cooper, P. F., Fitzgerald, P., & Parkes, K. R. (1982). The Cognitive Failures Questionnaire (CFQ) and its correlates. British Journal of Clinical Psychology, 21, 1-16.

Brown, G. K. (1990). A causal analysis of chronic pain and depression. Journal of Abnormal Psychology, 99, 127-137.

Brown, G. K. & Nicassio, P. M. (1987). Development of a questionnaire for the assessment of active and passive coping strategies in chronic pain patients. Pain, 31, 53-64.

Bruera, E., Macmillan, K., Hanson, J., & MacDonald, R. N. (1989). The cognitive effects of the administration of narcotic analgesics in patients with cancer pain. Pain, 39(1), 13-16.

Bruera, E., Fainsinger, R. L., Miller, M. J., & Kuehn, N. (1992). The assessment of pain intensity in patients with cognitive failure: A preliminary report. Journal of Pain and Symptom Management, 7(5), 267-270.

Butters, N. & Miliotis, P. (1985). Amnestic disorders. In K. M. Heilman & E. Valenstein, (Eds.), Clinical Neuropsychology (2nd ed.). New York: Oxford.

Canadian Psychological Association. (1988). Canadian code of ethics for psychologists. Old Chelsea, Quebec: Author.

Carlesimo, G. A. & Oscar-Berman, M. (1992). Memory deficits in Alzheimer's patients: A comprehensive review. Neuropsychology Review, 3, 119-169.

Cavenaugh, S. V., Clark, D. C., & Gibbons, R. D. (1983). Diagnosing depression in the hospitalized medically ill. Psychosomatics, 24, 809-815.

Chen, A. C. N. & Dworkin, S. F. (1985). Human pain and evoked potentials: Possible assessment of headache with endogenous brain potentials triggered by the R wave of EKG in pain patients. Clinical Applications of Evoked Potentials in Neurology, 389-395.

Cimprich, B. (1992). Attentional fatigue following breast cancer surgery. Research in Nursing and Health, 15, 199-207.

Covelli, V., Antonaci, F. & Puca, F. M. (1984). Pain, affective life and memory impairment. Acta-Neurologica, 6(6), 455-461.

Coyne, J. C. & Gotlib, I. H. (1983). The role of cognition in depression: A critical appraisal. Psychological Bulletin, 94, 472-505.

Crawford, J. R., Stewart, L. E., Besson, J. A. O., Parker, D. M., & De Lacey, G. (1989). Prediction of WAIS IQ with the National Adult Reading Test: Cross-validation and extension. British Journal of Clinical Psychology, 28, 267-273.

Davis, G. C., Cortez, C., & Rubin, B. R. (1990). Pain management in the older adult with rheumatoid arthritis or osteoarthritis. Arthritis Care and Research, 3(3), 127-131.

Deary, I. J., Langan, S. J., Hepburn, D. A., & Frier, B. M. (1991). Which abilities does the PASAT test? Personality and Individual Differences, 12(10), 983-987.

Delis, D. C., Kramer, J. H., Kaplan, E., & Ober, B. A. (1987). The California Verbal Learning Test - research edition. New York: The Psychological Corporation.

Delis, D. C., Freeland, J., Kramer, J. H., & Kaplan, E. (1988). Integrating clinical assessment with cognitive neuroscience: Construct validation of the California Verbal Learning Test. Journal of Consulting and Clinical Psychology, 56(1), 123-130.

Delis, D. C. (1989). Neuropsychological assessment of learning and memory. In F. Boller and J. Grafman (Eds.), Handbook of Neuropsychology, Vol. 3 (pp. 3-33). Amsterdam: Elselvier Science Publishers.

Devins, G. M., Edworthy, S. M., Paul, L. C., Mandin, H. et al. (1993). Restless sleep, illness intrusiveness, and depressive symptoms in three chronic illness conditions: Rheumatoid arthritis, end-stage renal disease, and multiple sclerosis. Journal of Psychosomatic Research, 37, 163-170.

DiClemente, C. C. (1981). Self-efficacy and smoking cessation maintenance: A preliminary report. Cognitive Therapy and Research, 5(2), 175-187.

Dolce, J. J., Crocker, M. F. & Doleys, D. M. (1986). Prediction of outcome among chronic pain patients. Behavior Research and Therapy, 24, 313-319.

Dolce, J. J. (1987). Self-efficacy and disability beliefs in behavioral treatment of pain. Behavior Research and Therapy, 25(4), 289-299.

Downie, W. W., Leatham, P. A., Rhind, V. M., Wright, V., Brancho, J. A., & Anderson, J. A. (1978). Studies with pain rating scales. Annals of Rheumatic Diseases, 37, 378-381.

Dufton, B. D. (1989). Cognitive failure and chronic pain. International Journal of Psychiatry in Medicine, 19, 291-297.

Duggleby, W. & Lander, J. (1994). Cognitive status and postoperative pain: Older adults. Journal of Pain and Symptom Management, 9, 19-27.

Dunn, V. K. & Sacco, W. P. (1989). Psychometric evaluation of the geriatric depression scale and the Zung self-rating depression scale using an elderly community sample. Psychology and Aging, 4(1), 125-126.

Edwards, L., Pearce, S., Collett, B. J., & Pugh, R. (1992). Selective memory for sensory and affective information in chronic pain and depression. British Journal of Clinical Psychology, 31(2), 239-248.

Egan, V. (1988). Paced auditory serial addition test: Observed correlations with IQ. Personality and Individual Differences, 9, 179-180.

Eich, E., Reeves, J. L., Jaeger, B. & Graff-Radford, S. B. (1985). Memory for pain: Relationship between past and present pain intensity. Pain, 23, 375-380.

Ellis, N. R., Woodley, Z., Dulaney, C. L. & Palmer, R. L. (1989). Automatic-effortful processing and cognitive inertia in persons with mental retardation. American Journal on Mental Retardation, 93, 412-423.

Erskine, A., Morley, S., & Pearce, S. (1990). Memory for pain: A review. Pain, 41, 255-265.

Ferrell, B. A., Ferrell, B. R., & Osterweil, D. (1990). Pain in the nursing home. Journal of the American Geriatric Society, 38, 409-414.

Feuerstein, M., Carter, R. L., & Papciak, A. S. (1987). A prospective analysis of stress and fatigue in recurrent low back pain. Pain, 31(3), 333-444.

Fiedler, K. & Stroehm, W. (1985). What kind of mood influences what kind of memory: The role of arousal and information structure. Journal of Experimental Psychology, 114, 104-118.

Fields, H. (1991). Depression and pain: A neurobiological model. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 4(1), 83-92.

Fleury, J. (1992). The application of motivational theory to cardiovascular risk reduction. Image Journal of Nursing Scholarship, 24(3), 229-239.

Freischlag, J. (1981). Selected psycho-social characteristics of marathoners. International Journal of Sport Psychology, 12(4), 282-288.

Gallie, K. (1994). Neuroimaging and related techniques for determining measurable effects of pain in the human nervous system: A literature review in the quest for "objective" pain measures. Post-Doctoral Consultancy: Workers' Compensation Board of British Columbia, Richmond, B.C..

Gardner, W. J. & Licklider, J. C. R. (1959). Auditory analgesia in dental operations. Journal of the American Dental Association, 59, 1144-1149.

Giolas, M. R. & Sanders, B. (1992). Pain and suffering as a function of dissociation level and instructional set. Dissociation Progress in the Dissociative Disorders, 5(4), 205-209.

Graf, P., Uttl, B., & Tuokko, H. (1995). Color- and picture-word Stroop tests: Performance changes in old age. Journal of Clinical and Experimental Neuropsychology, 17(3), 390-415.

Grafman, J., Rao, S., Bernardin, L., & Leo, G. J. (1991). Automatic memory processes in patients with multiple sclerosis. Archives of Neurology, 48, 1072-1075.

Gronwall, D. M. A. (1977). Paced auditory serial addition task: A measure of recovery from concussion. Perceptual and Motor Skills, 44, 367-373.

Hamann, S. B. (1990). Level of processing effects in conceptually driven implicit tasks. Journal of Experimental Psychology, Learning, Memory, and Cognition, 16, 970-977.

Hamilton, V. (1980). An information processing analysis of environmental stress and life crises. In I. G. Sarason and C. D. Spielberger (Eds.), Stress and anxiety, vol. 7, (pp. 3-30). New York: Hemisphere Publishing Company.

Hartlage, S., Alloy, L. B., Vazquez, C., & Dykman, B. (1993). Automatic and effortful processing in depression. Psychological Bulletin, 113, 247-278.

Hasher, L. & Zacks, R. (1979). Automatic and effortful processes in memory. Journal of Experimental Psychology, 108, 356-388.

Heyer, L. & Blount, J. (1984). Concurrent and discriminant validities of the geriatric depression scale with older psychiatric patients. Psychological Reports, 54, 611-616.

Hitchcock, L. S., Ferrell, B. R., & McCaffery, M. (1994). The experience of chronic nonmalignant pain. Journal of Pain and Symptom Management, 9(5), 312-318.

Hodes, R. L., Howland, E. W., Lightfoot, N., & Cleeland, C. S. (1990). The effects of distraction on responses to cold pressor pain. Pain, 41(1), 109-114.

Hultsch, D. F., Masson, M. E., & Small, B. J. (1991). Adult age differences in direct and indirect tests of memory. Journal of Gerontology, 46, 22-30.

Hunter, M., Philips, C., & Rachman, S. (1979). Memory for pain. Pain, 6, 35-46.

Isen, A. M., & Shalker, T. E. (1982). The effect of feeling state on evaluation of positive, neutral and negative stimuli: When you "accentuate the positive" do you "eliminate the negative"? Social Psychology Quarterly, 45, 58-63.

Jamison, R. M., Sbrocco, T., & Parris, W. C. (1988). The influence of problems with concentration and memory on emotional distress and daily activity in chronic pain patients. International Journal of Psychiatry in Medicine, 18, 183-191.

Jelicic, M. & Bonke, B. (1991). Level of processing affects performance on explicit and implicit memory tasks. Perceptual and Motor Skills, 72, 1263-1266.

Jensen, M. P., Karoly, P., O'Riordan, E. F., Bland, F., & Burns, R. S. (1989). The subjective experience of acute pain: An assessment of the utility of ten indices. Clinical Journal of Pain, 5, 153-159.

Jensen, M. P. & Karoly, P. (1992). Self-report scales and procedures for assessing pain in adults. In D. C. Turk and R. Melzack (Eds.) Handbook of pain assessment. New York: Guilford Press.

Jensen, M. P., Turner, J. A., & Romano, J. M. (1991). Self-efficacy and outcome expectancies: Relationship to chronic pain coping strategies and adjustment. Pain, 44, 263-269.

Jones, A. K. P., Brown, W. D., Friston, K. J., Qi, L. Y., & Frackowiak, R. S. J. (1991). Cortical and subcortical localization of response to pain in man using positron emission tomography. Proceedings of the Royal Society of London, B Series, 244, 39-44.

Keefe, F. J., Wilkins, R. H., Cook, W. A., Crisson, J. E., & Muhlbaier, L. H. (1986). Depression, pain, and pain behavior. Journal of Consulting and Clinical Psychology, 54, 665-669.

Keefe, F. J., Caldwell, D. S., Queen, K., Gil, K. (1987b). Osteoarthritic knee pain: A behavioral analysis. Pain, 28, 309-321.

Kester, D. B., Saykin, A. J., Sperling, M. R., O'Connor, M. J., Robinson, L. J., & Gur, R. C. (1991). Acute effect of anterior temporal lobectomy on musical processing. Neuropsychologia, 29, 703-708.

Kewman, D. G., Vaishampayan, N., Zald, D. & Han, B. (1991). Cognitive impairment in musculoskeletal pain patients. International Journal of Psychiatry in Medicine, 21, 253-262.

King, D. A., Caine, E. D., & Cox, C. (1993). Influence of depression and age on selected cognitive functions. Clinical Neuropsychologist, 7(4), 443-453.

Kinsmen, R., Dirks, J. F., Wunder, J., Carbaugh, R., et al (1989). Multidimensional analysis of peak pain symptoms and experiences. Psychotherapy and Psychosomatics, 51(2), 101-112.

Kleinke, C. L. & Spangler, A. S. (1988). Psychometric analysis of the audiovisual taxonomy for assessing pain behavior in chronic pain patients. Journal of Behavioral Medicine, 11, 83-94.

Koenig, H. G., Meador, K. G., Cohen, H. J., & Blazer, D. G. (1988). Self-rated depression scales and screening for major depression in older hospitalized patients with medical illness. Journal of the American Geriatrics Society, 36, 699-796.

Kores, R. C., Murphy, W. D., Rosenthal, T. L., Elias, D. B., & North, W. C. (1990). Predicting outcome of chronic pain treatment via a modified self-efficacy scale. Behavior Research and Therapy, 28(2), 165-169.

Kreuger, G. P. (1989). Sustained work, fatigue, sleep loss and performance: A review of the issues. Work and Stress, 3(2), 129-141.

Kutner, K. C., Busch, H. M., Mahmood, T., Racis, S. P., & Krey, P. R. (1988). Neuropsychological functioning in systemic lupus erythematosus. Neuropsychology, 2(3-4), 119-126.

Levin, H. S., Goldstein, F. C., High, W. M., & Williams, D. (1988). Automatic and effortful processing after severe closed head injury. Brain and Cognition, 7, 283-297.

Lezak, M. D. (1983). Neuropsychological assessment (2nd ed.). New York: Oxford University Press.

Lowe, N. K. & Holm, K. (1988). Convergent and discriminative validity of questionnaire and visual analogue scale measures of pain and anxiety. Unpublished manuscript.

Luria, R. E. (1979). The use of visual analogue mood and alert scales in diagnosing hospitalized affective psychoses. Psychological Medicine, 9, 155-164.

Lyons, J. S., Strain, J. J., Hammer, J. S., & Fulop, G. (1989). Reliability, validity, and temporal stability of the geriatric depression scale in hospitalized elderly. International Journal of Psychiatry In Medicine, 19(2), 203-209.

Marek, T., Noworol, C., & Karwowski, W. (1988). Mental fatigue at work and pain perception. Work and Stress, 2(2), 133-137.

McAllister, T. W. (1981). Cognitive functioning in the affective disorders. Comprehensive Psychiatry, 22, 572-586.

McArthur, D. L., Cohen, M. J., Gottlieb, H. J., Naliboff, B. D. & Schandler, S. L. (1987). Treating chronic low back pain: I. Admissions to initial follow-up. Pain, 29, 1-22.

McCaul, K. D. & Malott, J. M. (1984). Distraction and coping with pain. Psychological Bulletin, 95, 516-533.

McCaul, K. D., Monson, N., & Maki, R. H. (1992). Does distraction reduce pain-produced distress among college students? Health Psychology, 11(4), 210-217.

McDowall, J. (1984). Recall of pleasant and unpleasant words in depressed research participants. Journal of Abnormal Psychology, 93, 401-407.

Melzack, R. (1961). The perception of pain. San Francisco: W. H. Freeman.

Melzack, R. & Casey, K. L. (1968). Sensory, motivational, and central control determinants of pain: A new conceptual model. In D. Kenshalo (Ed.), The skin senses. Springfield, Ill.: Thomas.

Melzack, R & Wall, P. (1988). The challenge of pain. Suffolk: Richard Clay Ltd.

Mersky, H., & Spear, F. G. (1967). Pain, psychological and psychiatric aspects. London: Bailliere, Tindall & Cassell.

Miller, G. A. (1956). The magical number seven plus or minus two: Some limits on our capacity for processing information. Psychological Review, 63, 81-97.

Miller, L. (1990). Chronic pain complicating head injury recovery: Recommendations for clinicians. Cognitive Rehabilitation, 12-18.

Milner, B. (1971). Interhemispheric differences and psychological processes. British Medical Bulletin, 27, 272-277.

Moffitt, P. F., Kalucy, E. C.; Kalucy, R. S., Baum, F. E., & Cook, R. D. (1991). Sleep difficulties, pain and other correlates. Journal of Internal Medicine, 230, 245-249.

Mueller, J. H., Esler, M. J. & Rollack, D. N. (1993). Test anxiety and implicit memory. Bulletin of the Psychonomic Society, 31, 531-533.

Nicassio, P. M. & Wallston, K. A. (1992). Longitudinal relationships among pain, sleep problems, and depression in rheumatoid arthritis. Journal of Abnormal Psychology, 101, 514-520.

Nicholas, M. K., Wilson, P. H., & Goyen, J. (1992). Comparison of cognitive-behavioral group treatment and an alternative non-psychological treatment for chronic low back pain. Pain, 48, 339-347.

Niederehe, G. & Yoder, C. (1989). Metamemory perceptions in depressions of young and older adults. Journal of Nervous and Mental Disease, 177(1), 4-14.

Nobeck, C. R., Strominger, N. L. & Demarest, R. J. (1991). The human nervous system: Introduction and review (4th ed.). Philadelphia: Lea & Fibinger.

O'Donnell, J. P., MacGregor, L. A., Dabrowski, J. J., Oestreicher, J. M., & Romero, J. J. (1994). Construct validity of neuropsychological tests of conceptual and attentional abilities. Journal of Clinical Psychology, 50(4), 596-600.

Parkin, A. J. & Russo, R. (1990). Implicit and explicit memory and the automatic effortful distinction. European Journal of Cognitive Psychology, 2, 71-80.

Parmalee, P.A., Lawton, M. P., & Katz, I. R. (1989). Psychometric properties of the Geriatric Depression Scale among the institutionalized aged. Psychological Assessment: A Journal of Consulting and Clinical Psychology, 1(4), 331-338.

Pincus, T. & Callahan, L. F. (1993). Depression scales in rheumatoid arthritis: Criterion contamination in interpretation of patient responses. Special Issue: Psychosocial Aspects of Rheumatic Disease. Patient Education and Counseling, 20, 133-143.

Pollina, L. K., Greene, A. L., Tunick, R. H., & Puckett, J. M. (1993). Dimensions of everyday memory in late adulthood. Current Psychology: Developmental, Learning, Personality, Social, 12, 46-56.

Pollina, L. K., Greene, A. L., Tunick, R. H., & Puckett, J. M. (1992). Dimensions of everyday memory in young adulthood. British Journal of Psychology, 83, 305-321.

Posner, M. I. & Presti, D. E. (1987). Selective attention and cognitive control. Trends in Neurosciences, 10, 13-17.

Rabbitt, P. & Abson, V. (1990). "Lost and found": Some logical and methodological limitations of self-report questionnaires as tools to study cognitive aging. British Journal of Psychology, 81(4), 1-16.

Radanov, B. P., di Stefano, G., Schnidrig, A., & Sturzenegger, M. (1993). Psychosocial stress, cognitive performance and disability after common whiplash. Journal of Psychosomatic Research, 37(1), 1-10.

Radanov, B. P., Di Stefano, G., Schnidrig, A., Sturzenegger, M., & Augustiny, M. A. (1993). Cognitive functioning after common whiplash: A controlled follow-up study. Archives of Neurology, 50(1), 87-91.

Regard, M. (1981). Cognitive rigidity and flexibility: A neuropsychological study. Unpublished doctoral dissertation, University of Victoria, British Columbia, Canada.

Roediger, H. L. & McDermott, K. B. (1992). Depression and implicit memory: A commentary. Journal of Abnormal Psychology, 101, 587-591.

Rosenstiel, A. K., & Keefe, F. J. (1983). The use of coping strategies in chronic low back pain patients: Relationship to patient characteristics and current adjustment. Pain, 17, 33-44.

Rule, B. G., Harvey, H. Z., & Dobbs, A. R. (1989). Reliability of the geriatric depression scale for younger adults. Clinical Gerontologist, 9(2), 37-43.

Sandroni, P., Walker, C., & Starr, A. (1992). "Fatigue" in patients with multiple sclerosis: Motor pathway conduction and event-related potentials. Archives of Neurology, 49(5), 517-524.

Sandstrom, J. (1986). Clinical and social factors in rehabilitation of patients with chronic low back pain. Scandinavian Journal of Rehabilitation Medicine, 18, 35-43.

Sargent, J. & Solbach, P. (1988). Stress and headache in the workplace: The role of caffeine. Medical Psychotherapy - An International Journal, 1, 83-86.

Scogin, F. (1985). Memory complaints and memory performance: The relationship reexamined. Journal of Applied Gerontology, 4(2), 79-89.

Scogin, F. & Rohling, M. (1989). Cognitive processes, self-reports of memory functioning, and mental health status in older adults. Journal of Aging and Health, 1, 507-520.

Scott, J. & Huskisson, E. C. (1976). Graphic representation of pain. Pain, 2, 175-184.

Schachtel, B. P., Fillingim, J. M., Thoden, W. R., Lane, A. C., & Baybutt, R. I. (1988). Sore throat pain in the evaluation of mild analgesics. Clinical Pharmacology and Therapeutics, 44, 704-711.

Schneider, W., Dumais, S. T., & Shiffrin, R. M. (1984). Automatic and controlled processing and attention. In R. Parasuraman & D. R. Davies (Eds.), Varieties of Attention (pp. 1-27). Orlando, Fl.: Academic Press.

Schwartz, D. P., Barth, J. T., Dane, J. R., Drenan, S. E., DeGood, D. E., & Rowlingson, J. C. (1987). Cognitive deficits in chronic pain patients with and without history of head/neck injury: Development of a brief screening battery. The Clinical Journal of Pain, 3, 94-101.

Seltzer, S. F. & Yarczower, M. (1991). Selective encoding and retrieval of affective words during exposure to aversive stimulation. Pain, 47(1), 47-51.

Sepe, C., Colao, A. M., Merola, B., Massari, F. et al. (1993). Headache and memory impairment: Study on 100 headache patients. Acta Neurologica, 15(6), 421-426.

Sherman, E. M. S., Strauss, E., Spellacy, F., & Hunter, M. (in press). Construct validity of WAIS-R factors: Neuropsychological test correlates in adults referred for possible head injury. Psychological Assessment.

Shiffrin, R. M. & Schneider, W. (1977). Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. Psychological Review, 84, 127-190.

Shimamura, A. P. (1989). Disorders of memory: The cognitive science perspective. In F. Boller & J. Grafman (Eds.), Handbook of Neuropsychology, Vol. 3. Amsterdam: Elselvier Science Publishers.

Silberstein, S. D. (1992). Advances in understanding the pathophysiology of headache. Neurology, 42, 6-10.

Smith, W. L. & Duerksen, D. L. (1979). Personality and the relief of chronic pain: Predicting surgical outcome. Clinical Neuropsychology, 1, 35-39.

Soetens, E., Hueting, J., & Wauters, F. (1992). Traces of fatigue in an attention task. Bulletin of the Psychonomic Society, 30(2), 97-100.

Sohlberg, M. M. & Mateer, C. A. (1989). Introduction to cognitive rehabilitation: Theory and practice. New York: The Guilford Press.

Spinhoven, P., ter Kuile, M. M., Linssen, A. C. & Gazendam, B. (1989). Pain coping strategies in a Dutch population of chronic low back pain patients. Pain, 37, 77-83.

Spink, K. S. (1988). Facilitating endurance performance: The effects of cognitive strategies and analgesic suggestions. Sport Psychologist, 2(2), 97-104.

Spink, P. J. (1983). Hypnosis in the relief of pain: A literature review. Medical Hypnoanalysis, 4(1), 12-16.

Spreen, O. & Strauss, E. (1991). A compendium of neuropsychological tests. New York: Oxford University Press.

Sprock, J., Braff, D. L., Saccuzzo, D. P., & Atkinson, J. H. (1983). The relationship of depression and thought disorder in pain patients. British Journal of Medical Psychology, 56, 351-360.

Squire, L. R. (1992). Declarative and nondeclarative memory: Multiple brain systems supporting learning and memory. Journal of Cognitive Neuroscience, 4, 232-243.

Stevens, M. J. & Turner, J. L. (1993). Moderators of cognitive coping derived from attentional and parallel processing models of pain. Imagination, Cognition and Personality, 12(4), 341-353.

Swanson, D. W., Maruta, T., & Wolff, V. (1986). Ancient pain. Pain, 25, 383-387.

Szekely, J. I., Torok, K., Karczag, I., Tolna, J., & Till, M. (1986). Effects of D-Met-sup-2, Pro-sup-5-enkephalinamide on pain tolerance and some cognitive functions in man. Psychopharmacology, 89(4), 409-413.

Tabachnick, B. G. & Fidell, L. S. (1989). Using Multivariate Statistics, Second Edition. Northridge, California State University: Harper Collins.

Tack, B. B. (1990). Fatigue in rheumatoid arthritis: Conditions, strategies, and consequences. Arthritis Care and Research, 3, 65-70.

Tack, B. B. (1990). Self-reported fatigue in rheumatoid arthritis: A pilot study. Arthritis Care and Research, 3(3), 154-157.

Talbot, J. D., Marrett, S., Evans, A. C., Meyer, E., Bushnell, M. C., & Duncan, G. H. (1991). Multiple representations of pain in human cerebral cortex. Science, 251, 1355-1358.

Teasdale, J. D., & Russell, M. L. (1983). Differential effects of induced mood on the recall of positive, negative, and neutral words. British Journal of Clinical Psychology, 22, 163-171.

Tenenbaum, S. J., Kurtz, R. M., & Bienias, J. L. (1990). Hypnotic susceptibility and experimental pain reduction. American Journal of Clinical Hypnosis, 33(1), 40-49.

Teske, K., Daut, R. L., & Cleeland, C. S. (1983). Relationships between nurses' observations and patients' self-reports of pain. Pain, 16, 289-296.

Tipper, S. P. & Baylis, G. C. (1987). Individual differences in selective attention: The relation of priming and interference to cognitive failure. Personality and Individual Differences, 8, 667-675.

Tomporowski, P. D. & Ellis, N. R. (1986). The effects of exercise on cognitive processes: A review. Psychological Bulletin, 99, 338-346.

Townsend, L. A. (1992). Adult chronic pain: The development of an assessment model. Unpublished master's thesis, University of Victoria, Victoria, British Columbia, Canada.

Turner, J. A., & Clancy, S. (1986). Strategies for coping with chronic low back pain: Relationship to pain and disability. Pain, 24, 355-364.

Villard, H. P., Imbeault, J. & Duguay, M. (1986). Low-back pain: A psychosomatic clinical study. Psychotherapy and Psychosomatics, 45, 78-83.

Waddell, G. (1987). A new clinical model for the treatment of low-back pain. Spine, 12(7), 632-644.

Watts, F. N., MacLeod, A. K., & Morris, L. (1988). Association between phenomenal and objective aspects of concentration problems in depressed patients. British Journal of Psychology, 79(2), 241-250.

Watts, F. N. & Sherrock, R. (1985). Description and measurement of concentration problems in depressed patients. Psychological Medicine, 15, 317-326.

Wechsler, D. (1987). Wechsler Memory Scale - Revised. New York: Psychological Corporation.

Weinberg, R. S., Hughes, H. H., Critell, J. W., England, R., & Jackson, A. (1984). Effects of preexisting and manipulated self-efficacy on weight loss in a self-control program. Journal of Research in Personality, 18(3), 352-358.

Weingartner, H., Cohen, R. M., Murphy, D. L., Martello, J., & Gerdt, C. (1981). Cognitive processes in depression. Archives of General Psychiatry, 38, 42-47.

Weins, A. N., Bryan, J. E. & Crossen, J. R. (1992). Estimating WAIS-R FSIQ from the National Adult Reading Test - Revised in normal research participants. The Clinical Neuropsychologist, 7, 7-84.

Westin, C. G. (1973). Low back sick listing. Scandinavian Journal of Social Medicine, Supplementum, 7.

Wewers, M. E. & Lowe, N. K. (1990). A critical review of visual analogue scales in the measurement of clinical phenomena. Research in Nursing and Health, 13, 227-236.

Widner, S. & Zeichner, A. (1993). Psychologic intervention for the elderly chronic pain patient. Clinical Gerontologist, 13, 3-18.

Wilkins, A. J. & Baddeley, A. (1978). Remember to recall in everyday life: An approach to absent-mindedness. In M. M. Grunberg, P. E. Morris, and R. N. Sykes (Eds.) Practical Aspects of Memory, Academic Press: London.

Williams, S. L. & Kinney, P. J. (1991). Performance and nonperformance strategies for coping with acute pain: The role of perceived self-efficacy, expected outcome, and attention. Cognitive Therapy and Research, 15(1), 1-19.

Wine, J. (1971). Test anxiety and direction of attention. Psychological Bulletin, 76, 92-104.

Workers' Compensation Board of British Columbia. (1991). Report of the task force on chronic pain syndrome. Richmond, B.C., Canada.

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M. B., & Leirer, V. O. (1983). Development and validation of a geriatric depression rating scale: A preliminary report. Journal of Psychiatric Research, 17, 37-49.

Yesavage, J. A., Brink, T. L., Rose, T. L., & Adey, M. (1986). The geriatric depression rating scale: Comparison with other self-report scales. In L. Poon (Ed.) Handbook of Clinical Memory Assessment of Older Adults, American Psychological Association: Washington, D.C..

Zeitlin, C. & Oddy, M. (1984). Cognitive impairment in patients with severe migraine. British Journal of Clinical Psychology, 23, 27-35.

APPENDIX I

Order of Test Administration

<u>Order 1</u>

Consent Form
Interview Questions
Pain Rating #1
Level of Fatigue, Rating #1
Self-Perception Rating Re: Impact of Pain on Concentration/Memory
Quality of Sleep Rating

Direct Recall After Lexical Decision Task
Stem-Completion Measure
PASAT
Mood Assessment Scale
Cognitive Failures Questionnaire
Coping Strategies/Rating of Pain Control
Pain Rating #2

Level of Fatigue, Rating #2
NAART

CVLT (Immediate/Short Delay Trials)
Stroop Test
Visual Memory Span
Digit Span
CVLT (Delay/Recognition Trials)

Pain Rating #3
Level of Fatigue, Rating #3

<u>Order 2</u>

Consent Form
Interview Questions
Pain Rating #1
Level of Fatigue, Rating #1

NAART
CVLT (Immediate/Short Delay Trials)

Stroop Test
Visual Memory Span
Digit Span
CVLT (Delay/Recognition Trials)
Pain Rating #2

Level of Fatigue, Rating #2
Self-Perception Rating Re: Impact of Pain on Concentration/Memory
Quality of Sleep Rating
Direct Recall After Lexical Decision Task

Stem-Completion Measure
PASAT
Mood Assessment Scale
Cognitive Failures Questionnaire
Coping Strategies/Rating of Pain Control
Pain Rating #3
Level of Fatigue, Rating #3

APPENDIX II

North American Adult Reading Test

ID#___________

I want you to read slowly down this list of words starting with the left column and continuing with the right. After each word please wait until I say 'next' before you read the next word. There are many words that most people do not recognize, so just guess at these.

DEBT
DEBRIS
AISLE
REIGN
DEPOT
SIMILE
LINGERIE
RECIPE
GOUGE
HEIR
SUBTLE
CATACOMB
BOUQUET
GAUGE
COLONEL

SUBPOENA
PLACEBO
PROCREATE
PSALM
BANAL
RAREFY
GIST
CORPS
HORS D'OEUVRE
SIEVE
HIATUS
GAUCHE
ZEALOT
PARADIGM
FACADE

CELLIST
INDICT
DETENTE
IMPUGN
CAPON
RADIX
AEON
EPITOME
EQUIVOCAL
REIFY
INDICES
ASSIGNATE
TOPIARY
CAVEAT
SUPERFLUOUS

LEVIATHAN
PRELATE
QUADRUPED
SIDEREAL
ABSTEMIOUS
BEATIFY
GOALED
DEMESNE
SYNCOPE
ENNUI
DRACHM
CIDEVANT
EPERGNE
VIVACE
TALIPES
SYNECDOCHE

APPENDIX III

Mood Assessment Scale

ID#__________

1. Are you basically satisfied with your life? .... YES/NO
2. Have you dropped many of your activities and interests? .... YES/NO
3. Do you feel that your life is empty? .... YES/NO
4. Do you often get bored? .... YES/NO
5. Are you hopeful about the future? .... YES/NO
6. Are you bothered by thoughts that you can't get out of your head? .... YES/NO
7. Are you in good spirits most of the time? .... YES/NO
8. Are you afraid that something bad is going to happen to you? .... YES/NO
9. Do you feel happy most of the time? .... YES/NO
10. Do you often feel helpless? .... YES/NO
11. Do you often get restless and fidgety? .... YES/NO
12. Do you prefer to stay home rather than go out & do new things? .... YES/NO
13. Do you frequently worry about the future? .... YES/NO
14. Do you feel you have more problems with memory than most? .... YES/NO
15. Do you think it is wonderful to be alive now? .... YES/NO
16. Do you often feel downhearted and blue? .... YES/NO
17. Do you feel pretty worthless the way you are now? .... YES/NO
18. Do you worry a lot about the past? .... YES/NO
19. Do you find life very exciting? .... YES/NO
20. Is it hard for you to get started on new projects? .... YES/NO
21. Do you feel full of energy? .... YES/NO
22. Do you feel that your situation is hopeless? .... YES/NO
23. Do you think that most people are better off than you are? .... YES/NO
24. Do you frequently get upset about little things? .... YES/NO
25. Do you frequently feel like crying? .... YES/NO
26. Do you have trouble concentrating? .... YES/NO
27. Do you enjoy getting up in the mornings? .... YES/NO
28. Do you prefer to avoid social gatherings? .... YES/NO
29. Is it easy for you to make decisions? .... YES/NO
30. Is your mind as clear as it used too be? .... YES/NO

APPENDIX IV

Score Sheets For Stroop Test, Visual Memory Span, and Digit Span

ID#______

STROOP TEST

Part D.		*Part C.*	
	G B Y R		G B Y R
	Y R G B		Y R G B
	B G Y R		B G Y R
	B Y R G		B Y R G
	R G B Y		R G B Y
	Y G B R		Y G B R
	Time:________		Time:________
	Errors:_______		Errors:_______

VISUAL MEMORY SPAN

Tapping Forward

1. 2-6	2. 8-4
3. 2-7-5	4. 8-1-6
5. 3-2-8-4	6. 2-6-1-5
7. 5-3-4-6-1	8. 3-5-1-7-2
9. 1-7-2-8-5-4	10. 7-3-6-1-4-8
11. 8-2-5-3-4-1-6	12. 4-2-6-8-3-7-5
13. 7-5-6-3-8-7-4-2	14. 1-6-7-4-2-8-5-3

Tapping Backward

1. 3-6	2. 7-4
3. 6-8-5	4. 3-1-8
5. 8-4-1-6	6. 5-2-4-1
7. 4-6-8-5-2	8. 8-1-6-3-7
9. 7-1-8-3-6-2	10. 3-8-1-7-5-4
11. 1-5-2-7-4-3-8	12. 6-7-4-3-1-5-2

TOTAL = ______

DIGIT SPAN

Digits Forward

1. 6-2-9	2. 3-7-5
3. 5-4-1-7	4. 8-3-9-6
5. 3-6-9-2-5	6. 6-9-4-7-1
7. 9-1-8-4-2-7	8. 6-3-5-4-8-2
9. 1-2-8-5-3-4-6	10. 2-8-1-4-9-7-5
11. 3-8-2-9-5-1-7-4	12. 5-9-1-8-2-6-4-7

Digits Backward

1. 5-1	2. 3-8
3. 4-9-3	4. 5-2-6
5. 3-8-1-4	6. 1-7-9-5
7. 6-2-9-7-2	8. 4-8-5-2-7
9. 7-1-5-2-8-6	10. 8-3-1-9-6-4
11. 4-3-7-9-1-2-8	12. 8-1-2-9-3-6-5

TOTAL = ________

APPENDIX V

Word List Recall Sheet

ID#____________

Please write down as many of the "real" words as you can think of that were presented to you in the lexical decision task.

________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________

APPENDIX VI

Word Completions

ID#____________

On this page are the first three letters of a number of English words. I would like you to add one or more letters to complete each word. In each case, several answers are possible. Fill in the letters of the first word you think of.

1. hea________
2. chi________
3. des________
4. nor________
5. cou________
6. rad________
7. sou________
8. mou________
9. cit________
10. met________
11. tru________
12. com________
13. hou________
14. eff________
15. tod________
16. mot________
17. cen________
18. hor________
19. blo________
20. exa________
21. min________
22. poi________
23. isl________
24. col________
25. mon________
26. mac________
27. cor________
28. wor________
29. mus________
30. mor________
31. stu________
32. spa________
33. sto________
34. deg________
35. wom________
36. mem________
37. def________
38. gro________
39. tra________
40. res________
41. riv________
42. fro________
43. val________
44. spi________
45. pri________
46. hum________
47. str________
48. pla________
49. hus________
50. boa________
51. fri________
52. cla________
53. att________
54. flo________
55. par________
56. fut________
57. sur________
58. rec________
59. gir________
60. tre________

APPENDIX VII

PASAT Scoring Sheet

ID#________

2.4 second pacing

2

7 (9)		8 (12)		5 (13)	
5 (12)		7 (15)		4 (9)	
1 (6)		1 (8)		8 (12)	
4 (5)		6 (7)		2 (10)	
9 (13)		3 (9)		1 (3)	
6 (15)		5 (8)		7 (8)	
5 (11)		9 (14)		5 (12)	
3 (8)		2 (11)		9 (14)	
8 (11)		7 (9)		1 (10)	
4 (12)		5 (12)		3 (4)	
3 (7)		3 (8)		6 (9)	
2 (5)		4 (7)		2 (8)	
6 (8)		7 (11)		9 (11)	
9 (15)		1 (8)		7 (16)	
3 (12)		5 (6)		8 (15)	
4 (7)		8 (13)		2 (10)	
5 (9)		3 (11)		4 (6)	
8 (13)		4 (7)		7 (11)	
6 (14)		6 (10)		6 (13)	
4 (10)		8 (14)		3 (9)	

TOTAL CORRECT: __________

APPENDIX VIII

California Verbal Learning Test

ID# ________

LIST A (Monday)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
drill					
plums					
vest					
parsley					
grapes					
paprika					
sweater					
wrench					
chives					
tangerines					
chisel					
jacket					
nutmeg					
apricots					
pliers					
slacks					

LIST B (Tuesday)	Trial 1	*LIST A SHORT DELAY FREE RECALL*	*LIST A SHORT DELAY CUED RECALL*	
toaster			Spices & Herbs:	Fruits:
cherries				
halibut				
ginger				
pineapple				
spatula				
oregano				
flounder			Tools:	Clothing:
sage				
lemons				
cod				
skillet				
peaches				
salmon				
cinnamon				
bowl				

CVLT Delay Trials

ID#____________

LIST A LONG DELAY FREE RECALL	*LIST A LONG DELAY CUED RECALL*		*LIST A LONG DELAY RECOGNITION*	
	Clothing:	Tools:	sweater	grapes
			oregano	salmon
			flounder	paprika
			rug	racket
			tires	ginger
			pepper	slacks
			jacket	books
			aspirin	parsley
	Fruits:	Spices & Herbs:	wax	vest
			drill	apples
			apricots	grill
			spatula	plums
			cherries	wrench
			drums	lemons
			chives	tapes
			film	vitamins
			chisel	pliers
			briefcase	bowl
			pastry	hammer
			tangerines	nutmeg
			clock	chimes
			shoes	soap

APPENDIX IX

VISUAL ANALOG SCALE FOR PAIN INTENSITY

Instructions: " Please use this scale to indicate your current level of pain, that is, your pain at this very minute."

Pain as bad as it could be

No pain

APPENDIX X

VISUAL ANALOG SCALE FOR LEVEL OF FATIGUE

Instructions: "Please use this scale to indicate your current level of fatigue. What your subjective sensation of generalized tiredness or exhaustion is at this very minute."

The most fatigued you could be

Not at all fatigued

APPENDIX XI

VISUAL ANALOG SCALE FOR QUALITY OF SLEEP LAST NIGHT

Instructions: "Please use the following scale to indicate your quality of sleep for last night, just last night only."

The worst it could be

The best it could be

APPENDIX XII

VISUAL ANALOG SCALE FOR CONCENTRATION AND MEMORY

Instructions: "Please use the following scale to indicate how much you feel that pain affects your ability to concentrate on and remember things in every day life."

Severely affected

Not at all affected

APPENDIX XIII

COGNITIVE FAILURES QUESTIONNAIRE

ID# ____________

The following questions are about minor mistakes which everyone makes from time to time, but some of which happen more often than others. We want to know how often these things have happened to you in the last six months. Please circle the appropriate number.

	Very often	Quite often	Occasionally	Rarely	Very Rarely
1. Do you read something and find you haven't been thinking about it and must read it again?	4	3	2	1	0
2. Do you find you forget why you went from one part of the house to the other?	4	3	2	1	0
3. Do you fail to notice signposts on the road?	4	3	2	1	0
4. Do you find you confuse right and left when giving directions?	4	3	2	1	0
5. Do you bump into people?	4	3	2	1	0
6. Do you find you forget whether you've turned off a light or a fire or locked the door?	4	3	2	1	0
7. Do you fail to listen to people's names when you are meeting them?	4	3	2	1	0
8. Do you say something and realize afterwards that it might be taken as insulting?	4	3	2	1	0
9. Do you fail to hear people speaking to you when you are doing something else?	4	3	2	1	0
10. Do you lose your temper and regret it?	4	3	2	1	0
11. Do you leave important letters unanswered for days?	4	3	2	1	0
12. Do you find you forget which way to turn on a road you know well but rarely use?	4	3	2	1	0
13. Do you fail to see what you want in a supermarket (although it's there)?	4	3	2	1	0
14. Do you find yourself suddenly wondering whether you've used a word correctly?	4	3	2	1	0
15. Do you have trouble making up your mind?	4	3	2	1	0
16. Do you find you forget appointments?	4	3	2	1	0
17. Do you forget where you put something like a news-paper or a book?	4	3	2	1	0
18. Do you find you accidentally throw away the thing you want and keep what you meant to throw away (e.g. throwing away the matchbox and putting the used match in your pocket)?	4	3	2	1	0
19. Do you daydream when you ought to be listening to something?	4	3	2	1	0
20. Do you find you forget people's names?	4	3	2	1	0
21. Do you start doing one thing at home and get distracted into doing something else (unintentionally)?	4	3	2	1	0
22. Do you find you can't quite remember something although it's on the tip of your tongue?	4	3	2	1	0
23. Do you find you forget what you came to the shops to buy?	4	3	2	1	0
24. Do you drop things?	4	3	2	1	0
25. Do you find you can't think of anything to say?	4	3	2	1	0

APPENDIX XIV

EFFECTIVENESS RATINGS FOR PAIN CONTROL

ID#_______

What are some of the ways in which you cope with your pain (e.g. undertake an activity, say something to yourself)? Please note these techniques below.

Based on all the things you do to cope or deal with your pain on an average day, how much control do you feel you have over it? Please circle the appropriate number. You can circle any number along the scale.

0	1	2	3	4	5	6
No control			Some control			Complete control

Based on all the things you do to cope or deal with your pain on an average day, how much are you able to decrease it? Please circle the appropriate number. Remember you can circle any number along the scale.

0	1	2	3	4	5	6
Can't decrease it at all			Can decrease it somewhat			Can decrease completely