

**COGNITIVE FUNCTIONING
AND ACADEMIC ACHIEVEMENT
IN CHILDREN AND ADOLESCENTS
WITH CHRONIC PAIN**

by

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B.A.(Hons.), The University of British Columbia, 2001

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS

In the
Department
of
Psychology

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SIMON FRASER UNIVERSITY

Fall 2005

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Your file *Votre référence*
ISBN: 978-0-494-16882-0
Our file *Notre référence*
ISBN: 978-0-494-16882-0

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ABSTRACT

The current study examined the profiles of cognitive functioning and academic achievement in school-aged children and adolescents with chronic pain. The standardized psychoeducational testing results of 57 patients (ages 8 to 18) seen at a major pediatric pain clinic between 1998 and 2004 were retrospectively reviewed. Pediatric pain patients scored higher in measures of general intelligence, verbal ability, nonverbal reasoning and processing speed than the general population. Verbal ability was a relative strength for many, while some exhibited relative weaknesses in working memory and processing speed. Their mean academic achievement was in the Average range on all of the scholastic domains covered. A subset of patients scored higher in reading and writing, but lower in arithmetic, than the general population. The level of academic achievement for most participants was consistent with their intellectual ability. The current research highlights the utility of incorporating psychoeducational assessments in treatments for pediatric chronic pain.

Keywords:

Chronic Pain, Pain in Children, Chronically Ill Children – Psychological Testing,
Children – Intelligence Levels, Academic Achievement

ACKNOWLEDGEMENTS

This project would not have been possible without the contributions of many. First I would like to thank my supervisory committee: Dr. David Cox for his guidance, encouragement, and attention to detail; and Dr. Gary Poole for his valuable feedback and his enthusiasm in health research. The support from both of them was what motivated me to take risks, to do better work, and to look at the data from different angles. I also would like to thank Dr. Ruth Grunau for donating her time to be the external examiner of my thesis defense.

At the British Columbia's Children's Hospital, I am forever indebted to Dr. Sue Bennett for her unconditional support during difficult times. This Master's degree would have been a distant dream without her generosity and trust in me. I am grateful to other staff members in the Department of Psychology, particularly Dr. Joyce Ternes, who always finds the time to be a mentor for the next generation of psychologists, and has helped me get this project started in a short period of time. My sincerest thanks to Drs. Julie Desroches and Tina Wang, the then-interns of the Department, whose precious advice and support would never be forgotten. I also would like to thank the staff of the Complex Pain Service for their cooperation and help in this project. Last but not least, I would like to thank the pediatric outpatients of the Complex Pain Service who have served as the participants of the current study. Their courage in facing the everyday challenge of a debilitating condition has been the source of inspiration for me and many others who work in the field.

At the University of British Columbia, I would like to thank Dr. Ralph Hakstian, who has been my statistics instructor since 1999. The statistical techniques I learned from his lectures have helped me tremendously when writing up this thesis. Dr. Kenneth Craig, my Honours thesis supervisor, has inspired me to do pain research in children. At Simon Fraser University, Dr. Marilyn Bowman has been my advocate throughout my MA. She would be greatly missed.

To my family, who remains confident in me even when I have lost hope. Their relentless support is what keeps me going in graduate school. The generosity of Mr. Anthony Tsang and Ms. Jennifer Li often warms my heart. Among my friends, I would like to thank Ms. Sirad Deria, who has been there for me since the beginning; Mr. Jason Li, Mr. Louis Ng, and Ms. Janet Tsang, who have been the greatest listeners and cheerleaders whenever I needed them; Dr. Tracey Brickell, whose understanding and sense of humour would always be cherished; and Drs. Michael Papsdorf and Michelle Haring, who have been my role models since my undergraduate days. Finally, I am grateful to have met Mr. Michael Y. C. Tsang, my companion through thick and thin for the last 10 years, whose love and acceptance have made everything worthwhile.

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INTRODUCTION

Theories of Pain

Pain is a universal yet mysterious experience that seems to defy a concrete definition. Traditionally, pain has been seen as a sensory response to tissue damage whose magnitude reflected the extent of injury (Melzack & Wall, 1996). Descartes, for example, conceptualized the pain system as a straightforward “alarm system” consisting of a direct connection between the skin and a specific pain centre in the brain. Von Frey, a physician in the late nineteenth century, proposed a similar theory in which skin receptors specific to the detection of pain transmit signal that is invariably perceived by the brain as pain. These theories imply that the origin of pain always lies in the periphery (e.g. in areas where skin receptors are found), and that there is a one-to-one relationship between the peripheral stimulation and the resultant psychological experience – that stimulation of certain receptors will elicit only the sensation of pain (Melzack & Wall, 1996). Yet research over the past four decades, while acknowledging that skin receptors are highly differentiated and specialized in their responses, has failed to confirm that the stimulation of one type of receptor or nerve fibre results in one and only one specific sensation. Clinical evidence has also suggested that pain can occur without signs of peripheral injury, and that factors other than sensory input can modulate the eventual quality and amount of pain.

In their groundbreaking Gate Control Theory in 1965, Melzack and Wall proposed that pain is not simply a sensation or a consequence of body injury (Melzack & Wall, 1996). It is instead a multidimensional experience encompassing sensory

components such as the detection of a nociceptive stimulus, cognitive factors such as past experience and interpretation of the pain sensation, and emotional responses towards the situation. In this theory, cells at the dorsal horn of the spinal cord – the interneurons at the substantia gelatinosa and spinal cord transmission cells for instance – act as a gate which modulates the amount and type of peripheral input to be transmitted to the brain (Hart, Martelli, & Zasler, 2000). Injury can activate nerve fibres such as the small myelinated A-delta fibres and the unmyelinated C fibres, which send nerve impulses to the spinal cord and form excitatory synapses with T cells at the dorsal horn (Zeltzer, Bush, Chen, & Rival, 1997). Descending pathways from the frontal cortex through the amygdala, periaqueductal gray matter, and rostral ventral medulla also synapse at the dorsal horn, permitting possible cognitive and emotional control of pain from the central nervous system (Zeltzer, Bush, et al., 1997; Villemure & Bushnell, 2002). These pathways form powerful, inhibitory synapses with the T cells through the action of inhibitory interneurons. Pain therefore involves a complex process of summation and cancellation of the activities between the peripheral and the central pain system at the T cells (Malleon, 1993). The Gate Control Theory is the most widely accepted theory of pain to date and has served as the guiding framework for research and clinical practice in pain over the past several decades (Hart et al., 2000). Research, for example, has suggested that chronic pain is more likely caused by dysfunction of the central system of pain (e.g. cerebral cortex and spinal cord) than by the continual innervation of peripheral nociceptors due to tissue injury (Sherry & Malleon, 2002). The theory also highlights the role of psychological factors such as cognition and emotion in determining the subsequent pain experience. Comprehensive pain assessment and treatment, therefore,

require an “integration of biological, psychological, family, and social factors” (Bursch, Walco, & Zeltzer, 1998, p.45).

Chronic Pain in Children

Pain has received considerable research and clinical attention in the adult population, as it is frequently associated with tremendous personal and economic costs such as staggering medical charges and lost work days (Goodman & McGrath, 1991; Palermo, 2000). Yet pain in children has been largely ignored. Pediatric pain is often considered as less debilitating, probably because the functional consequences of pain on children and adolescents cannot be as easily measured in terms of economic burden for society as those associated with adult pain (Varni et al., 1996). Numerous myths and misconceptions are also associated with pediatric pain, such as the belief that children are less sensitive to pain due to an immature nervous system, or that analgesics are harmful to children and should be avoided as much as possible. These assumptions, however, have not been substantiated by empirical research (Malleon, 1993; Kain & Rimar, 1995). Moreover, accurate pain assessment in children is fraught with challenges. While it is agreed that pain is a subjective experience and self-report is the “gold standard” in the assessment of pain, there is still debate over the reliability and validity of a child’s report of pain (Chambers, Giesbrecht, Craig, Bennett, & Huntsman, 1999). Even if parent reports are used as an estimate of the child’s pain, the poor agreement between parent reports and children’s self-report implies that a child’s level of disability may be underestimated if only the parent report is used (Anttila et al., 2004). These problems continue to plague the field and may have contributed to the “nonrecognition, dismissal and undermedication” of children’s pain (Brennan-Hunter, 2001).

Prevalence of Chronic Pain in Children

Despite the myths that children have an elevated pain threshold compared with adults and that pain is less important in children, epidemiological studies have revealed that recurrent pain syndromes are common among children, with the actual prevalence varying depending on pain types and the diagnostic criteria used. In a recent Dutch population-based study, 54% of their sample of over 5000 children up to the age of 18 reported pain within the past 3 months, with half of the reported pain lasting over 3 months (Perquin et al., 2000). The most common types of chronic pains in children are headaches, abdominal pain, and musculoskeletal pain (Palermo, 2000). In terms of headache, 10 to 30% of children in the community suffer from headaches on a weekly basis (Campo & Fritsch, 1994). In a sample of over 2,000 schoolchildren from Maastricht of the Netherlands, half of them reported headache pain occurring at least once a month, and 12% reported severe headache with a duration of at least an hour that occurred once a week or more (Bandell-Hoekstra et al., 2001). In terms of the prevalence of different subtypes of headache, Goodman and McGrath (1991) suggested that migraine occurs in 3% to 10% of the pediatric population. The prevalence of migraine has ranged from 3% to 15% in studies based on diagnostic criteria from the International Headache Society (e.g. Abu-Arefeh & Russell, 1994; Metsahonkala & Sillanpaa, 1994; Egger, Angold, & Costello, 1998), whereas tension-type headache has been found to occur in 10% to 12% of children (e.g. Anttila et al., 2002). In addition, 10 to 25% of schoolchildren and adolescents report recurrent abdominal pain, accounting for 2 to 4% of all pediatric office visits in a year (e.g. Larsson, 1991). Musculoskeletal pain is estimated to occur in 4.2 to 15.5% of children in nonclinical settings and in up to 32% of children in pediatric

rheumatology clinics (Aasland, Flato, & Vandvik, 1997). The prevalence of chronic pain also seems to be on the rise (Sillanpaa & Anttila, 1996). A steady increase in weekly neck-shoulder pain and back pain from 1985 to 2001, for example, was observed among Finnish adolescents (Hakala et al., 2002).

Typical age of onset for pediatric chronic pain is late childhood or early adolescence (e.g. Sherry & Malleson, 2002; Rhee, 2003). Symptoms are equally distributed across gender in early childhood but differences start to emerge in adolescence, with a higher prevalence of pain symptoms found among females (Rhee, 2003; Egger, Costello, Erkanli, & Angold, 1999). The prevalence of chronic pain also tends to increase with age (e.g. Connelly, 2003). In a longitudinal study by Borge, Nordhagen, Moe, Botten, and Bakketeig (1994), headaches were noted to occur more frequently when the participants were 10 years old than when they were in preschool. Allen, Mathews, and Shriver (1999) have also showed that recurrent headaches appear in about 5 to 10% of all children under the age of 10 but 11 to 15% of all adolescents.

Comorbidity

The co-occurrence of different pain types is common, as children suffering from one type of chronic pain frequently report other somatic symptoms. In Anttila, Metsahonkala, Mikkelsen, Helenius, and Sillanpaa (2001), a majority of their community sample of 10-year-old children with headache reported a large variety of comorbid pains such as throat pain, limb pain, recurrent abdominal pain, neck and shoulder pain, and otalgia. Those suffering from migraine were found to be particularly at risk for multiple pains. Gladstein and Holden (1996) have noted that 40% of children and adolescents presented to their pediatric headache clinic had comorbid headaches i.e. co-

occurrence of two distinctive headache types. Aasland and colleagues (1997) also found that 42% of patients with idiopathic musculoskeletal pain reported other recurrent aches and pains (e.g. headache and stomach ache). Comorbidity tends to increase with age. Borge and colleagues (1994) reported that while only 4.4% of 4-year-olds in their longitudinal study complained of both headache and stomach ache, the prevalence of comorbid pain symptoms rose to 20.6% 6 years later.

Course of Chronic Pain

Pain in children tends to persist in the majority of the sufferers with remarkable stability over time (Perquin et al., 2003). Patients with idiopathic musculoskeletal pain, for example, have experienced pain for a median of 9.6 months before their first admission to the hospital (Aasland et al., 1997). Nine years later, 57% of these patients were still suffering from significant pain. An equally chronic course has also been observed in pediatric migraine. Andrasik, Kabela, Quinn, and Attanasio (1988) found that their participants had been experiencing headaches for a mean of 5 years at the time of the study, and reported an average of 9.5 headaches with moderate intensity during a 4-week period. Borge et al. (1994) also found that children who complained of pain at age 4 were, compared to those who were pain-free, 3 times more likely to continue experiencing pain at age 10. In a longitudinal study by Walker, Garber, Van Slyke, and Greene (1995), children diagnosed with recurrent abdominal pain 6 years before continued to complain of significant levels of pain and other somatic symptoms at follow-up. Similar results were replicated by Brattberg (2004), in which children and adolescents aged 8 to 17 who reported back pain and severe debilitating headache still experienced pain 13 years later, and by Fearon and Hotopf (2001), in which children who

reported headache at 7 were nearly twice as likely to develop more somatic symptoms and psychiatric problems when they were 33. There is even speculation that certain childhood pain, such as recurrent abdominal pain, may serve as precursors of adult “functional disorders” such as irritable bowel syndrome (e.g. Blanchard & Scharff, 2002; Jarrett, Heitkemper, Czyzewski, & Shulman, 2003).

Etiology

The pathophysiology of chronic pain remains poorly understood (Connelly, 2003), and very often the etiology of such pain is unknown. It has been suggested that detectable disease or an organic cause is absent in 90 to 95% of cases of recurrent abdominal pain (Compas & Thomsen, 1999; Garralda, 1992). In Chalkiadis’ (2001) descriptive study of children receiving treatment from a multidisciplinary pain clinic at a tertiary pediatric hospital, 61% of those with no preexisting medical condition suffered from pain that had no clear organic basis. Connelly (2003) has also suggested that most childhood headaches are not caused by “an underlying disease or disorder but rather are typically related to cognitive, behavioral and emotional factors” (p. 163). Idiopathic, or physically unexplained, pain that persists beyond the amount of time expected for healing is often termed “functional” or “psychogenic” in clinical practice, and interpreted as being caused solely by psychological distress (Malleon, Connell, Bennett, & Eccleston, 2001). The use of such terms may imply that the pain is not real and only exists in the patient’s mind (Nicholson & Martelli, 2004). Campo and Fritsch (1994), for example, described such patients as “somatizing”, whose pain was a result of their tendency to transform their distress into physical symptoms in order to defend against the awareness of unpleasant feelings and memories. Such a simplistic Cartesian view of mind-body

dualism unfortunately has persisted in clinical practice despite criticism in the literature (e.g. Bursch et al., 1998; Nicholson & Martelli, 2004) and recent research and conceptualization that has suggested otherwise (Garralda, 1992; Martelli, Zasler, Bender, & Nicholson, 2004). McGrath and Craig (1989), for example, have argued that chronic pain can never be seen as exclusively physiological or psychological, as pain always needs to be interpreted against a background of complex interactions among biological, psychological, and social factors. Walker and Greene (1989) also showed that a high level of depression and anxiety was present in abdominal pain patients regardless of whether there was an organic basis to their pain. Similar results were replicated by Kaufman and colleagues even after controlling for demographic variables and using both self-report and parent-report in measuring psychological distress (Kaufman et al., 1997). These findings suggest that the presence of organic pathology associated with chronic pain does not preclude coexisting psychological distress, and that chronic pain cannot be classified on the basis of organic versus psychological causes (Walker & Greene, 1989).

The Impact of Chronic Pain on Various Aspects of a Child's Life

Research on chronic pediatric pain has focused more on the measurement of pain symptoms than the functional consequences of pain (Palermo, 2000). Goodman and McGrath (1991) have argued that pain, regardless of etiology, can lead to extensive emotional disturbance and disability in the everyday functioning of children.

Psychiatric Symptoms

Despite mixed findings in the literature (e.g. Wasserman, Whittington, & Rivara, 1988), chronic pain in children is generally associated with psychiatric symptoms such as

depression and anxiety. In Tamminen, Bredenberg, Escartin, and Kaukonen (1991), for example, a strong relationship between the presence of psychosomatic symptoms (headaches, abdominal pain, and other pains) and depression scores was found for both boys and girls. Andrasik and colleagues (1988) also revealed that headache sufferers scored 2 to 3 times higher on the Children's Depression Inventory and the Depression Scale of the Personality Inventory of Children compared to non-headache controls, with the difference increasing with age. Adolescent migraine sufferers also reported more generalized anxiety than matched controls. Their scores, however, still fell within the normal range even though they were elevated. In Campo et al. (2004), 79% of their sample of pediatric patients with recurrent abdominal pain were diagnosed with a concurrent anxiety disorder using standardized interviews while another 43% suffered from depression. These numbers overwhelmingly exceeded the prevalence of anxiety and depression in the control group. Liakopoulou-Kairis and colleagues (2002) noted that more than 80% of recurrent abdominal pain patients in their sample had a concurrent psychiatric diagnosis, with anxiety and depression being the most common. Seventy percent of the clinical sample of adolescents referred to a specialized tertiary care pain clinic in Eccleston, Crombez, Scotford, Clinch, and Connell (2004) reported clinical-level depression, and their score on an anxiety measure was twice as large as that reported by a community sample. Higher pain intensity was associated with higher depression, trait and state anxiety, more internalizing and externalizing behavioural problems, and lower self-esteem, in both child and adolescent patients from a pediatric rheumatology clinic in Varni et al. (1996). Even though these patients' average emotional functioning was not in the clinically maladjusted range, the authors still argued that given the variability in

individual functioning within the group, it was likely that a number of participants in the group suffered from significant emotional distress. In addition, Egger and colleagues (1998) found gender differences in the types of psychopathology associated with headache in their epidemiological study. While in general those with a Diagnostic and Statistical Manual of Mental Disorders (Third Edition, Revised; DSM-III-R) diagnosis were twice as likely to suffer from headache, females with internalizing disorders such as depression and anxiety reported 3 to 4 times more headaches than those without such diagnoses. In contrast, externalizing disorders were related to prevalence of headaches in males. In particular, those with conduct disorder reported twice as many headaches as those without conduct disorder. In summary, results from past research suggest that children with chronic pain may be particularly at risk for developing emotional and behavioural problems (Allen et al., 1999)

School Performance

School functioning is one of the most important functional parameters in pediatric pain (Palermo, 2000). It is considered as the pediatric equivalent of adult pain patients' work performance for measuring the extent of pain-associated disability (Varni et al., 1996). It has been suggested that a comprehensive pain assessment in children should always include taking a careful history of academic performance, which can then be used to gauge a child's ability in coping with chronic pain (Bursch et al., 1998; Smith, 1986).

School absence has been considered the simplest variable to use as an estimate of a child's functioning in school (Goodman & McGrath, 1991). High levels of school absenteeism have been observed among pediatric chronic pain sufferers. Pain-related school absences seem to be more frequent compared to those associated with other

chronic health conditions (Palermo, 2000). Stang and Osterhaus (1993) have estimated that approximately one million children and adolescents in the United States experience headaches and that several hundred thousand school days are missed as a result of headaches alone. While some argued that most of the school absences are brief and last no longer than a school day, an overwhelming number of children with pain have missed school as a result of pain. In Bandell-Hoekstra et al. (2001), 69% of the Dutch schoolchildren with the most severe and most frequent pain reported absence from school in the past year. In Bennett and colleagues' investigation of the impact of chronic pain on children who sought help from tertiary-care outpatient pain management services, 91% of the parents in their sample reported finding their children's pain interfering with school attendance within the past year (Bennett, Chambers, et al., 2000). Twenty-six percent of these children even missed more than 1 month of school. Chalkiadis (2001) found that 95% of school-age children referred to a hospital outpatient pain clinic missed a significant amount of school because of pain, whereas Larsson (1988) discovered that students with headache missed significantly more school than headache-free controls – 30% of those with headache missed school several times or more per month because of somatic complaints compared to only 8% of the controls. Recently, Malhi & Singhi (2004) studied their sample of “somatizing” children seeking help from an outpatient pediatric psychology clinic in India, and found a high rate of school absenteeism – 53% of the children in their sample were attending school intermittently with school absences of two to three days per week. 17% were not attending school at all.

Besides school absenteeism, little research has focused on other aspects of school functioning such as academic achievement (Palermo, 2000). Relationship between

academic achievement and pain is likely complex and reciprocal. School stress, for example, can serve as a cause of chronic pain. Stressors in school were frequently cited as causes of pain in surveys of pediatric pain sufferers (Kain & Rimar 1995). In Bille's (1962) landmark study of migraine in school children, a majority of migraine sufferers in his sample mentioned worry about school tests and conflicts at school as precipitating factors in their headache attacks. In Passchier and Orlebeke (1985)'s community sample of schoolchildren, stress was the most commonly reported precipitating factor of headache among both elementary and secondary school students. In a more recent study, 69% of Dutch schoolchildren with significant headache pain perceived stress as a trigger. High school students were also more likely to report stress as a precipitating factor than elementary school students (Bandell-Hoekstra et al., 2001). Thirty-two percent of patients with non-organic recurrent abdominal pain from a hospital gastrointestinal clinic identified school-related stressors (e.g. performance anxiety before exams) as the most common cause of their pain (Woodbury, 1993). Torsheim and Wold (2001) also found that high school students who reported high levels of school pressure were 4 times as likely to suffer from various pain symptoms such as headache, abdominal pain, and back pain. It has been proposed that children react to their difficulties in school by developing pain symptoms as a channel for their frustration and anxiety (Aasland et al., 1997). Some clinicians have even suggested that somatic pain is a masquerade for school phobia or refusal (e.g. Berger, 1974; Schmitt, 1977; Bush, 1987; Nader, Bullock, & Caldwell, 1975). McGrath and Hillier (2001), for example, proposed that recurrent pediatric headaches are a result of the child's failure to resolve stressors found in academic, social, and physical activities. In their reinforcement model of headache, anxiety mounts as

stressors accumulate, leading to the development of the first headache episode. The pain is rewarded and perpetuated when the child is removed from the stressful situation (e.g. school) because of the pain and gains temporary relief of stress as a result.

Conversely, school problems can occur as a result of living with chronic pain on a daily basis. Previous research has suggested that a child's ability to complete homework is often disrupted by chronic pain (Bennett, Huntsman, & Lilley, 2000). Outcome studies from tertiary pain management clinics have also showed that effective treatment of pain can lead to improvement in academic areas such as school attendance and homework (Bennett, Chambers, et al., 2000; Chalkiadis, 2001; Palermo, 2000; Eccleston, Maleson, Clinch, Connell, & Sourbut, 2003). In addition, the high level of school absenteeism in this population may have hindered learning. Children who are frequently absent not only miss opportunities for learning, they also need to make up for the missed work after their absence (Eaton, Haye, Armstrong, Pegelow, & Thomas, 1995). The extra time spent on catching up with missed work implies that less energy can be diverted to the mastery of new material. The previously learned material may also not be consolidated enough to facilitate subsequent acquisition of new knowledge (Heller, Alberto, & Meagher, 1996). The learning progress is therefore delayed and school grades may fall behind as a result. Even if the child does not need to leave school due to pain, chronic pain can also affect concentration, making it difficult for him or her to focus and learn in class (Heller et al., 1996; Metsahonkala, 1998).

Pain may also indirectly cause school problems through other associated symptoms such as depression, anxiety, other types of functional limitations (e.g. loss of relationships with peers and teachers), or sleep problems. Smith (1986) has observed that

a decline in scholastic performance often ensues an onset of major depression or anxiety disorder. Egger and colleagues (1998) found that females who received a DSM-III-R diagnosis of depression reported more headaches and missed more school than those who were not depressed. Quality of life is also related to intensity and frequency of pain among adolescents with various types of chronic pain. Those with stronger and more frequent pain tend to report poorer psychological functioning, lower quality of daily living, and worse physical health (Hunfeld et al., 2001). Failure to control headache pain may also negatively impact children's involvement in social and extra-curricular activities (Andrasik et al., 1988). Fichtel and Larsson (2002), for example, demonstrated that adolescents with frequent headaches had a higher level of functional disability, or interference to one's functioning in everyday activities (e.g. participating in sports, playing with friends), than those with infrequent headaches. In Chalkiadis (2001), 71% of pediatric chronic pain patients in his sample reported that pain had limited their ability to play sports. Hunfeld et al.'s (2002) interview with adolescents with physically unexplained chronic pain revealed that pain can lead to widespread disability such as social withdrawal, difficulty with concentration, drowsiness, irritability, mood lability, and physical disability such as problems with standing, sitting upright and physical exertion for an extended period of time. Fifty-five percent of the participants became so used to the presence of persistent pain that they have structured their lives around their pain, yet the unpredictability of their pain still made it difficult for them to plan activities. Recently, Roth-Isigkeit, Thyen, Stoven, Schwarzenberger, and Schmucker (2005) documented the substantial functional limitations associated with pediatric chronic pain in a non-clinical population. Of the 622 school-aged children and adolescents who

reported pain in the past three months, 68% experienced restrictions to their activities of daily living due to pain. These ranged from school absence and poor appetite to inability to continue with their hobbies and disruption to their social functioning. Moreover, Lewin and Dahl (1999) have suggested that children with chronic pain often suffer from significantly more sleep problems because pain episodes and the patients' heightened vigilance to onset of pain can make it difficult for them to fall and stay asleep. Emotional disturbances associated with chronic pain such as depression can also affect one's quality of sleep. Miller, Palermo, Powers, Scher, & Hershey (2003), for example, confirmed that children aged 2 to 13 referred to two neurology clinics for assessment of migraine complained of more sleep disturbance when compared to the normative sample; in particular, a higher rate of insufficient sleep, tooth grinding, co-sleeping with parents, and snoring was noted. Konijnenberg et al. (2005) further demonstrated that children with unexplained chronic pain were more prone to frequent nocturnal awakening. Sleep deprivation can subsequently affect daytime functioning through the involvement of the prefrontal cortex, leading to difficulties with attention, memory, impulse control and fluency in attending to multiple stimuli – all are core skills required for optimal functioning in a complex social setting such as the classroom.

Finally, it is likely that the presence of “common factors” may predispose children to both chronic pain and poor academic achievement. Boey, Omar, and Arul Phillips (2003), for example, argued that stressful life events could affect both the occurrence of recurrent pain and school performance.

Clinical anecdotes have painted two very different pictures of how pediatric sufferers of chronic pain may perform in the classroom. Some have suggested that these

children and adolescents are perfectionistic, obsessive high achievers who are shy, rigid, anxious about school, sensitive towards their performance at school, and under so much parental pressure to achieve that they would suppress their own emotional needs to please others (e.g. Connelly, 2003; Kain & Rimar, 1995; Kozłowska, 2001; Malleson, Al-Matar, & Petty, 1992; Rangaswamy, 1982; Sherry & Malleson, 2002). It is assumed that pain develops as a result of the tremendous stress in their lives and their long-term suppression of emotions. Others have suspected undiagnosed learning disabilities that are “almost always present” in those with chronic pain, and predicted that they are overwhelmed by school demands beyond their intellectual capacity (e.g. Zeltzer, Bursch, & Walco, 1997, p. 419; Malleson et al., 1992; Rangaswamy, 1982; Sherry & Malleson, 2002). Some have suggested that these children may successfully complete elementary school but will struggle when they get to Grade 7 or 8 – a time that coincides with the typical age of onset of pediatric recurrent pain (late childhood or early adolescence) – during which school tasks become more complex and abstract (e.g. Smith, 1986). Pain therefore serves as a cry for help in school, and as a way for them to avoid school. Past research, however, remains inconsistent in determining which profile of academic functioning is more commonly associated with chronic pain in children and adolescents.

In terms of the research using non-clinical samples, Passchier and Orlebeke (1985) found that fear of failure and school problems, but not achievement motivation, were associated with headache complaints in schoolchildren. Rangaswamy (1982) studied a community sample of 20 senior high-school students (mean age 16.5) suffering from tension headache who were “top ranking students in the class but dissatisfied with their achievement”. Those with headache were more neurotic and introverted, and faced

more adjustment difficulties and anxiety than their headache-free counterparts with similar educational status. In another community sample of high school students aged 16 to 18, students with frequent headache reported spending more time on their homework than those with no headache (Larsson, 1988). Homework time and school absence were also two of the six variables that differentiated headache sufferers from controls.

However, there was no discussion on whether spending longer time on homework was a result of perfectionistic expectation on one's performance or a sign of learning problems.

Contrary to the clinical observations of overachieving chronic pain sufferers with perfectionistic parents, Kowal and Pritchard (1990) revealed that parents of children with headaches actually reported lower "achievement orientation" in their family i.e. these parents reported lower expectation of their children compared to parents in the control group. However, while no between-group difference was found in the frequency and severity of perfectionist-compulsive behaviours, a higher score on the perfectionist-compulsive subscale, together with higher anxiety and a lower number of stressful life events, predicted more severe headache pain in children. In another community sample of 8-year-olds in Finland, poor school performance estimated based on teachers' report was associated with more complaints of pain (Tamminen et al., 1991). Yet contradictory findings emerged in a later study, as Borge and Nordhagen (1995) failed to find a significant difference in the teachers' estimates of learning problems between a group of 10-year-olds with various types of chronic pain and their pain-free counterparts. Recently, Boey and Yap (1999) studied a community sample of schoolchildren aged 11 and 12 in Malaysia, and also could not find a significant relationship between teacher-report academic performance and recurrent abdominal pain. While in a later study failure

in a major school exam was found to be a significant predictor of recurrent abdominal pain (Boey & Goh, 2001), the nature of such relationship was unclear. Poor performance in an exam may implicate learning problems as the cause of pain. On the other hand, failure in a major school exam may be particularly damaging to children who are sensitive to their performance, thus leading to various somatic symptoms.

Boey and colleagues (2003) further examined the relationship between recurrent abdominal pain and academic achievement in a community sample using scores on a national examination completed by all Grade 6 students in Malaysia. Results revealed that while the presence of recurrent abdominal pain was associated with poorer exam performance in bivariate analysis, it failed to emerge as a significant predictor of academic achievement in subsequent multivariate analyses. Similar results were found in a community sample of 2,629 Dutch schoolchildren aged 9 to 18 (Bandell-Hoekstra et al., 2002). While there was a trend of decreased self-reported school functioning with an increase in pain, the finding did not achieve statistical significance.

On the other hand, Fichtel and Larsson (2002) noted that Swedish students in “theoretical programs” in high school (i.e. more academically oriented programs) reported more headache, joint pain, anxiety and depressive symptoms compared to those in vocational programs. The authors attributed this to the higher academic demands and stress associated with theoretical programs. In an interesting longitudinal study by Waldie, Hausmann, Milne, and Poulton (2002), childhood academic achievement was shown to predict pain status in adulthood. The authors tracked a representative cohort of children born in a New Zealand town between April 1, 1972 and March 31, 1973. Academic achievement was measured by their grades on national exams and on six

school subjects obtained during their last two years of high school, and was correlated with headache status when they turned 26. Results showed that those diagnosed with migraine at age 26 did poorer in school than those with tension-type headache and those without headache. They were also less likely to graduate from high school and pursue post-secondary education compared with those suffering from tension-type headache.

While population-based studies can avoid the selection biases in clinical studies (Egger et al., 1999), the generalizability of their results to clinical populations remains unknown. Goodman and McGrath (1991) commented that due to the ubiquitous nature of pain, there may be substantial differences among those who sought medical attention and those who did not. Clinical samples, for instance, may represent those with more severe pain and associated disability (Palermo, 2000; Robins, Smith, & Proujansky, 2002).

Research on academic achievement in clinical samples of pediatric chronic pain patients, however, has also emerged as inconsistent. Bille (1962) argued that headaches led to school absences but not underachievement. Conversely, in Woodbury's (1993) sample of pediatric pain patients recruited from a hospital GI clinic, 6 out of 50 students were diagnosed with learning disability. However, psychoeducational testing was not offered to every participant in the sample; it was administered only to those who were suspected to have learning problems in the first place. The true prevalence of learning disability among chronic pain patients therefore remains unknown. Eaton et al. (1995) found that children with sickle cell anemia (for which pain is the most common symptom) performed below average on core academic skills such as reading, mathematics, and writing as measured in terms of school grades and scores on the Wide Range Achievement Test-Revised (WRAT-R). Participants in their sample had a school

average of C and below, and their standardized test scores were one to 1.5 standard deviations below the normative mean for their age group. It was further revealed that participants in this study missed more school compared to those in other studies, which probably created more disruption in their learning. However, such finding may not be generalizable to children with other types of pain, since the cognitive and learning difficulties observed in patients with sickle cell anemia are probably not caused by pain but by neurological risk factors such as vascular dementia, hypoxia and brain lesions commonly associated with the disease process of sickle cell anemia (Schatz, Finke, & Roberts, 2005).

Aasland and colleagues (1997), using a standardized child interview schedule, concluded that a majority of patients with idiopathic musculoskeletal pain had “unrealistic worries about school performance or learning difficulties”. Nine years later, those with persistent idiopathic musculoskeletal also tended to report more worries about school performance than those who have remitted. In addition, Walker and Heflinger (1998) revealed that higher self-evaluation of academic competence was associated with poorer recovery among recurrent abdominal pain patients at their 5-year follow-up. The authors postulated that higher levels of academic competence might lead to higher expectation of one’s school performance and stress, resulting in an exacerbation of their pain.

Campo, Comer, Jansen-McWilliams, Gardner and Kelleber (2002) studied 55 children aged 4 to 15 who presented to family physicians complaining of aches and pains. They found that those with frequent pain were rated by their parents as performing worse in school. Campo and colleagues (2004) also noted that those with recurrent abdominal

pain reported more symptoms of school phobia on a self-report questionnaire measuring anxiety than the control group did. In Malhi and Singhi (2004), however, both profiles of academic functioning (“perfectionistic overachievers” and “poor students with learning problems”) were observed, as a considerable number of children seeking help from an outpatient pediatric psychology clinic in India due to “functional somatic symptoms” mentioned both school difficulties and pressure from parents to excel academically as significant life stressors.

The inconsistencies observed in previous research may be attributable to the differences in the types of participants across studies (e.g. different age groups, different types of pain studied). Past research in this area has also been fraught with measurement problems and questions over the validity of the conclusions drawn in a number of studies. For example, most studies used only self-report (such as checklists or interview) to evaluate the participants’ academic functioning. Standardized achievement tests were seldom used, and evaluation of school functioning was often solely based on a single question in the instrument without any consideration of its reliability and validity (Palermo, 2000). Erroneous and far-fetched conclusions not substantiated by existing data were often reached as a result. Aasland and colleagues (1997), for example, concluded that one-third of their sample of patients with idiopathic musculoskeletal pain were high achievers with “unrealistic worries about school performance”, while one-third were suffering from learning difficulties. However, the constructs “unrealistic worries about school performance” and “learning difficulties” were never defined, and the authors classified the participants into these two groups based on their answers on a single question in a semi-structured interview without corroborative evidence from standardized

testing. The authors also failed to examine whether those children who reported “unrealistic worries about school performance” were also the same children who reported learning difficulties, as it is possible that their worry about school stemmed from a history of poor performance. Borge and Nordhagen (1995) deduced that symptoms of headache tended to occur in well-behaved preschoolers who “showed a tendency towards high achievement motivation at school” based on a nonsignificant difference in mothers’ estimates of their children’s ambition for achievement at school among various chronic pain groups and a pain-free control. Malleson et al. (1992) reported that among their clinical sample of children with localized idiopathic musculoskeletal pain, 26% were noted on clinical charts as high or overachievers, while another 24% had learning disabilities. An even higher prevalence of such problems was found among those with diffused musculoskeletal pain, as 54% were judged to be high achievers and 29% learning disabled. Yet no attempt was made to delineate the criteria they used to make such classifications and to corroborate their clinical judgments with standardized measures. Sherry and colleagues (1991), based on their clinical observations during interview, concluded that most of the patients with idiopathic musculoskeletal pain had difficulty identifying their emotional needs and had a tendency to please authority figures. They also noted that 66% of children in their sample were excelling academically, while 17% were struggling in school, based on data gathered from an unstructured patient interview without corroboration from other informants. Given the prevalent problems of inaccurate measurement and inadequate operationalization of constructs in this area, von Baeyer and Walker (1999) argued for the need for future research to assess these pain-related constructs with standardized instruments.

Cognitive Functioning

Surprisingly, there has been a lack of research on the impact of chronic pain on children's cognitive functioning despite the call for developmentally appropriate pain treatment and assessment in the literature. Children's cognitive development may have implications for pain management. Since pain is a subjective experience, the first step a child takes to solicit help requires the ability to accurately communicate his or her pain to others through the use of appropriate "pain vocabulary", a skill that is dependent on one's intellectual ability (Twycross, 1997). An accurate memory for pain is necessary in this process as well, since the reporting of pain is usually retrospective (Ornstein, Manning, & Pelphrey, 1999). Furthermore, it has been argued that cognitive development affects a child's ability to understand the meaning of the pain and the purpose of treatment, which are two important determinants of coping success and treatment outcome (Bush, Young, & Radecki-Bush, 1998; Marcon & Labbe, 1990). More advanced cognitive development has been showed to be associated with an internal health locus of control, and specific treatments such as cognitive-behavioural therapy for pain control require a more mature level of cognitive ability (Marcon & Labbe, 1990; McGrath & Craig, 1989).

Both Heller et al. (1996) and Rhee (2003) have suggested that cognitive development may be affected by pain-associated disability as a result of decreased opportunities for interacting with the environment and peers. Cognitive problems can also emerge as a direct result of pain. As suggested by Bandell-Hoekstra and colleagues (2001), children with migraine often report concentration problems as "warning signals" of an upcoming headache episode. On the other hand, cognitive ability may moderate the relationship between pain symptoms and academic achievement. Rangaswamy and

Balakrishnan (1982), for example, observed that headache patients with learning difficulties often had just average or even below average intelligence, while Rangaswamy (1982) found that his sample of pediatric headache patients with excellent scholastic performance had above average intelligence. Lastly, given the concern of prevalent learning disabilities in this population, it is important to study a child's cognitive ability in addition to his or her academic achievement before a diagnosis of learning disability is made (American Psychiatric Association, 2000).

Recently, there has been a surge in research examining profiles of neurocognitive functioning associated with chronic pain in adults. It has been suggested that pain can distort neurocognitive testing results. Problems associated with chronic pain, such as sleep disturbance, affective disorders, and use of medication may affect neurocognitive performance especially in the area of attention, memory, executive control, and processing speed (Nicholson, Martelli, & Zasler, 2001). Patients with chronic pain may also be in a state of hyperarousal, further impairing their memory. In addition, pain has been called "an attention-demanding modality" which tends to capture attention when one has to divide attention between pain and another sensory modality (Villemure & Bushnell, 2002). Eccleston and Crombez (1999) have postulated pain as a threatening stimulus which interrupts attention to concurrent tasks in the environment so that the body can mobilize resources for escape and action. Chronic pain therefore implies chronic interruption of current attentional engagement, to the point that pain dominates one's attentional resources. These hypotheses have been gathering support in the literature. In Hart et al.'s (2000) review of research on cognitive impairment and chronic pain in adults, chronic pain patients (excluding those with traumatic brain injury) often

demonstrated deficits in measures of attention, immediate and delayed memory, and processing speed, compared either to controls or to the normative sample. McCracken and Iverson (2001) studied 275 adult chronic pain patients recruited from a university outpatient clinic. Based on the participants' self-report of cognitive complaints on the Alertness Behaviour subscale of the Sickness Impact Scale, the authors found that 44% of the sample reported at least one cognitive problem. The most frequent complaints were forgetfulness, minor accidents, difficulty finishing tasks, and difficulty in concentration. Iezzi, Archibald, Barnett, Klinck, and Duckworth (1999) also demonstrated that chronic pain patients with a high level of psychological distress experienced more difficulty in general cognitive functioning, verbal memory, abstract thinking, and cognitive efficiency. Subsequent hierarchical regression analyses examining the impact of pain severity on cognitive functioning revealed that both pain severity and psychological distress contributed significantly to the prediction of memory scores. The authors concluded that pain and mood can disrupt the consolidation and retrieval processes involved in memory (Iezzi, Duckworth, Vuong, Archibald, & Klinck, 2004). Yet little is known about whether such cognitive deficits also appear in pediatric chronic pain sufferers.

Most research in the area of pediatric pain and cognition has focused on children's attitudes, cognitive appraisal and beliefs about pain, and the developmental changes in children's understanding of pain using Piaget's stage approach (e.g. Beales, 1986; Hurley & Whelan, 1988). Few studies have employed standardized cognitive testing to measure their cognitive-developmental level (Thompson & Varni, 1986). Bille (1962) noted that complex cognitive functioning and general intelligence did not differentiate between child migraine sufferers and controls, but the two groups differed

on tests of motion perception and sensory performance, which he speculated was a result of the deliberate, cautious and restrained personality allegedly associated with migraine sufferers. Sherry and colleagues (1991) studied the cognitive profiles of children with chronic pain by administering the Wechsler Intelligence Scale for Children-Revised (WISC-R), a comprehensive measure of children's cognitive functioning, to 62 patients at a pediatric rheumatology centre. The results indicated that their mean Full-Scale IQ, Verbal IQ, and Performance IQ scores were all within the Average range. A significant difference between Verbal and Performance IQ was found in 73% of the participants, with the Performance IQ being higher than Verbal IQ in two-thirds of the case. The authors suggested that these children may have trouble expressing their feelings, and may struggle in school as a result of their lower Verbal IQ. Partial support for their claim came from Tamminen et al. (1991) who found that girls who were dexterous, were skilled in writing or had good oral performance were more likely to have fewer symptoms.

Childhood verbal ability may also be implicated in the occurrence of pain in adulthood. In a 23-year longitudinal study by Waldie and colleagues (2002), children underwent a series of neurocognitive testing biennially from age 3 to age 18. Measures used included the Peabody Picture Vocabulary Test (a measure of receptive vocabulary), the Verbal Comprehension and Verbal Expression subscales of the Illinois Test of Psycholinguistic Ability, the WISC-R, and the Burt Word Reading Test. At age 26, the participants' headache status was assessed. Results showed that childhood Verbal IQ measured on the WISC-R differentiated migraine sufferers from those with tension-type headache and their headache-free counterparts.

Recently, Haverkamp, Honscheid, and Muller-Sinik (2002) compared 37 pediatric migraine outpatients with 17 healthy siblings on their performance on the German version of the Kaufman Assessment Battery for Children (K-ABC), another composite measure of children's intelligence. The scores from the patients fell within the normal range, and no between-group difference was found.

While findings from these studies suggest that children with chronic pain are not particularly at risk of general cognitive impairment, it is still unclear whether specific cognitive profiles observed in adult chronic pain sufferers (e.g. impairment in memory and processing speed) can also be found in children. In light of the weak relationship between chronic pain and neurocognitive test performance in previous research using nonclinical samples, Hart and colleagues (2000) argued that clinical samples may be more appropriate for future research since pain may be more disruptive to cognitive functioning among those who are in treatment for it.

Current Study

Objectives

The purpose of the current study was to examine cognitive functioning and academic achievement using standardized testing in children and adolescents with chronic pain through a retrospective chart review of consecutive referrals to the Complex Pain Service (CPS) at British Columbia's Children's Hospital (BCCH), a pediatric outpatient pain treatment program. This study aimed to:

1. Describe the levels of cognitive functioning and academic achievement in children and adolescents with chronic pain, and compare them to those of the general population;
2. Examine pediatric chronic pain patients' profiles of intraindividual discrepancies among their various cognitive abilities; and
3. Examine the discrepancy between their general cognitive functioning and their academic achievement;

Since past research on cognitive abilities and academic achievement of pediatric chronic pain patients has been inconsistent, the current study was expected to be descriptive and exploratory.

METHOD

Participants

Participants of this retrospective chart review were child and adolescent outpatients presented to the CPS at BCCH between 1998 and 2004. The CPS is a tertiary-level, interdisciplinary pain management service that draws from a large urban area and is composed of two developmental pediatricians, a nurse clinician, a psychologist, a physiotherapist and an anesthesiologist, all of whom specialize in pediatric pain management (Bennett, Chambers, et al., 2000). Patients referred to this service and others similar to it usually suffer from a variety of complex chronic pain syndromes, which may be caused by a known chronic illness or are of an unknown origin, and are usually associated with sustained pain and disability (Bennett, Chambers, et al., 2000; Chalkiakis, 2001). To be accepted for services at the CPS, the patient must meet at least 3 of the following 5 acceptance criteria:

1. The patient's pain has persisted for more than 6 months;
2. Pain is associated with significant interference with one's activities of daily living;
3. Pain is affecting one's physical and / or mental health;
4. Pain has not resolved, despite prior treatment and consultation with appropriate specialists; and
5. There is a need for an interdisciplinary approach to diagnosis and treatment.

Patients admitted to the CPS first underwent an initial assessment / consultation session with the pediatrician, psychologist, nurse clinician and physiotherapist working on the team. As part of their multidisciplinary treatments, they would receive

psychological services from the psychologist on the team. Since 1998, a psychoeducational assessment has been included in the CPS's psychological treatment plan for most cases of school-aged children and adolescents. Of the 93 outpatients presented to CPS between 1998 and 2004, 57 (61%) underwent psychoeducational assessments and thus served as the participants of the current study. Table 1 summarizes the reasons for non-participation in psychoeducational assessments for the other 36 outpatients.

Table 1 Reasons for Non-participation in CPS Psychoeducational Assessments for the Patients Excluded from the Study ($N = 36$)

Reason	<i>n</i>	%
Dropped out of treatment / discharged	19	53
Completed similar assessments elsewhere	6	17
Consultation cases only	6	17
Too young to complete testing	3	8
On waiting list for assessment	1	3
Geographical restrictions	1	3

Note: Percentages do not necessarily add to 100 due to rounding error.

Non-participants did not differ from participants with respect to age ($t(91) = 2.00$, $p > 0.05$, $d = 0.45$), gender ($\chi^2(1, N = 93) = 4.25$, $p > 0.05$), pain types ($\chi^2(2, N = 93) = 5.15$, $p > 0.05$), pain intensity ($t(91) = -0.52$, $p > 0.05$, $d = 0.07$), pain frequency ($\chi^2(1, N = 93) = 2.68$, $p > 0.05$), and history of pain in months ($t(91) = 1.12$, $p > 0.05$, $d = 0.28$).

The participants' age at the time of testing ranged from 8 to 18 ($M = 14.64$, $SD = 2.39$). The majority of them ($n = 46$, 81%) were females. As shown in Table 2, a large

variety of pain syndromes were present in this sample. On average, the participants had been experiencing pain for 46.98 months before being evaluated at the CPS ($SD = 34.92$). Most of the participants reported being in pain on a daily basis ($n = 48, 84\%$), and their mean rating of pain intensity on a 10-point scale was 6.26 ($SD = 1.63$).

Table 2 Types of Pain Syndromes Presented in the Current Sample ($N = 57$)

Diagnosis	<i>n</i>	%
Headache	17	30
Abdominal pain	6	11
Back pain	6	11
Diffuse idiopathic musculoskeletal pain	7	12
Localized idiopathic musculoskeletal pain	6	11
Foot or leg pain	2	4
Multiple pains (e.g. headache and back pain)	13	23

Note: Percentages do not necessarily add to 100 due to rounding error.

Qualitative information regarding the participants' self-reported school functioning was collected during their pre-assessment interviews and is presented in Table 3. Nearly two-thirds of the participants reported absence from school due to pain. Eighteen percent ($n = 10$) had been taking a partial course load, and 25% ($n = 14$) needed to be homeschooled due to the severity of their pain. More than half of the participants noted that they had experienced academic problems such as failing a course, slipping grades, and difficulty in concentration and getting work done. Nevertheless, more than

one quarter of the participants reported getting good grades (A's and B's) in school despite their pain.

Table 3 Self-Report of School Functioning ($N = 57$)

Variable	<i>n</i>	%
Absence from school due to pain	42	74
Preexisting school problems	33	58
Good grades	16	28
School as stressor	15	26
Homeschooled due to pain	14	25
Enrolment in special services in school / tutoring	13	23
Reduced course load	10	18

Measures

General Cognitive Ability

Participants aged 8 to 15 who completed psychoeducational assessment at CPS between 1998 and 2003 were assessed using the Wechsler Intelligence Scale for Children-Third Edition (WISC-III; Wechsler, 1991). Those who were seen in 2004 were administered the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003). The Wechsler Adult Intelligence Scale-Third Edition (WAIS-III; Wechsler, 1997) was used for participants aged 16 or above.

The Wechsler family of intelligence tests comprises standardized, comprehensive test batteries on various intellectual abilities for children and adults. The WISC-III,

published in 1991, consists of 13 subtests. Ten of them are used to calculate the Full Scale IQ (FSIQ), an overall measure of a child's general cognitive functioning. The subtests can be further categorized into two scales and four indices, based on the nature of cognitive abilities a particular subtest measures (Sattler, 2001). The Verbal Scale measures verbal abilities such as language comprehension and verbal reasoning and yields a Verbal IQ score (VIQ). The Performance Scale, from which a Performance IQ score (PIQ) is derived, assesses nonverbal abilities such as nonverbal problem solving, perceptual speed, and visuospatial skills. The four indices include the Verbal Comprehension Index (VCI), a pure measure of verbal ability; the Perceptual Organization Index (POI), a measure of nonverbal reasoning, visuospatial processing, and visual-motor integration; the Freedom from Distractibility Index (FDI), a measure of attention, concentration, and one's ability to temporarily retain information in memory, such that he or she could manipulate the information stored and produce a result; and the Processing Speed Index (PSI), a measure of mental and psychomotor speed, sustained attention and fine motor coordination. WISC-IV, a revision of the WISC-III published in 2003, comprises 15 subtests and retains only the Full Scale IQ and the four indices. Given the changes of the subtests that underlie the four indices, two of the indices have been renamed – the POI was given the name Perceptual Reasoning Index (PRI), and the FDI became the Working Memory Index (WMI). The VCI and the PRI also replace the VIQ and the PIQ respectively in the clinical interpretation process of the scores. WAIS-III, published in 1997, is structurally similar to WISC-III, except that the WAIS-III index that measures working memory was called WMI instead of FDI. An individual's scores on these tests are derived by comparing his / her performance to that from the peers from

the same age group in the normative sample. Scores on all of the scales and indices of the three Wechsler tests are normally distributed. Subtest scaled scores have a population mean of 10 and a population standard deviation of 3; the composite scores have a population mean of 100 and a population standard deviation of 15.

The Wechsler intelligence tests are the most widely used instruments for evaluating general cognitive ability in children and adults. They were standardized on normative samples of over 2,000 individuals stratified on age, ethnicity, geographic region, and socioeconomic status to ensure that the samples were representative of the population of children or adults in the United States at the time the tests were developed (Sattler, 2001; Sattler & Dumont, 2004). Their reliability and validity have been well established – for example, the average internal consistency reliability coefficients for the Full Scale, Verbal Scale, and Performance Scale in WISC-III are .96, .95, and .91 respectively. Excellent criterion validity has been demonstrated through their high correlations with other intelligence tests, measures of achievement, and school grades (Sattler, 2001; Sattler & Dumont, 2004; Kaufman & Lichtenberger, 2002). Validity studies correlating the three Wechsler tests with one another have also been performed to ensure that they measure similar constructs (Sattler, 2001; Sattler & Dumont, 2004; Wechsler, 2004).

Academic Achievement

The core academic areas assessed in the psychoeducational assessments were as follows:

Word Reading

Participants completed either the Word Reading subtest in the Wechsler Individual Achievement Test-Second Edition (WIAT-II; The Psychological Corporation, 2001) or the Reading subtest in the Wide Range Achievement Test-Third Edition (WRAT-3; Wilkinson, 1993). They were asked to pronounce letters and words presented to them visually on a stimulus booklet and / or a reading card.

Reading Comprehension

Reading comprehension was assessed using the WIAT-II Reading Comprehension subtest, the Gray Oral Reading Test-Third Edition (GORT-3; Wiederholt & Bryant, 1992), or the Gray Oral Reading Test-Fourth Edition (GORT-4; Wiederholt & Bryant, 2001). Participants were asked to read passages of increasing length and difficulty, and then answer questions related to information presented in the passages.

Arithmetic Computation

Participants were asked to complete a list of written arithmetic questions in either the WIAT-II Numerical Operations subtest or the WRAT-3 Arithmetic subtest to assess their ability to perform numerical calculations.

Mathematical Reasoning

The WIAT-II Math Reasoning subtest was used to assess the participants' ability to reason mathematically and to apply mathematical concepts through a series of both printed and orally presented questions.

Spelling

Participants completed either the WIAT-II Spelling subtest or the WRAT-3 Spelling subtest. In both tests they were asked to write down the spelling of dictated letters and words.

Written Expression

Writing skills were assessed either with the WIAT-II Written Expression subtest or the Test of Written Language-Third Edition Story Construction subtest (TOWL-3; Hammill & Larsen, 1996). Participants tested using the WIAT-II Written Expression subtest were asked to generate a list of words that fitted a particular category, to rewrite sentences, and / or to write an essay. The TOWL-3 Story Construction subtest involved writing a story describing a picture in 15 minutes.

The achievement tests administered in the current study have been extensively used in both the clinical and academic settings for evaluating students' academic progress. Published in 2001, the WIAT-II is a multiple-subject comprehensive test of academic skills for individuals aged 4 through 89. It was co-normed with the WISC-III, and has demonstrated good reliability and validity (Doll, Tindal, & Nutter, 2003). The WRAT-3 is a multiple-subject screening test assessing basic skills in reading, arithmetic, and spelling. The test can be administered to individuals from age 5 to 75, and was standardized on a stratified normative sample of over 4,000 individuals, with 183 to 200 individuals in each age group (Sattler, 2001). Its psychometric properties have been well established – for example, test-retest reliability ranges from .91 to .98 for examinees aged 6 to 16. Standard scores of the subtests in both instruments have a population mean of 100 and a population standard deviation of 15.

The Gray Oral Reading Test is a single-subject screening test for measuring reading ability in individuals aged 7 to 18. The GORT-3 was published in 1992 while the latest edition, the GORT-4, was released in 2001. The content of GORT-4 is identical to that of GORT-3 except for the addition of one new story at the beginning. Both versions were standardized on stratified normative samples that were representative of the 1990 and 2001 U.S. Census respectively (Crumpton & Miller, 2003; Sattler, 2001). The test assesses reading speed, accuracy, and comprehension, which collectively yield an Oral Reading Quotient (ORQ) as an overall measure of reading ability. The ORQ has a population mean of 100 and a population standard deviation of 15.

The TOWL-3 assesses written language for children aged 7 to 17. Developed in 1996, it was standardized on a normative sample of over 2000 students stratified by age, geographic region, gender, and ethnicity (Hansen, 1998). The Story Construction subtest completed by the participants in the current study was scored based on specific criteria such as grammar, punctuation, spelling, and plot, after which a Spontaneous Writing Composite (SWC) score was computed (Bucy, 1998). The SWC has a population mean of 100 and a population standard deviation of 15.

Visual-Motor Skills

Some participants underwent additional testing on their visual-motor skills. The Beery-Buktenica Developmental Test of Visual-Motor Integration-Fourth Edition (VMI; Beery, 1997) is a standardized test assessing the integration of visual perception and motor abilities in individuals aged 3 to 18 by having the examinee use a pencil to copy, match and trace geometric designs. The result is expressed in the form of standard scores

(with a population mean of 100 and a standard deviation of 15) through comparison to a stratified normative sample.

Procedures

Ethics approval for this project was granted by Simon Fraser University's Research Ethics Board, the University of British Columbia's Clinical Research Ethics Board, and Children's and Women's Health Centre of British Columbia's Research Review Committee. The Psychology Charts of all the outpatients seen by the CPS psychologist at the BCCH's Psychology Department during the period of 1998 and 2004 were retrospectively reviewed. Patients who did not undergo psychoeducational assessments were excluded from the study. For those who have received psychological testing, data collected from their charts included their demographic information (i.e. age and gender), qualitative information on school functioning gleaned from clinical interviews and assessment reports, information on pain parameters (diagnosis, location, rating of intensity, frequency, and history of pain), and their scores on the various tests used in the psychoeducational assessments.

Data Analyses

Statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS) for Windows (Version 13.0) and Microsoft Excel 2003. All tests were two-tailed with an alpha level of 0.05.

*Levels of Cognitive Functioning, Academic Achievement and Visual-Motor Skills
as Compared to the General Population*

Sample means and standard deviations were first calculated for the composite scores (FSIQ, VIQ, PIQ, and index scores) on the three Wechsler tests and the standard scores on the various achievement tests and the VMI. One-sample z-tests were conducted to examine whether the sample means significantly differed from the means of the standardization samples of the respective tests (i.e. $M=100$).

The various Wechsler scores, achievement scores, and VMI scores were further classified into seven descriptive categories according to Wechsler (2003) (see Table 4). The seven descriptive categories were then collapsed into three (by combining the “Extremely Low”, “Borderline”, and “Low Average” categories into “Below Average”, and combining “Very Superior”, “Superior”, and “High Average” into “Above Average”; the “Average” category is retained).¹ Chi-square goodness-of-fit tests were performed to study whether the proportion of participants in each of the three categories differed from those observed in the general population – where 50% of individuals were expected to score within the Average category, while 25% would fall in each tail of the distribution.

¹ According to Cochran (1954), the reliability of the chi-square test is affected when any of the expected cell frequencies is less than one, or when more than 20% of the table cells have expected cell frequencies less than five. Given the sample size in the current study, the expected frequencies for over 20% of the cells (e.g. the cells that represent the descriptive categories in the two extremes, “Extremely Low” and “Very Superior”) would be less than five if the chi-square test is performed on a cell table with seven categories. Combining the categories at the tails of the frequency distribution can help avoid violating the assumption of the test.

Table 4 Descriptive Classification Categories for Scores on the Cognitive and Achievement Measures

Standard Score Range	Category
69 and below	Extremely Low
70-79	Borderline
80-89	Low Average
90-109	Average
110-119	High Average
120-129	Superior
130 and above	Very Superior

Individual Profiles of Discrepancies in Cognitive Abilities

Besides the normative approach for interpreting Wechsler scores described above (in which the mean composite scores were compared to those of the general population), ipsative Wechsler profile analyses were also performed (Sattler, 2001). First, individual WISC-III, WISC-IV, and WAIS-III standard score profiles were analyzed to determine whether significant differences (“discrepancies”) existed among the various composite scores (VIQ, PIQ, and index scores) at the 0.05 level. Second, the statistically significant differences would be further examined to see whether they were “clinically significant” i.e. the magnitude of difference should occur in less than 15% of the general population (Sattler, 2001). In general, a score difference of 9 to 16 points would be deemed statistically significant at the 0.05 level, while a score difference of over 14 points would usually be considered as clinically significant (actual critical value varied depending on

the test, the individual's age, and the specific comparison being made) (Sattler, 2001; Sattler & Dumont, 2004; Wechsler, 2003). The number of participants exhibiting each type of significant discrepancy was tallied.

Furthermore, subtest analyses were performed for each individual participant to uncover whether significant strengths or weaknesses existed in his / her subtest profile. An individual's subtest scores were compared to his / her own average subtest score to determine whether skills examined in a particular subtest were better or more poorly developed relative to his / her own average ability level. For those tested with the WISC-III or the WAIS-III, each of the scaled scores on the Verbal subtests was compared to the mean of all the Verbal subtests administered to examine whether it significantly deviated from the individual's own mean subtest scaled score at the 0.05 level (Sattler, 2001). The same procedure was then repeated on the Performance subtests by comparing each of their scaled scores to the mean of all the Performance subtests. For those who completed the WISC-IV, the subtest scaled scores were compared to the mean scaled scores of those subtests that underlay the corresponding index (e.g. the three VCI subtest scaled scores were compared to the mean subtest scaled score of the VCI subtests, etc.). In general, a scaled score difference of 1.5 to 5 would be deemed significant at the 0.05 level; the actual critical value varied depending on the age of the participant, the test, and the specific comparison made. The percentages of participants exhibiting a relative strength or weakness for each subtest were calculated.

Ability-Achievement Discrepancy Analysis

A regression model suggested by Reynolds (1985) was used to examine whether significant discrepancy existed between each participant's general cognitive ability and

his or her level of academic achievement. This method of examining ability-achievement discrepancy is considered as more psychometrically sound, since it takes into account the imperfect correlation between IQ and achievement. Because of the “regression towards the mean” phenomenon, individuals with above-average IQ will tend to have achievement scores below their IQ scores, whereas those with below-average IQ will be more likely to have achievement scores above their IQ scores. If one determines ability-achievement discrepancy simply by subtracting an individual’s IQ from his or her achievement score, the resulting difference may reflect a statistical artifact rather than a genuine discrepancy between one’s aptitude and achievement. Thorndike (1963) therefore argued that ability-achievement discrepancy should be defined as a significant discrepancy between an individual’s actual achievement and predicted achievement calculated based on his or her IQ score.

In the current study, each individual participant’s FSIQ was first converted to a z-score. It was then used to generate a “predicted achievement standard score” with a mean of 100 and a standard deviation of 15 for each academic area based on the following regression formula:

$$\text{Predicted Achievement Standard Score} = 15r_{xy}z_{ab} + 100$$

where r_{xy} was the correlation between the Wechsler FSIQ and the achievement test, and z_{ab} was the z-score of the FSIQ. For those who displayed “clinically significant” discrepancy between their VIQ and PIQ (or for those tested using WISC-IV, between their VCI score and PRI score), their VIQ from the WISC-III or WAIS-III or their VCI score from the WISC-IV would be used in the comparison in lieu of their FSIQ (Flanagan & Alfonso, 1993). The correlation between the Wechsler scale and a particular

achievement measure was usually listed in the respective test manuals. If such a correlation was not available, it was estimated based on a formula by Reynolds (1990):

$$\text{Estimated } r_{xy} = \sqrt{0.5} \sqrt{r_{xx} r_{yy}}$$

where r_{xx} and r_{yy} were the age-specific internal consistency reliability coefficients of the Wechsler scale and the achievement test used respectively.

The discrepancy score was calculated by subtracting a participant's actual score on an achievement test from his or her predicted achievement score for that test. It was then compared to a critical value to determine whether a severe discrepancy existed between a participant's actual achievement score and his or her predicted level of achievement (roughly 2 standard deviations of the distribution of the difference scores). The critical value was calculated as:

$$\text{Critical value} = 1.96(15) \sqrt{1 - r_{xy}^2}$$

Relationships Between Self-Reports of School Functioning and Results from Standardized Testing

Three variables of the participants' self-reported school functioning (school absence, pre-existing school problems, and good grades) were chosen to examine the relationship between the participants' own account of their academic performance and results from standardized testing. Independent-sample t-tests were performed to examine whether significant differences in cognitive ability and academic achievement existed between those who missed school and those who did not, between those who reported

pre-existing school problems and those who did not, and between those who reported getting good school grades despite their pain and those who did not.²

Power Analysis

Due to the inconsistencies in previous research, there was no clear indication of the magnitude of differences in cognitive abilities and academic achievement that could be expected between pediatric chronic pain patients and the general population. Assuming a medium effect size (ES) (i.e. $ES = 0.50$, or half a standard deviation), an a priori power analysis suggested that a sample of approximately 32 participants would be needed for a one-sample z-test to detect a difference in the mean level of cognitive functioning and academic performance between the current sample and the general population with 80% power at a contrast-based alpha level of 0.05 (Glass & Hopkins, 1996). On the other hand, a sample of approximately 110 participants would be needed for a chi-square goodness-of-fit test with 2 degrees of freedom to detect a difference between the sample frequency distribution of scores on a particular test and that of the corresponding normative sample with 80% power at an alpha level of 0.05, assuming that the difference is of a medium effect size (i.e. $ES = 0.30$) (Cohen, 1988). Lastly, a minimum of 64 participants in each group was required for an independent-sample t-test to detect a difference of a medium effect size (i.e. $ES = 0.50$) with 80% power.

² Given the fact that different achievement tests were administered to different participants to measure academic achievement in the same domain, a two-factor analysis of variance (ANOVA) (test x types of self-report) would have been more appropriate for examining the relationship between self-report of school functioning and academic achievement as measured by standardized testing. Yet a closer examination of the data suggested that orthogonality, a necessary condition for proper partition of variances in the ANOVA, could not be achieved due to the significantly unequal and disproportional cell sizes (Glass & Hopkins, 1996). As a result, independent-sample t-tests were performed instead, which ignored possible between-test differences and test-self-report interaction.

RESULTS

General Cognitive Functioning of Children and Adolescents with Chronic Pain

Approach to Differences in Instruments

In the current sample, 38 participants were assessed using the WISC-III, while seven completed the WISC-IV. Twelve participants who were over age 16 at the time of testing were tested using the WAIS-III. The broad age range of the participants and the wide time span of the chart review implied that the use of different measures of cognitive functioning for different participants was inevitable. While combining scores from different instruments may introduce certain imprecision to the results, performing separate analyses for each Wechsler test may negatively impact the power of the analyses, and the results may not reflect the *general* level of cognitive functioning of this group as a whole. Furthermore, a series of one-way ANOVA confirmed that no difference in FSIQ ($F(2, 54) = 0.97, p = 0.39, \eta^2 = 0.03$), VIQ ($F(1, 48) = 0.45, p = 0.51, \eta^2 = 0.01$), and PIQ ($F(1, 48) = 0.43, p = 0.51, \eta^2 = 0.01$) was found among the three tests used. Similarly, no between-test differences were found for the four Wechsler index scores: VCI ($F(2, 54) = 0.70, p = 0.50, \eta^2 = 0.03$), POI (PRI in WISC-IV) ($F(2, 54) = 0.57, p = 0.57, \eta^2 = 0.02$), WMI (FDI in WISC-III) ($F(2, 51) = 2.50, p = 0.09, \eta^2 = 0.09$), and PSI ($F(2, 52) = 1.76, p = 0.18, \eta^2 = 0.06$). The effect sizes (in the form of eta squared i.e. η^2) were also less than 0.1, the threshold for a small effect size (Cohen,

1988). As a result, the Wechsler composite scores from all participants were combined and analyzed as a whole, regardless of which Wechsler test was administered.

***Cognitive Functioning of Children and Adolescents with Chronic Pain
as Compared to the General Population***

Table 5 presents the means and standard deviations of the seven Wechsler composite scores obtained in the current sample. While the means were all in the Average range, one-sample z-tests revealed that they were significantly different from the population mean ($M = 100$) except for mean FDI/WMI. The participants' mean FSIQ, VIQ, PIQ, VCI score, POI/PRI score, and PSI score were found to be 5 to 10 IQ points higher than those of the general population. The effect sizes of these six dimensions also approached or exceeded Cohen's (1988) threshold of 0.50 for a medium effect.

Table 5 Means and Standard Deviations of Wechsler Composite Scores of Children and Adolescents with Chronic Pain, with Comparisons to the General Population

Wechsler Scale	<i>n</i>	<i>M</i>	<i>SD</i>	<i>z</i>	<i>ES</i>^a
Full-Scale IQ	57	106.89	13.77	3.47***	0.46
Verbal IQ	50	108.24	13.81	3.88****	0.55
Performance IQ	50	105.58	15.01	2.63*	0.37
VCI	57	109.65	14.21	4.86****	0.64
POI / PRI	57	105.35	15.12	2.69*	0.36
FDI / WMI	54	99.17	12.68	0.41	0.06
PSI	55	105.96	12.87	2.95**	0.40

^a *ES* is the difference between the obtained mean IQ or index score and the population IQ mean (i.e. 100) divided by the population standard deviation (i.e. 15)

* $p < 0.01$. ** $p < 0.005$. *** $p < 0.001$. **** $p < 0.0005$

Table 6 presents the sample frequency distributions of the seven Wechsler scores as classified into seven descriptive categories respectively. While all of the distributions appeared to be negatively skewed, chi-square goodness-of-fit tests indicated that only the frequency distributions of VIQ, VCI scores and PSI scores were significantly different from the normal distribution, χ^2 (2, $N = 50, 57,$ and 55 respectively) = 13.68, 15.49, and 7.29, $ps < 0.0025, 0.0005,$ and 0.05 respectively. More participants performed in the Above Average range than the general population in terms of their verbal ability and their ability to process information in a fast and accurate manner.

Table 6 Frequency Distributions of Wechsler Composite Scores

Descriptive Category	FSIQ (N=57)		VIQ (N=50)		PIQ (N=50)		VCI (N=57)		POI/PRI (N=57)		FDI/WMI (N=54)		PSI (N=55)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Extremely Low	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Borderline	1	2	0	0	1	2	0	0	0	0	2	4	0	0
Low Average	6	11	2	4	8	16	4	7	10	18	11	20	6	11
Average	31	54	28	56	22	44	28	49	26	46	33	61	29	53
High Average	8	14	7	14	11	22	11	19	12	21	3	6	14	26
Superior	7	12	10	20	5	10	8	14	4	7	5	9	3	6
Very Superior	4	7	3	6	3	6	6	11	5	8	0	0	3	6

Note: Percentages do not necessarily add to 100 due to rounding error.

Significant Discrepancies among Individual Wechsler Composite Scores

The number and percentage of participants displaying a significant VIQ-PIQ discrepancy are presented in Table 7. In total, 20 (40%) of those in the current sample were found to have a statistically significant difference between their Wechsler VIQ and PIQ. Fifteen of them had a VIQ-PIQ discrepancy considered as clinically significant. The majority of them had a higher VIQ than PIQ.

Table 7 The Number and Percentage of Participants Displaying Significant Discrepancy between VIQ and PIQ

Significance Level	VIQ vs PIQ (<i>N</i> =50)			
	VIQ > PIQ		PIQ > VIQ	
	<i>n</i>	%	<i>n</i>	%
Statistically significant at the 0.05 level	14	28	6	12
Clinically significant (Statistically significant plus occurrence in less than 15% of the general population)	12	24	3	6

Tables 8 to 11 depict the numbers and percentages of participants exhibiting significant discrepancies among their Wechsler index scores. For a majority of the participants with statistically significant index score discrepancies, those differences also tended to be clinically significant. In general, most of the participants with significant index score discrepancies had significantly higher VCI scores and lower FDI/WMI scores

than their other index scores. For instance, among the 42% of participants with a significant VCI-POI/PRI discrepancy, 75% had higher VCI scores than their POI/PRI scores. Similarly, 68% of those with a significant VCI-PSI discrepancy had higher VCI scores than their PSI scores. Even though both the VCI and FDI/WMI were factors underlying the Wechsler Verbal Scale, there was significant score variability between these two constructs in the current sample – half of the participants in the sample exhibited a significant VCI-FDI/WMI discrepancy, with VCI scores being higher in 85% of them. Moreover, among those who displayed significant discrepancies between their FDI/WMI and POI/PRI or between their FDI/WMI and PSI, their FDI/WMI scores tended to be the lower one in the comparisons. Nearly 35% of participants exhibited a significant POI/PRI-PSI discrepancy; approximately equal numbers of participants were found in either direction.

Table 8 The Numbers and Percentages of Participants Displaying Significant Discrepancies between VCI and Other Index Scores

Significance Level	VCI vs POI/PRI (N=57)				VCI vs FDI/WMI (N=54)				VCI vs PSI (N=55)			
	VCI > POI/PRI		POI/PRI > VCI		VCI > FDI/WMI		FDI/WMI > VCI		VCI > PSI		PSI > VCI	
	n	%	n	%	n	%	n	%	n	%	n	%
Statistically significant at the 0.05 level	18	32	6	11	23	43	4	7	15	27	7	13
Clinically significant (Statistically significant plus occurrence in less than 15% of the general population)	16	28	4	7	21	39	3	6	10	18	6	11

Table 9 The Numbers and Percentages of Participants Displaying Significant Discrepancies between POI/PRI and Other Index Scores

Significance Level	POI/PRI vs VCI (N=57)			POI/PRI vs FDI/ WMI (N=54)			POI/PRI vs PSI (N=55)					
	POI/PRI > VCI	VCI > POI/PRI		POI/PRI > FDI/WMI	FDI/WMI > POI/PRI		POI/PRI > PSI	PSI > POI/PRI				
	n	%	n	%	n	%	n	%	n	%		
Statistically significant at the 0.05 level	6	11	18	32	17	31	6	11	10	18	9	16
Clinically significant (Statistically significant plus occurrence in less than 15% of the general population)	4	7	16	28	16	30	2	4	9	16	9	16

Table 10 The Numbers and Percentages of Participants Displaying Significant Discrepancies between FDI/WMI and Other Index Scores

Significance Level	FDI/WMI vs VCI (N=54)		FDI/WMI vs POI/PRI (N=54)		FDI/WMI vs PSI (N=52)	
	FDI/WMI > VCI	VCI > FDI/WMI	FDI/WMI > POI/PRI	POI/PRI > FDI/WMI	FDI/WMI > PSI	PSI > FDI/WMI
	<i>n</i> %	<i>n</i> %	<i>n</i> %	<i>n</i> %	<i>n</i> %	<i>n</i> %
Statistically significant at the 0.05 level	4 7	23 43	6 11	17 31	3 6	14 27
Clinically significant (Statistically significant plus occurrence in less than 15% of the general population)	3 6	21 39	2 4	16 30	2 4	12 23

Table 11 The Numbers and Percentages of Participants Displaying Significant Discrepancies between PSI and Other Index Scores

Significance Level	PSI vs VCI (N=55)			PSI vs POI/PRI vs (N=55)			PSI vs FDI/WMI (N=52)					
	PSI > VCI		VCI > PSI	PSI > POI/PRI		POI/PRI > PSI	PSI > FDI/WMI		FDI/WMI > PSI			
	n	%	n	%	n	%	n	%	n	%		
Statistically significant at the 0.05 level	7	13	15	27	9	16	10	18	14	27	3	6
Clinically significant (Statistically significant plus occurrence in less than 15% of the general population)	6	11	10	18	9	16	9	16	12	23	2	4

Relative Strengths and Weaknesses in Individual Wechsler Subtest Profiles

Individual subtest analyses revealed that the majority of participants (82%) exhibited significant relative strengths and weaknesses in at least one Wechsler subtest; only 10 participants (18%) failed to show any intraindividual discrepancy patterns in their profiles. Tables 12 and 13 depict the numbers and percentages of participants displaying strengths or weaknesses for each Wechsler subtest. Among the Verbal subtests, Similarities, Vocabulary, Letter-Number Sequencing, and Comprehension were the ones in which the most participants demonstrated a strength. On the other hand, two subtests underlying the FDI in WISC-III and the WMI in WAIS-III, Arithmetic and Digit Span, had the most participants displaying a weakness.

With regards to the Performance subtests, those with the most participants exhibiting a significant strength were Picture Concepts, Picture Completion, Matrix Reasoning, and Symbol Search. Conversely, Picture Concepts, Coding / Digit Symbol–Coding, and Object Assembly were the Performance subtests that had the most participants showing a significant weakness.

Table 12 Relative Strength and Weakness Patterns Observed in Wechsler Verbal Subtests

Subtest	<i>N</i> ^a	Strength		Weakness	
		<i>n</i>	%	<i>n</i>	%
Similarities	57	8	14	1	2
Vocabulary	57	7	12	1	2
Comprehension	56	6	11	1	2
Information ^b	50	2	4	4	8
Digit Span	56	2	4	18	32
Arithmetic ^b	50	2	4	6	12
Letter-Number Sequencing ^c	17	2	12	1	6

^aTotal number of participants that completed the subtest

^bNot a core subtest in WISC-IV

^cSubtest found in WISC-IV and WAIS-III only

Table 13 Relative Strength and Weakness Patterns Observed in Wechsler Performance Subtests

Subtest	<i>N</i> ^a	Strength		Weakness	
		<i>n</i>	%	<i>n</i>	%
Block Design	57	3	5	5	9
Picture Completion ^b	52	6	12	0	0
Picture Arrangement ^c	50	2	4	2	4
Object Assembly ^d	38	0	0	4	11
Matrix Reasoning ^e	19	2	11	0	0
Coding / Digit Symbol–Coding ^f	57	5	9	10	18
Symbol Search	55	6	11	2	4
Picture Concepts ^g	7	1	14	2	29
Mazes ^h	3	0	0	0	0

^a Total number of participants that completed the subtest

^b Subtest found in both WISC-III and WAIS-III; not a core subtest in WISC-IV

^c Subtest found in both WISC-III and WAIS-III; deleted from WISC-IV

^d Subtest found in WISC-III; not a core subtest in WAIS-III, and was deleted from WISC-IV

^e Subtest found in WISC-IV and WAIS-III

^f The Coding subtest in WISC-III and –IV was named Digit Symbol–Coding in WAIS-III

^g New subtest found in WISC-IV only

^h Supplementary subtest in WISC-III only

Visual-Motor Skills of Children and Adolescents with Chronic Pain

Comparison to the General Population

Thirty-four participants underwent additional testing on their visual-motor skills using the VMI. Their mean VMI score was 101 with a standard deviation of 14.06. The

mean score was not significant different from the population mean of 100, $z = 0.39$, $p = 0.70$, $ES = 0.07$.

Table 14 shows the sample frequency distribution of the VMI standard scores as classified into seven descriptive categories. Close to 60% of the participants performed in the Average range. A chi-square goodness-of-fit test failed to detect a significant difference between the sample frequency distributions of VMI scores and the normal distribution, $\chi^2 (2, N=34) = 1.06$, $p = 0.59$.

Table 14 Frequency Distribution of VMI Standard Scores

Descriptive Category	VMI ($N=34$)	
	<i>n</i>	%
Extremely Low	0	0
Borderline	2	6
Low Average	5	15
Average	20	59
High Average	3	9
Superior	3	9
Very Superior	1	3

Academic Achievement of Children and Adolescents with Chronic Pain

Comparison to the General Population

Four participants were not assessed with the achievement measures examined in the current study; as a result they were excluded from the analysis of academic performance.

Word Reading

Word reading was assessed in 51 participants; 24 completed the WRAT-3 Reading subtest, while the remaining 27 were tested using the WIAT-II Word Reading subtest. Regardless of the tests the participants completed, the mean standard score for word reading for the entire group was 105.82, with a standard deviation of 12.86. An independent-sample t-test, however, revealed a significant difference between these two groups on their word reading score, $t(49) = 2.08$, $p < 0.05$, $d = 0.58$. Separate analyses were therefore performed for the two tests.

Table 15 lists the means and standard deviations of the standard scores on both tests. One-sample z-tests found that only the mean WRAT-3 Reading score was significantly different from the population mean of 100. The effect size of the difference was 0.64, exceeding Cohen's (1988) threshold of 0.50 for a medium effect.

Table 15 Means and Standard Deviations of Word Reading Standard Scores

Test	<i>n</i>	<i>M</i>	<i>SD</i>	<i>z</i>	<i>ES</i>
WRAT-3 Reading	24	109.67	9.31	3.16*	0.64
WIAT-II Word Reading	27	102.41	14.68	0.83	0.16

* $p < 0.005$

The frequency distributions of the scores on both tests are presented in Table 16. The frequency distribution of the WRAT-3 Reading scores was found to be significantly different from the normal distribution, $\chi^2(2, N = 24) = 8.33, p < 0.025$. More participants scored in the Above Average range in that particular test compared to the general population.

Table 16 Frequency Distributions of Word Reading Standard Scores

Descriptive Category	WRAT-3 Reading (<i>N</i> =24)		WIAT-II Word Reading (<i>N</i> =27)	
	<i>n</i>	%	<i>n</i>	%
Extremely Low	0	0	2	7
Borderline	0	0	0	0
Low Average	1	4	2	7
Average	12	50	14	52
High Average	9	38	6	22
Superior	2	8	3	11
Very Superior	0	0	0	0

Note: Percentages do not necessarily add to 100 due to rounding error.

Further analyses showed that more males were assigned to complete the WRAT-3 Reading subtest than the WIAT-II Word Reading subtest, $\chi^2(1, N = 51) = 4.14, p < 0.05$. Participants who were assessed using the WRAT-3 Reading subtest also turned out to have higher FSIQ ($t(49) = 3.42, p < 0.0025, d = 0.96$), VIQ ($t(43) = 2.60, p < 0.05, d = 0.78$), PIQ ($t(49) = 3.42, p < 0.005, d = 0.96$), and POI / PRI score ($t(49) = 3.42, p < 0.0025, d = 1.00$) than those assessed with the WIAT-II Word Reading subtest.

Reading Comprehension

Forty-one participants completed testing on their reading comprehension; 20 were evaluated using the GORT-3, 16 completed the GORT-4, while the remaining 5 participants were assessed with the WIAT-II Reading Comprehension subtest. Regardless of the tests the participants completed, the mean standard score for reading comprehension for the entire group was 101.59, with a standard deviation of 21.42. A one-way ANOVA showed that there was a significant score difference among the three groups, $F(2, 38) = 4.50, p < 0.025, \eta^2 = 0.19$. Specifically, the GORT-3 group scored significantly higher than the GORT-4 group as revealed by the Tukey Honestly Significant Difference (HSD) analysis, $p < 0.05$. Separate analyses were performed for each of the tests.

The means and standard deviations of the scores on the three tests are presented in Table 17. One-sample z-tests revealed that only the mean GORT-3 ORQ was significantly different from the population mean. The effect size approached Cohen's (1988) threshold of 0.80 for a large effect.

Table 17 Means and Standard Deviations of Reading Comprehension Standard Scores

Test	<i>n</i>	<i>M</i>	<i>SD</i>	<i>z</i>	<i>ES</i>
GORT-3 ORQ	20	111.05	13.88	3.30*	0.74
GORT-4 ORQ	16	93.06	24.12	1.85	0.46
WIAT-II Reading Comprehension	5	91.00	24.73	1.34	0.60

* $p < 0.001$

The frequency distributions of the scores on the three tests are presented in Table 18. Only the frequency distribution of GORT-3 ORQ was found to be significantly different from the normal distribution, $\chi^2 (2, N = 20) = 8.30, p < 0.025$, with more participants scoring above average compared to the normal population.

Table 18 Frequency Distributions of Reading Comprehension Standard Scores

Descriptive Category	GORT-3 ORQ (N=20)		GORT-4 ORQ (N=16)		WIAT-II Reading Comprehension (N=5)	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Extremely Low	0	0	3	19	1	20
Borderline	0	0	3	19	0	0
Low Average	1	5	2	13	1	20
Average	9	45	5	31	3	60
High Average	5	25	0	0	0	0
Superior	4	20	2	13	0	0
Very Superior	1	5	1	6	0	0

Note: Percentages do not necessarily add to 100 due to rounding error.

Similar to the findings in word reading, a significant difference in cognitive ability was also found across the participants assigned to the three tests. Significant between-group differences were observed in FSIQ ($F(2, 38) = 9.48, p < 0.0005, \eta^2 = 0.33$), VIQ ($F(2, 36) = 7.18, p < 0.0025, \eta^2 = 0.29$), PIQ ($F(2, 36) = 5.84, p < 0.01, \eta^2 = 0.24$), VCI score ($F(2, 38) = 7.46, p < 0.0025, \eta^2 = 0.28$), and POI / PRI score ($F(2, 38) = 6.22, p < 0.01, \eta^2 = 0.25$). Post-hoc Tukey HSD analyses confirmed that the GORT-3

group and GORT-4 group differed on all five of these IQ dimensions ($ps < 0.05$), with those in the GORT-3 group scoring higher. The GORT-3 group and the WIAT-II group also differed on their FSIQ and POI / PRI scores ($ps < 0.05$), again with those in the GORT-3 group scoring significantly higher in these two dimensions.

Arithmetic Computation

Of the 52 participants who completed testing on their arithmetic computational skills, 24 were assessed using the WRAT-3 Arithmetic subtest, while the remaining 28 were tested using the WIAT-II Numerical Operations subtest. Regardless of the tests the participants completed, the mean standard score for arithmetic computation for the entire group was 96.46, with a standard deviation of 13.18. However, an independent-sample t-test revealed a significant difference between these two groups on their arithmetic computations score, $t(50) = 2.83$, $p < 0.01$, $d = 0.79$. Subsequent analyses were separately performed for the two tests.

The means and standard deviations of the scores on both tests are presented in Table 19. One-sample z-tests found that only the mean WIAT-II Numerical Operations subtest score was significantly different from the population mean of 100, $z = 2.61$, $p < 0.005$. The effect size of the difference was 0.54, which exceeded Cohen's (1988) threshold of 0.50 for a medium effect.

Table 19 Means and Standard Deviations of Arithmetic Computation Standard Scores

Test	<i>n</i>	<i>M</i>	<i>SD</i>	<i>z</i>	<i>ES</i>
WRAT-3 Arithmetic	24	101.71	9.88	0.56	0.11
WIAT-II Numerical Operations	28	91.96	14.13	2.84*	0.54

* $p < 0.005$

The frequency distributions of the scores on both tests are presented in Table 20. Neither of the two frequency distributions was found to be significantly different from the normal distribution, $\chi^2(2, N = 24 \text{ and } 28 \text{ respectively}) = 3.00 \text{ and } 4.57, ps = 0.10 \text{ and } 0.22$ respectively.

Table 20 Frequency Distributions of Arithmetic Computation Standard Scores

Descriptive Category	WRAT-3 Arithmetic (<i>N</i>=24)		WIAT-II Numerical Operations (<i>N</i>=28)	
	<i>n</i>	%	<i>n</i>	%
Extremely Low	0	0	2	7
Borderline	0	0	4	14
Low Average	3	13	5	18
Average	16	67	14	50
High Average	4	17	2	7
Superior	1	4	1	4
Very Superior	0	0	0	0

Note: Percentages do not necessarily add to 100 due to rounding error.

Further analyses showed that more males were assigned to complete the WRAT-3 Arithmetic subtest than the WIAT-II Numerical Operations subtest, $\chi^2(1, N = 52) = 4.38$, $p < 0.05$. The WRAT-3 group also happened to have higher FSIQ ($t(50) = 3.58$, $p < 0.0025$, $d = 1.00$), VIQ ($t(44) = 2.73$, $p < 0.01$, $d = 0.80$), PIQ ($t(44) = 3.42$, $p < 0.0025$, $d = 1.01$), and POI / PRI score ($t(50) = 3.76$, $p < 0.0005$, $d = 1.04$) than the WIAT-II group.

Mathematical Reasoning

Twenty-one participants completed the WIAT-II Math Reasoning subtest. The mean WIAT-II Math reasoning score was 95.33 with a standard deviation of 14.44. The sample mean score was not significantly different from the population mean of 100, $z = 1.43$, $p = 0.15$, $ES = 0.31$. The frequency distribution of the WIAT-II Math Reasoning scores is depicted in Table 21. A chi-square goodness-of-fit test failed to detect a significant difference between this frequency distribution and the normal distribution, $\chi^2(2, N = 21) = 2.90$, $p = 0.24$.

Table 21 Frequency Distribution of WIAT-II Math Reasoning Standard Scores

Descriptive Category	WIAT-II Math Reasoning (N=28)	
	<i>n</i>	%
Extremely Low	0	0
Borderline	4	19
Low Average	1	5
Average	14	67
High Average	1	5
Superior	0	0
Very Superior	1	5

Note: Percentages do not necessarily add to 100 due to rounding error.

Spelling

Of the 50 participants tested on spelling, 24 were evaluated using the WRAT-3 Spelling subtest. The other 26 completed the WIAT-II Spelling subtest. Regardless of the tests the participants completed, the mean standard score for word reading for the entire group was 102.80, with a standard deviation of 12.15. No significant difference was found between the means of the two tests, $t(48) = 0.09$, $p = 0.93$, $d = 0.02$. Both were also not significantly different from the population mean of 100. Table 22 lists the means and standard deviations of the spelling scores on both tests.

Table 22 Means and Standard Deviations of Spelling Standard Scores

Test	<i>n</i>	<i>M</i>	<i>SD</i>	<i>z</i>	<i>ES</i>
WRAT-3 Spelling	24	102.96	10.18	0.90	0.20
WIAT-II Spelling	26	102.65	13.93	0.97	0.18

With regards to the frequency distributions of the WRAT-3 and WIAT-II Spelling scores (see Table 23), while that of the WRAT-3 Spelling scores appeared to have a narrower range, both were found not to be significantly different from the normal distribution, $\chi^2(2, N = 24 \text{ and } 26) = 2.25 \text{ and } 1.39, ps = 0.33 \text{ and } 0.50$ respectively.

Table 23 Frequency Distributions of Spelling Standard Scores

Descriptive Category	WRAT-3 Spelling (<i>N</i> =24)		WIAT-II Spelling (<i>N</i> =26)	
	<i>n</i>	%	<i>n</i>	%
Extremely Low	0	0	0	0
Borderline	0	0	2	8
Low Average	3	13	3	12
Average	15	63	12	46
High Average	6	25	8	31
Superior	0	0	1	4
Very Superior	0	0	0	0

Interestingly, the WRAT-3 group also turned out to have higher FSIQ ($t(48) = 3.52, p < 0.0025, d = 1.00$), VIQ ($t(43) = 3.75, p < 0.01, d = 0.88$), PIQ ($t(43) = 3.27, p <$

0.0025, $d = 0.98$), VCI score ($t(48) = 2.26, p < 0.05, d = 0.64$), and POI / PRI score ($t(48) = 3.54, p < 0.0025, d = 1.00$) than the WIAT-II group.

Written Expression

A total of 40 participants completed testing on their writing skills. Twenty-six were assessed using the TOWL-3 Story Construction subtest, and the remaining 14 were tested using the WIAT-II Written Expression subtest. Regardless of the tests the participants completed, the mean standard score for written expression for the entire group was 107.10, with a standard deviation of 18.95. An independent-sample t-test failed to detect a significant difference between these two groups on their writing scores despite the medium effect size, $t(38) = 1.81, p = 0.08, d = 0.60$.

The means and standard deviations of the scores on both tests are presented in Table 24. One-sample z-tests found that only the mean TOWL-3 SWC score was significantly different from the population mean of 100. The effect size of the difference was 0.73, approaching Cohen's (1988) threshold of 0.80 for a large effect.

Table 24 Means and Standard Deviations of Written Expression Standard Scores

Test	<i>n</i>	<i>M</i>	<i>SD</i>	<i>z</i>	<i>ES</i>
TOWL-3 SWC	26	110.96	17.17	3.73*	0.73
WIAT-II Written Expression	14	99.93	20.63	0.02	0.005

* $p < 0.00025$

The frequency distributions of the scores on both tests are presented in Table 25. Chi-square analysis could not be performed for the frequency distribution of the WIAT-II scores due to the small sample size ($n=14$). The frequency distribution of the TOWL-3

SWC scores was shown to be significantly different from the normal distribution, $\chi^2 (2, N = 26) = 11.54, p < 0.005$. In particular an upward shift was observed for the TOWL-3 SWC frequency distribution compared to the normal distribution i.e. more individuals have scored in the above average range.

Table 25 Frequency Distributions of Written Expression Standard Scores

Descriptive Category	TOWL-3 SWC (<i>N</i> =26)		WIAT-II Written Expression (<i>N</i> =14)	
	<i>n</i>	%	<i>n</i>	%
Extremely Low	0	0	1	7
Borderline	2	8	1	7
Low Average	2	8	1	7
Average	8	31	8	57
High Average	7	27	1	7
Superior	5	19	0	0
Very Superior	2	8	2	14

Note: Percentages do not necessarily add to 100 due to rounding error.

Similar to the findings in the other academic areas examined in the current study, significant differences in cognitive abilities were observed between the two groups completing different writing tests. Specifically, the TOWL-3 group had higher FSIQ ($t(38) = 2.63, p < 0.025, d = 0.87$), VIQ ($t(36) = 2.28, p < 0.05, d = 0.78$), PIQ ($t(36) = 2.92, p < 0.01, d = 1.00$), and POI / PRI score ($t(38) = 2.80, p < 0.01, d = 0.93$) than the WIAT-II group.

Discrepancy between Individual Intellectual Ability and Academic Achievement

Table 26 depicts the numbers of participants with a severe discrepancy between their actual performance on various achievement tests and their predicted scores based on their intellectual ability. In the domain of reading, more participants displayed significant ability-achievement discrepancy in reading comprehension than in word reading. The number of participants found to be performing above prediction was similar to that of those performing below prediction. In the domain of mathematics, however, all of the participants who displayed significant ability-achievement discrepancy were found to be performing below prediction. In the domain of writing, the number of participants performing below expectation was identical to that of those performing above expectation.

Table 26 The Numbers and Percentages of Participants Exhibiting a Severe Discrepancy between their Actual Achievement and the Predicted Achievement

Achievement Domain	Below Prediction		Above Prediction	
	<i>n</i>	% ^a	<i>n</i>	% ^a
Word Reading (<i>N</i> =51)	1	2	2	4
Reading Comprehension (<i>N</i> =41)	6	15	4	10
Arithmetic Computation (<i>N</i> =52)	4	8	0	0
Mathematical Reasoning (<i>N</i> =21)	2	10	0	0
Spelling (<i>N</i> =50)	1	2	1	2
Written Expression (<i>N</i> =40)	4	10	4	10

^a Calculated based on the total number of participants who completed the subtest

Relationships between Self-Reported School Functioning and Results from Standardized Testing in Cognitive Functioning and Academic Achievement

School Absence

Tables 27 and 28 present the means and standard deviations of IQ scores and the various achievement scores of the participants who reported absenteeism due to pain versus those who did not. Independent-sample t-tests failed to detect a significant difference between these two groups on their cognitive functioning and academic achievement.

Self-Report of Pre-Existing Academic Problems

The means and standard deviations of the IQ scores and the various achievement scores of the participants who reported pre-existing school problems and those who did not are listed in Tables 29 and 30 respectively. Independent-sample t-tests again failed to detect a significant difference between these two groups on their cognitive functioning and academic achievement

Self-Report of Getting Good School Grades

The means and standard deviations of IQ scores and the various achievement scores of the participants who reported receiving good grades in school and those who did not are listed in Tables 31 and 32 respectively. Independent-sample t-tests again failed to detect a significant difference between these two groups on their cognitive functioning and academic achievement.

Table 27 Means and Standard Deviations of IQ Scores of Participants with or without School Absence

Wechsler Scale	Absence		No Absence		<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>					<i>M</i>	<i>SD</i>
FSIQ	42	106.21	14.26	15	108.80	12.52	-0.62	55	0.54	0.19
VIQ	35	108.94	14.24	15	106.60	13.07	0.55	48	0.59	0.17
PIQ	35	103.77	16.19	15	109.80	11.18	-1.31	48	0.20	0.40
VCI	42	110.17	14.14	15	108.20	14.79	0.46	55	0.65	0.14
POI/PRI	42	103.71	15.78	15	109.93	12.46	-1.38	55	0.17	0.41
FDI/WMI	39	99.82	13.68	15	97.47	9.93	0.61	52	0.54	0.18
PSI	40	104.28	13.73	15	110.47	9.16	-1.61	53	0.11	0.49

Table 28 Means and Standard Deviations of Achievement Scores of Participants with or without School Absence

Achievement Domain	Absence		No Absence					<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>					
Word Reading	39	106.56	12.74	12	103.41	13.53	0.74	49	0.46	0.24	
Reading Comprehension	33	101.33	21.30	8	102.63	23.33	-0.15	39	0.88	0.03	
Arithmetic Computation	40	95.50	13.77	12	99.67	10.89	-0.96	50	0.34	0.32	
Mathematical Reasoning	17	96.06	15.11	4	92.25	12.58	0.47	19	0.65	0.26	
Spelling	38	103.87	12.30	12	99.42	11.49	1.11	48	0.27	0.37	
Written Expression	28	105.36	19.70	12	111.17	17.19	-0.89	38	0.38	0.31	

Table 29 Means and Standard Deviations of IQ Scores of Participants with or without Self-Report of Pre-Existing Academic Problems

Wechsler Scale	With Self-Report			Without Self-Report			<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>				
FSIQ	33	104.94	11.25	24	109.58	16.50	-1.26	55	0.21	0.34
VIQ	28	106.00	12.73	22	111.09	14.88	-1.30	48	0.20	0.37
PIQ	28	102.29	16.19	22	109.77	16.38	-1.79	48	0.08	0.46
VCI	33	108.55	12.95	24	111.17	15.94	-0.68	55	0.50	0.18
POI/PRI	33	102.88	12.90	24	108.75	17.45	-1.46	55	0.15	0.39
FDI/WMI	31	98.77	12.82	23	99.70	12.75	-0.26	52	0.79	0.07
PSI	31	103.35	13.38	24	109.33	11.59	-1.74	53	0.09	0.47

Table 30 Means and Standard Deviations of Achievement Scores of Participants with or without Self-Report of Pre-Existing Academic Problems

Achievement Domain	With Self-Report			Without Self-Report			<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>				
Word Reading	29	106.45	12.54	22	105.00	13.52	0.40	49	0.70	0.11
Reading Comprehension	22	102.14	18.18	19	100.95	25.16	0.18	39	0.86	0.05
Arithmetic Computation	30	94.40	13.93	22	99.27	11.82	-1.33	50	0.19	0.37
Mathematical Reasoning	13	94.77	12.47	8	96.25	18.12	-0.22	19	0.83	0.10
Spelling	28	104.75	11.72	22	100.32	12.51	1.29	48	0.20	0.37
Written Expression	20	105.25	19.72	20	108.95	18.47	-0.61	38	0.54	0.19

Table 31 Means and Standard Deviations of IQ Scores of Participants with or without Self-Report of Getting Good Grades in School

Wechsler Scale	With Self-Report			Without Self-Report			<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>				
FSIQ	16	110.94	11.54	41	105.32	14.36	1.40	55	0.17	0.41
VIQ	12	110.83	11.42	38	107.42	14.52	0.74	48	0.46	0.25
PIQ	12	110.83	14.02	38	103.92	15.11	1.40	48	0.17	0.46
VCI	16	113.31	12.28	41	108.22	14.79	1.22	55	0.23	0.36
POI/PRI	16	108.75	15.09	41	104.02	15.11	1.06	55	0.29	0.31
FDI/WMI	16	101.88	13.80	38	98.03	12.19	1.02	52	0.31	0.30
PSI	15	109.73	10.44	40	104.55	13.52	1.34	53	0.19	0.41

Table 32 Mean Achievement Scores of Participants with or without Self-Report of Getting Good Grades in School

Achievement Domain	With Self-Report			Without Self-Report			<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>				
Word Reading	16	108.19	8.15	35	104.74	14.49	0.89	49	0.38	0.27
Reading Comprehension	9	104.11	25.10	32	100.88	20.66	0.40	39	0.69	0.15
Arithmetic Computation	16	98.25	12.84	36	95.67	13.44	0.65	50	0.52	0.19
Mathematical Reasoning	7	96.71	14.04	14	94.64	15.12	0.30	19	0.77	0.14
Spelling	15	106.33	10.11	35	101.29	12.76	1.36	48	0.18	0.42
Written Expression	11	115.82	13.22	29	103.79	19.92	1.85	38	0.07	0.65

DISCUSSION

The current research is the first study to examine the profiles of cognitive abilities and academic achievement in children and adolescents with chronic pain from a specialized pain clinic using standardized testing. Results suggest that on average, the patients studied not only have scored within the Average range on measures of their general cognitive ability and visual-motor skills, they have also outperformed their peers on a variety of cognitive functions such as general intelligence, verbal ability, perceptual reasoning ability, and processing speed. While previous (but limited) research has confirmed that pediatric chronic pain sufferers tend to perform within the normal range on cognitive tests (e.g. Bille, 1962; Sherry et al., 1991; Haverkamp et al., 2002), none has detected any significant difference between the patients' mean level of cognitive functioning and that of the general population. Differences in sample composition may have contributed to these inconsistent findings. The current study has included a large variety of pain syndromes in its sample. Previous research in this area, however, was restricted to specific pain conditions. Both Bille (1962) and Haverkamp et al. (2002), for example, studied migraine sufferers exclusively, whereas Sherry et al. (1991) focused only on those with musculoskeletal pain. While Sherry et al. and Haverkamp et al. utilized clinical samples, Bille's pioneering work on migraine in children was conducted on non-clinical, school children residing in an industrial town in Sweden during the 1950's. Participants in the current study also reported a longer history of pain (mean duration was close to four years) than those in Sherry et al. (1 year) and Haverkamp et al. (3 years). The differences in the instruments used for cognitive testing further complicate

the comparison of findings across studies. Lastly, the amount of time elapsed since some of the older research was published may limit the applicability of their findings to the present population of pediatric pain patients.

In comparison to the findings on cognitive functioning, the results concerning the mean level of academic achievement in this group seem less straight-forward. As a whole, pediatric pain patients have performed in the Average range in all of the academic domains assessed. This is surprising given the amount of disrupted schooling observed in this sample. As suggested by Rangaswamy and Balakrishnan (1982) and Rangaswamy (1982), the patients' above-average IQ may have served as a "protective buffer" against scholastic difficulties by providing them with higher capacity to learn. Further analyses have also revealed that a subset of children and adolescents with chronic pain were better in single-word reading, reading comprehension, and written expression, but worse in arithmetic computation, than the general population. However, only those individuals tested with certain instruments (e.g. WRAT-3 Reading Subtest, GORT-3, WIAT-II Numerical Operations Subtest, and TOWL-3 Spontaneous Writing Subtest) were shown to deviate from their peers in their performance. In most of the academic areas covered in the study, significant between-test differences in the participants' performance within the same academic domain were also observed. Several possible explanations may account for these findings. First, different tests were administered to different participants to measure achievement in each scholastic domain in the current study. Although tests belonging to the same domain are supposed to measure the same type of academic skills, they may not always produce similar scores (McGrew, 1999). Error variance unique to each test, differences in the recency of the norms and in the composition of the normative

samples, and differences in the items of the tests can all result in significant differences between the scores derived from different tests within the same domain. Second, cohort differences within the current sample may have contributed to the findings of between-test differences. A closer look at the data revealed that the WRAT-3-GORT-3-TOWL-3 combination was more likely to be administered to participants assessed before 2001, while those tested after 2001 were more likely to have completed the WIAT-II and the GORT-4 which were published that year. It is possible that those seen at the CPS before 2001 might simply have a higher level of academic achievement than those who sought services after 2001. Moreover, those who completed the WRAT-3, the TOWL-3, and the GORT-3 were shown to have higher IQ compared to those tested with the WIAT-II and GORT-4, which may have led to their better performance in achievement testing.

Verbal skills appear to be particularly prominent in this group of children and adolescents with chronic pain. The participants' mean VIQ and VCI scores were found to be higher than the population mean with significantly more individuals functioning in the above average range. In intraindividual comparisons of Wechsler index scores, the VCI score consistently emerged as the highest of the four for a number of participants. Moreover, pediatric pain patients were more likely to show relative strength in Wechsler verbal subtests such as Vocabulary, Similarities and Comprehension. Many further demonstrated above-average reading and writing skills in achievement testing. This finding may have tremendous implications for successful pain assessment and management in the pediatric pain population. Pain is a subjective experience, yet recognition of one's pain by others is an interpersonal, communicative process (Craig, 2004). A child needs to be able to translate his or her inner state of pain into behavioural

forms (e.g. through verbal expression) in order for others to infer whether he or she is in pain (Rosenthal, 1982). A child's high verbal ability (such as that observed in the current clinical sample) may facilitate better articulation of his or her pain experience, thus allowing parents and health care professionals to more accurately judge whether the child's pain is severe enough to warrant treatments. Conversely, it is possible that despite their severe pain, some children and adolescents in the community may remain under-identified and undertreated because they are not able to adequately communicate their pain to others, or their way of communicating their pain is less likely to capture others' attention. Recent research, for example, has revealed that an attenuation of pain expression (both verbal and nonverbal), a decrease in help-seeking behaviours, and an underestimation of pain by parents are often associated with children with communication limitations (Gilbert-MacLeod, Craig, Rocha, & Mathias, 2000; LaChapelle, Hadjistavropoulos, & Craig, 1999; Nader, Oberlander, Chambers, & Craig, 2004). The well-being of the pediatric pain population relies on successful pain recognition and appropriate care provided by the adults around them. It is important for future studies to examine the relationship between verbal ability and pain expression in children, particularly in the non-clinical population, and how verbal ability may affect subsequent treatment decisions and outcomes. Craig, Lilley, and Gilbert's (1996) Sociocommunication Model of Pain, which conceptualizes pediatric pain as a communication process involving social factors that can affect pain expression and pain judgment, can serve as an appropriate theoretical framework for future work in this area.

As shown in previous research, adult chronic pain patients often demonstrate impairment in attention / concentration, working memory, and processing speed (Hart et

al., 2000), but similar studies have not been conducted in the pediatric population. In the current study, the participants' mean performance on the FDI/WMI was in the Average range and was at a level comparable to the general population. However, for a majority of those with significant discrepancies among their index scores, their FDI/WMI scores were often the lowest one in the comparison. Digit Span and Arithmetic, the subtests underlying the Freedom from Distractibility / Working Memory factor in the Wechsler tests (which taps into working memory, attention and / or concentration), were also the ones with the most participants scoring below their own average performance. With regards to processing speed, even though the participants were found to have a significantly higher mean score in this dimension compared to the general population, 18% of the sample still demonstrated a significant intraindividual weakness in the Wechsler Coding / Digit Symbol-Coding subtest, which measures psychomotor speed. These findings suggest that even if attention/concentration, working memory and processing speed are not regarded as absolute weaknesses for this group as a whole (i.e. a significant deficit compared to the performance of the normative samples), they may still be relative weaknesses (i.e. a significant deficit within an individual's reservoir of skills) for many of the patients. The correlational, retrospective nature of the current study, however, has made it difficult to determine whether such difficulties predated the pain or emerged as a consequence of the disrupted attentional resources by pain (Eccleston & Crombez, 1999). More research is needed to replicate the current findings in other children and adolescents with chronic pain using other instruments that are sensitive to attention/concentration, working memory and processing speed deficits (e.g. continuous performance tests, neuropsychological batteries). Future research in this area should also

expand to other cognitive functions such as memory, whose relationship with chronic pain has been established in the adult pain literature (e.g. Iezzi et al., 2004). Given the combined influence of psychological distress and chronic pain on cognitive performance identified in adult chronic pain patients (e.g. Iezzi et al., 1999), incorporation of measures on emotional well-being in future research could help uncover more significant predictors of neuropsychological functioning in pediatric chronic pain patients. Longitudinal studies providing information on the premorbid level of functioning of pain patients will also be useful in uncovering the changes in their cognitive functioning in relation to the progress of their pain.

Much has been speculated about whether children and adolescents with chronic pain are “overachievers” or “underachievers” (e.g. Zeltzer, Bursch, et al., 1997; Malleson et al., 1992), yet little has been said about how those variables should be operationalized. The current study has provided a more objective way to examine these dimensions through the use of a regression formula in calculating ability-achievement discrepancy. If one defines “underachievement” as “a substantially lower actual level of achievement compared to the level predicted by a measure of the individual's ability” (and the opposite for “overachievement”), the current results seem to have refuted Zeltzer, Bursch and Walco’s (1997) assertion that learning disability is “almost always present” among those with chronic pain (p. 419). The level of academic achievement for most of the participants in the current study was commensurate with their intellectual ability. The rates of participants exhibiting patterns of underachievement in reading (2% to 15% of those tested on reading) and writing (2% to 10% of those tested on writing) were also comparable to the population prevalence of Reading Disorder (5% to 17.5%; Shaywitz &

Shaywitz, 2005) and Disorder of Written Expression (2% to 8%; American Academy of Child and Adolescent Psychiatry, 1998). While the number of those performing below expectation in mathematics (8% to 10% of those tested on math) seemed higher than the population prevalence of Mathematics Disorder (3% to 6%; Shalev, Auerbach, Manor, & Gross-Tsur, 2000), a severe ability-achievement discrepancy does not always constitute a diagnosis of learning disability (Reynolds, 1990). The functional disability associated with chronic pain and the disruption of schooling due to absenteeism may have deprived pediatric pain patients of an optimal learning environment, thus contributing to patterns of underachievement observed in this group. Conversely, while a minority of participants exhibited a pattern of overachievement, the pattern was restricted to areas of reading (4%-10%) and writing (2% to 10%) only. The number of participants classified as “overachievers” was also quite similar to the number of those classified as “underachievers”, particularly in reading and writing. Taken all together, these findings indicate that more than one pattern of academic achievement can be found in this population. The practice of stereotyping all pediatric chronic pain patients into a single group of “overachievers” or “underachievers” therefore lacks empirical support.

The current study has failed to find any correlation between the participants’ self-report of their school functioning and the results from their standardized psychoeducational assessments despite the medium effect sizes for some of the differences. It is possible that the detection of such differences requires a larger sample size and higher statistical power. The system used for coding the participants’ self-report in the current study was crude (presence versus absence of self-report), and better documentation of the school grades and the nature and extent of the participants’

academic problems would have strengthened the analysis. Nevertheless, this finding further supports the need for using multiple sources of information in the clinical assessment of pain in children suggested by Bush and DeLuca (2001). Standardized testing is less susceptible to recall biases and yields more objective and reliable data compared to self-report. It also allows for the comparison of an individual's performance to that of the general population (Sattler, 2001). Self-report, on the other hand, provides more personalized information about an individual, which serves as an appropriate context for interpreting the meaning of the results from standardized testing. Both sources of information therefore complement each other to give a more comprehensive picture of an individual. Even inconsistencies between self-report and standardized test results can be useful for generating hypotheses on possible areas to explore in treatment. For instance, a child who reports being unhappy with his or her school grades but performs in the above average range on standardized testing may be struggling with issues such as perfectionism and pressure to succeed, which can be significant stressors that exacerbate his or her pain.

The current study also highlights the importance of incorporating standardized psychoeducational assessments in the treatment plan for pediatric chronic pain patients, especially in light of the findings that 1. a large number of participants exhibited significant discrepancies among their index scores and distinct relative strength and weakness patterns in their individual Wechsler subtest profiles; 2. more than half of the participants in the current sample scored significantly below the general population in arithmetic computation; and 3. the level of academic achievement for 2% to 15% of the participants was significantly below expectation. These findings suggest that although on

average these children and adolescents appear to be functioning within the normal range both cognitively and academically with many exhibiting excellent verbal skills, not all of their skills are equally well-developed. Skills that are more poorly developed compared to the individual's other abilities (e.g. working memory, psychomotor speed, arithmetic computation) may become a significant source of stress and contribute to one's pain and disability (Bursch et al., 1998). These relative weaknesses may also not be readily detected by parents or teachers since they are easily overshadowed by the individual's strengths in other areas. A psychoeducational assessment can pinpoint both the strengths and the weaknesses of an individual in various domains, and inform parents and school officials if the child or adolescent is functioning at the expected developmental level. Furthermore, treatment for chronic pain in children and adolescents is often multidimensional and utilizes a rehabilitation approach that aims at increasing independent functioning and adaptive problem-solving strategies in daily living, academic, social and physical domains (Bursch et al., 1998). Psychoeducational assessments can yield useful information for treatment planning, such that clinicians can recommend ways to better accommodate an individual's unique pattern of capabilities, to capitalize on one's assets, and to design interventions for improving one's ability to cope with environmental demands. Treatment approaches can also be tailored to the patient's developmental level to optimize treatment success.

Several limitations of the current study need to be addressed. The number of CPS patients excluded from this study due to their non-participation in psychoeducational assessment has significantly reduced the sample size of the current study, and prevented more complicated and sophisticated analyses from being performed (e.g. examining

possible differences in cognitive functioning and academic achievement across pain types). Although the use of different achievement tests for different participants helps increase the external validity of the current study as it reflects clinicians' usual practice of tailoring their assessment protocols to different patients, such procedure has negatively impacted the statistical power of the study since separate analyses were needed for each test. The differences in the instruments used may have introduced extraneous variance to the results of the participants' mean level of academic achievement, making their interpretation difficult. The archival nature of the current study implies an inability to assess the participants firsthand, to control the types of instruments and procedures used to generate the data, and to introduce other measures (e.g. emotional and family functioning) to provide a better understanding of the overall functioning of this group. The correlational data also prevent causal conclusions from being drawn. Further research examining more variables of the functional consequences of chronic pain in children using a prospective, longitudinal design with a larger sample is needed.

In summary, results from the current study indicate that on average, children and adolescents with chronic pain perform in the Average range on measures of general cognitive functioning and visual-motor skills. Their mean general cognitive ability, verbal ability, nonverbal reasoning ability and processing speed are superior to those of the general population. Verbal ability appears to be a relative strength for many in this group, while some exhibit significant relative weaknesses in domains of working memory and processing speed. With regards to academic achievement, their mean performance is in the Average range on all of the scholastic domains covered, with a subset of children and adolescents scoring significantly higher in word reading, reading comprehension and

written expression, but worse in arithmetic computation, than the general population. The levels of academic achievement for a majority of the participants are consistent with their intellectual ability. Incorporating psychoeducational assessments in the treatment plan for chronic pain in children and adolescents can help highlight their individual strengths and weaknesses, and facilitate treatment planning and success.

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