Running Head: Personality and postconcussion symptoms

The relationship between personality characteristics and postconcussion symptoms in a non-clinical sample.

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Abstract

Postconcussion symptoms are relatively common in the acute recovery period following mild traumatic brain injury (MTBI). However, for a small subset of patients, self reported postconcussion symptoms continue long after injury. Many factors have been proposed to account for the presence of persistent postconcussion symptoms. The influence of personality traits has been proposed as one explanation. The purpose of this study was to examine the relation between postconcussion-like symptom reporting and personality traits in a sample of 96 healthy participants. Participants completed the British Columbia Postconcussion Symptom Inventory (BC-PSI) and the Millon Clinical Multiaxial Inventory III (MCMI-III). There was a strong positive relation between the majority of MCMI-III scales and postconcussion-like symptom reporting. Approximately half of the sample met the International Classification of Diseases-10 Criterion C symptoms for Postconcussional Syndrome (PCS). Compared with those participants who did not meet this criterion, the PCS group had significant elevations on the negativistic, depression, major depression, dysthymia, anxiety, dependent, sadistic, somatic, and borderline scales of the MCMI-III. These findings support the hypothesis that personality traits can play a contributing role in self reported postconcussion-like symptoms.

Keywords: mild traumatic brain injury; postconcussion syndrome; personality; MMCI-III, BC-PSI.

The relationship between personality characteristics and postconcussion symptoms in a non-clinical sample.

It is relatively uncommon for cognitive, psychological, or psychosocial problems due to the biological effects of a mild traumatic brain injury to persist longer than three to six month (Belanger, Curtiss, Demery, Lebowitz, & Vanderploeg, 2005; Belanger & Vanderploeg, 2005; Carroll et al., 2004; Iverson, 2005; Rees, 2003; Schretlen & Shapiro, 2003). Individuals that remain symptomatic beyond this time period have been referred to as the "miserable minority" (Ruff, 2005; Ruff, Camenzuli, & Mueller, 1996; Wood, 2004) and they may be diagnosed with post-concussion syndrome. This syndrome is recognised in major diagnostic classification systems, including the International Classification of Diseases, 10th edition (ICD-10; World Health Organization, 1992) and the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric Association, 2000).

Individuals with PCS may report headaches, dizziness, light and noise sensitivity, nausea, fatigue, sleep disturbance, irritability, temper problems, emotional problems, poor concentration, and memory impairment. However, this suite of symptoms does not appear to be specific to PCS. The lack of specificity of PCS symptoms is demonstrated by research in healthy and non-MTBI clinical groups both of which endorse the symptoms associated with PCS. Several research groups have shown that healthy adults endorse such symptoms (Gouvier, Uddo-Crane, & Brown, 1988; Iverson & Lange, 2003; Machulda, Bergquist, Ito, & Chew, 1998; Meares et al., 2008; Mittenberg, DiGiulio, Perrin, & Bass, 1992; Sawchyn, Brulot, & Strauss, 2000; Trahan, Ross, & Trahan, 2001; Wang, Chan, & Deng, 2006; Wong, Regennitter, & Barrios, 1994). PCS symptoms have also been reported in outpatients seen for psychological treatment (Fox, Lees-Haley, Ernest, & Dolezal-Wood, 1995) or minor medical problems (Lees-Haley & Brown, 1993), non-brain injured trauma patients (Meares et

al., 2008), personal injury litigants (Dunn, Lees-Haley, Brown, Williams, & English, 1995; Lees-Haley & Brown, 1993) and individuals with post-traumatic stress disorder (Foa, Cashman, Jaycox, & Perry, 1997), orthopedic injuries (Mickeviciene et al., 2004), depressive symptoms (Garden & Sullivan, in press; Iverson, 2006; Iverson & Lange, 2003), or chronic pain (Gasquoine, 2000; Iverson & McCracken, 1997; Radanov, Dvorak, & Valach, 1992; Smith-Seemiller, Fow, Kant, & Franzen, 2003).

In addition, PCS symptom report is influenced by demographic factors, such as age, education, and gender (Garden & Sullivan, in press; Groswasser, Cohen, & Keren, 1998; Keyser-Marcus et al., 2002; Meares et al., 2008; Sherer et al., 2002; Testa, Malec, Moessner, & Brown, 2005), premorbid personality characteristics (Evered, Ruff, Baldo, & Isomura, 2003; Greiffenstein & Baker, 2001; Hibbard et al., 2000), and a diverse range of psychosocial factors (e.g., external incentives, expectations, misattribution, and an idealized view of pre-injury functioning Davis, 2002; Ferguson, Mittenberg, Barone, & Schneider, 1999; Gunstad & Suhr, 2001, 2004; Hahn, 1997; Hilsabeck, Gouvier, & Bolter, 1998). The lack of PCS symptom specificity and the association between PCS symptoms and non-organic factors suggests that an otherwise healthy individual could present with symptoms that mimic PCS. For the same reasons, the presentation of MTBI clients might suggest a diagnosis of PCS when such an attribution to organic factors may be incorrect. The diagnostic situation is further complicated because premorbid or co-morbid conditions that may be present in MTBI, such as pain, PTSD, and depression, can mimic PCS in the absence of MTBI. The challenge for the clinician is to determine whether the self-reported, non-specific, PCS symptoms are related or unrelated to the injury.

Of particular interest to this study is the influence of personality traits on self reported postconcussion symptoms. Personality traits are known to influence the way people respond to an injury, personality changes may occur as a result of an injury, and it is known that

certain personality types are at higher risk of MTBI. Thus, personality is likely to be an important factor in understanding the development, maintenance and exacerbation of postconcussion symptoms following a MTBI (Iverson, Zasler, & Lange, 2007).

Research that has attempted to identify the *specific* personality characteristics that may be related to postconcussion symptoms suggests that a number of traits may be involved. For example, it has been shown that following injury, patients may become more depressed, anxious, irritable and restless (Hibbard et al., 2000; Prigatano, 1992; Rush, Malec, Brown, & Moessner, 2006; Rush, Malec, Moessner, & Brown, 2004). These reactions can mimic PCS because they overlap with it. Others traits that could be implicated with PCS include those that have been reported as vulnerable to significant reactionary change post-injury, such as increased neuroticism, and decreased extraversion and conscientiousness (Kurtz, Putnam, & Stone, 1998; Lannoo, De Deyne, Colardyn, De Soete, & Jannes, 1997). Yet more research suggests that specific pre-injury personality traits may be heightened post-injury, such as narcissism, grandiosity, perfectionism, dependency, and borderline personality (Kay, Newman, Cayallo, Ezrachi, & Resnick, 1993; Ruff et al., 1996; Rush et al., 2004), and these traits may be linked to PCS. Whilst it is clear that there are a number of specific characteristics that could be associated with postconcussion symptom reporting, the relation between self reported postconcussion symptoms and personality remains poorly understood (Rush et al., 2004).

The current study examined the relation between postconcussion-like symptom reporting and personality traits in a healthy sample. It was hypothesized that there would be a positive correlation between personality characteristics and endorsement of postconcussion-like symptoms.

Method

Participants

The 93 healthy participants in this study were part of a larger program of research (Garden & Sullivan, in press). The sample consisted of 46 first year students and 47 individuals recruited from the community. University students were recruited from the first year participant pool from a large university in Queensland, Australia and received course credit for their participation. The community participants were recruited at a local shopping centre in response to an advertisement placed at the centre. Participants were excluded if they had a history of brain injury or neurological disorders.

All participants were proficient in English, with the majority (n = 91) of participants nominating English as their first language. A majority of participants (n = 91) indicated they were of Caucasian descent. Seventy percent of the sample was aged between 18-29 years (sample age range = 18 and 78 years), and 73% of the sample was male. Valid MCMI-III profiles were returned by all participants and MCMI modifying index scores were as follows: Scale X [M=46.24, SD=19.09], Scale Y [M=67.80, SD=16.56], Scale Z [M=44.24, SD=25.20]).The highest level of education completed by most of the individuals in the combined sample was high school (only 7 individuals from the community group had completed tertiary studies). There was no significant difference in the level of education between participants recruited from the community and university, t (91) = -2.84, p =.07.

Materials and Procedure

Participants completed the British Columbia Postconcussion Symptom Inventory (Iverson et al., 2007), the Millon Clinical Multiaxial Inventory-III (Millon, Davis, Millon, & Grossman, 2006), and a brief questionnaire designed to illicit demographic information, as well as medical history. These measures were given as part of a larger battery of tests that included three other postconcussion checklists and a depression inventory for other research

purposes. The BC-PSI was selected for inclusion in this study because of its unique features (ie. unlike several other PCS measures, the BC-PSI assesses PCS symptom intensity as well as frequency, and its item content maps onto ICD-10 disorder criteria).

The *British Columbia Postconcussion Symptom Inventory (BC-PSI)* is a 16-item measure designed to assess the presence and severity of postconcussion symptoms. This questionnaire was based on ICD-10 (WHO, 1992) category C criteria for Postconcussional Syndrome, and requires the respondent to rate the frequency and intensity of 13 symptoms (e.g., headache, poor sleep, and reduced concentration) over the past two weeks. Symptoms are rated on a 5 point Likert-type scale. Frequency ratings range from 0 (*not at all*) to 5 (*constantly*). Intensity ratings range from 0 (*not at all*) to 5 (*very severe problem*). In addition, participants rated the effect of three 'life problems' on daily living. These life problems address past effects of alcohol consumption, worrying and/or dwelling on postconcussion symptoms, and self-perception of brain damage (Iverson & Lange, 2003). Life problems are rated on a scale ranging from 1 (*not at all*) to 5 (*very much*). To score the BC-PSI, the frequency and intensity ratings for the 13 symptoms are multiplied to create a single score for each item. These product-based scores are then converted to item scores that reflect both the frequency and intensity of symptom endorsement (range = 0 to 4). Item product scores convert to item total scores as follows: 0–1 = 0, 2–3 = 1, 4–6 = 2, 8–12 = 3, and 15+ = 4 (Iverson, 2006; Iverson & Lange, 2003). Item total scores of 1-2 reflect mild symptom endorsement. Item total scores of 3 or higher reflect at least moderate symptom endorsement.

The *Millon Clinical Multiaxial Inventory-III (MCMI-III)* is a measure of adult personality and psychopathology for adults aged 18 years and older. The MCMI-III has been widely used is a number of clinical studies (see Craig, 2005 for a comprehensive review). In particular, the MCMI-III (or its predecessors) has been used in various studies that have examined personality traits in brain injured (Evered et al., 2003; Ruocco & Swirsky-

Sacchetti, 2007; Ruocco, Swirsky-Sacchetti, & Choca, 2007; Ruttan & Heinrichs, 2003; Tuokko, Vernon-Wilkinson, & Robinson, 1991) and non-clinical populations (King, 1998; Watson & Sinha, 1995). The MCMI-III consists of 175 true/false items and is designed to assess the interaction of DSM-IV Axis I and Axis II disorders (APA, 2000). The inventory consists of a total of twenty-four scales. The first fourteen clinical scales evaluate Axis II personality patterns (including depressive, dependent, histrionic), with 11 moderate PD scales and three severe personality pathology scales. The remaining 10 scales represent Axis I clinical conditions (including somatoform, anxiety, and drug dependence), consisting of seven moderate syndrome scales and three severe syndrome scales. Raw scores are converted to base rate (BR) scales on a common metric. These empirically derived estimates range from 0 to 115 (median = 60) and are used to reflect the probability that an individual demonstrates a particular trait or personality disorder (Millon et al., 2006; Ruocco et al., 2007).BR scores of 75 or higher are viewed as indicating the presence of clinically significant personality traits. In contrast, scores of 85 or higher are viewed as indicating pathology pervasive enough to be considered a personality disorder (Millon et al., 2006).

Results

Descriptive statistics for the 24 MCMI-III scales are presented in Table 1. The highest mean scores were found on the narcissistic, histrionic, and compulsive scales. The lowest mean scores were found on the delusional (26.53), dysthymic (26.23), PTSD (25.45) and major depressive disorder (28.25) scales. The frequency of participants with *clinically relevant* elevations on personality scores is also presented in Table 1. Clinically relevant elevations were defined based on two classifications: (a) ‘Trait present’ (MCMI-III scores = 75 to 84), or (b) ‘Disorder/Syndrome present’ (MCMI-III score = 85 or higher; Millon et al., 2006). On all but three of the 22 MCMI-III scales, fewer than 10% of participants scored at a clinically significant level (i.e., Disorder/Syndrome present). The histrionic, dependent, and

sadistic scales were exceptions to this trend, with 11%, 14% and 17% of participants endorsing these scales at this level respectively.

Insert Table 1 here

Descriptive statistics and frequencies of the 13 BC-PSI symptoms endorsed at (a) a mild level or higher, and (b) a moderate level or higher, are presented in Table 2. The highest mean scores were found for fatigue (1.7), irritability, nervousness/tension, poor sleep and poor concentration (all 1.5). The lowest mean scores were found for difficulty reading and noise sensitivity (both .6) as well as nausea/feeling sick (.7) and dizziness/lightheadedness (.8). Symptoms endorsed at a mild level or higher ranged from 36% (difficulty reading) to 83% (headache). The most frequently endorsed symptoms were headache (83%), nervous/tense (77%), irritable (78%), and fatigue (82%). Of those symptoms endorsed at a *moderate level or higher*, more than 20% of the sample endorsed six of the 13 PCS symptoms at this level. The most frequently endorsed symptoms were headache (28%), fatigue (27%), poor sleep (24%), irritability (22%), memory problems (22%), and poor concentration (21%).

Insert table 2 here

Kendalls Tau was used as a measure of association between personality and postconcussion scores because of the ordinal level data generated by the BC-PSI. These data are presented in Table 3. Moderate correlations were found between the majority of MCMI-III scales and the BC-PSI total score. In most cases (16 out of the 24 scales), correlations were positive and statistically significant. A significant negative correlations was found between the BC-PSI total score and the MCMI-III compulsive scale.

Insert table 3 here

To further explore the relation between personality traits and self reported postconcussion-like symptoms, the sample was divided into two groups based on ICD-10

Criterion C symptoms for Postconcussion Syndrome (PCS): PCS-like symptoms present (*n* = 55) and PCS-like symptoms absent (*n* = 38). Participants were categorized into the 'PCS-like symptom present' group if they endorsed symptoms as a mild problem or higher on three of the six ICD-10 Category C criteria (see Appendix). Descriptive statistics, *t*-tests results, and effect sizes (Cohen, 1988) for the 24 MCMI-III scales across the two PCS groups are presented in Table 4. With alpha set at $p < .01$, there were statistically significant group differences (and medium to very large effect sizes; range: d = .50 to d = 1.5) on nine MMCI-III scales (depressive, dependent, sadistic, negativistic, borderline, anxiety, somatic, dysthymia, and major depression). Higher scale elevations were found in the group with PCS-like symptoms on these nine scales.

Insert table 4 here

Discussion

The purpose of this study was to examine the relation between personality traits and self reported postconcussion-like symptoms in a healthy sample. Consistent with our hypothesis, these results demonstrate that personality traits are closely linked to self-reported postconcussion-like symptoms. Significant positive correlations were found between total postconcussion-like symptoms and the majority of MCMI-III scales. Using a conservative alpha level, compared to those participants who endorsed a low number of symptoms on the BC-PSI, participants who endorsed a high number of postconcussion-like symptoms had higher MCMI-III scores on the depressive, dependent, sadistic, negativistic, borderline, anxiety, somatic, dysthymia, and major depression scales. In the two previous studies that have explored the links between PCS and personality as measured by the MCMI-III, two of these characteristics (dependent, Ruocco & Swirsky-Sacchetti, 2007; and somatic, Ruocco et al., 2007) emerged as significantly related to PCS. However, just as in this study, other

associations were also identified (i.e., Ruocco and Swirsky-Sacchetti (2007) also identified associations between PCS symptom report following MTBI and masochistic, schizotypal, avoidant and paranoid personality characteristics; and Ruocco et al. (2007) showed that, compared to controls, TBI patients were also more likely to have elevated scores on histrionic and compulsive scales). There are clearly some important similarities in the past TBI studies of Ruocco and colleagues that extend to the current study of personality in a non-TBI sample who, nevertheless, reported a high number of PCS symptoms, and although some consistencies are emerging further research is clearly warranted.

As noted previously, traumatic brain injuries can cause changes in personality and behaviour. Personality changes typically manifest as a consequence of a complex interaction between the direct effects of the brain injury and secondary reactions to impairment or loss (Lezak, Howieson, & Loring, 2004). Changes that are commonly reported may be diagnosed on DSM-IV Axis 1 (i.e., depression, dysthymia, and anxiety; (Busch & Alpern, 1998; Hibbard et al., 2000; Iverson, 2006; Iverson et al., 2007) and II (i.e., dependent, masochistic, borderline, avoidant, and negativistic personality disorders; Hibbard et al., 2000; Kay et al., 1993; Ruff et al., 1996; Ruocco & Swirsky-Sacchetti, 2007; Rush et al., 2004). This study demonstrated that personality traits and the report of postconcussion-like symptoms are related in a non-clinical sample. Based on this demonstration it seems reasonable to suggest that in clinical groups such relationships might also contribute to postconcussion symptom reporting post-injury. Support for this proposition comes from Evered and colleagues who examined 129 patients with presumed postconcussive disorder following MTBI (Evered et al., 2003). These authors reported that more than 63% of patients met criteria for an Axis I or Axis II disorder. This rate of psychopathology is much higher than in the general population and suggests that psychological problems relating to personality and/or acute psychopathology are prominent in patients who report symptoms consistent with PCS. The

well documented occurrence of personality disorders and psychopathology following traumatic brain injury (TBI) may therefore have a direct impact on the endorsement of postconcussion symptoms.

In addition to the influence of postmorbid personality changes, the endorsement of postconcussion symptoms is also likely to be influenced by *premorbid* personality traits. The present study showed that postconcussion-like symptoms are closely linked with a number of personality traits in individuals free from brain injury. It therefore seems likely that premorbid personality traits contribute to the endorsement of pre-existing symptoms, and that this endorsement pattern may mimic the postconcussion syndrome. Using a modified SCID to examine premorbid personality traits following mild to severe TBI, Hibbard and colleagues found that 24% of the sample was diagnosed with a pre-injury personality disorder. The most common personality traits were antisocial and compulsive, with incidence rates higher than those reported in the general population (Hibbard et al., 2000). Given the high rate of premorbid personality disorders in individuals who sustain a TBI, and the findings from this study (that personality is related to PCS symptom report in a non-clinical sample), some of the non-specific PCS symptoms reported by clinical groups may be due to premorbid personality characteristics that when expressed post-injury, mimic PCS by meeting relevant diagnostic criteria.

It is important to remember that this study did not investigate self reported postconcussion symptoms in individuals who had sustained a MTBI. Rather, we studied the endorsement of postconcussion-like symptoms in a non head injured sample, and consistent with other research that has used this approach (Iverson & Lange, 2003), the level of endorsement of such symptoms was high. In a clinical sample, it is possible that greater score variation might occur and that this would produce a different pattern of associations between PCS symptoms and personality. However, such an change in score variation would

likely *increase* rather than decrease associations, in which case the results of this study can be viewed as providing a conservative account of how personality and PCS may be related. It is possible that there are other personality traits important to postconcussion symptom reporting in clinical samples, or that the more extreme responses that might be endorsed in a clinical group would produce a significant association where none was found with this sample of healthy participants. Whilst this possibility remains an important empirical question, the significant contribution of this study is that it demonstrates that the endorsement of postconcussion symptoms is closely related to personality in the absence of injury.

There are several limitations of this study. First, this study used a convenience sample comprised of university students and individuals recruited from a shopping centre. Findings from this study may not generalize to the wider population. Second, this study used self-report measures. It is possible that association between these measures may be due to the fact that some participants report more symptoms of all kinds (psychological, physical and cognitive) than other participants. Third, despite having been used previously in non-clinical samples (King, 1998; Watson & Sinha, 1995), the measure used in this study to assess personality was normed in a psychiatric sample and the item overlap of the MCMI-III has been criticized (see Craig, 2005). Although this choice of instrument may have introduced a source of potential bias to this study, the effects of which must remain an empirical question, the lack of item independence may have produce spurious correlations. The MCMI-III has been used previously as an outcome measure in a variety of studies examining personality in non-clinical samples; for example: college students (Aluja, Cuevas, García & García, 2007; Holliman & Guthrie, 1989; Wierzbicki, & Daleiden, 1993), chronic pain patients (Haggard et al., 2008, Manchikanti et al., 2002), substance abuse populations (Craig, 1997; Craig & Weinberg, 1992; Vanem, Krog & Hartmann, 2007), custody litigants (McCann et al., 2001), parental capacity assessees (Blood, 2008), domestic violence offenders (Gondolf, 1999), and

people seeking workers compensation (Repko & Cooper, 1985). Nevertheless, results should be interpreted cautiously until they are replicated using other personality measures.

This study builds on the extant research literature that supports the influence of multiple factors, unrelated to brain injury, that may influence the presence and exacerbation of self reported postconcussion symptoms following MTBI (see Iverson et al., 2007) for a review of these factors). Specifically, it shows that personality traits and self reported postconcussion-like symptoms are closely linked, which once again underscores the need for cautious interpretation of postconcussion symptoms following MTBI. The differential diagnosis of the postconcussion syndrome is complicated. Diagnosis and treatment of individuals who meet diagnostic criteria for PCS needs to take into consideration the potential role that factors such as depression and personality traits can have in producing, exacerbating and maintaining such symptoms (Trahan et al., 2001), remembering that these two factors are only a subset of many such factors. Future research in this area would benefit from incorporating diverse groups including individuals with MTBI and depression/personality disorders, MTBI without depression/personality disorders, as well as non head-injured groups with and without the abovementioned psychopathologies. Such studies may provide a means for untangling the complex relations that exist between these variables.

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Table 1

Descriptive statistics and sample percentage with clinically relevant MCMI-III scale elevations.

Scale	*M*	*SD*	*Trait/syndrome present* [1] *(%)*	*Disorder or Axis II* [2] *(%)*
Schizoid	44.1	24.0	7.5	7.5
Avoidant	38.8	29.6	5.4	9.7
Depressive	34.6	30.9	5.4	9.7
Dependent	45.5	32.7	18.3	14.0
Histrionic	61.3	22.4	15.1	10.8
Narcissistic	62.7	21.4	17.2	9.7
Antisocial	46.8	24.1	7.5	2.2
Sadistic	47.6	24.0	4.3	17.2
Compulsive	58.0	22.3	14	6.5
Negativistic	44.5	28.2	17.2	4.3
Masochistic	32.6	32.2	-	-
Schizotypal	38.1	27.1	-	-
Borderline	34.9	29.3	7.5	4.3
Paranoid	43.3	27.5	-	-
Anxiety	45.8	30.9	25.8	6.5
Somatoform	34.4	26.7	-	-
Bipolar	49.8	24.7	-	-
Dysthymia	26.2	27.3	6.5	3.2
Alcohol Dependence	43.36	26.44	-	2.2
Drug Dependence	45	25.73	3.3	1.1
Post traumatic stress disorder	25.5	24.5	-	-
Thought disorder	33.4	25.6	-	-
Major depression	28.3	27.3	-	-
Delusional Disorder	26.5	27.1	-	-

N = 93. MCMI-III = Millon Clinical Multiaxial Inventory III. Scores on the MCMI-III range from 0 to 115, whereby higher scores indicate a more significant presence of a personality trait or disorder. [1] = Trait/syndrome present (ie MCM-III score of 75-84); [2] = Syndrome present (ie MCM-III score of 85+). Dashes indicate that none of the sample scored in the clinically-relevant range.

Table 2

Descriptive statistics and percentage of endorsed symptoms for the 13 items of the BC-PSI.

Symptom	*M*	*SD*	Mild Endorsement or higher (%)	Moderate Endorsement or higher (%)
Headache	1.4	1.1	83	28
Dizziness/Light-headedness	0.8	0.9	48	7
Nausea/Feeling sick	0.7	0.8	53	12
Fatigue	1.7	1.3	82	24
Extra sensitive to noises	0.6	1.0	39	14
Irritable	1.5	1.3	78	22
Feeling sad	1.3	1.2	72	18
Nervous or tense	1.5	1.2	77	19
Temper problems	1.0	1.2	57	17
Poor concentration	1.5	1.3	74	21
Memory problems	1.0	1.1	70	22
Difficulty reading	0.6	0.9	36	5
Poor sleep	1.5	1.5	70	27

N = 93. BC-PSI = British Columbia Postconcussion Symptom Inventory. Mild endorsement = BC-PSI total item score of 1 to 5. Moderate or higher endorsement = BC-PSI total item score of 3, 4 or 5.

Table 3

Correlations (Kendall's tau) between the BC-PSI and the MCMI-III personality scales.

Scale	BC-PSI
Schizoid	.22
Avoidant	.19
Depressive	.30**
Dependent	.35**
Histrionic	-.20
Narcissistic	-.17
Antisocial	.28**
Sadistic	.45**
Compulsive	-29**
Negativistic	.46**
Masochistic	.27**
Schizotypal	.27**
Borderline	.41**
Paranoid	.21
Anxiety	.42**
Somatoform	.40**
Bipolar	.26**
Dysthymia	.31**
Alcohol Dependence	.18
Drug Dependence	.02
Post traumatic stress disorder	.24**
Thought disorder	.35**
Major depression	.34**
Delusional Disorder	.08

N = 93. BC-PSI = British Columbia Postconcussion Symptom Inventory. MCMI-III = Millon Clinical Multiaxial Inventory III. **$p < .001$.

Table 4

Descriptive statistics, effect sizes, and t-test results, for the MCMI-III by PCS group.

	PCS-like symptoms					
	Absent *n* = 38		Present *n* = 55			
Scale	*M*	*SD*	*M*	*SD*	*t*(91)	*d*
Schizoid	40.42	22.11	46.66	25.14	-1.23	0.26
Avoidant	30.53	25.56	44.51	30.99	-2.29	0.49
Depression	21.18	20.19	43.93	33.67	-3.72**	0.81
Dependent	29.68	27.65	57.05	31.57	-4.22**	0.91
Histrionic	67.38	17.98	57.10	24.22	2.33	0.47
Narcissistic	66.87	22.74	59.87	20.01	1.57	0.33
Antisocial	37.50	22.22	53.29	23.38	-3.27	0.69
Sadistic	24.21	24.48	56.83	18.90	-5.03**	1.54
Compulsive	65.16	20.45	53.02	22.30	2.67	0.56
Negativistic	28.89	20.66	55.22	27.73	-4.97**	1.06
Masochistic	21.21	25.45	40.47	34.13	-3.0	0.63
Schizophrenia	29.16	25.90	44.22	26.31	-2.73	0.58
Borderline	20.32	22.23	45.00	29.44	-4.38**	0.93
Paranoid	38.32	25.23	46.71	28.68	-1.46	0.31
Anxiety	32.71	27.58	55.53	29.53	-3.93**	0.79
Somatic	19.00	20.75	45.20	25.77	-5.18**	1.11
Bipolar	42.89	25.27	54.51	23.26	-2.29	0.48
Dysthymia	14.20	15.70	24.53	30.50	-5.18**	0.42
Alcohol Dependence	30.11	25.18	52.90	23.19	-1.62	0.9
Drug Dependence	36.13	28.76	51.13	21.62	.263	0.6
PTSD	17.63	18.93	30.85	26.53	-2.64	0.56
Thought Disorder	25.00	22.10	39.69	26.37	-2.72	0.60
Major Depression	14.58	17.77	37.69	28.75	-4.04**	0.95
Delusional Disorder	24.42	25.34	27.98	28.38	-0.62	0.13

N = 93. MCMI-II = Millon Clinical Multiaxial Inventory III. PCS-like symptoms absent = ICD-10 Post-Concussion Syndrome diagnostic criterion C not met. PCS-like symptoms present = ICD-10 Post-Concussion Syndrome diagnostic criterion C met. *d* = Cohen's effect size. ***p*<.001.