Observational Study

Prevalence of Extreme Trait Sensory Profiles and Personality Types in Nonspecific Chronic Low Back Pain with Predominant Central Sensitization: Secondary Analysis of an International Observational Study

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Disclaimer: There was no external funding in the preparation of this manuscript. Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 07-23-2018
Revised manuscript received: 10-02-2018
Accepted for publication: 11-12-2018

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Background: Individuals with nonspecific chronic low back pain (NSCLBP) and central sensitization (CS) exhibit sensory hypersensitivity that may be related to pre-existing trait characteristics. Sensory profiles and trait anxiety-related characteristics have sensory sensitivity in common with CS.

Objectives: The objectives of this study were 1) to observe the prevalence of 4 personality types and extreme scores of 4 trait sensory profiles in people with NSCLBP and predominant CS; and 2) to compare these between 2 subgroups based on high and low self-reported CS symptoms.

Study Design: An international cross-sectional observational study was undertaken.

Setting: Adults (n = 165; mean age = 45 ± 12 standard deviation) were recruited from physiotherapy clinics across 3 countries and 2 continents.

Methods: The inclusion criteria were: NSCLBP, aged 18-64 years, with clinically identified predominant CS pain, without specific pathology. The outcome measures were: Central Sensitization Inventory (CSI), Adolescent/Adult Sensory Profile, State/Trait Anxiety Inventory, and Marlowe Crowne Social Desirability Scale. Descriptive and comparative statistics were used.

Results: CSI scores ranged from 19-79 (mean = 50). There was a high prevalence of extreme 1) trait sensory hyper- and, unexpectedly, hyposensitivity profile scores ($P < 0.001$) and Defensive High Anxious personality type ($P < 0.01$) in the high-CSI (CSI ≥ 40; 78%) subgroup, and 2) trait sensory hyposensitivity profile scores ($P < 0.01$) and Repressor personality type ($P < 0.01$) in the low-CSI subgroup (CSI < 40; 22%).

Limitations: Self-report measures only were used; limited demographics.

Conclusions: To our knowledge, these results are the first to demonstrate extreme trait sensory profiles and personality types in people with NSCLBP and predominant CS. A subgroup who reports low levels of CS symptoms may have a hyposensitive sensory profile and Repressor personality type. Further study is required to investigate the extent to which these trait characteristics may predict CS symptoms in people with NSCLBP.

Key words: Central sensitization, nonspecific chronic low back pain, prevalence of extreme trait characteristics, sensory profiles, trait anxiety-related personality types

Pain Physician 2019: 22:E181-E190

Chronic musculoskeletal pain is often characterized by the pain mechanism of central sensitization (CS), whereby pain is experienced by the individual even when there is no or minimal pathology present (1), due to hypersensitivity of the nervous system to stimuli (sensory hypersensitivity). CS is defined as a dysregulation of the central nervous system causing neuronal hyperexcitability, characterized by generalized hypersensitivity of the somatosensory system to both noxious and non-noxious stimuli (2-4). A population prone to CS is a subgroup of people with nonspecific chronic low back pain (NSCLBP) (5,6), which is a condition having tremendous impact on society (7).

A recent systematic review (8) of predictors of CS in adults with musculoskeletal pain found evidence to suggest that the presence of sensory hypersensitivity (tested using quantitative sensory testing [QST]) and somatization (psychological distress manifesting as reports of physical symptoms) premorbidly, or at the acute stage of pain, predict the development of CS at outcome (3 or more months after pain onset). Other than genetic testing (9), none of the predictor studies measured the patients' trait characteristics. Following the results of the systematic review, further investigation into the role of trait characteristics of sensitivity was warranted. The question is posited in this study as to what aspects of an individual's trait characteristics might predispose them to the development of CS pain. Such aspects may include physiological and behavioral characteristics of sensitivity to sensory stimuli, which, as trait characteristics, may have been attributable to the individual prior to the development of CS pain, and therefore may play an important role in its etiology.

Physiological trait characteristics of sensitivity may include a lower neurologic threshold to sensory stimuli than most people (10), and/or a greater tendency toward physiological arousal in response to perceived threats, as part of characteristics related to high trait anxiety (11,12). Furthermore, behavioral characteristics may include active or passive adaptive responses to sensory stimulation or discomfort according to an individual's trait sensory profile (10,13), or attention to, or avoidance of, sensory feedback according to the nature of the individual's personality type (12).

The trait sensory profile by Dunn (10) was designed to assess individual sensory preferences across 5 senses (auditory, visual, movement, touch, taste/small) and activity levels, giving a profile to illustrate the neurologic thresholds to sensory stimulation (on a high to low continuum) and behavioral response to sensory discomfort (on a passive to active response continuum). Insufficient or excessive sensory stimuli require an adaptive behavioral response to maintain optimum sensory stimulation and feedback (10,14). In people with extreme trait sensory profiles, sensory processing may be compromised (14) and this may be related to the altered central processing observed in people with CS pain (15-17). Studies using Dunn's trait sensory profile model have investigated sensory sensitivity and behavioral responses in other populations with sensory sensitivity differences, such as Asperger syndrome (18), healthy populations with anxiety (19,20), and pain catastrophizing behaviors (20).

It is hypothesized that trait sensory hypersensitivity characteristics may be linked to CS through heightened 'natural' sensitivity to sensory stimuli. Furthermore, sensory stimuli may be interpreted as threatening by individuals high in trait anxiety (12,21,22), which in turn may further heighten sensory sensitivity. Four personality types have been described by previous authors based on trait anxiety and defensiveness measures (11). Individuals with each of these 4 personality types have been found to respond to threat-related stimuli in different ways (12,21-24), and this may have an impact on the extent of CS experienced. The Weinberger et al (11) 4 personality types are: High Anxious (high anxiety, low defensiveness), Defensive High Anxious (high anxiety, high defensiveness), Low Anxious (low anxiety, low defensiveness), and Repressor (low anxiety, high defensiveness). It has been proposed that individuals with high trait anxiety personality types possess cognitive biases that would influence their perception of, and response to, sensory stimuli (12). These cognitive biases are 1) selective attentional bias (attention is drawn toward threatening stimuli), 2) interpretive bias (stimuli are interpreted as threatening), and 3) negative memory bias (recall of threatening situations more than neutral ones). Individuals with the Defensive High Anxious personality type tend to selectively attend toward sensory stimuli and interpret them as threatening (12,25). These individuals are significantly more likely to remain in the care system and use a variety of treatment options (26). The opposite is so for individuals with low trait anxiety personality types. The Repressor personality type, however, self-reports low anxiety yet is prone to the physiological arousal of high state anxiety, and tends to avoid negative affect, believing stimuli are not threatening (12,24).

A recent pilot study (27) found a high prevalence of repressors and trait sensory hyposensitivity profiles among a group of people with NSCLBP with predominant CS pain, and who scored low on measures of CS symptoms (Central Sensitization Inventory [CSI] score < 40) (3,4). However, being a pilot study numbers were small, and this finding requires further investigation.

It was therefore anticipated that there might be a high prevalence of trait sensory hypersensitivity profiles and Defensive High Anxious personality types in a group of people with NSCLBP and predominantly CS pain, particularly in the high CSI-scoring subgroup (CSI ≥ 40). Furthermore, a high prevalence of repressors and trait sensory hyposensitivity profiles in the low CSI-scoring subgroup (CSI < 40) was anticipated.

The aims of this study were to investigate the prevalence of 4 personality types including extreme subgroups, and extreme scores of 4 trait sensory profiles, across a group of people with predominantly CS pain in a NSCLBP population, and to compare these between the low- (CSI < 40) and high- (CSI ≥ 40) CSI subgroups.

Methods

This study is presented according to the Strengthening the Reporting of Observational Studies in Epidemiology statement (28).

Design

This was an international cross-sectional observational study (29) of a NSCLBP population with predominantly CS pain. Ethical approval was obtained from Manchester Metropolitan University (ref: 1205), participating hospitals in Ireland, United Kingdom and New Zealand, the National Health Service in England (IRAS REC no.:15/NW/0378), and the Northern Y Ethics Committee, New Zealand.

Sample

The sample size of n = 165 was calculated based on the requirements of the concurrent primary study (30). This was performed by taking the mean sample size of 3, each calculated using suggested sample size formula (31,32), with a power of 80% and alpha (α) set at 0.05. A post hoc power analysis confirmed that the sample size in the current study was sufficient (13 per variable) (33).

Recruitment

Consecutive individuals with NSCLBP were identified by their physiotherapists, who were experienced in chronic pain and CS, as being most likely to be experiencing predominantly CS pain, based on their working knowledge of CS pain. Recruitment was based on strict inclusion criteria for adults (aged 18-64 years) with chronic (> 6 months) nonspecific (no identifiable tissue pathology present to explain the pain) low back pain. Furthermore, the current published clinical criteria for the identification of predominantly CS pain, to the exclusion of neuropathic and nociceptive primary pain presentations, were used as inclusion criteria (5,34) (Table 1). Recruitment took place from physiotherapy and pain outpatient clinics in Ireland, United Kingdom and New Zealand between July 2015 and March 2017.

Patients satisfying the inclusion criteria were provided with a participant information sheet. Consent was obtained at their subsequent visit to the clinic by the same clinician. Patients completed 4 self-assessed questionnaires supervised by the clinician. For omitted or ambiguously answered questions, patients were

Table 1. *Inclusion and exclusion criteria given to all physiotherapy health care providers involved in participant recruitment.*

Inclusion Criteria
Aged 18-64 years inclusive
Reported low back pain most days for >6 months
No clear diagnosis as to the specific source of the pain (such as malignancy, infection, or inflammatory disease like ankylosing spondylitis, etc.), and in which anti-inflammatory medication (NSAIDs) had been used and had not been found to be significantly helpful for the pain
Pain disproportionate to the current extent of the injury or pathology
Pain in variable areas around the back and/or other body parts and that were not always in the same place, with pain distribution that was not neuroanatomically logical
Exclusion Criteria
Pain that is predominantly neuropathic in origin (determined using the S-LANSS neuropathic pain score)
Pain that is predominantly nociceptive in origin (clear aggravating/easing factors and responds well to NSAIDs, if used)
Pregnancy and/or having given birth in the past 12 months
Spinal surgery within the last 12 months
Any inflammatory spondyloarthropathy, neurologic disease, cardiac, respiratory, metabolic, or endocrine disorder

Abbreviations: NSAIDs, nonsteroidal anti-inflammatory drugs; S-LANSS, Self-completed Leeds Assessment of Neuropathic Symptoms and Signs

telephoned when possible by an independent administrator to clarify responses, reducing the risk of any primary-researcher influence.

Outcome Measures

CSI

The CSI measures the extent to which the individual's symptoms are likely to be attributable to CS (3,4). Part A was used, which has 25 symptom-related items scored on a Likert scale (0-4, score range 0-100). Part B was used to identify those with concurrent fibromyalgia. The CSI has been shown to be valid and reliable (3) with a test-retest reliability of 0.82 and Cronbach's Alpha of 0.88, sensitivity of 81% and specificity of 75% (4). A cut-off score of 40 was used to identify low and high CS symptoms (35).

Adolescent/Adult Sensory Profile Questionnaire

The Adolescent/Adult Sensory Profile (AASP) is a 60-item questionnaire that measures 2 components of sensory processing function, neural thresholds to sensory stimulation and active or passive behavioral responses to sensory over- or understimulation (36).

The AASP identifies 4 trait sensory profiles of adolescents and adults based on Dunn's original model of sensory processing (10). The AASP combines the sensory thresholds with behavioral response continua to provide a summary score for each sensory profile: Sensory Sensitive (low neural threshold, passive adaptive response), Sensation Avoidance (low neural threshold, active adaptive response), Low Registration (high neural threshold, passive adaptive response) and Sensation Seeking (high neural threshold, active adaptive response) (Table 2). Scores in each sensory profile item range from 1-5 based on a Likert scale of 'almost never' to 'almost always,' respectively, with a total score for each profile of 75 on a scale from 'much less than' to 'much more than' most people. Normal values have previously been established in a healthy population (n = 495), aged between 18-64 years (36). Internal reliability (coefficient alphas) for each sensory profile is 0.81 for Sensory Sensitive, 0.66 for Sensation Avoidance, 0.82 for Low Registration, and 0.79 for Sensation Seeking (36).

State/Trait Anxiety Inventory

The State/Trait Anxiety Inventory (STAI) trait section measures trait anxiety, an enduring, relatively stable characteristic indicating the likelihood of the person responding to perceived threats with increased state anxiety (37,38). Trait anxiety has been found to be associated with sensory sensitivity to stimuli (39). It is a self-assessed 20-item questionnaire, using a 1 to 4-point Likert scale with answers ranging from "not at all" to "very much so," respectively, with a maximum score of 80 (with higher scores indicating higher trait anxiety). Internal consistency coefficients range from 0.86-0.95 and test-retest reliability coefficients range from 0.65-0.75 over a 2-month timeframe (38).

Marlowe Crowne Social Desirability Scale

The Marlowe Crowne Social Desirability Scale (MCSDS) measures defensiveness/social desirability (40). The short form of the MCSDS was used (41) that is a 10-item self-reported questionnaire with "true" or "false" responses with a scale of 0-10 (with higher scores indicating greater defensiveness) (42). Reynolds (42) reported an internal consistency alpha coefficient of 0.66 and a correlation coefficient of r = 0.90 ($P < 0.001$) between the 10 item MCSDS and the original 33-item MCSDS (40). The short form version was chosen in preference to the longer version for its time management advantage.

The MCSDS combined with the STAI indicate the personality type of the individual (11) described earlier and summarized in Table 3.

Table 2. *Sensory profiles identified by the AASP Questionnaire Adapted from (30).*

		Adaptive Behavioral Response	
Stimulus Threshold		Active	Passive
	High	Sensation Seeking	Low Registration
	Low	Sensation Avoidance	Sensory Sensitive

Table 3. *Personality types identified by combining the trait section of the STAI and the MCSDS.*

		Social Desirability/Defensiveness	
Trait Anxiety		High	Low
	High	Defensive High Anxious	High Anxious
	Low	Repressor	Low Anxious

Data Management

Data were pseudo-anonymized prior to data analysis by removing the front page containing the identifiable information and allocated a research number. Any missing data items were entered using individual mean scores per outcome measure.

Analysis

Data were analyzed using SPSS Statistics Version 22 (IBM Corporation, Armonk, NY) (43). The primary outcome measure was the CSI.

CSI Score

Descriptive statistics were used to describe the demographics and the range of CSI scores across the study population. The high- and low-CSI subgroups were identified using a cut-off score of ≥ 40 on the CSI (4). The prevalence of extreme scores from each sensory profile in the high- and low- CSI subgroups was calculated. Extreme scores were identified as one standard deviation on either side of the mean (± 1 standard deviation [SD]). Prevalence was compared with healthy population data (36) from the AASP user manual.

The Chi-squared (χ^2) test calculations were used to determine whether differences between the observed and expected calculations for each sensory profile were statistically significant ($P > 0.05$). Proportions of the 4 personality types were calculated in the 2 CSI subgroups and χ^2 calculations were used to establish any statistically significant proportional differences.

Personality Type

The method chosen for splitting the STAI and MCSDS scores for identification of the 4 personality types in the current study was to reflect the same method used by previous authors (36) for identifying the 4 sensory profiles. Personality types were identified using a cut-off score based on means and SDs identified in normative data (38,44,45). Using normative data as a reference has been done by previous authors (46). Other authors have also used a cut-off score above and below that identified as high or low anxiety and defensiveness scores, respectively (47). Therefore, the 4 personalities were identified as follows: High Anxious, STAI ≥ 39 and MCSDS ≤ 5; Defensive High Anxious, STAI ≥ 39 and MCSDS > 5; Low Anxious, STAI < 39 and MCSDS ≤ 5; and Repressor, STAI < 39 and MCSDS > 5. Heterogeneity of personality types was tested using the Levene's test. To identify extreme subgroups within each personality type, extreme scores were calculated using the SDs from normative data for the STAI (38,44) and MCSDS (46) scales as follows: STAI ≤ 29 for Low Anxious and ≥ 49 for High Anxious, and MCSDS ≤ 4 for Low Defensiveness and MCSDS ≥ 8 for High Defensiveness. The independent t test and effect sizes were used to test for differences in the mean trait anxiety scores between the high- and low-CSI subgroups in each personality type.

Results

Demographics

A total of n = 165 patients (n = 39 men) were recruited after n = 12 potential patients had refused to participate (5 = men, n = 6 from Ireland, n = 1 from England, and n = 5 from New Zealand). Recruitment took place from 8 physiotherapy and pain outpatient clinics in [New Zealand country] (n = 82), 3 in [England country] (n = 36), and 2 in [Ireland country] (n = 47). Ages ranged from 18-64 years (mean = 45 ± 12). CSI scores were normally distributed and ranged from 19-79, mean = 50 (95% confidence interval: 47.97-52.23).

Patients consisted of high- and low-CSI subgroups. The high-CSI (CSI ≥ 40) subgroup consisted of n = 129 individuals, mean CSI score = 55 (SD ± 11), mean age = 46 years (SD ± 11.7), n = 28 men, and n = 22 diagnosed with concurrent fibromyalgia (n = 20 women). The low-CSI (CSI < 40) subgroup consisted of n = 36 individuals, mean CSI score = 32 (SD ± 5.5), mean age = 49 years (SD +-10.0), n = 11 men, and n = 2 diagnosed with concurrent fibromyalgia (women). There was no significant difference in mean age between the 2 CSI subgroups (t = 1.5; $P < 0.05$), nor in the distribution of male/female patients ($\chi^2_{(1)} = 1.22$; $P < 0.05$).

A total of n = 112 (68%) patients were taking one or more pain-related medication (Table 4). Almost one-third of the group were not taking any medication (n = 53, 32%).

Prevalence of Extreme Sensory Profile (AASP) Scores in the High- Versus Low-CSI Subgroups

The AASP provides a summary score for all 4 sensory profiles; these are presented in 2 groups based on sensory hyper- and hyposensitivity:

Sensory Hypersensitivity Group: Sensory Sensitive and Sensation Avoidance Profiles

Patients in the high-CSI subgroup (CSI ≥ 40) had significantly more extreme scores in both the Sensory Sensitive (67%; $\chi^2_{(2)} = 182.63$; $P < 0.001$) and Sensation

Table 4. *Mean CS scores for each medication group used by the patients (N = 165) with NSCLBP and CS pain*

Medication Group	Patients (N =)	Mean CSI Score (± SD)
Anticonvulsants	38	57 (14)
Antidepressants: SS(N)RI	24	55 (15)
Tricyclics	29	54 (10)
Analgesics	48	53 (15)
Opioids	23	53 (14)
NSAIDs	37	50 (15)
Antispasmodics	8	49 (17)
Anti-anxiety (SARI)	7	49 (10)
No medication	53	44 (11)

Abbreviations: NSAIDs, nonsteroidal anti-inflammatory drugs; SARI, serotonin antagonist and reuptake inhibitors; SS(N)RI, selective serotonin (norepinephrine) reuptake inhibitors.

Table 5. *Prevalence of extreme sensory sensitivity scores in the low and high CSI groups.*

Sensory Sensitive Profile					
		Distribution of Patients			*P*
		≥ 1 SD	≤ ± 1 SD	> + 1 SD	
CSI ≥ 40 N = 129	N =	3	40	86	< 0.001
	Range	20-24	35-55	42-69	
	Mean (± SD)	22 (2)	45 (9.9)	51 (6.2)	
	Prevalence (%)	2	31	67	
CSI < 40 N = 36	N =	4	27	5	> 0.05
	Mean (± SD)	22 (3.9)	34 (7)	47 (2.1)	
	Range	16-25	27-41	42-50	
	Prevalence (%)	8	78	14	

Table 6. *Prevalence of extreme Sensation Avoidance scores in the low and high CSI groups.*

Sensory Avoiding Profile					
		Distribution of Patients			*P*
		≥ 1 SD	≤ ± 1 SD	> + 1 SD	
CSI ≥ 40 N = 129	N =	8	53	68	< 0.001
	Range	18-26	31-53	42-70	
	Mean (± SD)	24 (2.4)	42 (11)	51 (6.8)	
	Prevalence (%)	6	41	53	
CSI < 40 N = 36	N =	5	27	4	> 0.05
	Mean (± SD)	22 (2.8)	34(7)	49 (3.9)	
	Range	17-24	27-41	44-52	
	Prevalence (%)	14	75	11	

Avoidance profiles (53%; $\chi^2_{(2)} = 102.53$; $P < 0.001$) (Tables 5 and 6).

Conversely, patients in the low-CSI subgroup (CSI < 40) showed no significant difference in prevalence of extreme scores (Sensation Avoidance: 11%, $\chi^2_{(2)} = 2.5$, $P > 0.05$; Sensory Sensitive: 14%, $\chi^2_{(2)} = 5.72$, $P > 0.05$).

Sensory Hyposensitive Group: Sensation Seeking and Low Registration Profiles

In patients in the high-CSI subgroup (CSI ≥ 40), low extreme scores for Sensation Seeking were significantly more prevalent (47%; $\chi^2_{(2)} = 71.83$; $P < 0.001$) but not in the low-CSI subgroup (Table 7).

In patients in the high-CSI subgroup (CSI ≥ 40), high extreme scores were significantly more prevalent in Low Registration sensory profiles (63%; $\chi^2_{(2)} = 165.07$; $P < 0.001$) (Table 8). Unlike the other sensory profiles in the low-CSI (CSI < 40) subgroup, there was a significantly greater prevalence of both high (25%) and low (22%) extreme scores for the Low Registration sensory profile ($\chi^2_{(2)} = 9.12$; $P < 0.05$) (Table 8).

Personality Types

Across the whole group of people with NSCLBP and predominant CS, the largest proportion of individuals were Defensive High Anxious (n = 75, 45%), then the High Anxious (n = 43, 26%), and Repressor (n = 41, 25%) groups. The lowest proportion was the Low Anxious group (n = 6, 4%), none of whom were in the extreme score ranges (Fig.1). The 4 personality type groups were significantly distinguishable from each other in their trait anxiety and defensiveness scores: STAI, F(3,161) = 10.19; $P = 0.00$ and MCSDS, F(3,161) = 3.51; $P = 0.017$.

The proportion of low and high CSI scores was 22% and 78%, respectively (Fig.1). There was a significantly greater prevalence of repressors in the low-CSI subgroup ($\chi^2_{(1)} = 12$; $P < 0.01$). Although the prevalence of people with the Defensive High Anxious and High Anxious personality types were comparable between the low- and high-CSI subgroups, there was a significant difference in proportional distribution of the extreme Defensive High Anxious personality type: 100% of these individuals

scored > 40 on the CSI ($\chi^2_{(1)}$ = 21.7; *P* < 0.01) (Fig. 1).

Furthermore, the Defensive High Anxious group had significantly higher levels of trait anxiety in the high- compared with the low-CSI subgroup (U = 3.0; *P* = 0.000). There were no significant differences in the trait anxiety scores in the High Anxious and Repressor individuals, nor in defensiveness scores for all the personality types between low- and high- CSI subgroups.

Discussion

To our knowledge, this is the first and largest study to observe the prevalence of trait sensory profiles and personality types in people with NSCLBP and predominant CS. Furthermore, it is also the first to observe the prevalence of low- and high-CSI subgroups in people with clinically identified predominant CS pain.Extreme trait sensory hypersensitivity profiles in people with high-CSI scores suggests that a significant number of people with NSCLBP and CS have a low neurologic threshold for sensory stimulation, and either a passive (Sensory Sensitive) or an active (Sensation Avoidance) adaptive response to sensory overstimulation. The AASP claims to measure trait preferences (36) that imply that the characteristics of sensory hypersensitivity were present premorbidly. Other studies have suggested that sensory sensitivity may be a characteristic of individual differences in healthy populations (48-50), and a premorbid risk factor (identified using QST) in people who later developed musculoskeletal CS pain (51-54). The results of the current study may lend support to the concept of pre-existing trait sensory sensitivity.

Table 7. *Prevalence of extreme Sensation Seeking sensory profile scores in the low and high CSI groups.*

Sensory Seeking Profile					
		Distribution of Patients			*P*
		>- 1 SD	≤ ± 1 SD	> + 1 SD	
CSI ≥ 40 N = 129	N =	61	58	10	< 0.001
	Range	18-42	35-53	57-63	
	Mean (± SD)	36 (5.4)	44(9)	59 (1.9)	
	Prevalence (%)	47	45	8	
CSI < 40 N = 36	N =	7	26	3	> 0.05
	Mean (± SD)	37 (3.3)	47(7)	60 (2.1)	
	Range	31-42	40-54	58-62	
	Prevalence (%)	20	72	8	

Table 8. *Prevalence of extreme Low Registration sensory profile scores in the low and high CSI groups.*

Low Registration Profile					
		Distribution of Patients			*P*
		>- 1 SD	≤ ± 1 SD	> + 1 SD	
CSI ≥ 40 N = 129	N =	6	42	81	< 0.001
	Range	17-22	29-47	36-60	
	Mean (± SD)	20 (2.1)	38(9)	44 (6.3)	
	Prevalence (%)	4	33	63	
CSI < 40 N = 36	N =	8	19	9	< 0.05
	Mean (± SD)	21 (2.7)	30(8)	40 (4.6)	
	Range	15-23	22-38	36-50	
	Prevalence (%)	22	53	25	

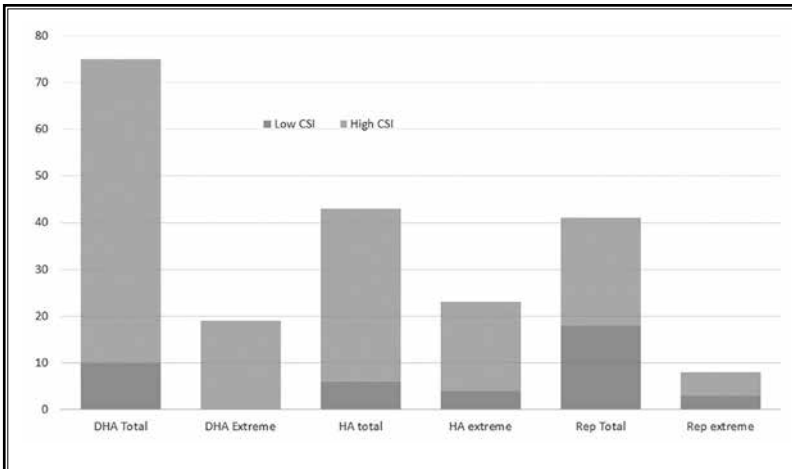

Fig. 1. *The proportions and prevalence of personality types, including the extreme personality type sub-groups, within the law and high CSI sub-groups in the non-specific chronic low back pain population with central sensitization.*

Also identified in the high-CSI group were extreme scores of trait sensory hyposensitivity (Low Registration and Sensation Seeking) profiles, which is unexpected when related to the hypersensitive nature of CS.

Other studies have also discussed sensory hyposensitivity (mislocalization and reduced sensory discrimination) in populations with NSCLBP (55,56). The prevalence of sensory hyposensitivity to various sensory stimuli has been estimated at 25%-50% of individuals with (unspecified) chronic musculoskeletal pain (57,58). Sixty-eight percent of the current study patients with NSCLBP and CS had extreme scores in the Low Registration sensory profile, more than that found in other studies (57). This increase may be attributable to the homogeneous sample in this study specific to CS pain and NSCLBP, and to the passive adaptive response nature of the Low Registration profile. Clinically, this may mean that individuals with NSCLBP and CS with a high neurologic threshold for sensory stimulation need to receive greater levels of sensory input to function healthily (13), which may in turn influence treatment programs for these individuals. Furthermore, extremes in the Low Registration profile may have implications for the use of QST to identify CS in people with NSCLBP in the event of some senses being hyposensitive, which could be misleading.

Personality Types

The way patients respond to pain may be influenced by their personality type (24). The largest proportion of patients in the current study were Defensive High Anxious individuals (45%). This was similar to a population with chronic fatigue syndrome (46%) (47), a chronic condition characterized by CS (59) and higher than that found in a healthy population (47). Nineteen (12%) patients in the current study were in the extreme subgroup for Defensive High Anxious personality type, similar to another study (46) (13%) of target shooters and hockey players with low back pain, but lower than another chronic low back pain group in which CS pain was not specified (26%) (21). However, the latter study used a clinical population-based cut-off score, using tertiary splits at 33% and 66%, in which STAI ≥ 42. This was lower than the current study normative-based cut-off score, using scores in ranges outside of ± 1 SD, of STAI ≥ 49, which may explain the difference in prevalence found.

All extreme Defensive High Anxious individuals scored high on the CSI (CSI ≥ 40). This may reflect the proneness of these individuals to attend to pain-related symptoms (22), show persistence in their seeking of multiple medical interventions (21), and interpret stimuli as threatening (24,61) significantly more than the other 3 personality types.

Implications

The clinical implications for people with NSCLBP and CS are that identification of these profiles may guide management accordingly. For example, pain neuroscience education (60) may reduce threat perception in the Defensive High Anxious and High Anxious individuals. Furthermore, identification of active or passive behavioral patterns in response to sensory stimulation, using the sensory profiles, may help the individual to modify their behaviors.

The current study findings of a subgroup of low CSI people with NSCLBP and clinically identified, predominant CS pain supports the latest clinical guidelines recommended (5), in which clinical criteria can be used to identify CS without there needing to be a score of CSI ≥ 40. It is proposed that a low CSI score should not discount those individuals as experiencing CS pain when 1) there is no evidence for predominant nociceptive or neuropathic pain mechanisms, and 2) they have a Repressor personality type and/or an extreme Low Registration sensory profile score.

Strengths and Limitations

Strengths of this study include the methodology, which followed the current clinical recommendations for identifying patients with NSCLBP and predominantly CS pain, thereby limiting heterogeneity within the sample. Bias was limited by ensuring patients were recruited by multiple participating clinicians across 3 countries and 2 continents, optimizing external validity. The study recruited more female than male patients, reflecting epidemiologic studies showing chronic low back pain is more prevalent among women (61).

Potential weaknesses included a lack of demographic information available from participating clinicians regarding the patients who refused to participate. Limitations may have been caused by the likely response bias related to questionnaires by different personality types, and a lack of blinding of the researcher to some patients.

Conclusions

To our knowledge, this study is the first to show that 1) extreme trait sensory profiles and personality

types are related to the extent of CS pain, and 2) low CSI scores are observable in people with NSCLBP who are clinically diagnosed with predominantly CS pain. Extremes in Defensive High Anxious personality type and the Sensory Sensitive profile may play an etiologic role in CS pain and this requires further investigation. Furthermore, low self-reported levels of CS symptoms (CSI < 40) should not exclude the possibility of a predominant CS pain mechanism in people with NSCLBP. Further investigations are required into which particular senses (of those investigated in the AASP) may be hyposensitive, and this may in turn guide individual treatment strategies.

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