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Disrupted self-perception in people with chronic low back pain. Further evaluation of The Fremantle Back Awareness Questionnaire

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Running title:

Disrupted self-perception in CLBP

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ABSTRACT

Several lines of evidence suggest that body-perception is altered in people with chronic back pain. Maladaptive perceptual awareness of the back might contribute to the pain experience as well as serve as a target for treatment. The Fremantle Back Awareness Questionnaire (FreBAQ) is a simple questionnaire recently developed to assess back-specific altered self-perception. The aims of this study were to present the outcomes of a comprehensive evaluation of the questionnaire's psychometric properties and explore the potential relationships between body-perception, nociceptive sensitivity, distress and beliefs about back pain and the contribution these factors might play in explaining pain and disability. Two-hundred and fifty-one people with chronic back pain completed the questionnaire as well as a battery of clinical tests. The Rasch model was used to explore the questionnaires psychometric properties and correlation and multiple linear regression analyses were used to explore the relationship between altered body-perception and clinical status. The FreBAQ appears unidimensional with no redundant items, has minimal ceiling and floor effects, acceptable internal consistency, was functional on the category rating scale and was not biased by demographic or clinical variables. FreBAQ scores were correlated with sensitivity, distress and beliefs and were uniquely associated with both pain and disability.

Perspective:

Several lines of evidence suggest that body perception might be disturbed in people with chronic low back pain, possibly contributing to the condition and offering a potential target for treatment. The Fremantle Back Awareness Questionnaire was developed as a quick and simple way of measuring back specific body-perception in people with chronic low back pain. The Questionnaire appears to be a psychometrically sound way of assessing altered self-perception.

The level of altered self-perception is positively correlated with pain intensity and disability as well as showing associations with psychological distress, pain catastrophization, fear avoidance beliefs and lumbar pressure pain threshold. In this sample, it appears that altered self-perception might be a more important determinant of clinical severity than psychological distress, pain catastrophization, fear avoidance beliefs or lumbar pressure pain threshold.

Key words

Chronic low back pain; psychometrics; Rasch analysis; Body image.

INTRODUCTION

Low back pain (LBP) is currently the leading cause of disability worldwide [41] and its management consumes substantial health care resources [21]. Clinical trial data indicate that most current interventions for LBP have limited efficacy [20] and epidemiological evidence suggests that outcomes are worsening despite increased health care expenditure [22, 23]. The failure of current treatment approaches to significantly impact on the problem has prompted numerous authors to suggest a reappraisal of how the problem is considered and managed [9, 29, 48].

We have previously proposed a model for LBP persistence underpinned by data on the cognitive and behavioural contributors to the LBP experience as well as recent evidence of significant alteration in central nervous system structure and function in people with chronic LBP (see Figure 1). The model suggests that maladaptive beliefs about the nature of the back problem and future consequences drive behaviours that might bring about maladaptive neuroplastic changes [50]. These central nervous system changes might contribute to ongoing LBP and disability by enhancing nociceptive efficiency, influencing normal attentional processing and potentially creating a state of maladaptive perceptual awareness of the back – that is a disruption of the consciously felt body [17]. This may be conceptualised in terms of how the back feels to the individual, the sense of control and ownership they feel they have over their back and the meaning and precision of sensory information from the back [45]. As pain is viewed as a the conscious correlate of the perception that the body is in danger and in need of protection [18, 24] the integrity of the consciously felt body should be seen as fundamental to the emergence of pain.

In this model maladaptive beliefs and maladaptive body image are seen as mutually reinforcing, contributing to the persistence of LBP [45] and may be targets for treatment [49]. There is considerable evidence available to clinicians on ways to evaluate the beliefs of people with low back pain, though little data on how to assess body perception in this population. We recently presented information on the development of the Fremantle Back Awareness Questionnaire (FreBAQ), a self-report questionnaire designed to assess back specific body perception [47]. Data collected from a small, homogeneous sample of people with chronic LBP confirmed the feasibility of using the questionnaire in clinical practice and classical test theory approaches supported aspects of the reliability and validity of the FreBAQ, though with potential misfitting of one item [47]. Some minor changes were also made to the wording of the questionnaire based on feedback from participants in this preliminary study [47]. The aim of this paper is to report on the initial testing of the updated questionnaire in a large heterogeneous sample of people with chronic LBP, particularly to present the outcomes of a comprehensive evaluation of the scale's psychometric properties using a Rasch analysis and the modifications to the scale that these data might suggest. We also aimed to explore the potential relationships between body perception, nociceptive sensitivity, distress and beliefs about back pain and the combined and unique contribution these factors might play in explaining pain and disability in this population.

METHODS

Design

This cross-sectional cohort study was approved by the Human Research Ethics Committees of Curtin University, Royal Perth Hospital, and Sir Charles Gairdner Hospital in Perth, Western Australia. The data presented here were collected as part of a larger study undertaking extensive biopsychosocial profiling of people with persistent low back pain, the results of which have been reported elsewhere [33]. All participants provided informed consent and all procedures conformed to the Declaration of Helsinki.

Participants

People with axial chronic LBP were recruited from two metropolitan hospitals in Perth, Western Australia (1.4%); private metropolitan physiotherapy clinics (20.1%), pain management and general practice clinics (1.0%) and via multimedia advertisements circulated throughout the general community in both metropolitan and regional Western Australia (77.6%). Willing volunteers were asked to contact one of the researchers (MIR) directly by telephone or e-mail, and were then sent a screening questionnaire. All questionnaire responses were screened and ambiguous responses clarified by telephone.

Volunteers were included if they were aged between 18-70 years of age, were fluent in written and spoken English, had experienced LBP for greater than three months, scored two or more on a numeric rating scale (NRS) for average pain intensity in the past week anchored with, 0="No pain," and 10="Worst pain imaginable," and five or more on the Roland Morris Disability Questionnaire (RMDQ) [35]. In addition participants needed a score of at least 60% LBP on the following question [44]. "Which situation describes your pain over the past 4 weeks the best? 100% of the pain in the low back; 80% of the pain in the low back and 20% in the leg(s); 60% of the pain in the low back and 40% in the leg(s); 50% of the pain in the low back and 50% in the leg(s); 40% of the pain in the low back and 60% in the leg(s); or 20% of the pain in the low back and 80% in the leg(s)." The latter question reliably differentiates participants with dominant leg pain or dominant LBP [44], minimising the likelihood of participants with primarily radicular pain being entered into the study.

Volunteers were excluded if they reported any previous extensive spinal surgery (greater than single level fusion or discectomy) or any type of spinal surgery within the past six months, were diagnosed with serious spinal pathology (cancer, inflammatory arthropathy, or acute vertebral fracture), had been diagnosed with a neurological disease, experienced bilateral pain at the dorsum of the wrist/hand or were currently pregnant.

Procedure

Only procedures relevant to this study are presented here. For a fuller description of all testing undertaken see Rabey et al. 2015 [33]. On initial presentation, all participants were screened for eligibility - including the presence of red flag conditions, given information about the project and invited to sign a consent form. Participants then provided basic demographic information and had their height and weight measured, from which their body mass index (BMI) was calculated.

All participants next completed a questionnaire that solicited information about the length of the current episode, pain distribution, current pain medications and the presence of any co-morbidities. In addition, the participants completed a set of standardized surveys that assessed disability, pain, and psychological functioning. LBP-related disability was measured using the RMDQ [35]. Average back pain intensity over the last week was measured using the NRS described above and pain related fear was estimated using the Fear Avoidance Beliefs Questionnaire (FABQ) [43]. As only 76.2% of the sample was currently working, only the physical activity subscale of the FABQ was used. The level of pain-related catastrophization was measured using the Pain Catastrophizing Scale (PCS) [39]. Symptoms of psychological distress (depression, anxiety and stress) were assessed with the Depression Anxiety Stress Scales 21 (DASS-21) [19], with the average score for the three subscales utilised for analysis. Finally, participants completed the FreBAQ (see APPENDIX) [47].

The original study involved an extensive sensory profiling of the participants using a combination of clinical bedside tests and laboratory tests [33]. Only the assessment of lumbar spine nociceptive sensitivity is reported here. Participants were positioned comfortably in prone and testing was undertaken at the area of maximal pain in the following order. Pressure pain threshold (PPT) was tested using an algometer with a probe size of $1cm^2$ (Somedic AB, Sweden) and was defined as the point at which the sensation of pressure changed to a sensation of pressure and pain [36]. Pressure was increased at a rate of 50 kPa/s until the participant indicated their PPT by pressing a button. Thirty second inter-stimulus intervals were adopted to reduce the possibility of temporal summation. The mean of three threshold recordings was used for analysis.

Heat pain threshold (HPT), the temperature at which a sensation of warmth becomes the first sensation of heat and pain [36], was tested using the Thermotest (Somedic AB, Sweden). Testing began at 32 ^{0}C and increased by 1^0 C/s until the participant indicated their HPT by pressing a button, or the device's upper temperature limit was reached (50^{0}C)**.** Thirty second inter-stimulus intervals were adopted and the mean of three threshold recordings was used for the analysis.

Cold pain threshold (CPT) was recorded as the point at which the sensation of cold became the first sensation of cold and pain [36]. Testing CPT utilised the same equipment as for testing HPT. Testing began at 32^{0}C and the temperature of the thermode decreased by 1^{0}C/s until the participant detected their threshold and pressed a button, or the device's lower temperature limit was reached (4^{0}C)**.** Thirty second inter-stimulus intervals were adopted and the mean of three threshold recordings was used for analysis.

Sample size

The sample size requirement for this study was not determined *a priori* as the sample was recruited as part of an extensive study exploring multidimensional subgrouping in a chronic LBP population. The sample size of 251 i) provided 0.8 power to detect potentially meaningful independent associations of FreBAQ with pain and disability (i.e. R^2 of .03 or more in regression models after adjusting for covariates) at α<.05 (G*Power Version 3.1.9), ii) was well over the minimum requirements for the number of subjects per variable for unbiased regression coefficients and model R^2 estimates in linear regression analyses [2], and iii) was in excess of the 243 persons recommended to ensure item calibration stability within +/- 0.5 logits with 99% confidence [16].

Data analysis

Sample description

Descriptive statistics were used to describe the demographic and clinical characteristics of the sample. The FreBAQ was summarised with range, median, mean and standard deviation measures reported for the total score. The frequencies in each response category were also reported.

Psychometrics

We used Rasch analysis (Winsteps v3.73.0 software) to assess the psychometric properties of the FreBAQ (see [5] for a comprehensive overview of Rasch analysis). The Andrich Rating Scale model was chosen because the FreBAQ items all share the same rating scale [14]. The following components were assessed: item hierarchy, category order, targeting, unidimensionality, person fit, internal consistency and differential item functioning [40].

Item hierarchy allows for the assessment of construct validity. The FreBAQ was developed to assess body-perceptual impairments in people with back pain. We compared the item hierarchy to ensure the items were ordered in a logical manner, from comparatively mild perceptual impairments to more severe impairments. Item Reliability >0.9 was considered sufficient to confirm the item hierarchy [15].

Category ordering was assessed to determine how the sample used the rating scale. The FreBAQ has five response categories (0 to 4) and thus four step-calibrations, thresholds at which the likelihood of endorsing one category is equal to that of endorsing the next were assessed. Respondents with high overall scores are expected to endorse higher categories on any given item. We assessed whether each of the five categories were utilised and whether the respondents used each category in the expected manner.

Targeting refers to how well the FreBAQ items targeted the sample. It was assessed by visual inspection of the distribution of persons and item threshold averages and through comparison of the summary statistics. The average item endorsability was anchored at zero logits; therefore positive average person agreeability would suggest the sample experienced perceptual impairments more frequently than the average of the scale. A negative average person value would suggest the opposite [40].

For questionnaire items to be validly summated to provide an overall measure of a construct, the questionnaire items must collectively assess one construct at a time. In this case, the FreBAQ intends to measure 'perceptual impairment' thus each item should assess a component of this construct. That is, each item should share in common an aspect of perceptual impairment yet be sufficiently different so as not to be redundant. Assessment of unidimensionality looks to identify clusters of items that together may be assessing a secondary dimension, thus threatening measurement of the primary dimension. Unidimensionality was assessed through analysis of item fit statistics and through principal components analysis of residuals (PCA) [37]. The chi-square based fit statistics, reported as mean-squares (in logits), have an expected value of 1 logit. Fit was considered excessive if >1.4 or <0.6 logits [53] and both infit (information-weighted fit statistic) and outfit (outlier-sensitive fit statistic) were analysed. The item characteristic curves of misfitting items were visually inspected to assess item performance across the person agreeability range. The PCA residual correlation matrix was inspected visually to identify the presence of secondary dimensions. Item clusters with substantial positive or negative loadings equivalent to an eigenvalue greater than 2 were reviewed to ascertain whether a second dimension was present [34].

PCA also allows for a test of local independence of items [40] and is used to identify redundant items. Large positive correlations, >0.5, were considered indicative of local dependence where the response to one item relies on the response to the other.

Assessment of Person fit identifies people who responded in an unexpected manner. Person fit was considered excessive if the outfit statistics were >2 logits [40]. Misfitting persons were compared across variables to those who fit the model using a chi-square test of significance (gender) or an independent samples t-test (FreBAQ total score, age, pain intensity (NRS), disability (RMDQ) and BMI). Response strings of those misfitting persons were visually analysed to identify patterns in their responses.

The Winsteps software provides two measures of internal consistency; the Rasch-specific 'person reliability index' and the more widely recognised Cronbach's alpha [10]. Acceptable internal consistency is considered to be >0.7 in both instances [32, 40].

The FreBAQ items should function similarly for all persons of the same level of agreeability. Differential item functioning (DIF) identifies whether characteristics other than the latent construct alters the functioning of the item (e.g. males and females with the same level of perceptual impairment endorse an item differently). We assessed whether age, gender, pain intensity or disability biased the functioning of the scale by splitting the sample, according to median, and comparing the two subgroups. Body mass index was split according to underweight/healthy weight (<25) and overweight/obese (≥25). Items with statistically significant ($p < 0.05$) contrasts > 0.5 logits were further explored [1].

Relationship to Clinical Status

The association between FreBAQ scores and i) demographic characteristics (age, gender, BMI), ii) clinical status (pain and disability), iii) cognitive/psychological characteristics and iv) nociceptive sensitivity measures, were assessed using correlation statistics (Pearson's R, Spearman's rho or point-biserial coefficient as appropriate). Multivariable linear regression analysis was used to estimate the unique association of FreBAQ scores with pain and disability adjusted for demographic, cognitive/psychological factors and sensitivity measures. A three-step process was utilised, by first evaluating the univariate association of each independent variable with the dependent variable, then estimating a multivariable model retaining those variables associated with the dependent variable at $p<0.1$ (Model 1), then estimating a final model (Model 2) retaining only those independent variables statistically significant at $p<0.1$ from Model 1. Forward and backward stepwise variable selection was also performed and confirmed the stability of the final models (probability of entry/removal $p=0.05$). For the disability model the log-transformed RMDQ was used as the dependent variable due to the skewed distribution of the measure. For the pain model the NRS for average pain in the last week was used as the dependent variable. Models were examined for absence of influential observations and multicollinearity, linearity of associations and normality and homoscedasticity of residuals. Standardised beta coefficients with 95% confidence intervals are reported to allow comparison of strength of associations. The total variance in disability and pain explained by each final model (R^2) was partitioned into unique variance attributable to FreBAQ and other variables in the model, and shared variance, by examination of squared semi-partial correlations between variables and outcome.

RESULTS

Sample characteristics

585 volunteers were screened for eligibility. Two hundred and ninety two were excluded for the following reasons. Low RMDQ score (n=130), age >70 years (n=42), dominant leg pain (n=28), bilateral wrist pain (n=23), suspected serious spinal pathology (n=8), low pain intensity (n=6), failed to complete baseline assessment (n=55). Of the 293 eligible participants the first 42 completed a pilot version of the FreBAQ [47] and their data were not used in this analysis. The remaining 251 participants completed the updated version of the questionnaire [47]. There were no differences in sex (p=.127), age (p=.107), disability (RMDQ, p=.424) or pain (NRS, p=.608) between those completing the pilot versus updated version. Demographic and clinical characteristics of the 251 included participants are shown in Table 1.

The average total FreBAQ score was 9.8 (SD 6.6) with a median score of 9.0 (IQR 4.0,14.0). Table 2 provides a full description of the frequency of response for each questionnaire item.

Psychometrics

Rasch analysis was performed on the data from 251 participants. Fifteen (6%) persons registered a minimum score and no persons registered a maximum score, suggesting ceiling and floor effects of the scale are negligible.

Table 3 lists the average item endorsability thresholds in hierarchal order, where higher thresholds indicate items that are harder to endorse. Item 9 (My back feels lopsided) was the easiest to endorse and item 8 (My back feels like it has shrunk) was the most difficult to endorse. The item order appeared to progress in a largely coherent fashion, from the comparatively lesser perceptual impairments (e.g. item 9 My back feels lopsided) to the more severe impairments (e.g. item 1 My back feels as though it is not part of the rest of my body), suggesting the FreBAQ has construct validity. An Item Reliability of 0.97 suggested the sample size was sufficient to confirm the item hierarchy is reproducible. Interestingly, item 8 (My back feels like it has shrunk) was significantly harder to endorse than the other items and did not fit the predicted hierarchal order.

Visual inspection of the category structure suggested the respondents used the categories in the expected manner although Category 1 (Rarely) was underutilised and did not have an interval on the latent variable (Figure 2).

The person-item distribution map shown in Figure 3 highlights the targeting of the FreBAQ to the sample. The sample was loaded toward less frequent experiences of perceptual impairment when compared to the average item endorsability. The average (SD) person agreeability was -0.96 (0.84) logits (range: -2.92 to 1.85 logits), in comparison with the default average (SD) item endorsability of 0 (0.46) logits (range: -0.73 to 0.82 logits).

The FreBAQ items constituted a unidimensional scale. Table 3 summarises the fit statistics for the 9 items. Item 8 showed excessive positive outfit (1.7 logits) and analysis of the item characteristic curves suggested the misfit was due to respondents with higher scores overall scoring this item low. Visual inspection of the PCA correlation matrix suggested items 4 (When performing everyday tasks, I don't know how much my back is moving), 5 (When performing everyday tasks, I am not sure exactly what position my back is in) and 6 (I can't perceive the exact outline of my back) could plausibly constitute a second dimension. However, an eigenvalue of 2.0 suggested the scale could be considered unidimensional [34]. Assessment of local dependence revealed no meaningful relationships between the FreBAQ item residuals, suggesting none of the questions are redundant.

Twenty three persons (9%) displayed excessive outfit. Comparatively, misfitting persons were significantly older (p = 0.02) and in more pain (p = 0.002). Visual analysis of the response strings of the misfitting persons revealed no meaningful patterns. Typically, persons with higher scores unexpectedly ranked an item low or, less commonly, persons with low scores overall scored an item high.

A Person Reliability Index of 0.74 and Cronbach's alpha value of 0.80 indicated that the internal consistency of the FreBAQ was adequate [40].

Analysis of DIF suggested age may influence responses to Item 8. Older persons (n = 128) found Item 8 0.61 logits easier to endorse than younger persons (n = 123) however this difference was not statistically significant (p = 0.054) and should be viewed with caution given the number of camparisons. No other statistically significant contrasts >0.5 logits were observed suggesting the items were not otherwise biased by the respondents' age, gender, pain, disability or body mass index.

Relationship to Clinical Status

The FreBAQ showed significant initial bivariate association with BMI, disability, pain intensity, pain catastophization, fear avoidance, psychological distress and lumbar pressure pain threshold (Table 4).

Table 5 displays the standardized beta coefficients for linear regression models for disability (logRMDQ). Alone, the FreBAQ score explained 12.4% of the variance in disability. The final model retaining FreBAQ score, psychological distress, BMI and pain intensity, explained 29.5% of the variance in disability. Of this, FreBAQ uniquely contributed 1.3%, while 13.4% was shared between all four variables. Psychological distress, BMI and pain intensity uniquely contributed 6.1%, 2.6% and 6.1% respectively. In the final model, an increase of one SD in the FreBAQ score was estimated to be associated with an increase in 0.13SD of logRMDQ (95%CI: 0.01 – 0.25, p=.032).

Table 6 displays the standardized beta coefficients for linear regression models for pain intensity (NRS). Alone, FreBAQ explained 7.0% of the variance in pain intensity. The final model retaining FreBAQ and pain catastrophization explained 9.9% of the variance in pain intensity, of which freBAQ uniquely contributed 3.6%, pain catastrophization uniquely contributed 2.7%, and 3.6% was shared between both variables. In the final model, an increase of one SD in FreBAQ was estimated to be associated with an increase in 0.20SD of pain NRS (95%CI: 0.07 – 0.33, p=.007).

DISCUSSION

One key aim of this study was to report on the initial testing of the updated FreBAQ in a large heterogeneous sample of people with chronic LBP and present the outcomes of a comprehensive evaluation of the scales psychometric properties using the Rasch model. The results of this analysis suggest that the scale functions well. The questionnaire appears unidimensional with no redundant items, has minimal ceiling and floor effects and acceptable internal consistency, with a Cronbach's α very close to that reported in the original development paper [47]. The item hierarchy appeared to progress in a theoretically plausible fashion supporting the construct validity of the questionnaire. Furthermore, the differential item functioning analysis showed that none of the items were biased by demographic or clinical variables. However, the FreBAQ items were relatively hard to endorse and are thus better suited to assessing those with comparatively more frequent episodes of perceptual impairment.

Item 8 (My back feels like it has shrunk) functioned poorly in that it was significantly harder to endorse than the other items, did not fit the predicted hierarchal order and demonstrated misfit. This, however, was not unexpected as both Items 8 and 7 (My back feels like it is enlarged) relate to the perceived size of the back. While it is plausible a respondent could experience either impairment at differing times, it is more likely they will experience one and not the other. The data support this notion with the majority of respondents reporting frequent feelings of enlargement but not shrinkage. The comparatively few responses to Item 8 accounted for the misfit and it being the hardest item to endorse. That some respondents do experience feelings of shrinkage however, suggests the item might be important for some and the minor statistical anomalies it creates do not warrant its exclusion.

We noted that Category 1 (Rarely) was underutilised by the sample, suggesting the respondents could not clearly discriminate between ‘rarely’ and ‘occasionally’. Nonetheless, the scale behaved in the expected manner, with persons with more frequent perceptual impairments scoring higher on each item suggesting changes to the category structure of the scale are not necessary. Retaining the original category structure also has the advantage of enabling comparisons to be made with data already reported [4, 47] and ongoing studies which may utilise the scale.

Overall, the sample used the FreBAQ as expected with only 9% of respondents displaying misfit. That misfitting persons were significantly older can be explained, in part, by their responses to Item 8. Older persons found Item 8 somewhat easier to endorse compared to younger persons suggesting older people experienced more frequent feeling of shrinkage, rather than expansion. Preferentially endorsing the rarely utilised Item 8 over Item 7 would result in person misfit. Future studies are needed to explain these differences but it is plausible that older people with relatively few perceptual impairments experience occasional specific impairments that are associated with age-related changes. Alternatively, they may have not understood the question or answered incorrectly. Nonetheless, that there were no overt patterns in the response strings in general suggests the FreBAQ items are not problematic.

Another key aim was to explore the relationships between body perception, nociceptive sensitivity, distress and beliefs about back pain. As hypothesised disturbed perpetual awareness of the back correlated with distress, fear avoidant beliefs and catastrophizing cognitions about pain. We also found that higher levels of disturbed self-perception were related to increased sensitivity to pressure at the low back but not cold or heat. This may represent the different tissues that are involved in testing as thermal sensitivity likely assesses sensitivity to stimulus delivered to superficial tissues whereas pressure sensitivity is thought to also assess sensitivity to stimuli delivered to deep tissue [11]. This is consistent with previous work which has suggested that pressure pain thresholds are highly accurate in discriminating between people with chronic LBP and healthy controls, whereas the discriminative ability of heat and cold pain sensitivity is limited [26]. The relationship found amongst these variables offers some preliminary support for the model hypothesized in figure 1, which suggest these factors are likely mutually reinforcing.

We also provide some evidence that disrupted perceptual awareness of the back significantly and uniquely contributes to pain intensity in this population. In our sample disturbed body perception appears to be a more strongly associated with pain intensity than psychological distress, fear avoidance beliefs or an objective measure of lumbar spine sensitivity. It is plausible that changes in how the back feels to the individual can impact on the pain experience, as our data suggest. Planning and coordination of movement requires an intact perception of the body and its position in space, and movement quality may be compromised if body perception is disrupted. Sub-optimal movement patterns might abnormally load the back and contribute to nociceptive input and movement related pain in those with chronic LBP [13, 28]. It has also been hypothesised that danger signals may arise centrally as a result of incongruence between predicted and actual sensory feedback associated with movement by virtue of disrupted body maps [12]. This mechanism might also contribute to the pain experience in people with chronic LBP whose perception of the back is degraded, though experimental support for this hypothesis is inconsistent [27, 51]. It is also plausible that sensitivity might be enhanced by changes in body perception [17]. Pain emerges when we conclude our body to be under threat and in need of protection [24] so how the body is perceived should be seen as fundamental to the emergence of pain. In support of this idea are data that show that sensitivity to experimental pain is increased when perception of the body part is distorted by visual manipulation [30, 31] and is partly endorsed by the correlations noted here between lumbar pressure pain threshold and FreBAQ scores. Finally loss of sensory precision and decreased ability to accurately localise sensory input could enhance sensitivity by increasing the salience and threat value of any sensory information, noxious or otherwise, received from the affected area. Importantly, preliminary data suggest that strategies that likely improve self-perception such as mirror visual feedback [52] and sensory discrimination training [46] may decrease activity-related pain in people with chronic LBP.

We also found that FreBAQ scores were uniquely associated with disability whereas measures of pain catastrophization, fear avoidance beliefs and lumbar spine sensitivity were not. It is plausible that how the back is perceived may uniquely influence disability. While numerous factors interact to determine the level of engagement in functional activities [42] the perception of the fitness, health and robustness of the back might be factors which drive avoidance. Previous research has shown that people with high levels of LBP related disability have a more patho-anatomical perspective on the cause of their back pain than those with low levels of disability [6] and qualitative research supports the notion that people with low back pain perceive the back as fragile and easy to injure [8, 38], particularly in those with high levels of pain related fear [7]. Features captured in the FreBAQ such as feelings of disconnection from the back, finding the back hard to control and altered perception in the size and shape of the back might add to the belief that the back is fragile and not fit for function which may contribute to avoidant behaviour. Actual peripheral tissue health is also likely to contribute to the perception of fitness. Exploratory studies on healthy subjects have reported a body-part-specific drop in temperature [25] and increased histamine reactivity [3], within minutes of experimental body awareness disruption suggesting a link between self-perception and homeostatic control. It is not clear whether such changes do lead to meaningful changes in tissue health but the possibility that altered body perception could also negatively influence actual peripheral tissue health is worthy of consideration.

These findings presented should be considered in light of the limitations of the study. The sample is quite heterogeneous, being drawn from both clinical and non-clinical settings so likely represents participants with very different treatment histories and may partly explain why the associations with clinical severity found here are weaker than we have previously noted with a sample drawn only from a clinical setting [47] . Also, while we attempted to only recruit participants with non-specific low back pain, the tool used to exclude individuals with radicular pain may not have successfully screened out all these individuals. Although altered self-perception appears to be a feature of CLBP its importance in the development and persistence of CLBP remains uncertain. It should be considered that self-perception changes may simply be epiphenomena. We have taken a robust multivariate approach to assessing the unique relationships between self-perception and clinical features of CLBP. However such approaches can only control for known and measured variables and it remains possible that observed relationships might be confounded by unknown variables. The cross-sectional nature of the study also precludes us from drawing any inferences of cause and effect. Finally the contribution of self-perception to the variance seen in pain and disability is relatively small. Small effect sizes increase the chance that relationships observed may not be causal in nature. Further longitudinal and experimental studies are required to explore these issues.

The findings presented here provide further evidence that body perception is disturbed in people with chronic low back pain. The level of perceptual disturbance is positively correlated with pain intensity and disability and in this sample disturbed body perception seems to make a more important contribution to severity of the clinical condition than commonly considered factors such as pain catastrophization, psychological distress, fear avoidance beliefs and local tissue sensitivity. These findings suggest that assessment of body perception might be useful in helping clinicians understand the complexity of the low back pain experience and could serve to guide management. The data presented here demonstrates that the FreBAQ is a simple, feasible and psychometrically sound way of assessing disruption of body image in people with chronic LBP.

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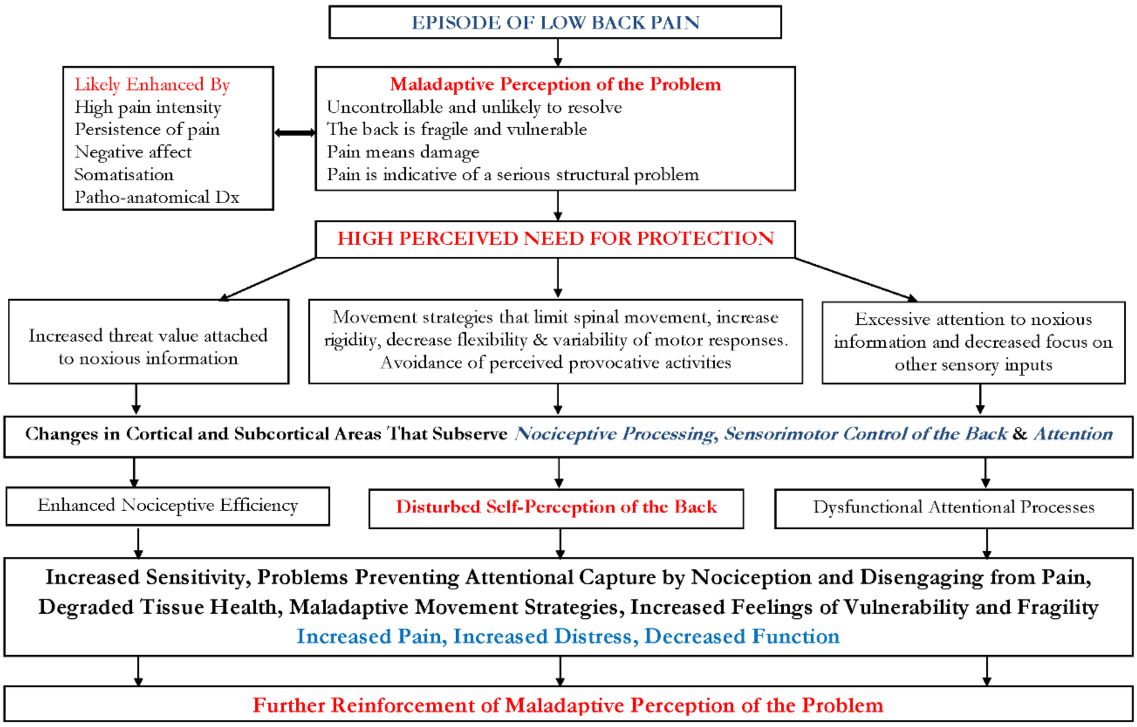
Figure Legends

FIGURE 1. The Maladaptive Perceptions Model

FIGURE 2. Probability curves for the five-category FreBAQ (C0 Never, C1 Rarely, C2 Occasionally, C3 Sometimes, C4 Always). Note the disordered threshold for C1.

FIGURE 3. Item-person threshold map for the FreBAQ. Persons who rarely experience perceptual impairments and items easier to endorse are located on the left side of the logit scale (i.e. <0 logits); Persons who regularly experience perceptual impairments and items harder to endorse are located to the right of the logit scale (i.e. >0 logits). Average item endorsability is set at 0 logits by default.

FIGURE 1. The Maladaptive Perceptions Model



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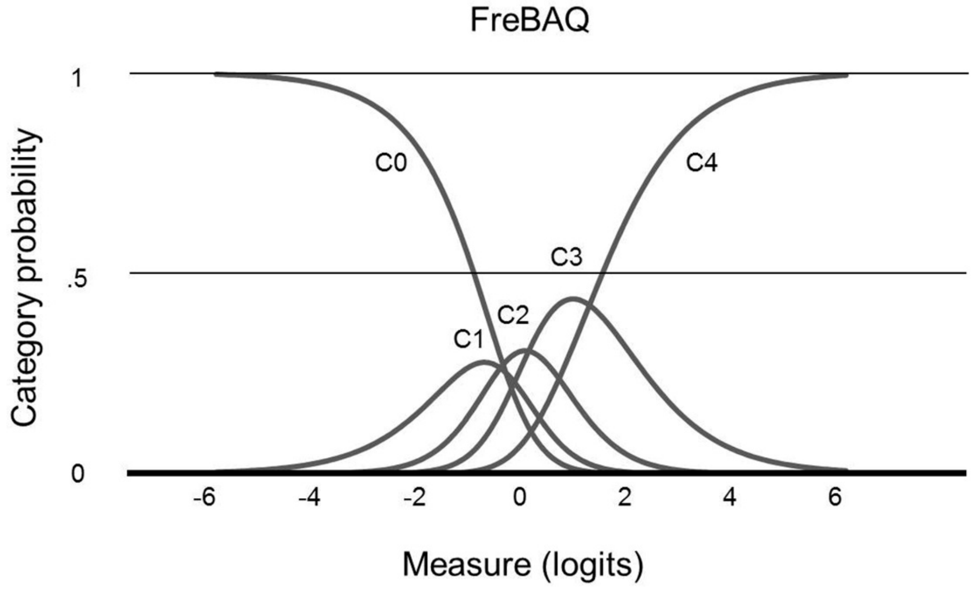

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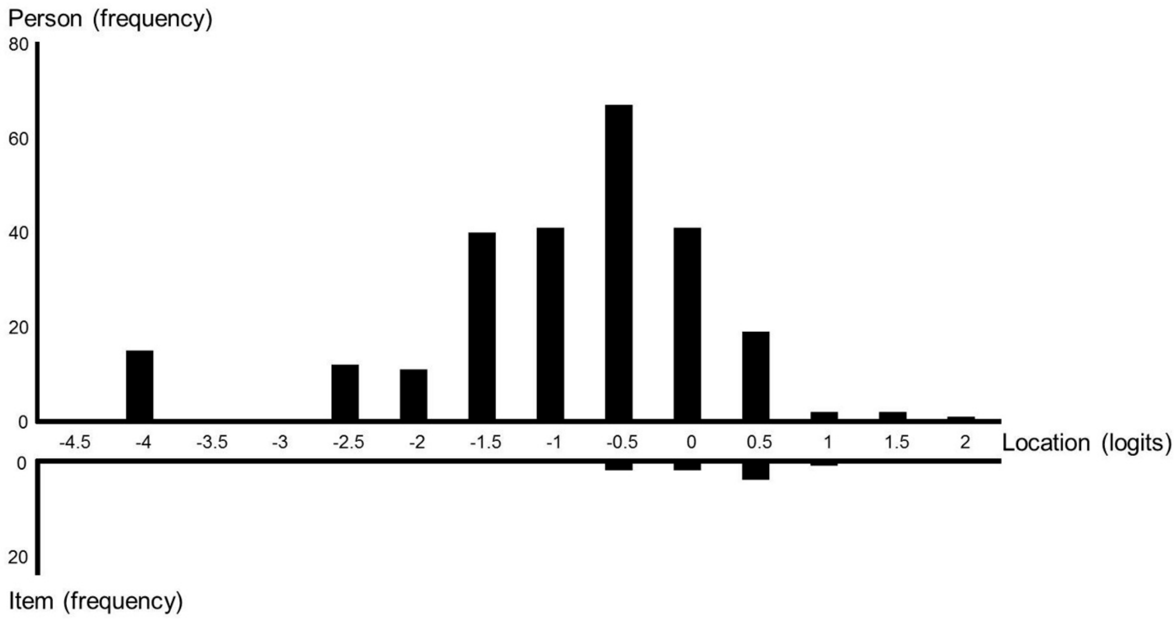

TABLE 1. Participants demographic and clinical information (N=251)

	Mean (SD), Median (IQR) or N(%)
Demographic information	
Gender (female)	148 (59.0%)
Age (years)	48.8 (13.4)
Height (cm)	170.9 (9.8)
Weight (Kg)	80.6 (16.7)
Body Mass Index	27.6 (5.2)
Work Status	
At work (or studying)	188 (74.9)
Off work	63 (25.1)
Clinical status	
Duration of LBP[e] (months)	120 (42, 240)
Pain Area	
Back pain only	121 (48.2%)
Back pain and leg pain	130 (51.8%)
Taking opioid medication	40 (15.9%)
Average Back Pain Intensity (0-10)	5.8 (1.9)
Disability (RMDQ[a], 0-24)	9 (6,13)
Pain Catastrophization[f] (PCS[b], 0-52)	18.8 (12.0)
Fear Avoidance (FABQ-PA[c] 0-24)	14.1 (6.0)
Psychological distress (DASS-21[d] 0 – 42)	8.0 (4.0,12.7)

[a]The Roland Morris Disability Questionnaire
[b]The Pain Catastrophizing Scale
[c]Fear Avoidance Beliefs Questionnaire, physical activity subscale
[d]Depression Anxiety Stress Scale – 21
[e]data missing for 4 cases
[f]data missing for 1 case

TABLE 2. Frequency of responses to each item of the FreBAQ (n=251)

Item	Never N(%)	Rarely N(%)	Occasionally N(%)	Often N(%)	Always N(%)	Median	Mean
1. My back feels as though it is not part of the rest of my body	143 (57.0)	47 (18.7)	29 (11.5)	25 (10.0)	7 (2.8)	0	0.8
2. I need to focus all my attention on my back to make it move the way I want it to	58 (23.1)	46 (18.3)	81 (32.3)	51 (20.3)	15 (6.0)	2	1.7
3. I feel as if my back sometimes moves involuntarily, without my control	144 (57.4)	52 (20.7)	33 (13.2)	19 (7.6)	3 (1.2)	0	0.7
4. When performing everyday tasks, I **don't** know how much my back is moving	104 (41.4)	75 (29.9)	39 (15.5)	29 (11.6)	4 (1.6)	1	1.0

5. When performing everyday tasks, I am **not** sure exactly what position my back is in	99 (39.4)	67 (26.7)	45 (17.9)	31 (12.4)	9 (3.6)	1	1.1
6. I can't perceive the exact outline of my back	125 (49.8)	61 (24.3)	29 (11.6)	25 (10.0)	11 (4.4)	1	0.9
7. My back feels like it is enlarged (swollen)	123 (49.0)	29 (11.6)	47 (18.7)	35 (13.9)	17 (6.8)	1	1.2
8. My back feels like it has shrunk	184 (73.3)	32 (12.8)	20 (8.0)	10 (4.0)	5 (2.0)	0	0.5
9. My back feels lopsided (asymmetrical)	84 (33.5)	25 (10.0)	48 (19.1)	59 (23.5)	35 (13.9)	2	1.7

TABLE 3. Average item endorsability thresholds, shown in hierarchal order, and fit statistics, for the FreBAQ scores of respondents with back pain (*n* = 251). Higher measures indicate harder to endorse items and lower measures indicate easier to endorse items.

Item	FreBAQ			
	Measure (logits)	Score*	Infit (mnsq)	Outfit (mnsq)
8	0.82	122	1.4	1.7
3	0.39	187	1.2	1.2
1	0.27	208	1.2	1.4
6	0.13	235	0.9	0.8
4	0.03	256	0.7	0.7
5	-0.1	286	0.8	0.8
7	-0.15	296	1.0	1.0
2	-0.66	421	0.9	1.0
9	-0.73	438	1.2	1.2

* raw score out of 1004 (possible score out of 4 x 251 participants)

TABLE 4: Correlations of demographic characteristics, clinical status, cognitive/psychological characteristics and psychophysical measures with the FreBAQ

	Correlation Coefficient	p-value
Female Sex	-.023	.714
Age	-.087	.166
BMI	.161	**.011**
Duration of LBP (months)	.084	.188
Disability (RMDQ[a])	.319	**<.001**
Average Back Pain Intensity	.265	**<.001**
Pain Catastrophization (PCS[b])	.358	**<.001**
Fear avoidance (PABQ-PA[c])	.263	**<.001**
Psychological distress (DASS-21[d])	.376	**<.001**
Lumbar pressure pain threshold	-.139	**.028**
Lumbar cold pain threshold	.112	.078
Lumbar heat pain threshold	-.077	.222

[a]The Roland Morris Disability Questionnaire
[b]The Pain Catastrophizing Scale
[c]Fear Avoidance Beliefs Questionnaire, physical activity subscale
[d]Depression Anxiety Stress Scale – 21

TABLE 5: Linear regression models for disability (logRMDQ[a])

	Univariable		Multivariable 1		Multivariable 2	
	beta[b](95% CI)	p	beta[b] (95% CI)	p	beta[b] (95% CI)	p
Back perception (FreBAQ[c])	0.35 (0.23 – 0.47)	<.001	0.10 (-0.02 – 0.23)	.096	0.13 (0.01 – 0.25)	.032
Psychological distress (DASS-21[d])	0.41 (0.29 – 0.52)	<.001	0.22 (0.09 – 0.36)	.001	0.28 (0.16 – 0.40)	<.001
Pain Catastrophization (PCS[e])	0.33 (0.21 – 0.45)	<.001	0.06 (-0.07 – 0.20)	.339		
Fear avoidance (PABQ-PA[f])	0.22 (0.10 - 0.34)	<.001	0.09 (-0.02 – 0.21)	.110		
BMI	0.34 (0.12 – 0.36)	<.001	0.16 (0.06 – 0.27)	.003	0.16 (0.06 – 0.27)	.003
Lumbar pressure pain threshold	-0.15 (-0.30 – -0.03)	.021	-0.03 (-0.14 – 0.08)	.594		
Average Back Pain Intensity (0-10)	0.37 (0.25 – 0.49)	<.001	0.26 (0.15 – 0.37)	<.001	0.26 (0.15 – 0.37)	<.001

[a]The Roland Morris Disability Questionnaire
[b]standardised beta coefficient represented expected change in SD units of logRMDQ for 1SD change in independent variable
[c]Fremantle Back Awareness Questionnaire
[d]Depression Anxiety Stress Scale – 21
[e]The Pain Catastrophizing Scale
[f]Fear Avoidance Beliefs Questionnaire, physical activity subscale

TABLE 6: Linear regression models for pain intensity (NRS[a])

	Univariable		Multivariable 1		Multivariable 2	
	beta[b](95% CI)	p	beta[b] (95% CI)	p	beta[b] (95% CI)	p
Back perception (FreBAQ[c])	0.26 (0.14 – 0.38)	<.001	0.19 (0.05 – 0.32)	.007	0.20 (0.07 – 0.33)	.002
Psychological distress (DASS-21[d])	0.22 (0.09 – 0.34)	.001	0.05 (-0.10 – 0.20)	.486		
Pain Catastrophization (PCS[e])	0.25 (0.13 – 0.37)	<.001	0.15 (0.01 – 0.30)	.034	0.18 (0.05 – 0.30)	.007
Fear avoidance (PABQ-PA[f])	0.04 (-0.07 – 0.16)	.547				
BMI	0.10 (-0.02 – 0.23)	.111				
Lumbar pressure pain threshold	-0.10 (-0.22 – 0.03)	.132				

[a]Numerical Rating Scale 0-10
[b]standardised beta coefficient represented expected change in SD units of NRS for 1SD change in independent variable
[c]Fremantle Back Awareness Questionnaire
[d]Depression Anxiety Stress Scale – 21
[e]The Pain Catastrophizing Scale
[f]Fear Avoidance Beliefs Questionnaire, physical activity subscale

APPENDIX

The Fremantle Back Awareness Questionnaire

Here are some things that other people with low back pain have told us about how their back feels to them. Using the following scale, please indicate the degree to which your back feels this way **when you are experiencing back pain**

0 = Never feels like that
1 = Rarely feels like that
2 = Occasionally, or some of the time feels like that
3 = Often, or a moderate amount of time feels like that
4 = Always, or most of the time feels like that

	Never	**Rarely**	**Occasionally**	**Often**	**Always**
1. My back feels as though it is not part of the rest of my body	0	1	2	3	4
2. I need to focus all my attention on my back to make it move the way I want it to	0	1	2	3	4
3. I feel as if my back sometimes moves involuntarily, without my control	0	1	2	3	4
4. When performing everyday tasks, I **don't** know how much my back is moving	0	1	2	3	4
5. When performing everyday tasks, I am **not** sure exactly what position my back is in	0	1	2	3	4
6. I **can't** perceive the exact outline of my back	0	1	2	3	4
7. My back feels like it is enlarged (swollen)	0	1	2	3	4
8. My back feels like it has shrunk	0	1	2	3	4
9. My back feels lopsided (asymmetrical)	0	1	2	3	4