ORIGINAL ARTICLE

Associations between biased threat interpretations, fear and avoidance of pain and pain-linked disability in adolescent chronic pain patients

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Abstract

Background: Biased interpretations of ambiguous bodily threat situations characterize youth with chronic pain, and have been associated with functional disability for this population. Despite predictions by the fear-avoidance model of chronic pain, that fear and avoidance of pain explain the association between threat perceptions and disability, this has not yet been explored in youth with chronic pain. This study aimed to address this gap by investigating these proposed relationships, in addition to the association between bodily threat interpretations and daily aspects of disability (as well as social, and emotional impairments).

Method: Sixty-eight adolescents aged 11–18 years old with a clinical diagnosis of chronic pain completed an extended version of the Adolescent Interpretations of Bodily Threat task to assess interpretations of bodily and social threat situations, alongside measures of disability and fear and avoidance of pain.

Results: Using mediation analysis, fear and avoidance of pain statistically accounted for the relationship between negative bodily threat interpretations and functional disability. Significant associations were also demonstrated between negative bodily threat interpretations and adolescent-reported impairments in daily, emotional and social impairments. Data revealed a significant relationship between negative social threat interpretations and daily functional disability.

Conclusions: Findings indicate the clinical relevance of bodily and social threat interpretations, and fear and avoidance of pain, for this population and raise further questions regarding the content-specificity of threat interpretations.

Significance: Psychological theories of pain-associated impact and disability point to fear and avoidance of pain, as well as information-processing biases. Here, we present novel data showing the clinical relevance of bodily and social threat interpretations in explaining pain-related disability amongst youth with chronic pain, potentially by shaping fear and avoidance of pain. Longitudinal designs will be required to assess these temporally sensitive mediation pathways.
INTRODUCTION

Chronic pain is common in youth (Huguet & Miró, 2008). A treatment-seeking minority report pain that disrupts daily functioning including social (Forgeron et al., 2013; Khan et al., 2015) and emotional (Palermo, 2000) aspects. While psychological interventions reduce youth pain intensity (Eccleston et al., 2014), their effects on disability and functioning are inconclusive (Fisher et al., 2014). To improve outcomes for youth with chronic pain, a better understanding of the mechanisms that influence these multiple functional domains is needed (Zale & Ditre, 2015).

Pain-related fear and avoidance influence disabling outcomes for young people with pain. Cognitive biases, the tendency to attend towards bodily sensations and interpret these as threatening, may drive fear and avoidance of pain (Leeuw et al., 2007) and therefore pain-linked disability, similar to their roles in anxiety (Glick & Orsillo, 2011). The threat interpretation model (Todd et al., 2015) proposes that when painful stimuli are interpreted as threatening this drives attention and vigilance towards pain-related stimuli/situations. Indeed, adult patients show a greater tendency to interpret ambiguous stimuli as pain-related than controls (Schoth & Liossi, 2016). This pain-related interpretation bias associates with negative clinical outcomes (Keogh & Cochrane, 2002) and greater fear of pain (Jones & Sharpe, 2014).

As interpretational style is more consistently associated with emotional behaviours in adolescents than children (Stuijfzand et al., 2018), linkages between biased interpretations and pain outcomes may differ in youth compared to adults (Brookes et al., 2018; Lau et al., 2018). Three studies have investigated biased interpretations in youth with pain (Heathcote et al., 2016, 2017; Lau et al., 2020), finding that adolescents with greater recent pain symptoms (Heathcote et al., 2016; Lau et al., 2020) and those with chronic musculoskeletal pain (Heathcote et al., 2017) endorsed significantly fewer benign interpretations of bodily threat situations than controls with few/no pain complaints. Community adolescents with pain symptoms also endorsed significantly more negative interpretations of these situations (Heathcote et al., 2016; Lau et al., 2020). Patients’ interpretation biases were associated with increased functional disability (Heathcote et al., 2017). Yet, no studies have assessed the hypothesized relationship between interpretation bias and fear and avoidance in paediatric samples.

Here, we aimed to first replicate associations between bodily threat interpretations and functional disability for youth with chronic pain (Heathcote et al., 2017). Given prior data suggesting that adolescent patients with chronic pain show biases only to bodily threat situations (Heathcote et al., 2017), we hypothesize that associations with disability would be content-specific. Since ‘disability’ associated with pain encapsulates functional limitations across life domains (Gauntlett-Gilbert & Eccleston, 2007), measures of social and emotional functioning will be included. Second, we aimed to test novel hypotheses that a) higher levels of negative bodily threat interpretations and lower levels of benign bodily threat interpretations will correlate with increased fear and avoidance of pain, and b) consistent with pain models (Vlaeyen & Linton, 2000), fear and avoidance of pain will statistically account for the association between bodily threat interpretations and functional disability for adolescents with chronic pain.

METHODS

Participants

Sixty-eight children and adolescents with chronic pain and their parent/carers were recruited from the Oxford Centre for Children and Young People in Pain at the Nuffield Orthopaedic Centre (OXCCYP), Oxford University Hospitals between January and May 2019. Sixty-seven participants were required to detect an association of medium effect size at $p < .05$, two-tailed, with 80% power, consistent with that expected of the size of the relationship between bodily threat interpretations and functional disability based on a prior study of youth with chronic pain aged 10–17 ($r^2 = 0.37$; Heathcote et al., 2017).

Inclusion criteria were that participants were aged 11–18 years, had been in pain at least once a week for over 3 months, and had a good understanding of English. Participants were excluded if they had a visual impairment, or a diagnosis of intellectual disability, schizophrenia, psychosis or substance abuse, due to difficulties with reading or a confounding association between these conditions and cognitive biases. Potential participants were approached following a multi-disciplinary assessment at the OXCCYP and had received a diagnosis related to chronic pain from a consultant paediatrician. Potential participants who expressed an interest in the research were provided with an information sheet and asked to opt into the study by contacting the research team, or by providing verbal consent to be contacted by the research team. Of the 75 families approached, 68 agreed to take part, resulting in a participation rate of 90.1%. Of the seven families, five declined participation due to time commitments and two no longer met criteria for the study.

MEASURES

Pain severity

Pain intensity and frequency were assessed separately. To assess pain intensity, participants rated their average or usual pain
using a 0–10 numeric rating scale. This is a reliable and valid method for obtaining self-reported information regarding children’s pain (von Baeyer, 2009). Consistent with similar studies (Wilson et al., 2011), pain frequency was reported by participants on a 6-point Likert Scale (0 = never; 6 = every day).

2.2.2 | Interpretation task

We used the Extended version of Adolescent Interpretations of Bodily Threat (E-AIBT) described in a recent study of 243 community adolescents aged 16–19 years (Lau et al., 2020). The first version of this task (called the AIBT) (Heathcote et al., 2016) included mostly immediate injury-related bodily threat situations within the bodily threat subscale and potential peer rejection situations within the social threat subscale. The Extended version (E-AIBT; Lau et al., 2020) assesses patterns of negative and benign interpretations to a broader range of adolescent-relevant bodily threat and social threat situations including longer-term health and illness situations that could also threaten bodily harm and other salient social evaluation situations, notably evaluation by teachers in terms of academic achievements. In the task, participants are presented with ambiguous scenarios (e.g. ‘Yesterday your bicycle was hit by a car. You will not be able to cycle for a while because the car broke your …’) which end with one of two possible word endings (in this case, leg and bike). One ending is negative, and one is benign. The participant is instructed to rate each ending in terms of likelihood on a scale from 1 to 5. In this example, higher likelihood ratings for ‘leg’ reflect endorsement of a negative interpretation while higher ratings for ‘bike’ index a benign interpretation. An example of a scenario describing longer term illness included in the negative/benign bodily threat subscales is: ‘You take a pill every morning at breakfast. The pill is … medicine/a vitamin’ (long-term illness item). Examples of scenarios included in the negative/benign social threat subscales are: ‘You are walking to your next class. As you approach the medicine/a vitamin item, you submit an article to your school newspaper. After a week, the Editor emails you to say that your article is … rejected/accepted’ (performance failure item). Participants respond to the 64 items (32 situations, half negative, half benign) in a fixed random order, presented using Qualtrics (Qualtrics, 2014).

Four subscale scores of negative bodily threat interpretations, negative social threat interpretations, benign bodily threat interpretations and benign social threat interpretations were created. Although the study that first reported usage of the E-AIBT used confirmatory factor analysis (CFA) to select items that best cohered to each of these constructs (see Lau et al., 2020 for details), these data were from a large community sample of adolescents. As we did not have sufficient sample sizes to use CFA for item selection in the present clinical dataset, and yet, as it cannot be assumed that inter-item correlations are similar in community versus clinical samples, we decided to include all the items to create the four subscales reported in our results. Cronbach’s alpha reliability scores were first computed for each subscale. In order to maximize reliability for each subscale, through an iterative process, we removed each item at a time to see if it improved the overall Cronbach’s alpha. Items that showed an increase in Cronbach’s alpha were then removed one at a time; we repeated this until there were no more improvements in Cronbach’s alpha. Through this procedure, three items were removed from the negative bodily threat subscale, resulting in a Cronbach’s alpha of 0.81; six items were removed from the benign bodily threat subscale, resulting in a Cronbach’s alpha of 0.68. For the negative and benign social threat subscales, removal of one item on each resulted in Cronbach’s alphas of 0.87 and 0.90, respectively. All final subscales were normally distributed. Although the analysis presented here reflects the average of E-AIBT items for each subscale after the removal of discrepant items (to maximize internal consistency of each subscale), we also ran analysis on the full subscales with all items included, with similar patterns of results found. One subscale (benign bodily threat) fell short of the 0.70 cut-off, but we have nonetheless included this in the analysis for completeness.

2.2.3 | Measure of daily functioning/functional disability

Functional Disability Inventory, Child-Report (FDI-C; Walker & Greene, 1991). The FDI-C is a 15-item self-report measure assessing children’s perception of their difficulties completing typical daily activities due to pain. Individuals rate their difficulty performing numerous everyday tasks over the past 2 weeks (e.g. walking upstairs) on a 5-point Likert scale (0 = no trouble; 4 = impossible). Total scores are calculated by summing the items: higher scores indicate greater perceived functional disability. The measure has high internal consistency (α = 0.86 to 0.91), moderate to high test–retest reliability (r = 0.74 at 2 weeks), good predictive validity and moderate cross informant (parent–child) reliability in groups of young people aged 8–17 with chronic pain conditions (Claar & Walker, 2006). Alpha reliability in this sample was 0.88.

2.2.4 | Broader measure of disability (Including social and emotional functioning)

The Bath Adolescent Pain Questionnaire, Child-Report (BAPQ-C, Eccleston et al., 2005). The BAPQ-C is a 61-item questionnaire measuring physical, social, family and
developmental functioning, depression, general anxiety and pain-specific anxiety. The three latter subscales combine to make the ‘emotional functioning’ domain. Participants are asked to respond to statements (e.g. ‘I feel sad’) on a 5-point Likert scale (e.g. 0 = never to 4 = always) in regard to the past 2 weeks. Total scores are calculated by summing the items: Higher scores indicate greater impairment across all subscales and domains. The questionnaire is well established for use with youth aged 11–18 with chronic pain, and has good internal consistency (α = 0.79 to 0.89), temporal reliability and comparative validity to other standardized measures (Eccleston et al., 2005). As the physical functioning subscale significantly correlated (r = 0.65, p = .001) with participants’ functional disability score (FDI-C) and reflected a similar construct (physical functioning in daily activities), only the social functioning subscale and emotional functioning domain were employed in this study to capture a broader conceptualization of adolescent disability. Alpha reliabilities within the current sample were a = 0.85 for the social functioning subscale, and a = 0.92 for the emotional functioning domain.

2.2.5 | Measure of fear and avoidance

The Fear of Pain Questionnaire, Child-Report (FOPQ-C; Simons et al., 2011). The FOPQ-C is a 24-item self-report questionnaire assessing pain-related fear and avoidance in youth with chronic pain. It includes a fear subscale and an avoidance subscale, with items relating to cognitions (e.g. ‘my pain controls my life’), behaviours (e.g. ‘I go immediately to lie down or rest when I feel really bad pain’) and physiological responses to pain (e.g. ‘I find it difficult to calm my body down when having pain’). Items are rated on a 5-point Likert Scale ranging from 0 to 4 (strongly disagree; strongly agree). Total scores are calculated by summing the items: Higher scores indicate greater fear and avoidance. It has been validated for use with youth aged 8–17 with chronic pain, and has moderate temporal stability, high internal consistency (α = 0.92) and good construct validity (Simons et al., 2011). As fear and avoidance are related constructs, and to reduce the number of analyses performed the total fear and avoidance score was used in analyses. The alpha reliability score for total fear and avoidance was 0.90 in the current sample (and a significant correlation was found between fear and avoidance subscales (r = 0.61, p = .001)).

2.3 | Procedure

Testing took place either in the OXCCYP outpatient department or the participants’ home depending upon the family’s preference. Of the final sample, 59 participants were tested in the clinic and nine in a quiet room in their home. On arrival, the purpose of the study and a description of the measures and procedure were verbally re-iterated to participants and parents/carers. They then completed the relevant written consent/assent forms. The researcher then read out the computerized E-AIBT task items to participants and asked them to respond accordingly. Participants then completed the FDI-C, BAPQ-C and FOPQ-C in digital format. At the same time, parents/carers completed a demographic information questionnaire for their child. Participants and their parents were then debriefed and thanked for taking part. The study took around 40 min, and participants were offered a £10 Amazon voucher as a gesture of gratitude for taking part.

The study was granted approval by the Health Research Authority and Care Research Wales (18/NW/0570); in addition, Trust Management Approval was confirmed by Oxford University Hospitals NHS Foundation Trust.

2.4 | Data Analysis

Data were analysed using the Statistics Package for Social Sciences (SPSS; IBM Corp, 2017). All data were screened for normality and outliers. If outliers were detected, analyses were performed with and without outliers. If no difference was found between the results, the findings with outliers were reported. Given that previous research has found an association between bodily threat interpretations and functional disability in adolescents with chronic pain (Heathcote et al., 2017), a hierarchical linear regression was used to examine whether bodily threat interpretations were associated with functional disability for this population. Checks were made to first ensure that the assumptions of each regression analysis (Berry, 1993) were met. Linearity, residual assumptions and multi-collinearity were assessed in line with guidance (Field, 2013). There were no extreme outliers. All data met the assumption of independent errors, with Durbin-Watson values ranging between 1.81 and 2.48, which is within the cut-off of values between 1 and 3 suggested by Field (2013). Variance inflation factors were all less than 2.5. Thus, there were no concerns about interpretation bias subscales being highly correlated. Functional disability score (as measured by the FDI-C) was entered as the dependent variable. As pain intensity (and not frequency) was found to predict functional disability in adolescents with chronic pain (Heathcote et al., 2017), this was included as a covariate, and entered on the first step. Negative and benign bodily threat interpretation scores were entered on the second step. To explore the content-specificity of these associations between threat interpretations and functional disability, regression analyses were also conducted separately for the social threat indices (benign/negative). To capture a broader definition of disability, separate analyses were also performed with
child-reported emotional functioning (BAPQ-C emotional functioning domain) and child social functioning (BAPQ-C social functioning subscale) as dependent variables with benign and negative bodily threat interpretations only.

A hierarchical multiple regression was employed to examine whether bodily threat interpretations were associated with fear and avoidance for adolescents with chronic pain. We ensured that the assumptions of the regression analysis (Berry, 1993) were met. Total fear and avoidance of pain score (as measured by the FOPQ-C) was entered as the dependent variable. Pain intensity was again entered on the first step as a covariate, and negative and benign bodily threat interpretation scores were entered on the second step.

If associations were found between bodily threat interpretations and both functional disability and fear and avoidance, a mediation analysis was conducted. To examine whether fear and avoidance explained the association between bodily threat interpretations and functional disability, the PROCESS tool (Hayes, 2017) was employed. First, it was established whether or not the direct path (path c) was significant. It was next determined whether the indirect effect (combined effects of path a and b) was significantly different from zero, by producing a confidence interval for the indirect effect of the predictor variable (bodily threat interpretations) on the outcome variable (functional disability), through the mediating variable (fear and avoidance of pain). This may not include zero.

3 | RESULTS

A summary of participant characteristics is presented in Table 1. One parent did not complete the demographic information questionnaire, so demographic information is reported for 67 participants. The majority of participants were Caucasian females with widespread chronic pain. There was variability in the level of treatment participants had received: one adolescent had undergone only an assessment (1.50%), four had completed an assessment and pain education (5.97%), 38 (56.72%) had completed assessment, pain education and outpatient appointments (which included sessions of physiotherapy, occupational therapy and psychological therapy) and 24 (35.82%) had also completed an intensive 2-week rehabilitation programme.

### TABLE 1 Overview of participant and parent/carer characteristics reported by parent/carer (N = 67)

| Participant/Parent Characteristic | N = 67 (%) |
|----------------------------------|------------|
| Age, mean (Range; SD)            | 15 (11–18, SD = 2.03) |
| Gender                           |            |
| Female                           | 49 (73.13%) |
| Male                             | 18 (26.87%) |
| Ethnicity                        |            |
| Caucasian                        | 61 (91.04%) |
| Pakistani                        | 4 (5.97%)  |
| White and Asian                  | 1 (1.49%)  |
| Indian                           | 1 (1.49%)  |
| Diagnosis of Chronic Pain        |            |
| Widespread                       | 44 (65.67%) |
| Complex regional pain syndrome   | 10 (14.93%) |
| Back pain                        | 4 (5.97%)  |
| Knee pain                        | 3 (4.48%)  |
| Headache                         | 3 (4.48%)  |
| Foot/Leg pain                    | 2 (2.99%)  |
| Hand/Arm pain                    | 1 (1.49%)  |
| Pain Characteristics             |            |
| Pain intensity [N = 68], mean (range, SD) | 6.80 (2–10, SD = 1.53) |
| Months since pain onset, mean (range) | 43.43 (5–132) |
| Pain frequency [N = 68]          |            |
| Everyday                         | 62 (91.18%) |
| Twice a week                     | 5 (7.35%)  |
| Once a week                      | 1 (1.47%)  |
| Physical health difficulties      |            |
| Hypermobility                    | 21 (31.34%) |
| Asthma                           | 7 (10.15%) |
| Spinal conditions                | 3 (4.27%)  |
| Cerebral palsy; Chronic Fatigue Syndrome; Congenital Heart Disease; Fibromyalgia; Eczema; vascular malformations | 1 (4.76%) per condition |
| Mental health or neurological difficulties | 22 (32.84%) |
| Anxiety                          | 8 (36.36%) |
| Anxiety and depression           | 8 (36.36%) |
| Autism spectrum disorder         | 2 (9.10%)  |
| Tourette syndrome; attention deficit | 1 (4.55%) per condition |
| Hyperactivity disorder; depression |            |
| Parent/carer respondents         |            |
| Mother                           | 55 (82.11%) |
| Father                           | 9 (13.43%) |
| Grandmother                      | 3 (4.50%)  |

(Continues)
interpretation scores significantly improved the model, \(F(3, 64 = 4.26, p = .01, R^2 = 0.17, \Delta R^2 = 0.10)\). In the model including all variables, both negative bodily threat interpretation, \((\beta = 0.29, t(67) = 2.45, p = .02)\), and pain intensity \((\beta = 0.25, t(67) = 2.12, p = .04)\), emerged as significant predictors of levels of child-rated functional disability. Benign bodily threat interpretation \((\beta = 0.07, t(67) = 0.60, p = .55)\) was not a significant predictor.

For social threat situations, the analysis found that pain intensity explained a significant amount of the variance in child-reported functional disability, \(F(1, 66 = 4.99, p = .03, R^2 = 0.07)\). Adding negative social threat interpretation and benign social threat interpretation scores significantly improved the model, \(F(3, 64 = 5.27, p < .01, R^2 = 0.20, \Delta R^2 = 0.13)\). In the model including all variables, both negative social threat interpretation, \((\beta = 0.40, t(67) = 2.62, p < .05)\), and pain intensity \((\beta = 0.25, t(67) = 2.25, p < .05)\), emerged as significant predictors of child-rated functional disability. Benign social threat interpretation \((\beta = 0.07, t(67) = 0.46, p = .65)\) was not a significant predictor.

Of note, we conducted some post hoc analysis to examine whether negative bodily threat and negative social threat interpretations were independent predictors of functional disability. The overall regression model was significant, \(F(2, 65 = 4.99, p = .003, R^2 = 0.14)\) but only negative social threat interpretation was a significant predictor, \((\beta = 0.27, t(67) = 2.11, p = .04)\); negative bodily threat interpretation was no longer significant, \((\beta = 0.20, t(67) = 1.53, p = .13)\).

### 3.2 Associations between bodily threat interpretations and social functioning

A hierarchical multiple regression analysis was also conducted for child-reported social functioning with bodily threat items entered as predictor variables. The analysis found that only pain intensity was not significant, \(F(1, 66 = 1.30, p = .26, R^2 = 0.02)\). The model that included negative/benign bodily threat interpretation was significant, \(F(3, 64 = 2.85, p = .04, R^2 = 0.12, \Delta R^2 = 0.10)\). In the model containing all variables, only negative bodily threat interpretation emerged as a significant predictor \((\beta = 0.32, t(67) = 2.67, p = .01)\); pain intensity \((\beta = 0.10, t(67) = 0.82, p = .41)\) and benign bodily threat interpretation \((\beta = -0.06, t(67) = -0.46, p = .65)\) were not significant predictors.

### 3.3 Associations between bodily threat interpretations and emotional functioning

Another hierarchical multiple regression analysis was conducted for child-reported emotional functioning with bodily threat items entered as predictor variables. The analysis found that pain intensity was a significant predictor of child-reported emotional functioning, \(F(1, 66 = 4.28, p = .04, R^2 = 0.06)\). Adding negative bodily threat interpretation and benign bodily threat interpretation scores significantly improved the model, \(F(3, 64 = 5.16, p < .01, R^2 = 0.20, \Delta R^2 = 0.13)\). In the model including all variables, only negative bodily threat interpretation \((\beta = 0.37, t(67) = 3.17, p < .01)\) emerged as a significant predictor of child-reported emotional functioning. Pain intensity was no longer a significant predictor, \((\beta = 0.21, t(67) = 1.85, p = .07)\). Neither was benign bodily threat interpretation \((\beta = 0.01, t(67) = 0.05, p = .97)\).

### 3.4 Associations between bodily threat interpretations and fear and avoidance

A hierarchical multiple regression analysis was conducted to see whether negative/benign bodily threat interpretations were linearly associated with child-reported fear and avoidance of pain. Pain intensity explained a significant amount of the variance in child-reported fear and avoidance of pain, \(F(1, 66 = 12.21, p < .01, R^2 = 0.16)\). Adding negative bodily threat interpretation and benign bodily threat interpretation scores significantly improved the model, \(F(3, 64 = 14.80, p < .01, R^2 = 0.41, \Delta R^2 = 0.25)\). In the model including all variables, both negative bodily threat interpretation \((\beta = 0.52, t(67) = 5.24, p < .01)\), and pain intensity \((\beta = 0.33, t(67) = 3.36, p < .01)\), emerged as significant predictors of child-reported fear and avoidance of pain. Benign bodily threat interpretation \((\beta = -2.73, t(67) = -0.96, p = .25)\) was not a significant predictor.

### 3.5 Mediation effect

The previous analysis confirmed that the negative bodily threat interpretation index was associated with higher levels of child-rated functional disability (FDI-C) and fear and
avoidance of pain. Therefore, an analysis was performed to
determine whether fear and avoidance of pain mediated the
association between negative bodily threat interpretation and
functional disability. In step one of the mediation model, the
regression of negative bodily threat interpretation on func-
tional disability, ignoring the mediator (i.e. path c), was
significant, $B = 5.08, t(67) = 2.81, p = .001$. Step two dem-
onstrated that the regression of negative bodily threat inter-
pretation on the mediator, fear and avoidance of pain (path a),
was also significant, $B = 23.00, t(67) = 5.10, p = .001$. Step
three showed that the mediator (fear and avoidance of pain; path b),
controlling for negative bodily threat (path b), was significant,
$B = 0.35, t(67) = 4.80, p = .001$. Step four revealed that, con-
trolling for the mediator (fear and avoidance of pain; path $c'$),
negative bodily threat interpretation was not a significant
predictor of functional disability, $B = 0.37, t(67) = 0.20, p = .84$. The 95% confidence limits (BootLLCI = 2.25; BootULCI = 7.79) did not include zero, indicating that the indirect effect test is significant. The mediation model is pre-
sented in Figure 1.

4 | DISCUSSION

This study used an expanded version of the Adolescent
Interpretations of Bodily Threat (Heathcote et al., 2016)
task to extend and integrate current findings regarding inter-
pretation bias, disability and fear and avoidance of pain, in adolescents with chronic pain. Consistent with predic-
tions, a significant association emerged between negative
bodily threat interpretations and functional disability (i.e.
impairments to daily functioning). This study further ex-
tended findings to demonstrate significant associations with
the emotional and social aspects of disability. The data also
showed that negative interpretations of bodily threat situa-
tions are associated with fear and avoidance of pain for these
adolescents with chronic pain. Importantly, fear and avoid-
ance of pain were found to account for the relationship be-
tween adolescents’ negative interpretations of bodily threat
and functional disability. Finally, a significant association
emerged between negative social threat interpretation and
functional disability. As post hoc analysis indicated that this
association was stronger than and even accounted for some
of the variance between negative bodily threat interpretations
and functional disability, these data could indicate a more
general (rather than pain-specific) pattern of threat interpret-
ations that is related to impairments to daily functioning
within this population. Key findings are discussed in turn.

4.1 | Associations between biased threat
interpretations of bodily and social threat
situations and multiple aspects of disability

The primary aim of this research was to replicate previous
findings demonstrating an association between bodily threat
interpretations and functional disability for children and ado-
lescents with chronic pain. In line with predictions, higher lev-
els of negative bodily threat interpretations were significantly
associated with increased child-reported functional disability,
even after controlling for pain intensity. This association with
bodily threat interpretations extended beyond impairments in
daily functioning, to social and emotional disability. In support
of previous research (Heathcote et al., 2017), this finding sug-
gests that adolescent interpretations of bodily threat are clini-
cally relevant for developing an understanding of the severity

![Figure 1](image-url)
of impairments for adolescents with chronic pain. In contrast to findings by Heathcote and colleagues (Heathcote et al., 2017), no significant association was found between lower levels of participants’ endorsements of benign bodily threat items and higher adolescent functional disability. As this study used an extended benign bodily threat subscale that included longer term health and illness situations, these additional items, as well as reducing the overall coherence of the scale (through poorer inter-item agreement, α = 0.68), may be less associated with functional disability.

Some previous findings (Heathcote et al., 2017; McKellar et al., 2003) suggest that individuals with chronic pain demonstrate an interpretation bias only for pain-related information or situations, and that this does not generalize to other potentially threatening situations. However, others have found that adult chronic pain patients demonstrate a more general disability-related bias rather than a pain-specific bias (Schoth & Liossi, 2016). This study aimed to extend findings by exploring the clinical relevance of different interpretation styles, investigating whether the relationship between interpretation style and functional disability existed only between interpretations for bodily threat items or extended to social situations. Greater endorsement of negative social threat interpretations emerged as a significant predictor of adolescent functional disability, beyond pain intensity. Indeed, many adolescents with chronic pain report social isolation and concerns about being negatively evaluated by peers (Forgeron et al., 2010), which could lead to reduced daily functioning. Post hoc analysis further indicated that this association was strong than and even accounted for some of the variance between negative bodily threat interpretations and functional disability.

4.2 Associations between biased interpretations of bodily threat situations and fear and avoidance of pain

This research also extended current findings by investigating the association between bodily threat interpretations and fear and avoidance of pain for adolescents with chronic pain. As hypothesized, higher levels of negative interpretations of bodily threat situations were significantly associated with greater levels of fear and avoidance of pain for adolescents with chronic pain, even after controlling for pain intensity. This is consistent with literature reporting an association between negative interpretations of painful faces and higher reported fear of pain in adults with chronic pain (Khatibi et al., 2015); and also with experimental findings reporting a causal link between interpretation bias and avoidance behaviours in healthy adults during a cold pressor task (Jones & Sharpe, 2014). Furthermore, fear and avoidance of pain were found to significantly account for the association between negative bodily threat interpretations and adolescent functional disability.

The fear-avoidance model (Vlaeyen & Linton, 2000) is an evolving concept, which is continually revised according to research. Revisions of the model suggest that cognitive processing styles (including interpretation bias) can predispose individuals to be fearful of pain (Pincus et al., 2010), which activates escape mechanisms causing avoidance of activity and movement, leading to impaired physical, social and emotional functioning (Zale & Ditre, 2015). The notion that interpretation biases pre-dispose avoidance is supported by an experimental study (Jones & Sharpe, 2014) which found that increasing healthy participants’ pain-related interpretation bias led to changes in pain-related avoidance. The current findings might also provide support for this extended model. However, as the results are cross-sectional, longitudinal and experimental studies are needed to infer causality. Future research should also further unpack the relations between interpretation bias and fear and avoidance of pain, either by analysing these concepts separately or by using real-life measures (e.g. diaries or observations) to increase ecological validity.

4.3 Clinical implications

Several clinical implications emerged from this study. First, there has been a call for studies to assess the impact of interventions on a range of outcomes, beyond pain intensity and physical functioning, including emotional and role functioning (McGrath et al., 2008). This study provides initial evidence that interpretation styles in children and adolescents with chronic pain, may be associated with a range of impairments, including functional as well as emotional and social disability. Future cognitive research should consider this wider definition of disability that extends across a range of life domains using a variety of questionnaires and even real-life measures (e.g. diaries). Second, given that biased interpretations have been associated with functional disability in this study and several others (Heathcote et al., 2017), these cognitive factors are likely to be a critical target for intervention. Targeting these through cognitive behavioural interventions (including possibly recent cognitive bias modification training paradigms; Krebs et al., 2018) may be especially beneficial for young people given that the association between interpretational style and social-emotional behaviour is more consistent across adolescence (Stuijzand et al., 2018), and may be more amenable to intervention before they become habitual and consistently linked with maladaptive emotional behaviour.

5 LIMITATIONS

There were several limitations. First, an earlier community study (Lau et al., 2020) using the extended AIBT measure created subscales by selecting items through data reduction. As our sample size did not enable us to use confirmatory
factor analysis, and as it cannot be assumed that these earlier findings extend to clinical samples, we used all items to create subscales here (although we did remove a handful of items to maximize Cronbach’s alpha). The inter-item reliability of the benign bodily threat subscale was deemed unacceptable, falling below 0.70. This may be because of the addition of long-term health and illness items to items around immediate bodily injury. As mortality and illness may be less salient for younger individuals, it may be that cognitions around these items are less consistent and stable, affecting overall reliability. As previous studies mark benign interpretations as an important construct for this population, future research should aim to more carefully identify health and illness situations that are age-appropriate, and interrogate their reliability. Second, we were unable to explore whether the pattern of interpretations found using the E-AIBT in this study represents a different interpretation pattern for adolescents with chronic pain compared to pain-free adolescents, as there was no comparison group included in the study. Future research should therefore replicate this study using a control group. Finally, as most young people had already received some form of treatment (sessions of physiotherapy, occupational therapy, psychological therapy and/or a 2-week rehabilitation programme), we were unable to assess whether the associations between interpretational style and disability/functioning were different at pre-treatment.

6 | CONCLUSIONS

Using the E-AIBT task, this study aimed to investigate relationships between interpretation bias, disability and fear and avoidance of pain, for the first time in a sample of adolescents with chronic pain. The major finding was that fear and avoidance of pain mediated the relationship between adolescents’ negative bodily threat interpretations and functional disability. As well as demonstrating associations between negative bodily threat interpretations and impairments to daily, emotional and social functioning for this population, the relationship between negative social threat interpretations and daily impairments raises further questions regarding the content-specificity of interpretation bias in chronic pain, and its relation to disability. As the sample size was modest, these findings will require replication in a larger clinical sample. Further research is also needed to clarify the directionality and specificity of relationships between these variables within adolescents with chronic pain in order to refine assessments and interventions for this population (Lau et al., 2018).

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CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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