Published in final edited form as:
Eur J Pain. 2020 August ; 24(7): 1339–1347. doi:10.1002/ejp.1581.

Stuck on pain? Assessing children's vigilance and awareness of pain sensations

L.C. Heathcote[*,1], **L.E. Simons**[1]

[1]Department of Anesthesiology, Perioperative, and Pain Medicine, Stanford University School of Medicine, Stanford, CA, USA

Introduction

Pain is evolutionarily primed to capture and hold attention. It interrupts other attentional demands and urges behavior to escape (Eccleston and Crombez, 1999). In the case of acute pain, these attention-grabbing qualities are largely adaptive and provide a protective function. In the case of chronic pain, however, repeated attentional interruption from pain can impair functioning and quality of life (Dick and Rashiq, 2007). Chronic attentional interruption by pain (Eccleston and Crombez, 1999) is proposed to increase pain severity, pain-related catastrophizing, fear and avoidance behaviors, and subsequent disability (Leeuw et al., 2007; Linton and Shaw, 2011; Vlaeyen et al., 2016; Vlaeyen and Linton, 2000). Accordingly, attentional processes have become intervention targets for chronic pain disorders, including via self-management, cognitive-behavioral therapies, and acceptance and commitment therapies. More recently, computerized attention bias modification has also been studied as a possible intervention for people with chronic pain (Heathcote et al., 2018a; Schoth et al., 2013; Sharpe et al., 2012).

While interruption by pain is ontogenetically and evolutionarily primed, there are differences in the degree to which one's attention is captured and held by pain. These differences can be situational (e.g., intensity, novelty, predictability) and can also reflect more stable tendencies within an individual (Eccleston and Crombez, 1999). The Pain Vigilance and Awareness Questionnaire (PVAQ; (McCracken, 1997)) arose from the ambition to measure individual differences in pain-related attention, with items intended to assess awareness, vigilance, preoccupation, and observation of pain. To date, the PVAQ has shown robust psychometric properties and has been used in experimental and clinical studies with healthy adult and patient populations. In these studies, elevated attention toward pain, sometimes referred to as 'hypervigilance', has been shown to correlate with more severe pain, pain-related fear and catastrophizing, functional disability, anxiety and depressive symptoms, and healthcare utilization (Kunz et al., 2017; McCracken, 1997; Roelofs et al., 2003).

[*]Corresponding author information: Lauren C. Heathcote. Suite 300, 1070 Arastradero Road, Palo Alto, CA 94304, USA. lcheath@stanford.edu; Tel.: +1(650)-736-0838.
Author Contributions:
All authors contributed to the study design, interpretation of results, and writing of the manuscript.

Conflicts of Interest: The authors report no conflicts of interest for this work.

Despite its demonstrated importance in adult samples, there are currently no validated tools to capture self-reported attention to pain in children. There are a number of reasons why a pediatric measure of pain-related attention is needed. First, principal theoretical models of chronic pain that include a core role for pain-related attention, including the Fear-Avoidance Model (FAM), have been extended to children (Asmundson et al., 2012; Simons and Kaczynski, 2012). Pediatric-specific measures are thus needed to test these models in child samples. Second, executive functioning capacities and their underlying neural architecture, including the ability to maintain and shift attention, change across development (Blakemore and Choudhury, 2006). Thus, findings from adult samples cannot be directly applied to developmental populations. Third, interventions that target or draw on attentional capacities are now being applied to pediatric pain samples (Heathcote et al., 2018a). Psychometrically sound measures of pain-related attention are required to test mechanisms of effect. The goals of this study were thus to adapt the PVAQ for use by children, to preliminary examine its psychometric properties in a sample of youth with chronic pain, and to assess its utility over and above a measure of general attentional capacities.

Methods

Participants and Procedures

Children ages 8–18 years who were recruited for research at the chronic pain clinics at X and Y Children’s Hospitals, USA between January 2016 and August 2019 were included in the current dataset. The sample (*N*=160) was predominantly female (*N*=121; 75.6%), with a mean age of 14.7 years (*SD* = 2.27). The patient sample was predominantly Caucasian (*N*=111; 69.4%) followed by Multiracial (*N*=27; 16.9%), Asian (*N*=6; 3.8%), Black or African American (*N*=2; 1.3%), Native American (*N*=2; 1.3%), or Other (*N*=9; 5.6%). Race was not reported for three children (1.9%). Patients presented with mixed-etiology chronic pain conditions including musculoskeletal pain (single or multi-site; 32.5%), headache (10.6%), complex regional pain syndrome or another neuropathic pain condition (9.4%), abdominal pain or endometriosis (18.1%), and widespread pain (this includes patients with multiple of the aforementioned conditions and/or fibromyalgia, pain amplification syndrome 15.6%). Diagnostic data was missing for 31 patients (*N* = 13.8% of the sample), however the following information was available based on self-reported pain locations: 13 (8.1%) additional patients reported single- or multi-site musculoskeletal pain, six additional patients (3.8%) reported widespread pain, and one (0.6%) additional patient reported abdominal pain. Both diagnostic and pain location data was missing for three (1.9%) patients.

The PVAQ-C was administered electronically either as part of a standard clinic battery completed before the patients’ appointment or as part of a baseline assessment for a study employing daily diary methodology to examine parent-child relations in the context of child pain (both study methods were employed at both sites; daily diary results to be reported elsewhere). Measure administration and data collection were approved by the Institutional Review Boards at X and Y.

Materials

Pain Vigilance and Awareness Questionnaire – child version (PVAQ-C).—The original (adult) version of the PVAQ (McCracken, 1997) is a 16-item self-report questionnaire assessing pain-related attention. Items developed for the original adult measure were intended to assess multidimensional aspects of pain-related attention, including awareness of pain (i.e., perception of pain sensations), vigilance for pain (i.e., keeping careful watch of pain), preoccupation with pain (i.e., a focus on pain and distraction from other things), and observation of pain (i.e., noticing and registering of pain). In the original adult measure, two of the items (8 and 16) are reverse scored before items are summed to create a total score (range = 0–80). Items are rated on a six-point scale, ranging from 0 (never) to 5 (always). For the child version, all items were retained but the language was simplified for 11 of the items. For example, "*I am quick to notice changes in the location or extent of pain*" (item 5) was changed to "*I am quick to notice if pain moves to another place on my body*", and "*I do not dwell on pain*" (item 16 – reverse scored) was changed to "*I do not focus on pain for very long*". Wording simplifications were initially made through iterative rounds of changes by the two authors (LCH and LES), both of whom have extensive experience working with pediatric pain populations and developing self-report measures for children/adolescents. Additional changes were made after iterative rounds of feedback from pediatric psychologists working within the authors' pediatric psychology laboratory. Finally, readability metrics were assessed, indicating that the PVAQ-C is 'very easy to read' (Flesch Reading Ease score = 92.3 (Kincaid, Fishburne, et al., 1975)) and is appropriate for children as young as 10–11 years old (i.e., U.S., Grade 4 reading level, Dale-Chall Readability Formula (Chall and Dale, 1995; Dale and Chall, 1948)).

Fear of Pain Questionnaire for Children – short form (FOPQC-SF).—The FOPQC-SF (Heathcote et al., 2020) is a 10-item measure that assesses children's fears and avoidance behaviors in the context of their pain. Items are rated on a 5-point scale from 'strongly disagree' to 'strongly agree' and can be summed to derive a total fear-avoidance score or to derive subscale scores of Fear and Avoidance. Higher scores indicate higher levels of pain-related fears and avoidance behaviors. The data for this study was aggregated across multiple studies, and the long form version of the FOPQC (Simons et al., 2011) was included in an earlier study before the short form had been developed. Thus, for those who completed the long form, we only included items that were also included in the short form when calculating totals. Cronbach's alpha for the FOPQC short form items in the long and short forms, respectively, were .89 and .84, indicating good internal consistency.

Pain Catastrophizing Scale, child version (PCS-C).—The PCS-C (Crombez et al., 2003) is a 13-item measure assessing children's rumination, magnification, and helplessness regarding pain. Items are rated on a 5-point scale from 'not at all' to 'extremely'. Items are summed to derive a total score, with higher scores indicating more pain catastrophizing. Cronbach's alpha for the PCS-C total score was .93, indicating excellent internal consistency.

Functional Disability Inventory (FDI).—The FDI (Walker and Greene, 1991) is a 15-item self-report measure that assesses children's perceived difficulty in performing common activities due to pain. Items are rated on a 5-point scale from 'no trouble' to 'impossible'. Items are summed to derive a total score, with higher total scores indicating greater disability. Cronbach's alpha for the FDI total score was .91, indicating excellent internal consistency.

Attention Control Scale (ACS).—The ACS (Derryberry and Reed, 2002) is a 20-item self-report measure that assesses general capacities for attention focusing and attention shifting. Items are rated an on 4-point scale from 1 to 4. Items are summed to derive a total score, yielding a total score that can range from 20 to 80 and higher scores indicating better attention control. The ACS has shown concordance with behavioral measures of attention control, for example predicting resistance to interference in Stroop-like spatial conflict tasks and attentional disengagement from threat stimuli (Derryberry and Reed, 2002). Attention control has also been measured with good reliability and validity in children (Muris et al., 2004). Cronbach's alpha for the ACS total score was .83, indicating good internal consistency.

Statistical Analyses

Data was entered into SPSS v22.0 (SPSS Inc, Chicago, IL). Descriptive statistics were conducted to examine underlying assumptions of normality (skew and kurtosis) for all items. Exploratory maximum likelihood factor analyses (EFA) with oblique rotation was conducted to examine underlying factor structure. We chose to perform exploratory rather than confirmatory factor analysis given that the measure was adapted at the item level for this study and thus yielded an essentially new measure that required an exploratory approach in this new population. Internal consistency was examined using Cronbach's alpha. Pearson correlations with the FAM constructs (PCS, FOPQC-SF fear subscale, FOPQC-SF avoidance subscale, and FDI) were used to assess criterion validity; effect sizes were defined as follows: <.3 weak; .3–.5 moderate, >.5 strong (Cohen, 1988). A hierarchical regression analysis was performed to examine the predictive utility of the PVAQ-C on functional disability, controlling for the child's age and sex (Step 1) and pain-related fear-avoidance and catastrophizing (Step 2). An additional series of hierarchical stepwise regression analyses were performed to assess the predictive validity of pain-related attention for FAM constructs over and above the child's general attention control capacities. To this end, demographic factors (child age and sex) were entered into Step 1, followed by ACS total score in Step 2, followed by PVAQ-C total score in Step 3.

Results

Item Properties, Factor Structure, and Internal Consistency of the PVAQ-C

No items violated assumptions of normality (i.e., skew and/or kurtosis >2.0). Participant responses covered the full possible range (0–4) for all items. Preliminary inspection of the item-total correlations indicated that the two reverse scored items (items 8 and 16) did not correlate highly with the other items (corrected item-total correlations < .35). This is in line with a number of previous factor analyses of the adult PVAQ, for which these two items have typically performed poorly and have often been disregarded from final analyses and examination of factor structure. It is also in line with the measure development literature more generally wherein reverse-scored items often do not perform well and are removed or reworded (van Sonderen et al., 2013). Thus, these two items were removed from the current dataset before submitting the remaining 14 items to EFA. Based on an unrestrained EFA, the criteria of eigenvalues >1 resulted in an initial two-factor solution. One of the item loadings exceeded 1.0 for the two-factor solution, suggesting a highly correlated, problematic structure. Thus, the EFA was repeated with a one-factor solution to examine a more parsimonious model. The one-factor model was an excellent fit to the data, explaining 45.9% of the variance and with all factor loadings greater than 0.5. This is in line with other studies in pediatric pain samples which have found that multi-factorial measures developed for adults can show a single-factor structure in child populations (Pielech et al., 2014). Table 1 presents the items and factor loadings for the final 14-item measure. Cronbach's alpha for the total score was .92, indicating excellent internal consistency.

Demographic Factors

There was no significant difference in PVAQ-C scores across child sex ($t(158) = 0.88$, $p = .93$) and no significant association with child age ($r = .08$, $p = .34$).

Criterion Validity

Associations between the PVAQ-C and measures of criterion validity are displayed in Table 2 (all VIFs < 1.5). As expected, the PVAQ-C was significantly positively associated with all FAM constructs, showing moderate-to-strong correlations. Results from a hierarchical regression analysis revealed that the PVAQ-C significantly predicted the child's functional disability ($\beta = .28$, $p = .001$) independently of demographic factors (age and sex), pain-related fear-avoidance, and catastrophizing (full model: $R^2 = .373$, $\Delta R^2 = .05$, $p = .001$).

Specificity of Pain-Related Attention

Results from the second hierarchical regression analyses, controlling for the child's general attention control capacities, are shown in Table 3 (all VIFs < 3.0). Child sex was a significant predictor only of functional disability; child age and sex did not significantly predict other FAM outcomes at Step 1. At Step 2, the child's general attention control abilities were a significant negative predictor of pain catastrophizing and avoidance of activities. General attentional control was not a significant predictor of functional disability at Step 2. Including pain-related attention in Step 3 significantly improved all model parameters. That is, after controlling for demographic factors and general attention control, pain-related attention emerged as a significant predictor of all FAM outcomes. All associations between pain-related attention and FAM outcomes were in the expected direction; greater pain-related attention was associated with more pain-related fear, catastrophizing, avoidance of activities, and functional disability.

Discussion

In this study we developed and performed a preliminary validation of a child version of the Pain Vigilance and Awareness Questionnaire (PVAQ-C). Like the original adult measure, the

PVAQ-C demonstrated excellent internal consistency. In line with findings using the adult measure, the two reverse coded items performed poorly and were thus removed to create a final 14-item measure. Exploratory Factor Analyses of these items revealed that a one-factor structure was the most parsimonious representation of the data. Importantly, the 14-item PVAQ-C showed moderate-to-strong criterion validity. That is, children who reported greater attention to pain also reported greater pain catastrophizing, fear of pain, avoidance of activities, and poorer physical functioning. Pain-related attention remained a significant predictor of the child's physical functioning while controlling for demographic variables (age and sex) and the child's level of catastrophizing, fears, and avoidance behaviors, thus indicating the utility of this newer construct in addition to established pediatric pain measures. In addition, pain-related attention significantly predicted all FAM constructs (catastrophizing, fears, avoidance, and functional disability) independent of the child's general attention control capacities, indicating added value of a pain-specific versus a general measure of attention.

Our findings support the FAM indicating that, like in adults, elevated attention to pain is associated with greater pain catastrophizing, fear-avoidance, and functional disability in youth with chronic pain. Replicating these associations in pediatric samples is important given that executive functioning capacity, including attention control, continues to develop throughout childhood and adolescence; thus, adult findings cannot be directly extended to pediatric populations. Indeed, during adolescence there is prolonged structural maturation of prefrontal cortical areas involved in cognitive and attentional control (Blakemore, 2012; Blakemore and Choudhury, 2006; Gogtay et al., 2004). Concomitantly, there is continued development of attention control capacities throughout adolescence, particularly for the processing of emotional information (Cohen Kadosh et al., 2014). More broadly, findings indicate that dissociations in executive functioning capacities, for example updating working memory, inhibition, and shifting, all of which can influence attentional processes, do not emerge until early adolescence (Xu et al., 2013). Given that there is protracted maturation of attentional capacities during adolescence, and that attention is central to both the pain experience and the ability to shift to non-pain goals, delayed age-typical maturation of attentional capacities may be a risk factor for pain chronicity in adolescence (Field and Lester, 2010). Our findings did not indicate effects of age; however, this should be interpreted with caution as we were likely underpowered to detect age effects, particularly as we used a continuous measure of age. Future studies using the PVAQ-C with larger samples, or with distinct developmental groups (e.g., younger versus older adolescents), will be helpful to determine how development shapes the nature, function, and consequences of pain-related attention in chronic pain. The PVAQ-C could also be used in pain-free or at-risk (e.g., surgical, injury) populations to determine how pain-related attention contributes to risk for pain chronicity across development.

This study contributes to the small but growing literature on pain-related attention in children. While few studies have measured self-reported attention to pain in child samples, likely in part due to the lack of available tools, a small number of studies have employed relevant behavioral tasks. Findings from these studies have been mixed (Brookes et al., 2018; Lau et al., 2018). For example, the visual probe task has been used in community (Beck et al., 2011; Heathcote et al., 2015) and patient samples (Beck et al., 2011; Boyer et al., 2006; Heathcote et al., 2018a; van der Veek et al., 2014) to assess children's attentional capture by and disengagement from pain-related words and facial expressions. Response times to locate or identify a probe appearing behind pain-related versus neutral stimuli are used as a behavioral proxy for attention to pain. Taken together, these studies do not strongly support a direct association between pain-related attention and pain outcomes in children (Brookes et al., 2018; Lau et al., 2018). However, one study using the dot-probe found a moderating role of attention control, showing that adolescents with high pain catastrophizing and low attention control were more likely to show vigilance for pain-related stimuli (Heathcote et al., 2015). Other studies have employed more direct measures of attention using eye-tracking methodology. Here, attention control has also shown a moderating effect, reinforcing the importance of this developmental construct in predicting pain-related attention in youth (Heathcote et al., 2017).

In contrast to these behavioral studies, in this study we found robust and direct associations between pain-related attention and FAM constructs in youth. Although determining moderating effects of attention control was beyond the scope of this initial measure validation study, we also found that pain-related attention was statistically predictive of pain outcomes over and above a measure of general attention control. These differences are likely due in part to overlapping measurement approach (i.e., both pain-related attention and FAM constructs were measured using self-report). One outstanding question is to what extent children's self-reported attention to pain, as measured using the PVAQ-C, correlates with behavioral tasks. Related to this, and also an issue within the wider attentional and cognitive literatures, is to what extent it is possible to reliably self-report on attentional processes. This may be particularly important for more automatic attentional capture by pain (e.g., hypervigilance). It is also particularly important to consider this in youth wherein attentional capacities are undergoing refinement; it thus may be more difficult to distinguish between subcomponents of attention (e.g., attentional capture by pain versus sustained engagement with pain) in youth. This lack of differentiation may in part explain why the PVAQ-C yielded a one-factor structure in this study. Nevertheless, the PVAQ-C will be useful to facilitate studies to help answer these questions, particularly for studies outside of the laboratory that provide more insight into the reliability of self-reported attention and the role of attention in the young person's everyday life.

The PVAQ-C will be most useful if used within a functional-motivational research framework (van Ryckeghem and Crombez, 2018). Indeed, the degree to which one attends to (chronic) pain is likely due in part to the individual's motivation for this pain attending and their beliefs about the usefulness of this attending for pain control. Functional and motivational contexts are equally important in children but may be different to those in adults. One key difference is the role of parents. Parents can powerfully shape their child's motivation for attending to pain by modelling pain-related attention, shaping interpretations of pain-related threat, and reinforcing the child's focus on pain control versus non-pain control goals (Heathcote et al., 2018b; Palermo et al., 2014). Parents with high levels of pain-related distress, worry, or diagnostic uncertainty may unwittingly encourage their child to focus on their pain in order to establish (and thus remove) possible contributors to the pain. On the other hand, parental distress may encourage the child's attentional avoidance of pain in order to regulate that distress. Indeed, Vervoort and colleagues found that children increasingly shifted their attention away from pain-related stimuli in a dot-probe task with increasing levels of parental pain-related rumination and helplessness (Vervoort et al., 2013). In contrast, parents with low levels of pain-related distress or a high degree of pain-related acceptance may also encourage the child to shift their attentional focus away from pain, not to reduce distress but to help the child shift away from pain and onto other life goals (Fisher and Palermo, 2016). These examples exemplify the importance of understanding pain-related attention from a motivational and functional perspective.

This study has limitations, pointing toward future research. First, our sample was relatively homogenous in terms of race and ethnicity. Studies with more diverse samples will help determine whether the current findings generalize across cultural groups. Second, we did not assess other important psychometric properties of the PVAQ-C, including divergent validity, test-retest reliability, or sensitivity to change. The validation of self-report measures is a continual and iterative process and these properties will be important to consider in future studies. Third, all variables were studied using static self-report measures, and thus observed associations may be due in part to shared method variance. It would be interesting to assess whether the PVAQ-C predicts fluctuations in the child's pain-related affect, cognitions, and physical functioning using daily diary or Ecological Momentary Assessment (EMA) approaches. Fourth, while direct adaptation of adult measures to child populations allows comparisons across a broad life span, there is a danger of overlooking domains of attention that are unique to child populations. A new measure of attention to pain developed in a bottom-up manner from qualitative child data and pediatric expert opinion will be useful.

In conclusion, the PVAQ-C shows strong indices of internal reliability and criterion validity and can be used in cross-sectional and experimental studies as a measure of pain-related attention in children with chronic pain. Further examination of its test-retest reliability and sensitivity to change will be important to consider, especially when examining mechanisms of treatment effects. Given the emergent literature from adult studies, it will be important to consider for studied going forward to consider the role of pain-related attention in childhood chronic pain from a functional-motivational perspective.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding Sources:

This study was funded in part by an NIH R01 grant awarded to Dr. Laura Simons (R01HD083270)

References:

Asmundson GJG, Noel M, Petter M, Parkerson HA (2012). Pediatric fear-avoidance model of chronic pain: Foundation, application and future directions. Pain Research and Management 17, 397–405. [PubMed: 23248813]

Attridge N, Crombez G, Van Ryckeghem D, Keogh E, Eccleston C (2015). The Experience of Cognitive Intrusion of Pain: Scale development and validation. Pain 156, 1978–1990. [PubMed: 26067388]

Beck JE, Lipani T. a., Baber KF, Dufton L, Garber J, Smith C. a., Walker LS (2011). Attentional bias to pain and social threat in pediatric patients with functional abdominal pain and pain-free youth before and after performance evaluation. Pain 152, 1061–1067. [PubMed: 21420789]

Blakemore SJ (2012). Imaging brain development: The adolescent brain. NeuroImage 61, 397–406. [PubMed: 22178817]

Blakemore SJ, Choudhury S (2006). Development of the adolescent brain: Implications for executive function and social cognition. Journal of Child Psychology and Psychiatry and Allied Disciplines 47, 296–312.

Boyer MC, Compas BE, Stanger C, Colletti RB, Konik BS, Morrow SB, Thomsen AH (2006). Attentional biases to pain and social threat in children with recurrent abdominal pain. Journal of Pediatric Psychology 31, 209–220. [PubMed: 15843503]

Brookes M, Sharpe L, Kozlowska K (2018). Attentional and Interpretational Biases Toward Pain-Related Stimuli in Children and Adolescents: ASystematic Review of the Evidence. J Pain 19, 1091–1101. [PubMed: 29733993]

Chall JS, Dale E (1995). Readability revisited : the new Dale-Chall readability formula (Cambridge, Mass. : Brookline Books).

Cohen J (1988). Statistical power analysis for the behavioral sciences.

Cohen Kadosh K, Heathcote LC, Lau JYF (2014). Age-related changes in attentional control across adolescence: how does this impact emotion regulation capacities? Frontiers in Psychology 5, 111. [PubMed: 24575077]

Crombez G, Bijttebier P, Eccleston C, Mascagni T, Mertens G, Goubert L, Verstraeten K (2003). The child version of the pain catastrophizing scale (PCS-C): A preliminary validation. Pain 104, 639–646. [PubMed: 12927636]

Crombez G, Van Ryckeghem DML, Eccleston C, Van Damme S (2013). Attentional bias to pain-related information: A meta-analysis. Pain 154, 497–510. [PubMed: 23333054]

Dale E, Chall JS (1948). A Formula for Predicting Readability. Educational Research Bulletin 27, 11–28.

Derryberry D, Reed MA (2002). Anxiety-related attentional biases and their regulation by attentional control. Journal of Abnormal Psychology 111, 225–236. [PubMed: 12003445]

Dick BD, Rashiq S (2007). Disruption of attention and working memory traces in individuals with chronic pain. Anesthesia and Analgesia 104, 1223–1229. [PubMed: 17456678]

Eccleston C, Crombez G (1999). Pain demands attention: a cognitive-affective model of the interruptive function of pain. Psychological Bulletin 125, 356–366. [PubMed: 10349356]

Field AP, Lester KJ (2010). Is there room for “development” in developmental models of information processing biases to threat in children and adolescents? Clin Child Fam Psychol Rev 13, 315–332. [PubMed: 20811944]

Fisher E, Palermo TM (2016). Goal Pursuit in Youth with Chronic Pain. Children (Basel) 3.

Gogtay N, Giedd JN, Lusk L, Hayashi KM, Greenstein D, Vaituzis AC, Nugent TF, Herman DH, Clasen LS, Toga AW, Rapoport JL, Thompson PM (2004). Dynamic mapping of human cortical development during childhood through early adulthood. Proceedings of the National Academy of Sciences 101, 8174–8179.

Heathcote LC, Bhandari RP, Timmers I, Harrison LE, Simons LE (2020). Rapid identification and clinical indices of fear-avoidance in youth with chronic pain: PAIN 161, 565–573. [PubMed: 31688496]

Heathcote LC, Jacobs K, Van Ryckeghem DML, Fisher E, Eccleston C, Fox E, Lau JYF (2018a). Attention bias modification training for adolescents with chronic pain: a randomized placebo-controlled trial. Pain 159, 239–251. [PubMed: 28968342]

Heathcote LC, Lau JYF, Mueller SC, Eccleston C, Fox E, Bosmans M, Vervoort T (2017). Child attention to pain and pain tolerance are dependent upon anxiety and attention control: An eye-tracking study. European Journal of Pain (United Kingdom) 21, 250–263.

Heathcote LC, Timmers I, Kronman CA, Mahmud F, Hernandez JM, Bentley J, Youssef AM, Pine DS, Borsook D, Simons LE (2020). Brain signatures of threat–safety discrimination in adolescent chronic pain: PAIN 161, 630–640. [PubMed: 31764389]

Heathcote LC, Vervoort T, Eccleston C, Fox E, Jacobs K, Van Ryckeghem DML, Lau JYF (2015). The relationship between adolescents' pain catastrophizing and attention bias to pain faces is moderated by attention control. Pain 156, 1334–1341. [PubMed: 25830926]

Heathcote LC, Vervoort T, Noel M (2018b). Caregiving impact upon sufferers' cognitive functioning In Social and Interpersonal Dynamics in Pain : We Don't Suffer Alone, (Springer), pp. 347–376.

Kincaid JP, Fishburne RP, Rogers RL, Chissom BS (1975). Derivation of New Readability Formulas (Automated Readability Index, Fog Count and Flesch Reading Ease Formula) for Navy Enlisted Personnel (Chief of Naval Technical Training: Naval Air Station Memphis).

Kunz M, Capito ES, Horn-Hofmann C, Baum C, Scheel J, Karmann AJ, Priebe JA, Lautenbacher S (2017). Psychometric Properties of the German Version of the Pain Vigilance and Awareness Questionnaire (PVAQ) in Pain-Free Samples and Samples with Acute and Chronic Pain. International Journal of Behavioral Medicine 24, 260–271. [PubMed: 27481106]

Lau JYF, Heathcote LC, Beale S, Gray S, Jacobs K, Wilkinson N, Crombez G (2018). Cognitive Biases in Children and Adolescents With Chronic Pain: A Review of Findings and a Call for Developmental Research. The Journal of Pain 19, 589–598. [PubMed: 29374535]

Leeuw M, Goossens MEJB, Linton SJ, Crombez G, Boersma K, Vlaeyen JWS (2007). The fear-avoidance model of musculoskeletal pain: Current state of scientific evidence. Journal of Behavioral Medicine 30, 77–94. [PubMed: 17180640]

Linton SJ, Shaw WS (2011). Impact of Psychological Factors in the Experience of Pain. Physical Therapy 91, 700–711. [PubMed: 21451097]

McCracken LM (1997). "Attention" to pain in persons with chronic pain: A behavioral approach. Behavior Therapy 28, 271–284.

Muris P, de Jong PJ, Engelen S (2004). Relationships between neuroticism, attentional control, and anxiety disorders symptoms in non-clinical children. Personality and Individual Differences 37, 789–797.

Palermo TM, Valrie CR, Karlson CW (2014). Family and Parent Influences on Pediatric Chronic Pain: A Developmental Perspective. Am Psychol 69, 142–152. [PubMed: 24547800]

Pielech M, Ryan M, Logan D, Kaczynski K, White MT, Simons LE (2014). Pain catastrophizing in children with chronic pain and their parents: Proposed clinical reference points and reexamination of the PCS measure. Pain 155, 2360–2367. [PubMed: 25180013]

Roelofs J, Peters ML, McCracken L, Vlaeyen JWS (2003). The pain vigilance and awareness questionnaire (PVAQ): Further psychometric evaluation in fibromyalgia and other chronic pain syndromes. Pain 101, 299–306. [PubMed: 12583873]

van Ryckeghem D, Crombez G (2018). Pain and attention: Toward a motivational account In Motivational Perspectives on Chronic Pain: Theory, Research, and Practice, (New York, NY, US: Oxford University Press), pp. 211–245.

Van Ryckeghem DM, Van Damme S, Eccleston C, Crombez G (2018). The efficacy of attentional distraction and sensory monitoring in chronic pain patients: A meta-analysis. Clinical Psychology Review 59, 16–29. [PubMed: 29126746]

Schoth DE, Georgallis T, Liossi C (2013). Attentional bias modification in people with chronic pain: a proof of concept study. Cognitive Behaviour Therapy 42, 233–243. [PubMed: 23731349]

Schoth DE, Nunes VD, Liossi C (2012). Attentional bias towards pain-related information in chronic pain; a meta-analysis of visual-probe investigations. Clin Psychol Rev 32, 13–25. [PubMed: 22100743]

Sharpe L, Ianiello M, Dear BF, Nicholson Perry K, Refshauge K, Nicholas MK (2012). Is there a potential role for attention bias modification in pain patients? Results of 2 randomised, controlled trials. Pain 153, 722–731. [PubMed: 22281100]

Simons LE, Kaczynski KJ (2012). The fear avoidance model of chronic pain: Examination for pediatric application. Journal of Pain 13, 827–835. [PubMed: 22832693]

Simons LE, Sieberg CB, Carpino E, Logan D, Berde C (2011). The Fear of Pain Questionnaire (FOPQ): Assessment of pain-related fear among children and adolescents with chronic pain. Journal of Pain 12, 677–686. [PubMed: 21354866]

van Sonderen E, Sanderman R, Coyne JC (2013). Ineffectiveness of Reverse Wording of Questionnaire Items: Let's Learn from Cows in the Rain. PLoS ONE 31, e68967.

Todd J, van Ryckeghem DML, Sharpe L, Crombez G (2018). Attentional bias to pain-related information: a meta-analysis of dot-probe studies. Health Psychology Review.

van der Veek SMC, Derkx BHF, Plak RD, Benninga M. a, Boer F, Lindauer RJL, de Haan E (2014). Attentional Bias to Activity of Different Parts of the Body in Children With Functional Abdominal Pain: An Experimental Study. Journal of Pediatric Psychology 39, 1–12. [PubMed: 24443743]

Vervoort T, Trost Z, Van Ryckeghem DML (2013). Children’s selective attention to pain and avoidance behaviour: The role of child and parental catastrophizing about pain. PAIN® 154, 1979–1988. [PubMed: 23792243]

Vlaeyen JWS, Crombez G, Linton SJ (2016). The fear-avoidance model of pain. Pain 157, 1588–1589. [PubMed: 27428892]

Vlaeyen JWS, Linton SJ (2000). Fear-avoidance and its consequences in chronic musculoskeletal pain: A state of the art. Pain 85, 317–332. [PubMed: 10781906]

Walker LS, Greene JW (1991). The functional disability inventory: measuring a neglected dimension of child health status. Journal of Pediatric Psychology 16, 39–58. [PubMed: 1826329]

Wiech K (2016). Deconstructing the sensation of pain: The influence of cognitive processes on pain perception. Science 354, 584–587. [PubMed: 27811269]

Xu F, Han Y, Sabbagh MA, Wang T, Ren X, Li C (2013). Developmental differences in the structure of executive function in middle childhood and adolescence. PloS One.

Significance Statement:

Pain-related attention is proposed as a key factor influencing fear-avoidance outcomes in both adults and youth with chronic pain, yet no self-report measures of pain-related attention have been validated for children. This paper presents a child version of the Pain Vigilance and Awareness Questionnaire (PVAQ-C), which indicates strong internal consistency, criterion validity, and unique predictive validity, and provides evidence to support the Fear-Avoidance Model in youth with chronic pain.

Table 1.

PVAQ-C item factor loadings obtained by exploratory factor analysis (14 items; forced one-factor structure)

Items	Factor Loadings
I pay close attention to pain	.819
I am quick to notice when pain goes up or down	.782
I am aware of quick changes in pain	.750
I am more aware of pain than other people	.736
I am quick to notice if pain moves to another place on my body	.701
I keep track of my pain level	.689
I know right away when pain starts or gets worse	.676
I know right away when pain levels go down	.656
When I do something that makes pain worse, the first thing I do is check to see how much worse it got	.643
I notice pain even if I am busy with another activity	.639
I become distracted by pain	.628
I focus on feelings of pain	.617
I am quick to notice effects of medicines on pain	.542
I am very sensitive to pain	.536

Removed items = '*I find it easy to ignore pain*' and '*I do not focus on pain for very long*' (both reverse-scored).

Table 2.

Criterion validity – Pearson correlations of the PVAQ-C with FAM constructs

	PVAQ-C total	*Mean*	*SD*	*Range*	*N*
PVAQ-C total		38.63	14.82	2–69	160
Criterion validity					
Pain Catastrophizing (PCS)	.532 ***	21.52	11.34	0–48	159
Fear of Pain (FOPQC-SF-fear)	.467 ***	6.81	3.85	0–16	160
Avoidance of activities (FOPQC-SF-avoidance)	.439 ***	12.48	5.68	0–24	160
Functional Disability (FDI)	.448 ***	20.98	11.04	0–45	160

*** $p \leq .001$.

Table 3.

Hierarchical regressions for PVAQ-C as a predictor of FAM constructs, controlling for demographics and general attentional control

	Catastrophizing[a]	**ΔR²**	**Fear**[a]	**ΔR²**	**Avoidance**[a]	**ΔR²**	**Disability**[a]	**ΔR²**
Step 1		.061 *		.001		.000		.068 *
Age	.128		.029		.012		.128	
Gender	.287 †		−.005		.004		.204 *	
Step 2		.067 **		.034		.051 *		.020
Age	.133		.032		.015		.130	
Gender	.132		−.044		−.044		.174	
General attention control	−.256 **		−.188 †		−.230 *		−.144	
Step 3		.346 ***		.273 ***		.298 ***		.289 ***
Age	.056		−.032		−.052		.064	
Gender	.147 †		−.030		.029		.189 *	
Gender attention control	−.170 *		−.104		−.143		−.059	
Pain-specific attention	.601 ***		.533 ***		.556 ***		.546 ***	

[a] Each FAM construct entered in separate model

Notes: Standardized regression coefficients (β) are reported,

† p <.06,

* *p*<.05,

** *p*<.01,

*** *p*<.001.