

The Experience of Cognitive Intrusion of Pain: scale development and validation

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Abstract

Patients with chronic pain often report their cognition to be impaired by pain, and this observation has been supported by numerous studies measuring the effects of pain on cognitive task performance. Furthermore, cognitive intrusion by pain has been identified as one of 3 components of pain anxiety, alongside general distress and fear of pain. Although cognitive intrusion is a critical characteristic of pain, no specific measure designed to capture its effects exists. In 3 studies, we describe the initial development and validation of a new measure of pain interruption: the Experience of Cognitive Intrusion of Pain (ECIP) scale. In study 1, the ECIP scale was administered to a general population sample to assess its structure and construct validity. In study 2, the factor structure of the ECIP scale was confirmed in a large general population sample experiencing no pain, acute pain, or chronic pain. In study 3, we examined the predictive value of the ECIP scale in pain-related disability in fibromyalgia patients. The ECIP scale scores followed a normal distribution with good variance in a general population sample. The scale had high internal reliability and a clear 1-component structure. It differentiated between chronic pain and control groups, and it was a significant predictor of pain-related disability over and above pain intensity. Repairing attentional interruption from pain may become a novel target for pain management interventions, both pharmacologic and nonpharmacologic.

Keywords: Attentional disruption, Cognitive intrusion, Anxiety, Rumination

1. Introduction

Patients with chronic pain report their cognition impaired by pain,^{3,6,28} an observation supported by studies of the effects of pain on task performance.^{4,9,12–14,16,21,24,30,35,37,59,60,61} Patients also report anxiety about pain and its consequences, anxiety that is often cognitively intrusive. Studies that have examined the factor structure underlying pain anxiety have identified 3 core components: general distress, fear of pain from injury/insult, and cognitive intrusion by pain.^{36,38} Although our understanding of general distress and fear of pain is well developed, much less is known about cognitive intrusion.

Cognitive intrusion may be an important determinant of pain-related distress and disability. In a sample of older adults with chronic low back pain, disruption to cognitive performance was found to mediate the relationship between pain and reduced physical functioning.⁶³ Pain interrupts by capturing attention, and directing it away from current concerns onto a new priority of threat detection and selection for action, typically characterised by attempts at avoidance or escape. Interruption involves costs to the performance of previously focal tasks and is thought to be

aversive. Increased attention to pain, or cues for pain, may increase rumination, catastrophizing, and fear of pain, contributing to distress and disability.^{29,61} This possibility was highlighted by Mounce et al.,³⁸ who drew a comparison between the 3 components of anxiety and the fear avoidance model, pointing out that each component may serve as a vulnerability factor for the development of chronic pain.

Although cognitive intrusion is a critical characteristic of pain, no specific measure designed to capture its effects exists. We describe the initial development and validation of a new measure of pain interruption: the Experience of Cognitive Intrusion of Pain (ECIP) scale. As the intrusion of pain into consciousness is thought to occur in sequential steps,²² these were used to inform the content of the scale. First, attention is reorientated away from its current engagement onto pain. This stage is responsible for the “attention-grabbing” function of pain, which serves to highlight a potentially harmful event. Second, the pain becomes a focus for rumination on threat. Finally, if pain and/or its threat value are not extinguished, pain will be difficult to disengage from.^{56,57}

In study 1, the ECIP scale was administered to a general population sample to assess its structure and construct validity. Although the scale items were based on a 3-stage model of attentional disruption, the stages are interdependent (eg, one cannot ruminate on pain before it has interrupted attention), and we therefore expected to find 1 component (hypothesis 1). We also expected ECIP scale scores to demonstrate construct validity through correlations with scores on other pain-related cognition scales (hypothesis 2). In study 2, the factor structure of the ECIP scale was confirmed in a large general population sample. In study 3, the ECIP scale and measures of pain-related disability were administered to fibromyalgia (FM) patients and matched controls. We

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predicted that the ECIP scale would differentiate between the FM and control groups (CGs) (hypothesis 3) and have unique predictive value for pain-related disability in the FM group (hypothesis 4).

2. Study 1: development of the Experience of Cognitive Intrusion of Pain scale

2.1. Method

2.1.1. Participant characteristics

Participants were 200 adults (150 female) aged 18 to 69 years (mean = 28.08, SD = 12.73) recruited on the Internet. In particular, the study link was posted on various Web sites that advertise online studies, such as “Psychological Research on the Net” (<http://psych.hanover.edu/research/exponnet.html>), on the University of Bath’s online notice board, and on the psychology department’s research participation scheme for first-year undergraduates. We aimed to be as inclusive as possible: our only inclusion criterion was that participants were aged 18 or over.

Participants were from 18 different countries, with 99 being from the United Kingdom, 66 from the United States, 10 from Singapore, and fewer than 5 each from the 15 other countries. The majority of participants reported their ethnicity as white (N = 156), with the remainder reporting Asian (N = 16), black (N = 5), mixed (N = 8), or other (N = 15) backgrounds. English was the native language for 165 participants, with the remainder of participants reporting a wide variety of languages. Because insufficient knowledge of the English language may potentially affect the results, we also performed the analyses with only the native English speakers included. The results remained essentially the same as those reported for the full sample.

Participants were asked to report the level of pain they were currently experiencing on a numerical rating scale from 0 (no pain at all) to 10 (pain could not be worse). Ratings ranged from 0 to 8 (mean = 2.44, SD = 2.31, median = 2.00) and were positively skewed (Fig. 1). Eighty-two participants (41%) reported being in pain at the time of the study (including acute pain [8%], such as migraine, and chronic pain [33%], such as FM), 32 (16%) also reported a second pain condition, and 12 (6%) reported having a third condition. Participants rated their own health as poor (N = 3), average (N = 17), good (N = 51), very good (N = 84), or excellent (N = 45).

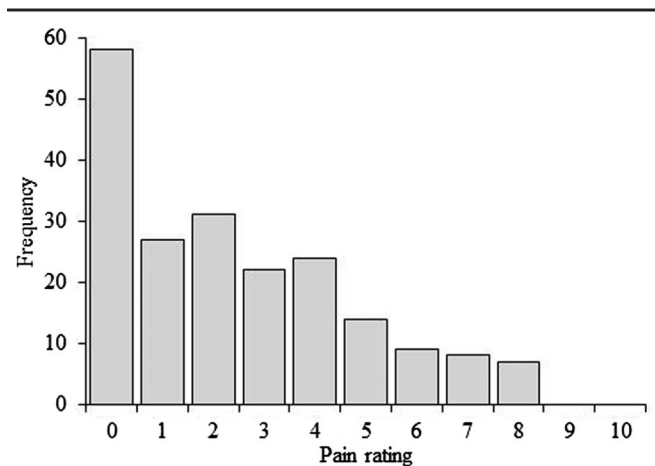


Figure 1. Distribution of pain ratings in the general population sample recruited for study 1.

2.1.2. Measures

2.1.2.1. Demographic data

Participants answered various biographical questions including their sex, age, native language, location, and overall health. They also reported the level of current pain they were experiencing on a numerical rating scale from 0 (no pain at all) to 10 (pain could not be worse), and they reported any current pain conditions they were suffering.

2.1.2.2. Experience of Cognitive Intrusion of Pain scale

The new 10-item ECIP scale was conceptually constructed to measure the extent to which people experience pain interrupting their thinking. Items were designed in a top-down theory-driven manner based on the expert opinion from 2 senior authors and guided by 3 principles: (1) the items should be clear and easy to understand; (2) they should be based on the theorised effects of pain on cognition (initial interruption, the dominance of pain in mind when it has interrupted, and the ability or difficulty to control/disengage from attention to pain); and (3) there should be no content overlap with separate but related theoretical constructs (eg, catastrophizing, distress). It should be noted that several existing scales do assess some elements of cognitive intrusion, although the ECIP scale is the first designed specifically to do so. For example, the Pain Vigilance and Awareness Questionnaire (PVAQ) measures attention towards the physical sensations of pain (eg, “I am quick to notice changes in pain intensity”), but it has only a few items dedicated to cognitive symptoms (eg, “I notice pain even if I am busy with another activity”). Similarly, the Pain Anxiety Symptoms Scale (PASS) contains some items related to cognitive symptoms of pain (eg, “I can’t think straight when I am in pain”), but this is not the focus of the scale. The Pain Catastrophizing Scale (PCS) also taps into cognitive intrusion (eg, “I can’t seem to keep it out of my mind”), but again it has a much broader focus. The ECIP scale was created to assess the phenomenology of cognitive intrusion when experiencing pain. As such, we did not intend to identify possible antecedents of these intrusions or the cognitive processes underlying these intrusions.

Ten items were developed based on the 3 aforementioned construct markers: interruption by pain (3 items, eg, “Pain interrupts my thinking”), rumination on pain (4 items, eg, “Pain goes around and around in my head”), and control by pain (3 items, eg, “I can’t push pain out of my thoughts”). Instructions read: “We are interested in pain and thinking. Please tell us how far the following statements describe your experience when you are in pain. How applicable are they to you?” These instructions were designed to be simple and nonleading and to convey that the statements refer to experiences during episodes of actual pain, not thoughts of pain in general. Participants indicated the extent to which each of the 10 statements applied to themselves on a 7-point Likert scale ranging from 0 (not at all applicable) to 6 (highly applicable). Scores were summed to create total scores ranging from 0 to 60.

2.1.2.3. Pain Catastrophizing Scale

The PCS^{50,51} consists of 13 items that describe thoughts and feelings that individuals may have while in pain. Participants indicated the extent to which they experience each thought or feeling when they are in pain on a 5-point scale, ranging from 0 (not at all) to 4 (all the time). The scale provides a total score and scores on 3 subscales: rumination (eg, “I can’t seem to keep it out

of my mind”), magnification (eg, “I wonder whether something serious may happen”), and helplessness (eg, “It’s awful and I feel that it overwhelms me”).⁵⁵ This scale has shown good reliability and validity.⁵⁵ In this study, Cronbach’s alpha was 0.94 for the total score, 0.93 for the rumination subscale, 0.72 for the magnification subscale, and 0.91 for the helplessness subscale.

2.1.2.4. Pain Vigilance and Awareness Questionnaire

The PVAQ³³ contains 16 items that measure attention towards and vigilance for pain sensations (eg, “I notice pain even if I am busy with another activity”). Participants rate the extent to which each statement is true of themselves when in pain on a 6-point scale from 0 (never) to 5 (always). Total scores range from 0 to 80. The PVAQ has been shown to be valid and reliable in both healthy populations and chronic pain patients.^{45,46} Cronbach’s alpha of the PVAQ in this study was 0.88.

2.1.2.5. Pain Anxiety Symptoms Scale 20

The 20-item PASS-20³⁴ measures pain-related fear and anxiety on 4 subscales: fear (eg, “When I feel pain, I am afraid that something terrible will happen”), cognitive (eg, “I can’t think straight when I am in pain”), escape/avoidance (eg, “I avoid important activities when I hurt”), and physiological (eg, “When I sense pain I feel dizzy or faint”). Participants rate how often they engage in each thought or activity on a 0 (never) to 5 (always) scale. The PASS has been found to be reliable.^{1,44} Cronbach’s alpha values of the fear, cognitive, escape/avoidance, and physiological subscales were 0.86, 0.92, 0.83, and 0.86 in this study, respectively, and 0.95 for the total score.

2.1.2.6. Depression, Anxiety, and Stress Scale

The Depression, Anxiety, and Stress Scale (DASS-21)³² is a 21-item measure of negative emotions with 3 subscales: depression (eg, “I couldn’t seem to experience any positive feeling at all”), anxiety (eg, “I experienced trembling”), and stress (eg, “I found myself getting agitated”). Participants rate the extent to which each feeling applied to them in the past week on a 4-point scale from 0 (never) to 3 (almost always). The DASS-21 is reliable in clinical and community samples.² In this study, the Cronbach’s alpha values for each subscale were 0.88, 0.85, and 0.88 for depression, anxiety and stress, respectively.

2.1.2.7. Short Form 36 Health Survey

The Short Form 36 Health Survey (SF-36)⁶² is a standardised 36-item questionnaire used to assess 8 aspects of health: (1) limitations in physical activities because of health problems, (2) limitations in social activities because of physical or emotional problems, (3) limitations in usual role activities because of physical health problems, (4) bodily pain, (5) general mental health (psychological distress and well-being), (6) limitations in usual role activities because of emotional problems, (7) vitality (energy and fatigue), and (8) general health perceptions. The measure is valid and reliable.⁸ In this study, the scale had a Cronbach’s alpha of 0.80.

2.1.3. Procedure

The study was approved by the University of Bath Department of Health and Department of Psychology ethics committees. Participants were directed to the Web page from advertisements in various online locations (see “Participants” section). After opening the Web page and giving informed consent, participants

completed demographics questions and 6 scales in a set order (ECIP, PCS, PVAQ, PASS-20, DASS-21, and SF-36) using Bristol Online Surveys. During this online assessment, each scale was presented on a separate screen, and participants were not able to revisit previous screens. It was necessary to answer all questions before progressing on to the next screen, but participants were free to withdraw from the study at any time. The questionnaires took 10 to 20 minutes to complete, and participants were debriefed and provided with the contact details of the researchers at the end.

2.1.4. Analysis

To determine the structure of the ECIP scale, the 10 items were entered into an exploratory factor analysis and an internal reliability analysis. To assess the construct validity of the scale, scores were entered into a correlation analysis with scores on the PCS, PVAQ, PASS-20, DASS-21, and SF-36.

2.2. Results

2.2.1. Prevalence of pain

Having a current pain condition was more prevalent in females (45.3%) than in males (28%), $\chi^2 = 4.66$, $df = 1$, $P = 0.031$. Sex differences in current pain intensity across the whole sample were investigated with a Mann–Whitney U test (given the nonnormal distribution of pain scores). This revealed higher current pain scores in females (mean = 2.61, SD = 2.32, median = 2.00) than in males (mean = 1.90, SD = 2.24, median = 1.00), $U(200) = 3004$, $z = 2.14$, $P = 0.032$. There was also a small positive correlation between current pain ratings and age, $r_s(200) = 0.20$, $P = 0.004$.

2.2.2. Exploratory factor analysis

To examine the structure of the ECIP scale, we used an exploratory factor analysis and extracted components with an eigenvalue greater than 1. Ten ECIP scale items were entered into the principal component analysis. The first component had an eigenvalue of 7.50, the second 0.65, and the third 0.47. Based on the eigenvalues and the scree plot, it was decided that a 1-component solution was most appropriate. All 10 items loaded highly onto the first component, with loadings ranging from 0.68 to 0.92, suggesting that all items reflect a unitary cognitive intrusion concept. **Table 1** displays the loadings for each item onto the first factor. Based on this analysis, all 10 items were retained. The final scale had a Cronbach’s alpha of 0.96.

Table 1
Factor loadings for the Experience of Cognitive Intrusion of Pain items in study 1.

Item	Loading
Pain interrupts my thinking (I)	0.68
I can’t stop thinking about pain (C)	0.90
Pain goes around and around in my head (R)	0.86
It is hard to think about anything else but pain (C)	0.92
I can’t push pain out of my thoughts (C)	0.89
Pain dominates my thinking (R)	0.92
Pain easily captures my thinking (I)	0.83
I keep thinking about pain (R)	0.90
When my mind wanders it goes to pain (R)	0.74
Pain intrudes on my thoughts (I)	0.84

Construct marker labels are given in parentheses (C, control; I, interruption; R, rumination).

2.2.3. Descriptive statistics

Scores on the ECIP scale had a range of 0 to 60 (representing the full possible range) with a mean of 26.55 (SD = 15.61) and a median of 26. The data were normally distributed although somewhat flat (skewness = 0.149, kurtosis = -0.841; **Fig. 2**). The ECIP scores of females were significantly higher (mean = 28.44, SD = 15.29) than those of males (mean = 20.88, SD = 15.33), $t(198) = 3.03$, $P = 0.003$, $d = 0.49$, 95% confidence interval [CI] = 0.17-0.82). Scores were not significantly correlated with age, $r(200) = 0.134$, $P = 0.059$ and did not differ depending on ethnicity, $F(1,193) < 1$. Scores were significantly higher in participants who reported that they were in pain at the time of the study (mean = 30.12, SD = 14.41) than those who did not (mean = 24.07, SD = 15.99), $t(198) = 2.74$, $P = 0.007$.

2.2.4. Predictive value of Experience of Cognitive Intrusion of Pain in pain- and health-related distress

Next, we examined the construct validity of the ECIP scale. **Table 2** displays the correlations between ECIP scale scores and scores on the PCS, PVAQ, PASS-20, DASS-21, and SF-36 in the participants who did and did not report a pain condition. The ECIP scale scores were significantly correlated with current pain intensity in the pain group ($r = 0.22$), with PCS total and subscale scores in both groups ($r_s = 0.52$ -0.72), with PVAQ total and attention to pain scores in both groups ($r_s = 0.32$ -0.66), with PVAQ changes in pain scores in the pain group ($r = 0.35$), with PASS total and subscale scores in both groups ($r_s = 0.35$ -0.65), with DASS total and subscale scores in the no pain group ($r_s = 0.18$ -0.31), with SF-36 emotional well-being in the no pain group ($r = 0.20$), with SF-36 pain in the pain group ($r = -0.28$), and with SF-36 general health in the no pain group ($r = -0.29$). The overlap between cognitive intrusion from pain and other pain- and distress-related cognitions indicates concurrent validity in the ECIP scale, but the ECIP scale does not seem to be redundant—it was not multicollinear with any of the other scales used.⁵²

2.3. Study 1 discussion

The 10 ECIP scale items loaded highly onto 1 component (hypothesis 1). Therefore, all 10 items were retained. Scores on the scale were normally distributed and moderately correlated with measures of other pain-related cognitions (hypothesis 2).

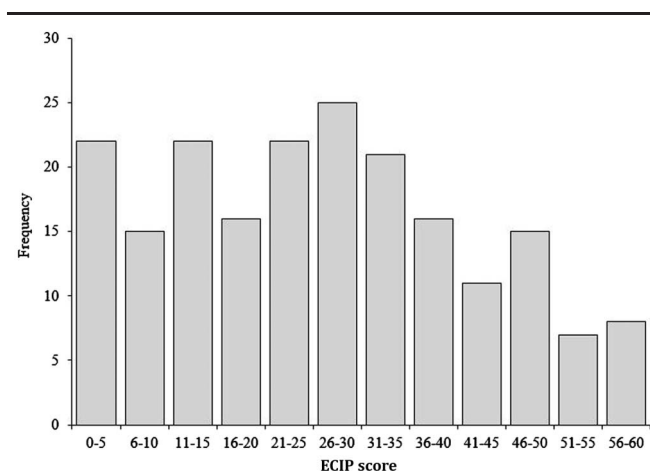


Figure 2. Distribution of Experience of Cognitive Intrusion of Pain scores in the general population sample in study 1.

The experience of cognitive intrusion from pain seems to vary widely in the general population, and it was not correlated with age but was higher in females than in males. Current pain was also higher in females than in males and was positively correlated with age.

Overall, the results of study 1 indicate that the 10-item ECIP scale has adequate psychometric properties and construct validity. Next, we aimed to confirm the factor structure in a larger online study with a general population sample.

3. Study 2: confirmation of Experience of Cognitive Intrusion of Pain factor structure in a large general population sample

3.1. Method

3.1.1. Participants

The study was run on the Internet using Inquisit Web 4.0²⁰ for study presentation and data recording. A total of 1500 participants were recruited through Amazon Mechanical Turk (MTurk; www.MTurk.com). MTurk is an open online marketplace for recruiting individuals to complete a variety of tasks for a small fee and can be used to obtain high-quality reliable research data quickly and inexpensively.^{10,39} Participants recruited through MTurk were given a link to the study pages and paid \$1 for their participation through the system's in-built rewards mechanism. An additional 199 participants were recruited through pain- and psychology-related forums, Web sites, and discussion groups that hosted a link to the study. Participants recruited outside of MTurk did not receive \$1 for their participation but were informed that they could sign up for an MTurk account if they wished to receive \$1. The inclusion criteria were that participants had to be aged 18 or older and with access to an Internet-enabled laptop or desktop computer.

Of the 1699 entries recorded, 20 participants were identified as having 2 submissions each. In these cases, only the first submission was included, and the 20 duplicate submissions were excluded. This left 1679 unique data submissions. Of these 1679 submissions, 15 were from individuals who did not give consent to take part and did not progress past the information and consent page. A further 1 participant reported his/her age as 17 and was excluded. Participants were also excluded if they indicated that they only wanted to browse the Web pages rather than seriously participate ($N = 18$), if they did not report whether or not they were currently in pain ($N = 8$), if they did not provide enough information to determine the duration of their pain ($N = 76$), or if they did not complete all ECIP items ($N = 24$). Removal of these cases resulted in a sample of 1537.

Of these 1537 participants, 1536 reported their age (mean = 34.23, SD = 11.22), 1537 reported their sex (750 female, 776 male, 4 intersex, 4 male-to-female male, 3 female-to-male male), 1534 reported their gender (753 selected woman, 779 selected man, and 2 selected trans*), 1537 reported their first language (1347 English, 63 Hindi, 8 Spanish, 6 Chinese, and 5 Bengali, with 13 participants indicating 10 other first languages and 95 participants selecting "other"), 1537 reported their country (1302 selected the United States, 196 selected India, 10 selected the United Kingdom, and 29 selected a range of other countries), 1537 reported their ethnicity (1057 were white, 274 were Asian, 96 were black, 64 were mixed, and 45 reported other or unknown), and finally, 1536 reported their highest qualification (680 had an undergraduate degree, 447 had finished high school, 198 had a masters degree, 176 had A-level/advanced placement/baccalaureate qualifications, 26 had a doctorate, 8 had completed some high school, and 1 had no qualifications).

Table 2

Correlations between measures administered in study 1.

	ECIP		Current pain intensity	PCS total		PCS rumination		PCS magnification		PCS helplessness		PVAQ total		PVAQ attention to pain	
	No pain	Pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain
Current pain intensity	—	0.22*													
PCS total	0.70†	0.69†	0.26*												
PCS rumination	0.72†	0.72†	0.20	0.94†	0.93†										
PCS magnification	0.52†	0.61†	0.27*	0.83†	0.84†	0.68†	0.73†								
PCS helplessness	0.65†	0.58†	0.25*	0.96†	0.95†	0.85†	0.80†	0.70†	0.71†						
PVAQ total	0.32†	0.60†	0.27*	0.34†	0.55†	0.34†	0.58†	0.36†	0.49†	0.27†	0.46†				
PVAQ attention to pain	0.42†	0.66†	0.22	0.46†	0.64†	0.46†	0.65†	0.39†	0.57†	0.38†	0.56†	0.92†	0.90†		
PVAQ changes in pain	0.10	0.35†	0.26	0.10	0.27*	0.10	0.32†	0.23*	0.25*	0.05	0.20	0.85†	0.84†	0.57†	0.52†
PASS total	0.54†	0.54†	0.13	0.57†	0.74†	0.57†	0.67†	0.50†	0.69†	0.58†	0.68†	0.69†	0.60†	0.77*	0.74†
PASS cognitive	0.65†	0.61†	0.11	0.64†	0.75†	0.64†	0.70†	0.48†	0.66†	0.61†	0.69†	0.60†	0.61†	0.72†	0.71†
PASS avoidance	0.47†	0.35†	0.07	0.50†	0.47†	0.50†	0.43†	0.38†	0.38†	0.46†	0.45†	0.68†	0.51†	0.73†	0.59†
PASS fear	0.41†	0.42†	0.17	0.47†	0.71†	0.47†	0.62†	0.52†	0.72†	0.55†	0.57†	0.55†	0.42†	0.62†	0.57†
PASS anxiety	0.37†	0.40†	0.10	0.37†	0.52†	0.41†	0.49†	0.40†	0.53†	0.56†	0.58†	0.63†	0.44†	0.70†	0.58†
DASS total	0.30†	0.24*	0.20	0.30†	0.45†	0.32†	0.37†	0.41†	0.53†	0.43†	0.39†	0.36†	0.23*	0.41†	0.39†
DASS depression	0.29†	0.14	0.18	0.29†	0.40†	0.30†	0.30†	0.39†	0.49†	0.39†	0.31†	0.31†	0.19	0.36†	0.31†
DASS anxiety	0.31†	0.20	0.06	0.31†	0.33†	0.29†	0.31†	0.36†	0.41†	0.43†	0.34†	0.40†	0.18	0.43†	0.34†
DASS stress	0.18*	0.30*	0.29†	0.18†	0.46†	0.26†	0.40†	0.35†	0.52†	0.35†	0.40†	0.28†	0.25*	0.30†	0.40†
SF-36 physical functioning	-0.10	-0.16	-0.21	-0.10	-0.21	-0.09	-0.10	-0.14	-0.21	-0.14	-0.24*	-0.06	-0.24*	-0.11	-0.24*
SF-36 physical role limitations	0.05	-0.33	-0.27*	0.05	0.38†	-0.05	-0.29†	-0.03	-0.40†	0.02	-0.32†	-0.09	-0.34†	-0.13	-0.32†
SF-36 emotional role limitations	-0.02	-0.18	-0.16	-0.02	-0.40†	-0.03	-0.33†	-0.14	-0.38†	-0.08	-0.41†	-0.08	-0.29*	-0.11	-0.41†
SF-36 energy and fatigue	0.04	0.07	0.11	0.04	0.02	0.07	-0.01	0.02	0.05	0.03	-0.08	0.08	-0.05	0.01	-0.08
SF-36 emotional well-being	0.20*	0.21	0.07	0.20*	0.35†	0.22*	0.35†	0.30†	0.30	0.23*	0.33†	0.30†	0.23*	0.26†	0.33†
SF-36 social functioning	-0.01	-0.21	-0.19	-0.01	-0.20	-0.09	-0.17	-0.09	-0.22	-0.03	-0.21	-0.07	-0.13	-0.06	-0.21
SF-36 pain	-0.16	-0.28*	-0.36†	-0.16	-0.30†	-0.11	-0.30†	-0.10	-0.26*	-0.19*	-0.25*	-0.26†	-0.28†	-0.36†	-0.14
SF-36 general health	-0.29†	-0.04	-0.19	-0.29†	-0.32†	-0.27†	-0.22*	-0.25†	-0.34*	-0.31†	-0.32†	-0.17	-0.07	-0.26†	-0.10
PVAQ changes in pain	PASS total		PASS cognitive		PASS avoidance		PASS fear		PASS anxiety		DASS total		DASS depression		
No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain
0.39†	0.25*														
0.30†	0.31†	0.90†	0.90†												
0.44†	0.27*	0.87†	0.78†	0.73†	0.62†										
0.30†	0.11	0.90†	0.39†	0.74†	0.69†	0.68†	0.39†								
0.36†	0.14	0.91†	0.58†	0.73†	0.65†	0.72†	0.58†	0.83†	0.64†						
0.21*	-0.03	0.54†	0.37†	0.45†	0.43†	0.46†	0.37†	0.56†	0.60†	0.47†	0.55†				
0.16	-0.02	0.47†	0.32†	0.40†	0.42†	0.41†	0.32†	0.49†	0.55†	0.40†	0.40†	0.90†	0.91†		
0.25†	-0.07	0.57†	0.32†	0.45†	0.30†	0.50†	0.32†	0.58†	0.47†	0.51†	0.55†	0.87†	0.85†	0.65†	0.62†

(continued on next page)

Table 2 (continued)

PVAQ changes in pain		PASS total		PASS cognitive		PASS avoidance		PASS fear		PASS anxiety		DASS total		DASS depression			
No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain		
0.17	-0.01	0.41†	0.36†	0.37†	0.43†	0.34†	0.36†	0.42†	0.57†	0.36†	0.53†	0.91†	0.92†	0.72†	0.77†		
0.03	-0.16	-0.16	-0.18	-0.10	-0.17	-0.19*	-0.18	-0.17	-0.17	-0.13	-0.02	-0.135	-0.27*	-0.14	-0.33†		
-0.01	-0.28*	-0.06	-0.27*	-0.02	-0.37†	-0.19*	-0.27*	-0.03	0.28*	0.01	-0.26*	-0.20*	-0.38†	-0.23*	-0.42†		
-0.01	-0.06	-0.06	-0.41†	-0.08	-0.41†	-0.04	-0.41†	-0.09	-0.47†	-0.002	-0.49†	-0.40†	-0.62†	-0.49†	-0.64†		
0.16	-0.01	0.04	-0.16	0.06	-0.20	0.01	-0.16	-0.01	0.06	0.08	0.08	0.03	0.02	-0.05	-0.09		
0.26†	0.04	0.25†	0.22*	0.24†	-0.28†	0.22*	0.22*	0.25†	0.42†	0.20*	0.37†	0.39†	0.42†	0.42†	0.36†		
-0.07	0.004	-0.04	-0.17	0.05	-0.20	-0.12	-0.17	-0.04	-0.25*	-0.02	-0.28*	-0.16	-0.29†	-0.18*	-0.36†		
-0.06	-0.38*	-0.33	-0.15	-0.26†	-0.17	-0.35†	-0.06	-0.29†	-0.15	-0.29†	-0.12	-0.33†	-0.11	-0.34†	-0.08		
0.01	-0.01	-0.38	-0.25*	-0.38†	-0.25*	-0.32†	-0.18	-0.37†	-0.27*	-0.29†	-0.11	-0.29†	-0.33	-0.32†	-0.37†		
DASS anxiety		DASS stress		SF-36 physical functioning		SF-36 physical role limitations		SF-36 emotional role limitations		SF-36 energy and fatigue		SF-36 emotional well-being		SF-36 social functioning		SF-36 pain	
No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain
0.71†	0.70†																
-0.15	-0.11	-0.07	-0.27*														
-0.12	-0.21	-0.17	-0.37†	0.28†	0.46†												
-0.18	-0.41†	-0.37†	-0.59†	-0.03	0.27*	0.21*	0.37†										
-0.01	0.02	0.15	0.15	-0.09	0.04	-0.02	-0.08	0.03	0.05								
0.30†	0.38†	0.31†	0.40†	-0.2*	0.01	-0.22*	-0.09	-0.27†	-0.35†	0.41†	0.15						
-0.10	-0.12	-0.14	-0.27*	-0.03	0.30†	0.14	0.32†	0.23*	0.46†	-0.04	0.06	-0.18*	-0.17				
-0.35†	-0.07	-0.18*	-0.15	0.10	0.23*	0.17	0.34*	0.25†	0.13	-0.01	-0.06	-0.16	-0.13	-0.11	0.04		
-0.23*	-0.20	-0.20*	-0.30†	0.10	0.43†	0.17	0.27*	0.22*	0.23*	0.18	0.11	0.125	-0.11	-0.16	0.29†	0.36	0.21

* $P < 0.05$.
 † $P < 0.01$.

3.1.2. Measures

In addition to the ECIP scale, participants completed the measures listed below, followed by an additional cognitive task that is not reported here.

3.1.2.1. Demographics

Participants were asked to provide demographic information including age, sex, gender, native language, country of residence, ethnicity, and level of education.

3.1.2.2. Pain experiences

To ascertain current pain status, participants were asked to indicate whether or not they were currently in any pain and the intensity of this pain on a scale of 0 (no pain at all) to 10 (pain could not be worse). Participants were asked to indicate the type(s) of pain they were experiencing by selecting any applicable items from a list or entering any other conditions in a free text box. Participants who reported pain were also asked to report the duration of their current pain using a free text box. Duration responses were coded into 2 categories: less than 3 months and 3 months or longer.

3.1.3. Procedure

The study was approved by the University of Bath Department of Health and Department of Psychology ethics committees. Participants were directed to the Web page from MTurk or advertisements in various online locations (see “Participants” section). After opening the Web page and giving informed consent, participants completed the demographics questions, the pain-related questions, the ECIP scale, and a subsequent cognitive task that was performed for the purpose of another study and is not described here. Each section was presented on a separate screen, and participants were not able to revisit previous screens. All questions were optional except for reporting the current presence or absence of pain. The study took 10 to 15 minutes to complete, and participants were debriefed and provided with the contact details of the researchers at the end.

3.1.4. Analysis

We ran a series of confirmatory factor analyses examining the 1-factor structure found in study 1, separately in the pain-free participants ($N = 961$), the participants with acute pain (duration <3 months, $N = 288$), and the participants with chronic pain (duration >3 months, $N = 288$). We used maximum likelihood analyses and examined various measures of goodness-of-fit. Although χ^2 is typically reported as an indicator of differences in fit between the hypothesised model and the data, it is often significant because of large sample sizes. We therefore took a goodness-of-fit index and a comparative fit index of over 0.90 as an indicator of acceptable fit, as well as a root mean square error of approximation value of 0.08 or below.⁴⁸

We also entered ECIP scores into a 2 (sex: males, females) \times 3 (pain group: no pain, acute pain, chronic pain) analysis of variance.

3.2. Results

Scores on the ECIP scale ranged from 0 to 60 (again representing the full possible range) with a mean of 23.94 ($SD = 14.60$) and a median of 23. The data were normally distributed (skewness = 0.270, kurtosis = -0.789). The ECIP scores were significantly

higher in females (mean = 24.94, $SD = 14.40$) than in males ([mean = 23.01, $SD = 14.74$], $t(1600) = 2.65$, $P = 0.008$, although the effect size was small, $d = 0.13$, 95% CI = 0.03–0.23).

The results of the confirmatory factor analyses are presented in **Table 3**. The 1-factor solution provided an adequate fit to the data for all 3 groups. All goodness-of-fit index and CFI values were above 0.90, and all root mean square error of approximation values were below 0.11.

Next, we examined the effects of sex and pain group on ECIP scores. A 2 \times 3 analysis of variance showed no main effect of pain group, $F(2,1520) = 1.42$, $P = 0.243$, a marginally significant effect of sex, $F(1,1520) = 3.70$, $P = 0.054$, where females (mean = 24.73, $SD = 18.47$) scored slightly higher than males (mean = 23.03, $SD = 16.02$), and no interaction, $F(2,1520) = 1.48$, $P = 0.229$.

3.3. Study 2 discussion

The exploratory factor analysis in study 1 suggested that the ECIP scale items fall on to 1 factor, and this structure was adequately confirmed in study 2 with a confirmatory factor analysis. Both analyses suggest that the experience of cognitive intrusion, as measured by the ECIP scale, is a unitary construct. This is consistent with previous research, which showed that cognitive intrusion, fear of pain, and general distress were each unitary components of pain-related anxiety.^{36,38} In study 3, we investigated the ECIP scale in a clinically diagnosed chronic pain sample and a comparison group. To further underpin the construct validity of the ECIP scale, we additionally looked at the relationship between cognitive intrusion and trait anxiety, life satisfaction, and emotion regulation. Furthermore, we aimed to investigate group differences in ECIP scale scores and the unique predictive value of the ECIP scale in pain-related disability.

4. Study 3: Experience of Cognitive Intrusion of Pain in fibromyalgia patients and healthy controls

4.1. Method

4.1.1. Participant characteristics

Participants were 49 FM patients (41 females) aged 23 to 61 (mean = 45.2, $SD = 9.35$) and 49 CG participants (40 females) aged 22 to 65 (mean = 45.39, $SD = 12.07$). A majority of the participants were married or cohabiting (FM: 67.3%; CG: 42.9%) and almost half of the participants had graduated from high school or university (FM: 38.8%; CG: 53.1%). In the FM patients, the mean pain duration was 186.36 months ($SD = 115.14$) and the mean Pain Disability Index (PDI) score was 41.80 ($SD = 10.39$). Patients with FM and healthy controls did not differ in terms of age ($t(96) < 1$, ns), sex ratio ($\chi^2(1) = 0.07$, ns), or education level ($\chi^2(3) = 3.97$, ns). All but 1 participant (in the healthy group) reported their nationality as Belgian, with the other participant being Spanish.

Table 3
Results of the confirmatory factor analysis in the no pain, acute pain, and chronic pain groups in study 2.

	χ^2	df	GFI	AGFI	CFI	RMSEA
Pain free	432.70*	35	0.906	0.852	0.961	0.109
Acute pain	134.10*	35	0.919	0.873	0.966	0.099
Chronic pain	152.76*	35	0.903	0.848	0.959	0.108

Bold values exceeded the desired cutoff point.

* $P < 0.001$.

4.1.2. Measures

As in study 1, participants completed the ECIP scale and the PCS,⁵⁵ as well as the following additional measures. All measures were presented in Dutch. The ECIP scale was translated and back translated to confirm accuracy.

4.1.2.1. Pain experience

All participants were asked to report the current level of pain they were experiencing on a numerical rating scale from 0 (no pain at all) to 6 (worst pain imaginable), as well as average, least, and worst pain over the previous week. Participants also rated their current extent of pain-related disability.

4.1.2.2. Body Vigilance Scale

The Body Vigilance Scale (BVS)⁴⁷ consists of 4 questions and measures participants' sensitivity to their internal bodily sensations, for example, "I am the kind of person who pays close attention to internal bodily sensations." The last item is an average of the awareness scores of 15 nonspecific body symptoms, for example, "Rate how much attention you pay to each of the following sensations": "dizziness," "heart palpitations," "nausea" (0 = none, 10 = extreme). Scores on the BVS can vary between 0 and 40. In this study, Cronbach's alpha of the 18 BVS items was 0.94.

4.1.2.3. Depression, Anxiety and Stress Scale

The DASS¹⁸ is a 42-item questionnaire that measures the presence of negative emotions with 3 subscales: depression (eg, "I felt that I had nothing to look forward to"), anxiety (eg, "I felt I was close to panic"), and stress (eg, "I found myself getting upset rather easily"). Participants rate the extent to which each feeling applied to them in the past week on a 4-point scale from 0 (never) to 3 (almost always). Scores for the DASS can vary between 0 and 42 for each subscale. The DASS has good reliability in clinical and community samples.² In this study, Cronbach's alpha values of the DASS-subscale were 0.96, 0.91, and 0.95 for the depression, anxiety, and stress subscale, respectively.

4.1.2.4. Pain Disability Index

The FM patients, but not the controls, completed the PDI,⁴² which measures the extent to which pain disables the participant from completing tasks in 7 areas of life, such as self-care and social activities, each on a Likert scale of 0 (no disability) to 10 (total disability). Scores range from 0 to 70. The reliability and validity of the PDI have been well established.⁵³ In this study, Cronbach's alpha of the PDI was 0.82.

4.1.2.5. State and Trait Anxiety Inventory-Trait scale

Participants completed the State and Trait Anxiety Inventory-Trait (STAI-T),⁵⁸ which consists of 20 items each rated on a 4-point Likert scale. The STAI-T subscale measures the disposition toward anxiety as a personality trait, which is defined as the relatively stable individual difference in anxiety proneness. Scores for STAI-T can vary between 20 and 80. This questionnaire has demonstrated adequate psychometric properties.⁵ In this study, Cronbach's alpha of the STAI-T was 0.94.

4.1.2.6. Satisfaction with Life Scale

The Satisfaction with Life Scale (SWLS)^{19,31} is a 5-item measure of global life satisfaction (eg, "In most ways my life is

close to ideal"). Agreement with each item is rated on a 1-7 scale. Scores for SWLS can vary between 0 and 35, and the scale is valid and reliable.⁴⁰ In this study, Cronbach's alpha of the SWLS was 0.89.

4.1.2.7. Emotion Regulation Questionnaire

The Emotion Regulation Questionnaire (ERQ)^{26,41} consists of 10 items across 2 dimensions, 6 to measure emotional reappraisal (eg, "I control my emotions by changing the way I think about the situation I'm in") and 4 to measure emotional suppression (eg, "I keep my emotions to myself"). Items are rated on a 1-7 scale. Scores for ERQ can vary between 10 and 70, and the scale has adequate psychometric properties.²⁶ In this study, Cronbach's alpha of the ERQ reappraisal scale was 0.72 and of the ERQ suppression scale was 0.76.

4.1.3. Procedure

The study design was approved by the Ethics Committee of the Ghent University Hospital. After ethical committee approval, participants were recruited into a larger study on emotional regulation and pain (the Ghent Attention and Self-regulation in Fibromyalgia study, ASEF-I; for a complete protocol, see <http://hdl.handle.net/1854/LU-5686902>) in Ghent, Belgium, for which they received monetary compensation. The data reported here consist of questionnaire data (ie, ECIP scale and several related questionnaires) collected in the context of the ASEF-I study. FM patients were recruited through the Multidisciplinary Pain Clinic of the Ghent University Hospital. Inclusion criteria for the ASEF-I study were (1) being aged between 18 and 65 years, (2) having sufficient knowledge of the Dutch language, (3) a diagnosis of FM according to the criteria of Wolfe et al.,⁶⁴ and (4) the absence of neurologic conditions. Individuals were also excluded when they were pregnant, unable to use their fingers, or when their eyesight was not normal or corrected-to-normal (eg, by spectacles). These criteria were selected for the purposes of other aspects of the ASEF-I study, such as investigating attentional processes in pain with electrocutaneous stimuli, which are not relevant here.

Although 61 patients were initially screened and recruited, 12 withdrew because of health problems, familial problems, or a lack of time, leaving a sample of 49 participants with FM. A comparison group matched for age, sex, and SES (at the group level) was invited to participate through a participant pool that had been recruited through advertisements in a local newspaper, flyers, and the university Web site. Inclusion and exclusion criteria were the same as those for the chronic pain group, except that participants who reported a current pain problem were also excluded. A total of 82 individuals were invited to participate, and 58 participants who met the criteria and agreed to participate were subsequently recruited into the study. However, 9 participants withdrew because of familial issues or a lack of time, leaving a comparison group of 49 individuals who reported no current pain problem.

Participants completed the questionnaires at home (demographics, PCS, BVS, PDI, DASS, STAI, SWLS, ERQ, and ECIP), either online (via LimeSurvey 2.0; n = 95) or on paper (n = 3) if online assessment was not possible. Each questionnaire was presented on a separate screen and all questions were compulsory. The questionnaires took approximately 45 minutes to complete. After finishing the full ASEF-I study, participants were debriefed.

4.1.4. Analysis

First, we compared the prevalence of pain in each group. Second, ECIP scale scores in the FM and matched CGs were compared with an independent samples *t* test. Pain and ECIP scores were not compared between sexes because of the small number of males in each group (this is typical of FM samples). Third, to assess the relationships between the ECIP scale and other pain-related scales, scores were first entered into a correlation analysis with pain intensity, current disability due to pain, and the measures of pain-related distress, separately for each group. Finally, we ran a hierarchical regression model to predict PDI scores in the FM group from average pain intensity over the previous week in block 1 and scores on the ECIP scale in block 2, to determine whether ECIP scores predicted additional unique variance in disability.

4.2. Results

4.2.1. Prevalence of pain

The FM group reported significantly more current pain (mean = 3.59, SD = 1.00) than the CG (mean = 0.45, SD = 0.89), $t(96) = 16.44$, $P < 0.001$ and significantly more pain over the past week, on average (FM: mean = 3.69, SD = 1.00, control: mean = 0.80, SD = 1.02), $t(96) = 14.17$, $P < 0.001$.

4.2.2. Cognitive intrusion in the chronic pain and control groups

The FM group scored significantly higher on the ECIP scale (mean = 19.33, SD = 13.51) than the CG (mean = 7.45, SD = 11.86), $t(96) = 4.63$, $P < 0.001$, $d = 0.93$, 95% CI = 0.51–1.35, **Fig. 3**). Nevertheless, there was a wide range of scores in both groups: in the FM group, scores ranged from 1 to 60, and in the CG, scores ranged from 0 to 53. The scale had very high internal reliability in both groups, with a Cronbach's alpha of 0.96 in the FM group and 0.97 in the CG.

4.2.3. Predictive value of Experience of Cognitive Intrusion of Pain scale in disability and distress

We examined the correlations between ECIP scale scores and pain intensity (current and previous week), current disability due to pain rating, PDI scores, PCS scores, DASS scores, BVS scores, STAI-T scores, SWLS scores, and ERQ scores (**Table 4**) in each group, with the exception of the disability scores because these measures were only administered to the FM group. Several observations are of note: first, ECIP scale scores were significantly positively correlated with ratings of current disability due to pain, $r(49) = 0.44$, $P = 0.002$ and with total scores on the PDI, $r(49) = 0.44$, $P < 0.001$. Second, ECIP scale scores were highly positively correlated with the tendency to catastrophize when in pain in the FM, $r(49) = 0.78$, $P < 0.001$, and CGs, $r(49) = 0.73$, $P < 0.001$. Third, higher ECIP scale scores were associated with higher depression, $r(49) = 0.63$, $P < 0.001$, anxiety, $r(49) = 0.57$, $P < 0.001$, and stress scores, $r(49) = 0.39$, $P = 0.006$, higher trait anxiety scores, $r(49) = 0.60$, $P < 0.001$, and lower satisfaction with life scores, $r(49) = -0.35$, $P = 0.013$, in the FM group only. Finally, in both groups, higher ECIP scale scores were related to higher scores on the suppression subscale of the ERQ, but they were not related to scores on the reappraisal subscale.

To formally examine the difference between groups in correlations between ECIP scale scores and measures of life quality, we compared the magnitudes of the correlations for each

measure between groups using Fisher's *r*-to-*z* transformation. The correlation between ECIP scale and DASS-depression scores was significantly larger in the FM group than the CG, $z = 3.20$, $P < 0.001$. This was also the case for DASS-anxiety scores, $z = 2.69$, $P = 0.007$, and marginally so for DASS-stress scores, $z = 1.86$, $P = 0.063$. However, the correlation between ECIP scale scores and satisfaction with life did not differ between groups, $z = 1.23$, $P = 0.219$ and neither did the correlation between ECIP scale scores and trait anxiety, $z = 1.35$, $P = 0.177$.

Next, to determine whether ECIP scores predicted variance in pain disability over and above pain intensity, we ran a hierarchical regression model predicting PDI scores in the FM group from pain intensity over the past week in block 1 and ECIP scale scores in block 2. Block 1 was significant, $R^2 = 0.32$, $F(1,47) = 22.29$, $P < 0.001$, pain intensity $\beta = 0.57$ and block 2 explained significant additional variance, $\Delta R^2 = 0.08$, $F(1,46) = 6.07$, $P = 0.018$, pain intensity $\beta = 0.48$, ECIP $\beta = 0.29$.

4.3. Study 3 discussion

The ECIP scale successfully differentiated between the FM and CGs with a large effect size, $d = 0.93$, in support of hypothesis 3. Those with chronic pain experienced more cognitive intrusion than controls, despite there being wide variation within each group. The scale also demonstrated high internal reliability in both groups. The ECIP scale scores were related to measures of pain-related disability and distress in the FM group (hypothesis 4). The ECIP scale even predicted unique variance in disability over and above pain intensity in the past week. The ECIP scale scores were related to satisfaction with life, trait anxiety and depression, anxiety, and stress scores in the pain group. Overall, the results of study 3 suggest that the ECIP scale can successfully differentiate between chronic pain and CGs, and that it provides unique predictive value of disability in chronic pain patients.

5. General discussion

The ECIP scale was conceptually constructed to measure the interference component of pain-related cognition. Ten items were developed based on a 3-stage model of cognitive intrusion, where pain interrupts thoughts, becomes the subject of thinking/thought, and becomes difficult to disengage from.^{56,57} Although the items were guided by this model, the scale was intended to measure the experience of cognitive intrusion, not the processes leading to it. The ECIP scale was evaluated in 3 studies. First, we examined the structure in a general population sample and confirmed that all items loaded on a single "cognitive intrusion" component. Scores on the ECIP scale were moderately correlated with scores on the PCS (highly correlated with the rumination subscale, $r = 0.72$), PVAQ, PASS, DASS, and subsections of the SF-36 Health Scale, indicating construct validity but not redundancy. In a second study, we used confirmatory factor analysis on a large sample of participants who reported no pain, acute pain, or chronic pain. The 1-factor solution found in study 1 fit the data for all 3 groups. In study 3, we administered the ECIP scale to FM patients and matched controls. The ECIP scores were significantly higher in the FM group than the CG and were related to current pain intensity and pain disability in the FM group. The ECIP scale scores predicted pain disability over and above pain intensity in the past week.

Our data indicated 1 component to the ECIP scale. This is unsurprising given that cognitive intrusion has emerged as a single component in previous investigations of pain-related cognition.^{36,38} This is not to say that cognitive intrusion stems

Table 4

Correlations between measures administered in study 3.

	ECIP		Current pain intensity		Average pain previous week		PDI		Current disability		PCS total		PCS rumination		PCS magnification	
	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain
Current pain intensity	0.25	0.41†														
Average pain previous week	0.21	0.30*	0.81†	0.68†												
PDI	—	0.44†	—	0.54†	—	0.57†										
Current disability	—	0.44†	—	0.79†	—	0.70†	—	0.60†								
PCS total	0.73†	0.78†	0.37†	0.45†	0.34*	0.43†	—	0.35*	—	0.42†						
PCS rumination	0.68†	0.72†	0.21	0.42†	0.19	0.43†	—	0.36*	—	0.38†	0.91†	0.90†				
PCS magnification	0.60†	0.66†	0.45†	0.39†	0.40†	0.29*	—	0.22	—	0.33*	0.88†	0.85†	0.67†	0.71†		
PCS helplessness	0.71†	0.72†	0.41†	0.41†	0.38†	0.41†	—	0.33*	—	0.41†	0.96†	0.94†	0.80†	0.74†	0.84†	0.69†
DASS anxiety	0.08	0.57†	0.13	0.50†	0.17	0.45†	—	0.44†	—	0.47†	0.35*	0.59†	0.29*	0.45†	0.33*	0.64†
DASS stress	0.02	0.39†	0.34*	0.32*	0.33*	0.25	—	0.25	—	0.34*	0.31*	0.56†	0.26	0.42†	0.27	0.56†
DASS depression	0.08	0.63†	0.18	0.47†	0.18	0.44†	—	0.45†	—	0.57†	0.39†	0.66†	0.42†	0.56†	0.26	0.56†
BVS	0.12	0.40†	-0.03	0.15	0.07	0.14	—	0.27	—	0.21	0.27	0.40†	0.26	0.28	0.20	0.37†
STAI-T	0.39†	0.60†	0.37†	0.31*	0.32*	0.21	—	0.17	—	0.27	0.55†	0.68†	0.54†	0.60†	0.43	0.63†
SWLS	-0.11	-0.35*	-0.19	-0.45†	-0.16	-0.40†	—	-0.35*	—	-0.52†	-0.24	-0.44†	-0.30*	-0.46†	-0.11	-0.30*
ERQ reappraisal	0.06	0.08	0.14	-0.08	0.21	-0.15	—	0.18	—	-0.17	0.09	0.02	0.06	0.07	0.05	-0.08
ERQ suppression	0.37†	0.47†	-0.18	0.33*	-0.24	0.25	—	0.09	—	0.32	0.18	0.42†	0.27	0.32*	-0.01	0.38†
PCS helplessness	DASS depression		DASS anxiety		DASS stress		BVS		STAI-T		SWLS		ERQ reappraisal			
No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	No pain	Pain	
0.35*	0.54†															
0.32*	0.53†	0.65†	0.66†													
0.37†	0.63†	0.86†	0.55†	0.71†	0.59†											
0.28	0.41†	0.17	0.55†	0.07	0.50†	0.10	0.34*									
0.52†	0.62†	0.13†	0.55†	0.61†	0.59†	0.70†	0.71†	0.25	0.30*							
-0.22	-0.41†	-0.36*	-0.17	-0.32*	-0.25	-0.50†	-0.60†	-0.22	-0.01	-0.64†	-0.47†					
0.13	0.04	0.10	-0.01	0.12	-0.10	0.13	0.02	0.18	0.30*	-0.05	-0.06	-0.10	0.11			
0.17	0.41†	-0.17	0.36*	-0.23	0.26	-0.10	0.36*	-0.10	0.00	-0.12	0.48†	0.03	-0.19	0.12	-0.06	

* $P < 0.05$.† $P < 0.01$.

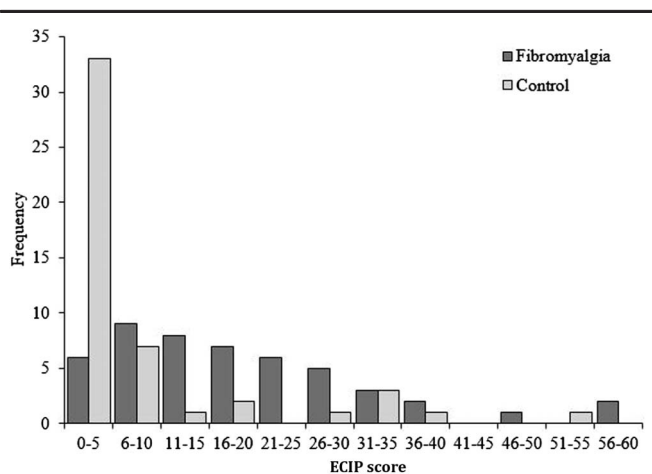


Figure 3. Distribution of Experience of Cognitive Intrusion of Pain scores in the fibromyalgia and control groups in study 3.

from a single process, but the experience of it seems to be unitary. Although the items were chosen based on 3 stages of cognitive intrusion, the stages were hypothesised to be interdependent and highly related. Indeed, they do not seem to be mathematically separable, but it may be useful to differentiate between them conceptually. For example, interventions to remedy cognitive intrusion might focus on the rumination and dominance elements, if the interruption element was found to be unavoidable.

DASS depression and anxiety scores were correlated with ECIP scale scores in the FM group but not in the CG. This could be due to a smaller range of DASS scores in the CG (depression: 0-25 vs 1-41 in the FM group, anxiety: 0-13 vs 0-40 in the FM group) or because cognitive intrusion contributes to negative affect in pain patients. The DASS measures negative feelings over the previous week, and the same correlation pattern with ECIP scale scores was not true for the long-term satisfaction with life or trait anxiety measures, suggesting that cognitive intrusion may contribute to short-term experiences of depression and anxiety in chronic pain patients.

The ECIP scale scores were moderately correlated with pain-related disability, and they predicted unique variance in disability over and above pain intensity. However, it is of course impossible to test for causation in the relationship between ECIP and disability using our current data set because the design was cross sectional. Nevertheless, cognitive intrusion may play an important theoretical role in pain cognition that is not well captured by other measures (as discussed in the method, the PCS, PVAQ, and PASS do touch on cognitive intrusion but their focus is elsewhere). For example, we might hypothesise that intrusion of pain into cognition allows for rumination and catastrophizing, which in turn feed into a fear of pain and promote avoidance and disability.^{15,17,43,49,51} These data cannot support such a suggestion, but if cognitive intrusion were established as a determinant of pain disability, then it may be a good target for intervention.

Scores on the ECIP scale and the PCS were highly correlated, but we do not believe this to be a limitation to the ECIP scale. The PCS does not reflect catastrophizing as it is conceived of in other areas of psychology,²⁷ and it has been subject to criticism,^{23,54} although this is largely ignored. We suggest that the overlap is due to impurity in the way the PCS measures catastrophizing, as opposed to the ECIP scale measuring catastrophizing.

FM patients had significantly higher scores on the ECIP scale than controls, and scores were correlated with pain intensity. This raises an interesting issue: does more pain lead to higher susceptibility to intrusion, or does higher susceptibility to intrusion lead to worse pain experiences, or perhaps the relationship is bidirectional as the cognitive-perceptual model of somatic interpretation would suggest.¹¹ The cognitive-perceptual model suggests that the relationship between biological state and symptom perception is influenced by psychosocial factors, including attention towards internal sensations and attribution of causes and consequences of symptoms. We do not mean to imply that chronic pain is caused by susceptibility to cognitive intrusion; but perhaps once pain occurs, individual differences in the extent to which that pain dominates attention are related to experiences of the pain. Selective attention to internal bodily sensations has been identified as a significant predictor of symptom perception,²⁵ and cognitive intrusion of pain may contribute in a similar fashion to pain symptom perception. In the bottom-up direction, more regular and/or high-intensity pain experiences may lead to more cognitive intrusion, and there may be an interactive relationship between top-down and bottom-up factors. However, it should be noted that there was no difference in ECIP scores between the pain and no pain groups in study 2. This may be due to the pain group in study 2 being nonclinical. Further research is needed to confirm the discriminative validity of the ECIP scale.

Our findings raise the question of the role of inhibition/control in pain cognition. The ECIP scale scores were related to the suppression subscale of the ERQ but not the reappraisal subscale. The suppression scale measures the extent to which participants refrain from expressing their emotions, which may reflect a need for control over one's emotions. Participants who scored higher on suppression also reported more cognitive intrusion. It may be the case that cognitive intrusion from pain is difficult to inhibit, and participants who tend to suppress their emotions have worse subjective experiences of cognitive intrusion because of the difficulty in ignoring it. This is of course speculative and should be examined empirically.

There are several limitations to our studies. Although a substantial proportion of participants in studies 1 and 2 reported a current pain condition (41% and 35%, respectively), they were community-based samples and not clinic-based samples. Future research should confirm the 1-factor structure of the ECIP scale in a large clinically diagnosed pain sample. Another limitation is the sex ratios of our samples. In studies 1 and 3, the number of females outweighed the number of males (3:1 and 4:1, respectively), limiting our capacity for sex comparisons (this is typical for FM samples). In study 2, we had a well-balanced female (750) to male (776) ratio, which also showed higher ECIP scores in females than in males, but there was a high prevalence of intersex and transgender participants compared with the population. Overall, the sex distributions of our samples may limit the generalisability of our findings.

A limitation of self-report scales is that they cannot discriminate between the processes and results of cognition. Here, we were interested in participants' experiences of cognitive intrusion from pain, not the processes leading to it. Finally, our data do not inform us on the relationship between participants' experiences of cognitive intrusion from pain and the extent to which their task performance is affected by pain. This is an important question for future research. Participants who score high on the ECIP scale may also show the largest effects of pain on task performance, or the relationship may be more complex. For example, individual differences in coping strategies may mean that some individuals

with high ECIP scores are able to counteract this effect and maintain their task performance.

A focus on the interruption of attention by pain highlights its motivational function in displacing current concerns with a new priority, in promoting interpretation, escape, and avoidance, and in its ability to fuel and maintain worry.¹⁵ Extending this account to the removal of pain in analgesia promotes the intriguing idea of novel outcome targets for pain management interventions, both pharmacologic and nonpharmacologic.⁷ Pain management can be targeted at reducing the frequency, intensity, or affective experience of interruption, at the character, content, and valence of the rumination or on the rigidity of the attentional focus on pain.²³

In sum, we have developed a novel measure specific to the experience of cognitive intrusion from pain. The scale is available in English (<http://www.bath.ac.uk/pain/assessment-tools/>) and Dutch (<http://www.ghplab.ugent.be/EN/assessment-and-research-tools>). Scores followed a normal distribution with good variance in general population samples. The scale had high internal reliability and a 1-component structure. It differentiated between chronic pain and CGs and was a significant predictor of pain-related disability.

Conflict of interest statement

The authors declare no conflicts of interest.

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