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The Concept of Pain Inventory for Adults (COPI-Adult): Assessing knowledge and beliefs regarding pain science education

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Abstract: (250 words, structured)

Objectives: Assessing knowledge and beliefs regarding pain science can identify gaps and misconceptions. The Concept of Pain Inventory (COPI) was recently developed in children with the intent to guide targeted pain science education. We utilized the original COPI item pool to (1) develop a tool to assess an adult's concept of pain in a cohort who had not received pain science education, (2) evaluate its psychometric properties, (3) examine distribution of scores in a cohort of adults who had received pain science education, and (4) examine associations between scores and clinical variables.

Methods: A total cohort of 627 adults were recruited via social media for an online survey. Initial development was conducted on those who had not received prior pain science education (n=125), then the COPI-Adult tool was tested in those who had received prior pain science education (n=502).

Results: The resulting unidimensional 13-item COPI-Adult had acceptable internal consistency (α=0.78) and good test-retest reliability at 1 week (ICC(3,1)=0.84 (95%CI 0.71 to 0.91). Higher COPI-Adult scores reflect greater alignment with contemporary pain science. COPI-Adult scores were correlated with revised Neurophysiology of Pain Questionnaire (rNPQ) scores and inversely correlated with average and current pain intensity, and pain interference. Adults who reported having received pain science education had significantly higher mean COPI-Adult scores than those who had not, and this difference exceeded the smallest detectable change.

Discussion: The COPI-Adult is a brief questionnaire with promising psychometric properties to identify conceptual gaps or misconceptions to inform individualized pain science education.

Keywords: Concept of pain, questionnaire, pain science education, scale development

1. Introduction

Pain science education refers to learning about the underlying biopsychosocial mechanisms of pain [1] and is considered foundational when educating adults about pain treatment strategies [2]. For example, a person engaging in pain science education may reconceptualise pain from 'tissue damage' to a marker of the perceived need to protect body tissue [3, 4]. The evidence for pain science education varies for different stages of pain and outcomes; for example, intensive pain education did not improve pain outcomes for individuals with high risk acute back pain [5], whereas pain science education for individuals with persistent pain appears to be more promising [5-9]. One recent systematic review found that pain science education reduces health care seeking in adults with chronic musculoskeletal pain [10], and another found moderate evidence that the addition of pain science education to usual physiotherapy treatment in patients with chronic low back pain improves disability in the short term [11].

The revised Neurophysiology of Pain Questionnaire (rNPQ) [12] has been used to assess knowledge of pain science before and/or after education in both research [13, 14] and clinical practice [15]. This questionnaire evaluates knowledge about pain neurophysiology, for example, 'Descending neurons are always inhibitory'. However, conceptual change theory that underpins pain science education [3] emphasizes the value of assessing both beliefs and knowledge [16]. Thus, a tool to assess both beliefs and knowledge about pain science in adults would be of benefit. To the authors' knowledge, no such tool currently exists. A further limitation of the rNPQ is the binary response option, therefore the degree to which a respondent endorses an item is unknown. A tool to assess an individual's concept of pain with non-binary response options could provide greater guidance on the efficacy of pain science education in creating conceptual change, and may also help to explain the varied findings from trials investigating pain science education [17]. Recently, a tool entitled the

Concept of Pain Inventory (COPI) was developed and validated in a cohort of school-aged children seeking care for pain, to assess both beliefs and knowledge of pain science [18].

The intent of the current study was to utilize the original COPI item pool to develop an assessment tool for an adult's concept of pain, which is an experience-dependent construct and therefore individual in its nature [19]. In addition, the current lack of assessment tool in adults means there is also currently no way to evaluate the effectiveness of pain science education in causing conceptual changes in adults [20]. Therefore, the aims of this study were to (1) develop a tool to assess an adult's concept of pain in a cohort who had not received pain science education, (2) evaluate its psychometric properties, (3) examine distribution of scores in a cohort of adults who had received pain science education, and (4) examine associations between scores on the tool and demographic and clinical variables.

Because higher scores on the Concept of Pain Inventory for Adults (COPI-Adult) are designed to reflect knowledge and beliefs more closely aligned with contemporary pain science, we hypothesized that respondents who had previously received pain science education would have higher COPI-Adult scores than those who haven't. Because of the knowledge component within an adult's concept of pain, we hypothesized that higher COPI-Adult scores would be correlated with higher levels of education.

2. Materials and Methods

This online survey study was approved by the University of Technology Sydney Human Research Ethics Committee (REF: ETH20-C0008).

The recently validated 14-item Concept of Pain Inventory (COPI) in school-aged children was developed from a larger item pool of 21 items that were rigorously generated and evaluated [21]. Since these items were developed with expert and patient input for children, they were expected to be potentially transferable to the adult population. Given the differences in knowledge and beliefs about pain science between adults and children, this larger item pool was used to identify which items loaded onto construct(s) in adults. The following steps were implemented to refine and test the COPI-Adult items.

2.1. COPI-Adult: Development

2.1.1. Participants and procedures

Adults aged ≥ 18 years accessing the survey information online via social media were potentially eligible to participate. Adults were excluded if they reported cognitive impairment and reported being unable to read and communicate in English sufficiently to complete the online survey.

Survey data were collected and managed using Qualtrics electronic data capture tools [22] hosted at University of Technology Sydney. Study enrollment occurred from April 2020 to August 2020. Potential participants who initially expressed interest by clicking on the invitation link, but did not complete the questionnaire, were sent reminder emails on 3 occasions. Informed consent was provided by participants at the start of the online survey. One week after completing the baseline survey, participants who opted in to a follow-up survey were emailed the survey link for that. Up to three reminder emails were sent to participants who did not complete the 1-week follow-up survey within 3 days of that invitation.

2.1.2. Survey

The baseline survey contained questions to collect demographic information (eg. age, sex, education status etc.) and clinical questions about the presence of pain, pain location and duration, the COPI item pool, and the questionnaires listed below. The follow-up survey only contained the COPI item pool.

COPI item pool. Twenty-one concept of pain items were thoroughly developed inductively and deductively using expert and patient input in previous research [18], and this is the item pool used in the present paper. Each item is rated on a 5-point (0-4) Likert scale ranging from 0 = ‘Strongly disagree’ to 4 = ‘Strongly agree’, with 2 = ‘Unsure’. A total score is calculated, where higher scores reflect knowledge and beliefs more closely aligned with contemporary pain science.

Other measures. In participants reporting pain, pain intensity and interference were assessed using the Brief Pain Inventory (BPI), which has been demonstrated to have good internal consistency (α >0.80) [23]. The instrument consists of 4 items concerning pain intensity and 7 items concerning pain interference during the past week. Each item is rated on an 11-point Likert scale ranging from 0 = ‘does not interfere’ to 10 = ‘completely inteferes’. An average interference score is calculated, where higher scores indicate greater interference.

Pain science knowledge was assessed with the revised Neurophysiology of Pain Questionnaire (rNPQ). The rNPQ is a 12-item questionnaire with ‘true’, ‘false’, or ‘unsure’ responses to statements, where correct answers score 1 point and incorrect or unsure responses score 0. The total score of correct answers is summed whereby a score of 12 indicates all answers were correct. The rNPQ has been validated in patients with chronic spinal pain and has good test-retest reliability [12].

Pain science education status. To determine which participants had received prior pain science education, participants were provided the following explanation during the survey: “Pain science education could include any information about what pain is, how pain is produced and what things may affect pain. If you have received pain science education from any of the below sources, please tick each box that applies to you.” Participants could select an option (eg. Doctor, Physiotherapist, Psychologist, Website, University etc. or “I don’t believe I have received pain science education”) or enter text in an open-ended “Other” box, to self-report whether they had received prior pain science education.

2.1.3. Statistical analysis

The recruitment procedure was expected to disproportionately reach a convenience sample of adults who had received prior pain science education via the first author's social media network. Therefore, initial development and evaluation was *a priori* planned to be conducted with the group who had not received prior pain science education, to ensure that the tool is broadly appropriate. The tool was then tested in those who had received prior pain science education (Aim 3), where higher scores and less variability in responses was expected with possible ceiling effects.

Sample size. A minimum target sample size of 105 respondents (who had not received prior pain science education) was established based on the principle of 5-10 individuals per inventory item [24] and the 21-item pool. Descriptive statistics were used to examine underlying assumptions of normality for all variables of interest. Data were analyzed using SPSS v25.0.0.1[25].

2.2. COPI-Adult: Evaluation of psychometric properties

We evaluated the COPI-Adult measurement properties according to the COSMIN guidelines [26].

Distribution of responses. Descriptive statistics were used to examine the distribution of responses. Items where >90% of respondents "agreed/strongly agreed" or "disagreed/strongly disagreed" at baseline were removed, due to floor and ceiling effects. Significant skewing or kurtotic response patterns were then examined, and items were removed that violated assumptions of normality (skew and/or kurtosis >2.0).

Corrected item-total correlations. To examine the extent to which responses on one item relate to the total score of all items, and to responses on all other items, corrected item-total correlations and inter-item correlations were calculated. Items were removed if they had corrected item-total correlations <0.3 [27].

Exploratory factor analysis. A maximum likelihood factor analyses with oblimin rotation was conducted to extract potential factors of the remaining COPI items. Factor solutions were identified based on visual inspection, theoretical groupings, and how well items loaded onto resulting factors. Items loading <0.32 were removed [28].

Internal consistency, test-retest reliability, agreement, and detectable change. To assess internal consistency, Cronbach's alpha was calculated using the items resulting from the factor analysis. A Cronbach's alpha value >0.70 indicates acceptable internal consistency of the scale [29]. To assess test-retest reliability, Intraclass Correlation Coefficient (ICC) estimates and their 95% confident intervals were calculated for the baseline and follow-up surveys based on a consistency, 2-way mixed-effects model, and single measures. ICC values <0.5 indicate poor reliability, values between 0.5-0.75 indicate moderate reliability, values between 0.75-0.9 indicate good reliability, and values >0.90 indicate excellent reliability [30]. The test-retest analysis was only conducted on those participants who responded within two weeks. To assess agreement, the Bland-Altman method [31] was used, providing a visual assessment of repeated measurement agreement. To do this, the average of the baseline and follow-up COPI-Adult scores were plotted against the difference between the baseline and follow-up scores. The mean and standard deviation (SD) of the mean difference were calculated, as well as the true value of the mean, by using 95% confidence intervals (CIs) to further assess the existence of systematic bias. To identify the smallest within-person change in score that can be interpreted as a 'real' change in a participant, above measurement error, the smallest detectable change (SDC) was calculated using the formula: SDC= 1.96 * sqrt 2 * SEM; where SEM = SD of mean difference * sqrt (1 – ICC) [32].

Construct validity. Pearson r correlations were calculated to determine the relationship between COPI-Adult scores and rNPQ scores. Because of the knowledge component within an adult's concept of pain, and because 'concept of pain' also includes beliefs, we hypothesized that higher COPI-Adult scores would be moderately or strongly correlated (r = 0.40 – 0.79) with higher rNPQ scores.

2.3. Distribution of scores of adults who had received pain science education

To test the hypothesis that respondents who had previously received pain science education would have higher COPI scores than those who haven't, mean COPI-Adult scores were calculated and possible ceiling effects were investigated in the participants who reported having received prior pain science education. A one-way ANOVA was used to compare the mean COPI-Adult scores between those who had an had not previously received pain science education.

2.4. Associations between COPI-Adult scores and demographic and clinical variables

To examine associations between potential COPI-Adult score and demographic and clinical variables as a guide for future research, regression analyses and correlations (Pearson r for continuous variables, and Tau for ordinal variables) were performed using the following demographic and clinical variables: education level, sex, age, persistent pain duration, average pain intensity, current pain intensity, and average pain interference scores. These analyses were conducted for both adults who had, and who had not, received prior pain science education.

3. Results

3.1. COPI-Adult: Developing the tool

3.1.1. Participants

The survey information was disseminated online via social media with a broad reach. For example, Twitter analytics report that one Tweet from JWP had 7554 impressions (times people saw the Tweet) and 401 engagements (times people interacted). Of the 732 adults clicking on the survey link, 627 consented and completed the baseline questionnaire, resulting in a 86% initial completion rate. Of these, 125 participants (20%) reported not having received prior pain science education and were included in the initial development and testing (see 3.2). **Table 1** presents the reported source of prior pain science education for the other 502 participants. **Table 2** shows the baseline clinical variables for both the adults who had and had not received prior pain science education. Overall, participants had a mean (SD) age of 41 (14) years, 74% were female, and 52% worked full time. Participants were generally well-educated, with 75% of participants reporting a university education. Current or any previous persistent pain (>3 months) was reported in 54% of participants. Sixty percent of participants reported current pain, for which the duration of pain varied greatly; two-thirds of these participants reported their current pain was persistent (>3 months).

3.2. COPI-Adult: Evaluation of psychometric properties

Distribution of responses. The distribution of responses for each of the 21 items analysed is presented in **Table 3**. Three items met the removal threshold of >90% agree/strongly agree or disagree/strongly disagree and were consequently deleted from the item pool. An additional four items violated assumptions of normality (skew and/or kurtosis >2.0) and were deleted (**Table 3**).

Corrected item-total correlations. One item had a corrected item-total correlation value <0.3 (**Table 3**) and this item was removed. Thirteen items remained for the factor analysis.

Exploratory factor analysis. The maximum likelihood factor analyses with oblique rotation led to an initial 1-factor solution. The visual inspection with scree plot elbow criteria suggested 1 factor. All items loaded onto this factor >0.32 (**Table 3**). The final COPI-Adult tool therefore consists of 13 items. Four items from the previously published 14-item COPI for school-aged children were not included in the final version of the COPI-Adult, and three new items were included (**Table 3**).

Internal consistency. Internal consistency for the 13-item COPI-Adult was acceptable (Cronbach's alpha = 0.78).

Test-retest reliability. Among the 125 participants, 57 provided their email address for the follow-up survey. When contacted 1 week after their baseline questionnaire, 45 (79%) completed the follow-up survey within 1 day and another 42 (74%) did so within a total of two weeks. The median (IQR) time between baseline and follow-up for these 42 participants was 7 (7.0 to 8.3) days. No significant baseline differences were found between participants who did and did not provide their email address for the follow-up survey, for sex (p=0.38), pain history (p=0.08), average pain intensity (p=0.31), current pain intensity (p=0.28), pain duration (p=0.36), rNPQ scores (p=0.69), or average pain interference (p=0.16) at baseline. However, participants who provided their email address were older (mean of 49 years compared to 38 years, p<0.001). The ICC(3,1) estimate for the 13-item COPI-Adult total score was calculated to be 0.84 (95%CI 0.71 to 0.91) reflecting 'good' reliability.

Agreement. The Bland-Altman plot (**Figure 1**) shows the difference in COPI-Adult scores against their average. The amount of discrepancy (in the vertical direction) shows the extent of the agreement between the baseline and 1-week follow-up, and the pattern indicates the nature of the discrepancy. Given the plotted points are approximately equally distributed above and below the zero line, minimal systematic bias is observed between the two measurements. The mean difference between baseline and follow-up was -0.74 points out of a possible total score of 52. The SD of this difference, 3.1, indicates that most plotted points (95%) showed a difference of less than 6.2 units (2 SD's). The pattern shows an essentially horizontal cloud of plotted points: to formally assess for any potential proportional bias, a linear regression (of difference against mean) was run, resulting in a slope estimate (unstandardized B) of -0.132 (p=0.162). This lack of significance indicates there is no proportional bias; that is, no greater difference between scores for those with higher or lower scores on COPI-Adult.

Detectable change. The smallest detectable change (SDC) was calculated to be 3.4 points (out of 52).

Concurrent validity. COPI-Adult scores were positively correlated with rNPQ scores (r=0.55).

3.3. Distribution of scores of adults who had received pain science education

The range of scores possible for the 13-item tool is 0-52 using the 5-point (0-4) Likert scale. In contrast to the mean (SD) COPI-Adult score of adults who had not received prior pain science education (35.9 (5.2)), the mean (SD) COPI-Adult score of adults who had received prior pain science education was 41.1 (6.8) which was significantly higher ($p<0.001$) and the mean difference between groups (MD = 5.2, 95%CI = 3.9 to 6.5) exceeds the SDC.

The distribution of baseline ratings of agreement of each of the 13 COPI-Adult items analysed in adults who had received prior pain science education is shown in **Table 4**. In these adults, five of the 13 items had a ceiling effect of >90% "agree/strongly agree" and 4 items also had a kurtosis > 2.0.

3.4. Associations between COPI-Adult scores and demographic and clinical variables

Table 5 shows the results of regression analyses and correlations between COPI-Adult scores and demographic and clinical variables for both adults who had and who had not received prior pain science education.

For adults who had not received prior pain science education, higher COPI-Adult scores were associated with higher rNPQ scores ($\beta = 1.302$ and r = 0.55). No other demographic or clinical variables assessed had moderate or large associations with higher COPI-Adult scores in this population (**Table 5**).

For adults who had received prior pain science education, higher COPI-Adult scores were associated with average pain interference (β = -0.85 and r = -0.346), female gender (β = -2.455 and r = -0.132), rNPQ score (β = 1.626 and r = 0.649), highest level of education (β = 1.996 and r = 0.332), average pain intensity (β = -0.989 and r = -0.286), and current pain intensity (β = -0.702 and r = -0.245). Older age and longer persistent pain duration were not significantly associated with higher COPI-Adult scores in this population (**Table 5**).

4. Discussion

This study developed a new tool for adults (COPI-Adult) derived from the COPI item pool developed in children. After administration to a large sample of adults, a maximum likelihood factor analysis led to a unidimensional assessment tool (Supplemental Digital Content 1, http://links.lww.com/CJP/A832) with acceptable internal consistency and good test-retest reliability. In the development sample of adults who had not received pain science education, the COPI-Adult was found to have adequate psychometric properties (distribution of responses, corrected item-total correlations, exploratory factor analysis, internal consistency, test-retest reliability, agreement, smallest detectable change, and construct validity). When the tool's variability and association with other constructs was examined in a sample of adults who had received prior pain science education, these adults had significantly higher mean COPI-Adult scores than participants who had not received prior education, as hypothesized.

4.1. The COPI-Adult in relation to the rNPQ

The COPI-Adult is the first tool to assess the broad construct of an adult's concept of pain. In contrast, the revised Neurophysiology of Pain Questionnaire (rNPQ) is currently used to assess pain-related knowledge [12] (which is only one aspect of an individual's concept of pain [20]), but it's application is limited by the complexity of the wording and limited response options. The correlation between COPI-Adult and rNPQ scores suggests a relationship between one's knowledge and concept of pain as theorized. The COPI-Adult has some overlap with the rNPQ, but it extends on it by allowing for a broader spectrum of responses showing the degree to which a particular concept is held. For example, if a person responds 'Strongly disagree' (0) to a COPI-Adult item, a clinician could ask "Why did you choose 'Strongly disagree' for this sentence?" which may then reveal specific thoughts or beliefs that could be amenable to change with pain science education. Future research can use the COPI-Adult to now engage in questions broader than knowledge change, such as how conceptual change relates to behavioural change in pain-related populations.

4.2. The COPI-Adult in relation to the the children's COPI

Differences between the COPI-Adult and the previously published children's COPI are potentially important because of cognitive developmental differences [21]. Ten of the 13 COPI-Adult items are also in the previously published 14-item COPI for children (Cronbach's alpha = 0.78, Table 3), and three items in the adult tool are not in the children's tool ('Resting for a long time can make pain worse', 'Pain is a feeling that is made by the brain', and 'Pain can be too protective if it stops you getting moving again'). Adults reported proportionally more uncertainty than children for three other items ('Feeling pain for a long time can make the brain more sensitive to warning messages', 'Learning about pain can help you to feel less pain', and 'The brain processes lots of details before you feel pain'). This finding regarding these potentially more complex items may reflect cognitive developmental differences (ie. 8-12 year old children are concrete thinkers) and these items may be useful for engaging adults in targeted pain science education. Further to this, the smallest detectable change in this study of adults (3.4 points on a scale out of 52) is much smaller than that reported in the previous study of children (12.7 points on a scale out of 56) [21]. One similarity in findings between the COPI-Adult and children's COPI is that higher scores in both studies were inversely correlated with higher average pain intensity and higher current pain intensity. This suggests that greater alignment with contemporary pain science is associated with 'better' pain, and future research could investigate mediators of this relationship.

4.3. Clinical implications

Several findings have potential clinical applications in adults that are worthy of further exploration. The 5-point increase in mean COPI-Adult scores for those who self-reported receiving pain science education compared to those who had not, exceeding the SDC, may suggest pain science education of many types (eg. clinican education, online searches, and coursework) could change COPI-Adult scores. The correlation found between COPI-Adult scores and higher levels of education suggests that formal education may also influence one's concept of pain. The inverse correlations between COPI-Adult scores and average pain interference scores, and larger unstandardised beta values, in adults who had received pain science education suggest that better pain outcomes are related to higher COPI-Adult scores. Taken together, these findings highlight the potential clinical utility of the COPI-Adult that now should be examined in future research.

The usefulness of specific COPI-Adult items in different populations requires further attention. Table 4 highlighted a ceiling effect and/or kurtosis in five COPI-Adult items in adults who had received prior pain science education. The five items relate to influences of emotions on pain, influences of enjoyment of activities on pain, pain without injury, injury without pain, and the overprotectiveness of pain. These are all common focusses in current pain science education [5-12, 14, 33-37]. Therefore, the COPI-Adult may be most useful in a clinical setting for adults who have not received prior pain science education to identify gaps to target with pain science education, and to measure conceptual changes over time in order to evaluate the effectiveness of pain science education.

4.4. Future research

Further evaluation of psychometric properties of the COPI-Adult will be valuable. For example, examining sensitivity to change in a study where the baseline and follow-up surveys can be completed following a specific treatment. Determination of the long-term predictive validity would also be useful particularly for people with persistent pain. A further aspect of research is to assess the mode of delivery. For example, investigate face-to-face administration of the tool to examine usability and interpretability in greater depth. Discussing the items out loud may also uncover other applications of the tool [19], and it may provide a method for patients to learn immediately after the tool has been scored. Clinicians' perceptions of the usefulness of using the COPI-Adult to target pain science education in this way should be investigated. The potential relationship between changes in COPI-Adult scores following pain science education and clinicians' perceptions of conceptual change should also be examined. In research, the COPI-Adult is a promising tool for use in clinical trials because of the promising validity and reliability findings in this study. The COPI-Adult could be tested to identify if it can effectively be used at baseline to guide treatment (e.g. pain science education tailored to COPI-Adult responses) and tested regarding its implementation as an outcome measure for pain science education.

4.5. Strengths and limitations

One key strength of this study was the use of the COSMIN checklist to evaluate the measurement properties of the COPI-Adult [26] which determined the methodology to be "adequate" to "very good" for the properties assessed (Supplemental Digital Content 2, http://links.lww.com/CJP/A833). For example, the target sample size decision is rated as 'adequate'. A futher strength was the large overall sample recruited, however, recruitment via social media involves the limitation of not knowing how many people were truly 'invited' but did not participate. Given that only 20% of participants had not received pain science education, and a high proportion of participants reported persistent pain, the overall sample is not likely to be representative of society [38]. An example of a Tweet's analytic data was reported in the Results and, based on the author's social media 'following', it is likely that the majority of people interacting with the survey information via this Tweet were researchers and health professionals, however this data was not collected for the present study. Therefore, generalizability of the present findings to typical clinical populations may be limited and should be investigated in further studies. One further potential limitation was the dichomization of data based on a self-report of receiving pain science education or not. The open-ended responses of education received varied greatly from videos through to university degrees (Table 1). Testing specific forms and dosages of pain science educational interventions (such as brief online animations [39, 40] as well as various books, short courses and university subjects) with the COPI-Adult in adults could clarify specifically what a learner learned, from whom and where, and the perceived importance of each aspect of education they engaged in.

4.6. Conclusions

The COPI-Adult is a promising new tool to assess an adult's concept of pain. The tool is designed for both clinical and research use, to enable targeted pain science education and to evaluate the effectiveness of pain science education. Further research examining its efficacy and impact is warranted.

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Figure Legends

Figure 1. Bland-Altman plot of the difference in COPI-Adult scores between baseline and follow-up versus mean of COPI-Adult scores from baseline and follow-up surveys (n=42).

Table Legends

Table 1: Reported source of previously received pain science education (n=502).

Table 2. Baseline clinical variables for adults who have and have not received prior pain science education.

Table 3. Distribution of baseline response ratings for each of the items analysed (n=125 adults who had not received prior pain science education), corrected item-total correlations of the items, and a summary of factor loadings for the final 13-item Concept of Pain Inventory for Adults (COPI-Adult).

Note: Red text indicates an item was removed. Items are sorted by their factor loading. The ***bold*** *items indicate those that remained after item reduction and factor analysis.*

Table 4. Distribution of baseline ratings of agreement of each of the 13 COPI-Adult items analysed in n=502 adults who had received prior pain science education.

Table 5. Results of regression analyses and correlations between COPI-Adult scores and demographic and clinical variables for both adults who had and who had not received prior pain science education.

Supplemental Digital Content 1: The Concept of Pain Inventory for Adults (COPI-Adult)
Supplemental Digital Content 2: Completed 'COSMIN Risk of Bias checklist'

Table 1: Reported source of previously received pain science education (n=502).
The participants who reported pain science education were asked to tick all of the sources of pain science education that apply:

Source of PSE	**n (%)**
Physiotherapist	310 (62)
Textbook/book	259 (52)
Website	240 (48)
Doctor	225 (45)
University/College/TAFE/Tertiary education	227 (45)
Video	180 (36)
Psychologist	141 (28)
Podcast	141 (28)
Blog	112 (22)
Nurse	79 (16)
Occupational Therapist	66 (13)
Exercise Physiologist	50 (10)
Other (open-ended responses could broadly be categorized as: 'I am a clinician', 'other health professional', 'professional development', and 'research')	81 (16)

Table 2. Baseline clinical variables for adults who have and have not received prior pain science education.

	Adults who had not received prior pain science education (n=125)	Adults who had received prior pain science education (n=502)
Baseline categorical variables	**n (%)**	**n (%)**
Sex: Female	84 (67)	379 (76)
Employment Status		
Full time	53 (42)	245 (49)
Part time	24 (19)	104 (21)
Casual	12 (10)	43 (9)
Currently unemployed	16 (13)	52 (10)
Other	25 (20)	74 (15)
Highest level of education		
Did not complete high school	3 (2)	5 (1)
High school	14 (11)	50 (10)
TAFE/vocational degree	26 (21)	55 (11)
Undergraduate degree	51 (41)	191 (38)
Postgraduate degree	24 (19)	145 (29)
Doctorate	7 (6)	53 (11)
Country		
Australia	89 (71)	240 (48)
Canada	9 (7)	59 (12)
UK	8 (6)	51 (10)
Denmark	1 (1)	33 (7)
USA	8 (6)	32 (6)
Other	10 (8)	87 (17)
Race		
Caucasian	111 (89)	441 (88)
Other	14 (11)	61 (12)
Primary language spoken at home		
English	120 (96)	410 (82)
Other	5 (4)	92 (18)
History of recurrent or persistent pain	55 (44)	283 (57)
Current pain	68 (54)	306 (61)
Current pain duration		
0 to 3 months	26 (38)	98 (32)
>3 to 6 months	6 (9)	7 (2)
>6 to 12 months	5 (7)	17 (6)
>1 to 3 years	8 12)	38 (12)
>3 to 10 years	10 (15)	72 (24)
>10 years	13 (19)	74 (24)
Current 'most pain' location		
back	16 (13)	90 (18)

shoulder/neck	17 (14)	57 (11)
leg/foot	15 (12)	56 (11)
arm/hand	5 (4)	20 (4)
pelvis	4 (3)	26 (5)
head	4 (3)	13 (3)
face/jaw	1 (1)	10 (2)
chest	1 (1)	3 (1)
abdomen	0 (0)	6 (1)
other	11 (9)	41 (8)
Baseline continuous variables	**Mean (SD)**	**Mean (SD)**
Age (years)	42.7 (16.2)	40.8 (13.8)
Average pain intensity for participants reporting pain /10 *	4.6 (1.8)	4.7 (2.0)
Current pain intensity for participants reporting pain /10 *	3.7 (2.3)	4.1 (2.4)
Pain interference for participants reporting pain /10 *	1.9 (2.6)	2.3 (2.8)
rNPQ score /12 ^	4.7 (2.2)	7.7 (2.7)

Note: Characteristics may not sum to exactly 100% due to the effect of rounding.

** Higher scores indicate higher levels of pain intensity/interference.*

^ Higher revised Neurophysiology of Pain Questionnaire scores indicated higher levels of pain science knowledge.

For brevity in reporting several categorical variables, only the most common responses were included in the table.

Table 3. Distribution of baseline response ratings for each of the items analysed (n=125 adults who had not received prior pain science education), corrected item-total correlations of the items, and a summary of factor loadings for the final 13-item Concept of Pain Inventory for Adults (COPI-Adult).

COPI items	Item pool number in Children's COPI [28]	Disagree /Strongly disagree (%)	Unsure (%)	Agree /Strongly agree (%)	Skewness	Kurtosis	Corrected Item-Total Correlation round 1	Corrected Item-Total Correlation round 2	Factor loadings
The brain processes lots of details before you feel pain *	**14**	4.8	53.6	41.6	0.4	0.0	0.48	0.49	0.56
Doing something you enjoy can make you feel less pain *	**4**	7.2	8.0	84.8	-1.0	1.2	0.47	0.47	0.55
Pain can be too protective if it stops you getting moving again	**19**	5.6	12.0	82.4	-0.8	0.9	0.49	0.49	0.54
Learning about pain can help you to feel less pain *	**8**	14.4	44.8	40.8	-0.2	0.2	0.44	0.46	0.54
The brain can make pain better or worse *	**10**	3.2	23.2	73.6	-0.5	0.6	0.46	0.47	0.53
Pain usually feels better if you move your body a little bit more each day *	**13**	9.6	18.4	72.0	-0.6	0.1	0.45	0.46	0.50
You can feel a little bit of pain even when an injury is big *	**11**	2.4	16.0	81.6	-0.6	1.6	0.44	0.42	0.48
Feeling sad can make you feel more pain *	**2**	3.2	8.0	88.8	-0.8	1.6	0.41	0.42	0.46
You can feel a lot of pain even when an injury is small *	**7**	4.0	9.6	86.4	-0.8	1.3	0.41	0.39	0.44
Pain is a feeling that is made by the brain	**17**	9.6	31.2	59.2	-0.5	0.2	0.33	0.33	0.40
You can have an injury and feel no pain *	**9**	10.4	8.8	80.8	-1.0	1.0	0.32	0.33	0.39
Resting for a long time can make pain worse	**16**	12.8	19.2	68.0	-0.6	-0.2	0.34	0.35	0.39
Feeling pain for a long time can make the brain more sensitive to warning messages *	**6**	12.0	48.8	39.2	0.2	-0.2	0.32	0.33	0.37
Pain is a warning that the body needs to be protected *	5	7.2	15.2	77.6	-1.0	1.6	0.07	-	-
You can feel pain even after an injury heals *	12	3.2	7.2	89.6	-0.8	2.3	-	-	-
Being distracted can make you feel less pain *	3	8.0	7.2	84.8	-1.4	2.7	-	-	-
You can feel pain without having an injury	20	4.8	7.2	88.0	-1.2	3.0	-	-	-
Body parts send warning messages to the brain	18	4.0	16.0	80.0	-1.1	3.2	-	-	-
Feeling stressed can make you feel more pain *	1	3.2	5.6	91.2	-0.9	1.8	-	-	-
Pain can help you to stop doing things that might injure your body	15	2.4	4.8	92.8	-1.3	6.2	-	-	-
Two people with the same injury can feel different amounts of pain	21	0.0	0.0	100.0	0.0	-2.0	-	-	-

Note:

Red text indicates an item was removed. Items are sorted by their factor loading.

*The **bold** items indicate those that remained after item reduction and factor analysis.*

** = Items in the previously published 14-item COPI for children [27].*

Table 4. Distribution of baseline ratings of agreement of each of the 13 COPI-Adult items analysed in n=502 adults who had received prior pain science education.

COPI-Adult items	Item number in Children's COPI [28]	Disagree /Strongly disagree (%)	Unsure (%)	Agree /Strongly agree (%)	Skewness	Kurtosis
1. Feeling sad can make you feel more pain.	2	3.0	5.8	91.2	-1.831	4.565
2. Doing something you enjoy can make you feel less pain.	4	5.4	3.2	91.4	-1.691	3.902
3. Feeling pain for a long time can make the brain more sensitive to warning messages.	6	8.4	17.3	74.3	-0.826	-0.024
4. You can feel a lot of pain even when an injury is small.	7	2.6	2.4	95.0	-1.648	5.016
5. Learning about pain can help you to feel less pain.	8	11.2	21.3	67.5	-0.694	-0.062
6. You can have an injury and feel no pain.	9	3.8	9.6	86.7	-0.992	1.364
7. The brain can make pain better or worse.	10	2.2	12.5	85.3	-0.868	0.865
8. You can feel a little bit of pain even when an injury is big.	11	1.8	6.4	91.8	-0.838	1.759
9. Pain usually feels better if you move your body a little bit more each day.	13	7.6	10.6	81.9	-1.091	1.282
10. The brain processes lots of details before you feel pain.	14	6.8	26.1	67.1	-0.487	-0.394
11. Resting for a long time can make pain worse.	16	6.0	9.8	84.3	-1.104	1.265
12. Pain is a feeling that is made by the brain.	17	7.6	17.5	74.9	-0.805	0.348
13. Pain can be too protective if it stops you getting moving again.	19	1.4	6.4	92.2	-1.331	2.915

Table 5. Results of regression analyses and correlations between COPI-Adult scores and demographic and clinical variables for both adults who had and who had not received prior pain science education.

Variable	Participants who had not received pain science education (n=125)		Participants who had received pain science education (n=502)	
	Unstandardized β	**r correlation***	**Unstandardized β**	**r correlation***
Older age (per year)	-0.007	-0.023	-0.042	-0.084
Gender (female)	-1.231	-0.076	-2.455	-0.132
rNPQ score (0-12)	1.302	**0.553**	1.626	**0.649**
Highest level of education˜	0.603	0.129	1.996	**0.332**
Longer pain duration˜	0.147	0.040	0.599	0.096
Average pain intensity (0-10)	-0.442	-0.155	-0.989	-0.286
Current pain intensity (0-10)	-0.145	-0.064	-0.702	-0.245
Average pain interference (0-10)	-0.246	-0.123	-0.85	-0.346

** = Pearson correlation used for continuous variables, and Tau correlation used for nominal (gender).*

˜ = The 5 point scales in Table 1 for the possible responses to 'level of education' and 'pain duration' were treated as continuous variables, scored from 0-5.

Bold = p<0.05 or when r>0.3

Supplemental digital content (SDC) 1:

Concept of Pain Inventory for Adults (COPI-Adult)

Pate, J. W., Simons, L. E., Rush, G., Heathcote, J., Hancock, M. J., Hush, J. M., Verhagen, A., Pacey, V. (2020)

Description: The Concept of Pain Inventory (COPI-Adult) was developed to assess an adult's concept of pain.

Scoring: The following scale should be used for all 13 items. No items should be reverse scored.

0 = Strongly Disagree
1 = Disagree
2 = Unsure
3 = Agree
4 = Strongly Agree

Higher COPI-Adult scores reflect greater alignment with contemporary pain science (Total scores can range from 0-52).

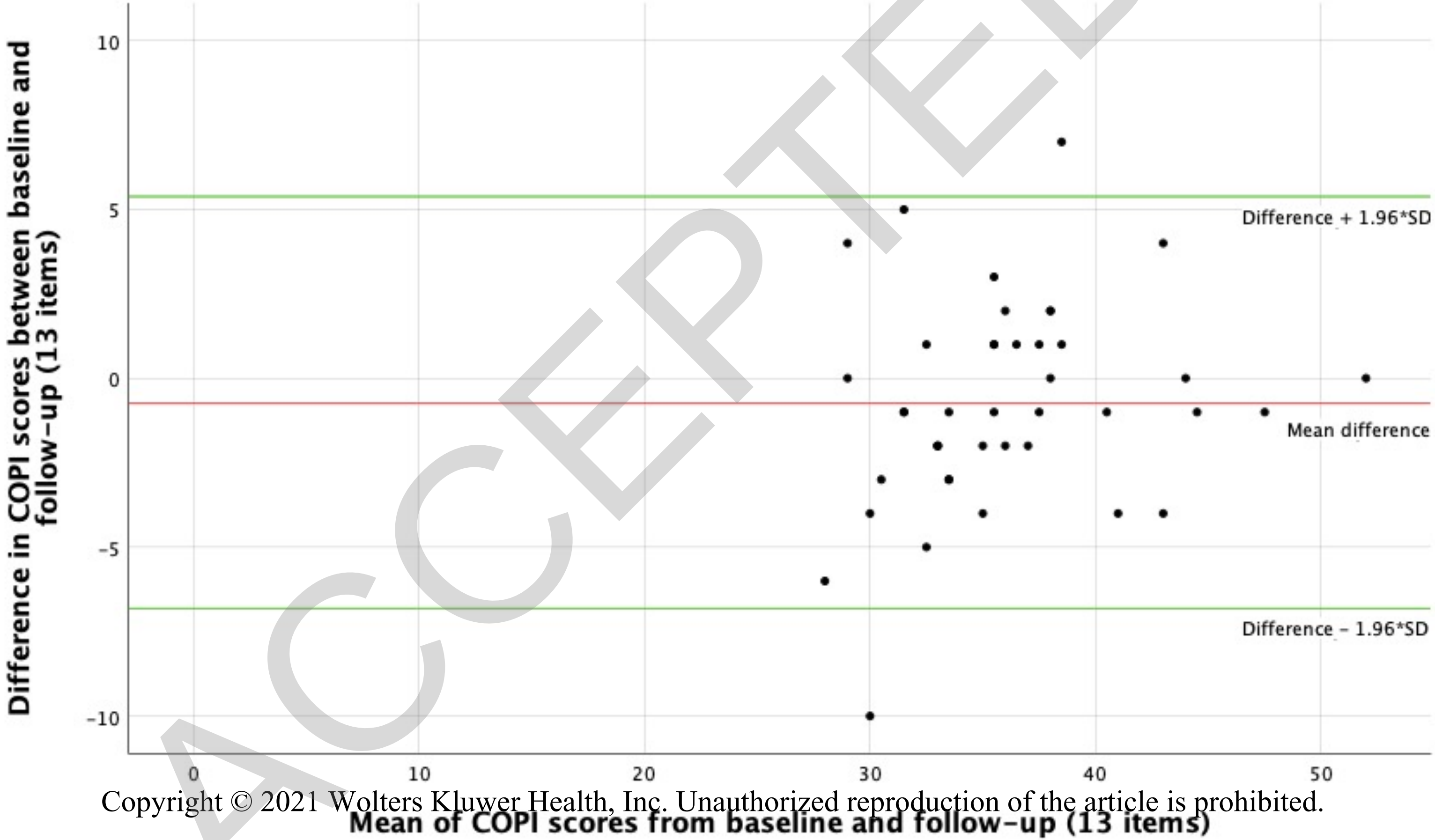
Shared Database: Please contact Joshua Pate on joshua.pate@uts.edu.au if you would like further information on contributing COPI data to a database being built for ongoing projects.

Concept of Pain Inventory for Adults (COPI-Adult)

Pate, J. W., Simons, L. E., Rush, G., Heathcote, J., Hancock, M. J., Hush, J. M., Verhagen, A., Pacey, V. (2020)

Instructions: These sentences are about what you think pain is, why you feel pain, and how you feel pain. Please read each sentence carefully. Indicate how much you agree or disagree with each sentence.

Items	Strongly disagree	Disagree	Unsure	Agree	Strongly agree
1. Feeling sad can make you feel more pain	○	○	○	○	○
2. Doing something you enjoy can make you feel less pain	○	○	○	○	○
3. Feeling pain for a long time can make the brain more sensitive to warning messages	○	○	○	○	○
4. You can feel a lot of pain even when an injury is small	○	○	○	○	○
5. Learning about pain can help you to feel less pain	○	○	○	○	○
6. You can have an injury and feel no pain	○	○	○	○	○
7. The brain can make pain better or worse	○	○	○	○	○
8. You can feel a little bit of pain even when an injury is big	○	○	○	○	○
9. Pain usually feels better if you move your body a little bit more each day	○	○	○	○	○
10. The brain processes lots of details before you feel pain	○	○	○	○	○
11. Resting for a long time can make pain worse	○	○	○	○	○
12. Pain is a feeling that is made by the brain	○	○	○	○	○
13. Pain can be too protective if it stops you getting moving again	○	○	○	○	○



Difference in COPI scores between baseline and follow-up (13 items)
10
5
0
-5
-10
Difference + 1.96*SD
Mean difference
Difference - 1.96*SD
0
10
20
30
40
50
Mean of COPI scores from baseline and follow-up (13 items)