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Critical Review

Associations Between Pain Appraisals and Pain Outcomes: Meta-Analyses of Laboratory Pain and Chronic Pain Literatures

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Abstract: **In this research, meta-analyses were performed to evaluate associations between primary appraisals of pain as a source of threat and/or challenge and responses to 1) noxious laboratory stimuli and 2) chronic noncancer pain. Twenty-two laboratory pain studies comprising 2,031 participants and 59 chronic pain studies based on 9,135 patients were identified for analysis. For laboratory pain, elevated threat appraisals were linked to overall increases in reported pain, reduced pain tolerance, and high levels of passive coping. Method of measuring appraisal as well as type and duration of noxious stimulation moderated some of these associations. Challenge appraisals were related to more pain tolerance and less passive coping but not pain intensity. For chronic pain studies, threat appraisals had positive overall correlations with pain intensity, impairment, affective distress, and passive coping but were negatively related to active coping. The pattern of associations between challenge appraisals and outcomes was largely complementary. Appraisal scale used and gender were consistent moderators of appraisal-outcome relations in chronic pain samples. In sum, appraisals of pain as a source of potential damage or opportunity have robust associations with responses to acute laboratory pain and ongoing chronic pain.**

Perspective: ***Meta-analyses evaluated associations between primary appraisals and responses to laboratory pain and chronic pain. Significant effect sizes for most outcomes suggest that appraisals of pain as a source of threat and challenge have important implications for functioning in response to pain.***

Key words: *Meta-analysis, threat appraisal, challenge appraisal, pain beliefs, laboratory pain, chronic pain.*

The transactional model[53,54] has been a useful approach for conceptualizing responses to stressors, including pain. From this perspective, upon confronting potential stressors, people make initial evaluations about events to assess their implications for well-being. Although not exhaustive, primary appraisals or beliefs include preexisting notions that stressors are sources of 1) threat for potential future damage or 2) challenge or opportunity for future growth, mastery, or profit.[20,53] Such appraisals can be relatively stable across situations or unique to particular events.[54] When threat appraisals predominate, individuals perceive the potential for loss, with little, if any, potential gain. Conversely, individuals who make challenge appraisals perceive events in terms of both possible gains (eg, positive incentives or avoidance of harm) and losses.[95]

In concert with person and situation characteristics as well as appraisals of resources available for meeting demands, primary appraisals are hypothesized to influence coping efforts and outcomes to stressors.[54,94] Specifically, threat appraisals should predict comparatively higher levels of passive or emotion-focused coping, negative emotional reactions, and/or performance inhibition,

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whereas challenge appraisals should predict more active, problem-focused coping, less subjective stress, and performance enhancement.[53,95] Past meta-analyses of general stressors[90] and cancer pain[27] provide general support for hypothesized links between primary appraisals and coping. Although numerous studies have examined links between primary appraisal and responses to laboratory pain or chronic noncancer pain, neither of these literatures has been subjected to meta-analysis.

In laboratory research, causal effects of threat appraisal have been evaluated by experimentally manipulating meanings of pain sensations as signals for possible tissue damage, although self-report scales of pain appraisal have also been used. Findings have been somewhat inconsistent. Whereas some researchers have found that threat appraisals predict lower tolerance for noxious stimuli,[26,41,42,84] others have not.[7,44,60,82] Conversely, threat appraisals have been linked to pain intensity in some studies[2,17,60,115] but not others.[7,26,41,42,44,82,103] Aside from measurement of appraisal (experimental manipulation vs self-report), type and duration of noxious stimulation are methodologic factors that might account for variable responses to laboratory pain. For example, Arntz and Claassens[2] found that a nociceptive stimulus manipulated to imply heat was judged as more threatening and painful than the same stimulus manipulated to imply cold, suggesting that the nature of painful stimuli is a moderating influence. Furthermore, because longer stimulus presentations may facilitate habituation, brief stimulus durations might be perceived as more threatening and painful.[41] Person factors such as gender may also contribute to variable relations between appraisals and laboratory pain responses in light of gender differences in appraisal, coping, and pain perception.[26,82,90]

In chronic pain studies, primary appraisals predict increases in pain[16,75,89] impairment[46-48,74,98] and affective distress,[47,48,70,75,79] but links have been modest in some samples.[22,34,62,69] Aside from gender, moderators of appraisal-outcome associations in chronic pain samples may be distinct from those hypothesized for laboratory pain. Meta-analytic findings for cancer pain suggest that age and pain duration are other demographic factors that affect such relations.[27] Because various self-report scales tap beliefs about chronic pain,[45,75,100] appraisal measurement is a plausible methodologic influence on variable findings.

Based on this overview, the overall strengths of association between primary appraisals and facets of functioning (pain perception, coping, impairment, affective distress) were synthesized in separate meta-analyses of 1) laboratory pain and 2) chronic noncancer pain. Following from the transactional perspective, we hypothesized that threat appraisals would be related to poorer overall outcomes whereas challenge appraisals would show complementary associations. Given potential variability between studies within each literature, moderating effects of specific methodologic and sample characteristics noted above were also evaluated.

Methods

Search Strategy

To identify relevant studies of primary appraisal and pain, PubMed, MEDLINE, PsycINFO, Web of Science, OvidSP, Google Scholar, Science Direct, and ProQuest dissertation database searches were performed between dates of inception and September 2012. Search terms included "appraisal" OR "beliefs" OR "threat" OR "harm" OR "challenge" AND "pain." Related self-report measures including the Survey of Pain Attitudes (SOPA),[45] Pain Appraisal Inventory (PAI),[100] Cognitive Appraisal Inventory for Chronic Pain Patients (CAI),[75] and Tampa Scale for Kinesiophobia (TSK)[63] were also used as search terms along with names of authors who had published papers on appraisal and pain (ie, Vlaeyen, Van Damme, Sharpe, DeGood, Jackson, Unruh, Jensen, Tait, Thorn, Romano, Ramirez, Turner). All searches used the broad search field "anywhere" to identify citations. Several of these authors were also contacted for data from unpublished conference presentations or theses. Finally, references lists of articles obtained from the above strategies were combed to identify other potentially relevant papers.

Inclusion/Exclusion Criteria

Abstracts of all potentially eligible studies were independently screened by the first 2 authors to exclude papers whose content was not relevant. Subsequently, full-text versions of relevant papers were retrieved and reviewed to determine whether they met the following 7 criteria:

1. Study participants were adult humans 18 years of age or older.
2. Studies included in the chronic pain meta-analysis comprised samples having chronic noncancer pain of at least 3 months' duration. Laboratory pain studies included participants drawn from nonclinical settings and exposed to noxious laboratory stimuli.
3. The study assessed at least 1 association between a key primary appraisal type based on transactional model operationalizations of threat appraisal (ie, beliefs that pain is a source of future damage or future harm) and challenge appraisal (ie, beliefs that pain is a source of opportunity for future growth, mastery, or profit) and a response to laboratory pain (ie, pain intensity, pain tolerance, coping) or chronic pain (ie, pain intensity, pain coping, disability/impairment, or affective distress).
4. Cross-sectional and longitudinal studies were included in the chronic pain meta-analysis, but for prospective studies reporting correlations between appraisal and pain outcomes at multiple time points, only baseline relations were analyzed. Studies that reported only correlations between change scores of appraisal and pain outcomes were excluded.
5. Studies were included when primary appraisal measures were treated as independent variables or predictors rather than dependent measures.
6. Reliability and validity data for measure(s) of primary appraisal and responses to pain were either reported or available.

7. Studies with results based on secondary analyses of data in other articles were excluded. All potentially relevant papers were reviewed independently by the first 2 authors for inclusion in the meta-analyses. Disagreements were resolved through discussion and consensus.

Data Extraction

For laboratory pain studies, data were extracted for demographics (mean age, gender), pain appraisal manipulations or measurements, noxious stimulus type, and pain outcomes (ie, pain intensity, pain tolerance, pain coping). Most studies used orienting information about exposure to noxious stimulation that varied in degree of threat so that data extracted typically involved comparisons of responses of lower versus higher threat appraisal conditions. In several studies that included pain intensity as a dependent variable, participant ratings of reported pain were assessed at 30 seconds during cold water immersion and/or immediately after withdrawing the hand at tolerance. Therefore, pain intensity ratings were assessed and reported at both points where relevant. From each potentially relevant chronic pain study, data were extracted about sample age, gender composition, pain duration, pain site, appraisal measure(s) and outcome measures related to coping, pain intensity, impairment, and affective distress.

Classification of Coping

Because various coping measures have been used in this literature, to permit analyses of associations with coping responses, all specific strategies were reclassified into broader, "active" versus "passive" coping categories following operational definitions of the Vanderbilt Pain Management Inventory (VPMI).[8] The first 2 authors independently reviewed subscale items and classified subscales as "active" when the strategy reflected direct attempts to manage pain or carry on functioning despite pain. "Passive" coping strategies involved "giving in" to pain, allowing pain to adversely affect other areas of one's life, or having another person take over aspects of one's functioning or responsibilities. Using these definitions, 32 coping strategies from several scales were reclassified with an interrater agreement level of 100% (see Appendix).

Quality Assessments

The first 2 authors independently assessed the quality of included studies based on 7 criteria outlined in the meta-analysis by Crombez et al[15]: demographic data provided (sex, age, and education), specification of inclusion/exclusion criteria, description of pain experiences, specification of recruitment procedures, study setting/location description, data-cleaning procedures reported, and cover story description. Sample size of at least 100 and assessment of more than 1 type of outcome (eg, self-report and behavior performance measures) were added as criteria. Studies were rated as not adequate (0) or adequate (1) on each criterion. A total quality score for each study was calculated by summing ratings on these criteria. The interrater agreement level was high, k = .995.

Meta-Analytic Procedures

Comprehensive Meta-Analysis Version 2.0[6] was used for analyses. For laboratory studies, Hedges' g, representing the mean difference between groups on outcome(s), was employed as a measure of effect size. When assessing relations between primary appraisal and multiple coping strategies within a single study (eg, diverting attention, reinterpreting sensations, and coping self-statements), effect sizes for each association were calculated individually and combined into an overall mean effect size[65] for active or passive coping. Similarly, in studies reporting more than 1 association for pain intensity,[17,60,82,84,103] the average of individual effect sizes less or more than 30 seconds was used.

In chronic pain studies, bivariate associations represented individual effect sizes. Six studies that used standard regression coefficients within multiple regression models rather than correlation coefficients were retained in main analyses. However, because bivariate associations with outcomes may be attenuated within multiple regression models having multiple predictors, overall effect sizes with each outcome were also calculated and reported in the text after excluding data from these studies.

In both meta-analyses, effect sizes were weighted by the inverse of the study's variance, and Cochran's Q test evaluated effect size heterogeneity for each outcome. When Q values indicated significant heterogeneity, subgroup analyses and meta-regression were conducted to identify sources of variability in effects. I-square values represented amount of observed heterogeneity. Following Higgins et al,[36] I-square values of 25%, 50%, and 75% were low, moderate, and high, respectively. Q_{within} and $Q_{residual}$ were reported as indicators of heterogeneity remaining after controlling for effects of moderators in subgroup and meta-regression analyses, respectively. Overall effect sizes were based on random effects models as recommended by Hoffman and Papas.[37] Based on Cohen,[9] standardized mean differences of Hedges' g = .2 were interpreted as small, Hedges' g = .5 as medium, and Hedges' g = .8 as large. For correlation effect sizes, r = .10 was interpreted as small, r = .3 as medium, and r = .5 as large.[9]

In the meta-analysis on laboratory pain, moderating effects of 3 methodologic influences—noxious stimulus type (cold vs heat vs other), noxious stimulus duration (ie, 30 seconds or less vs more than 30 seconds), and appraisal measure type (self-report vs experimentally manipulated)—were assessed via Cochran's Q. Moderating effects of gender (ie, percentage of women within each sample) were assessed using the method of moments.[14,93] In the chronic pain meta-analysis, categorical moderators based on appraisal measure used (SOPA vs PAI vs CAI vs TSK), age (younger vs older than the mean of 45.25 years), and pain duration (less vs more than the mean of 7.26 years) were evaluated from Cochran's Q. Meta-regression assessed gender (proportion of women per sample) as a potential moderator.

Based on recommendations of Borenstein et al,[6] mixed-effects models were used in all subgroup analyses. Following other meta-analyses,[3,56] subgroup analyses

were performed when at least 1 sample was included in each subgroup.

Evaluation of Publication Bias

Possible publication bias was assessed by inspecting funnel plots of all effect sizes for asymmetrical distributions around mean effect sizes via the trim and fill method.[23] Typically, larger samples (top of an effect size plot) provide the most accurate estimates of effect size; the spread should increase symmetrically with smaller samples toward the bottom of the plot. Hence, when there is no evidence of publication bias, the plot should resemble an inverted funnel. Bias against the publication of studies having nonsignificant effects is suggested by funnel plots that include fewer effects sizes on the left than on the right side of an outcome's mean effect size. This method provides an estimate of the nature and number of studies missing from the distribution and adjusted effect sizes based on estimated contributions of missing studies. Publication bias in laboratory studies was also evaluated by comparing effect size differences between published studies (n = 19) and unpublished theses (n = 3).

Results

Search Results

We found 1,250 potentially relevant studies in databases by key words, 522 studies from names of authors who had published on pain beliefs/appraisals, 795 studies based on appraisal questionnaire names, 13 by emailing authors who had published in the area, and 17 from reference lists of related papers. After removing duplicates, 2,383 potentially relevant studies were retained for initial consideration. Fig 1 summarizes details regarding the exclusion of studies from pools on which analyses were performed. In sum, 22 studies were retained for the laboratory pain meta-analysis (N = 2,031), whereas another 59 studies were included in the chronic pain meta-analysis (N = 9,135). Rates of interrater agreement were satisfactory for study inclusion/exclusion from a meta-analysis (k = .91) and the coding of variables used in the meta-analyses (k = .88).

Meta-Analysis of Laboratory Pain Studies

Description of Studies

Table 1 summarizes characteristics of studies included in the initial meta-analysis. Samples sizes ranged from n = 16 to n = 155 (mean [M] = 88.30, standard deviation [SD] = 41.94) and were typically composed of young adults in university settings with a mean age ranging from 18.70 to 31.29 years (M = 21.5 years, SD = 2.81). Regarding gender composition, samples included 58.42% women on average (SD = 9.83, range = 36–78.22%). Most studies (n = 15) used the cold presser test (CPT) as the noxious stimulus, but heat (n = 1), a cold metal bar (n = 1), laser (n = 1), electrocutaneous stimulation (n = 1), painful finger pressing (n = 1), and delayed muscle soreness (n = 3) were used as well. One study[9] used 3 different noxious stimuli (heat, ischemic pressure, exercise). The mean quality rating of laboratory studies was 6.22 (SD = 1.73, range = 2–8).

Regarding appraisal measurement, a majority of samples (n = 13) used experimental manipulations featuring

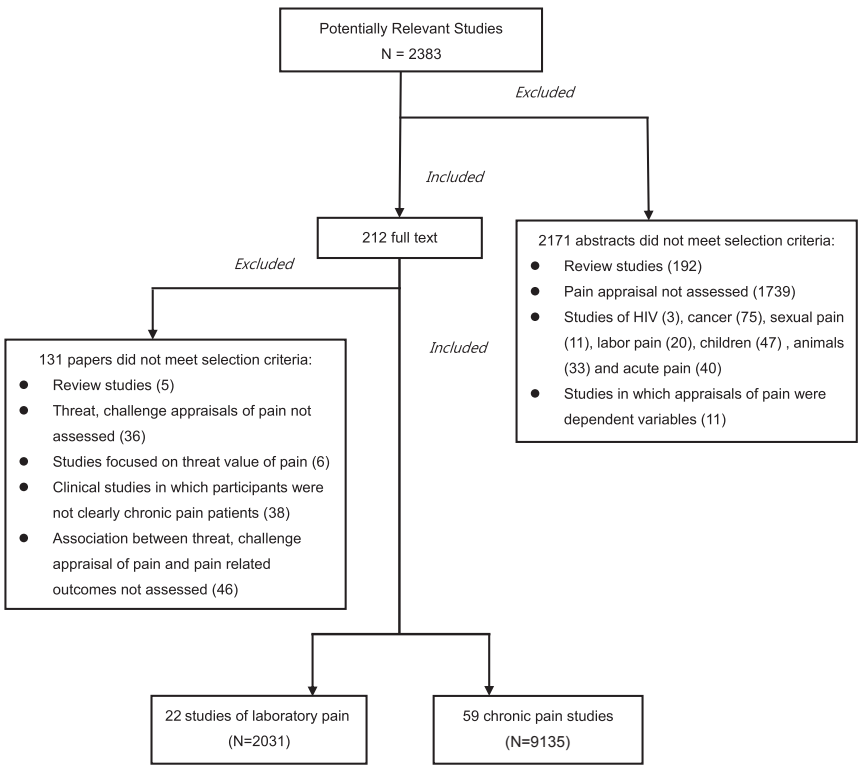

Figure 1. Outline of the study selection process.

Table 1. Overview of Studies Included in Meta-Analysis on Associations Between Primary Appraisal and Responses to Laboratory Pain

							Outcome Measure		
First Author	Year	N	Age (Years)	Noxious Stimulus	Appraisal Type	Appraisal Measurement	Pain Coping	Pain Intensity	Pain Tolerance
Arntz[2]	2004	16 F, 15 M	18–26	Cold metal bar	Thr	Perceived hot or cold	—	VAS	—
Bishop[4]	2011	23 F, 19 M	22.4	DOMS	Thr	TSK	—	VAS	—
Boston[7]	2005	36 F, 64 M	19.97	Cold water	Thr	Orienting passages	—	—	Y
Cunningham[16,*]	2011	43 F, 50 M	19.4	Cold water	Thr	PAI	PCS	VAS	Y
Dannecker[17]	2008	21 F, 23 M	20	Heat, ISC, EXR	Thr, Cha	PAI	—	VAS	—
Forsythe[26]	2011	83 F, 72 M	19.47	Cold water	Thr, Cha	PAI	PCS	VAS	Y
George[32]	2007	23 F, 19 M	20.2	DOMS	Thr	TSK	—	VAS	—
Jackson[41]	2005	77 F, 44 M	20.66	Cold water	Thr	Orienting passages	CSQ	NRS	Y
Jackson[42]	2009	35 F, 21 M	21.72	Cold water	Thr	Orienting passages	CSQ	NRS	Y
Jackson[43]	2011	80 F, 44 M	22.31	Cold water	Thr	Orienting passages	CSQ	NRS	Y
Jackson[44]	2012	93 F, 58 M	21.56	Cold water	Thr	Orienting passages	CSQ	NRS	Y
Karsdorp[50]	2012	68 F, 21 M	21.06	Finger pressing	Thr	Orienting passages	—	—	Y
Li[58]	2010	51 F, 43 M	22.38	Cold water	Thr	Orienting passages	CSQ	NRS	Y
		59 F, 40 M	21.22	Cold water	Thr	Orienting passages	CSQ	NRS	Y
Machin[59]	2012	58 F, 29 M	25.56	Cold water	Thr, Cha	PAI	COPE	NRS	Y
McGowan[60]	2009	69 F, 35 M	21.53	Cold water	Thr	Orienting passages	—	NRS	Y
Sanford[82]	2002	78 F, 66 M	—	Cold water	Thr, Cha	PAI	—	VAS	Y
Sharpe[84]	2010	65 F, 38 M	19.48	Cold water	Thr	Orienting passages	—	NRS	Y
Trost[96]	2011	14 F, 16 M	19.5	DOMS	Thr	TSK	—	PRI	—
Van Damme[103]	2008	79 F, 22 M	19.14	Cold water	Thr	Orienting passages	PCS	NRS	Y
Van Damme[105]	2012	30 F, 26 M	18.7	Electrocutaneous	Cha	Financial reward	—	NRS	—
Vlaeyen[112]	2009	88 F, 61 M	31.29	Cold water	Thr	Orienting passages	PCS	NRS	Y
Wiech[115]	2010	11 F, 5 M	24	Laser	Thr	Orienting passages	—	VAS	—

Abbreviations: F, female; M, male; Thr, threat; VAS, visual analog scale; DOMS, delayed-onset muscle soreness; PCS, Pain Catastrophizing Scale; ISC, ischemic; EXR, exercise; Cha, challenge; CSQ, Coping Strategies Questionnaire; NRS, numeric rating scale; PRI, Pain Rating Index.
*Measures of association based on standardized regression coefficients.

random assignment to orienting passages intended to increase or decrease the perceived meaning of pain sensations as a signal for potential tissue damage (ie, threat) before exposure to noxious stimulation. For example, orienting passages for higher threat appraisal conditions in cold water immersion studies featured factual descriptions of frostbite symptoms and consequenceses, whereas orienting passages for lower threat conditions emphasized how pain resulting from the immersion was not damaging. In Arntz and Claassens'[2] study, the threat value of a cold metal bar pressed against the back of one's neck was manipulated by suggesting that the stimulus was either hot (higher threat) or cold (lower threat). All studies using threat manipulations reported successful manipulation checks, although these were based on threatened subgroups reporting relatively higher scores on a variety of indices including perceptions of potential damage, worry, anxiety, fear, and/or catastrophizing. Consistent with Lazarus and Folkman's[53] conceptualization of challenge appraisal as involving perceived opportunities for future mastery, growth, or profit, Van Damme et al[105] were the first to experimentally manipulate the meaning of pain as a challenge (ie, receipt vs nonreceipt of financial rewards for choosing to persist in trials that included potential pain). Five studies used the PAI[100] to assess self-reported threat (n = 5) and/or challenge (n = 4) appraisals. Three studies assessed threat appraisals of pain stimuli with the TSK.[63] Although the TSK is a popular measure of pain-related fear, the content of its items directly assesses or implies pain as a source of potential harm in line with Lazarus' formulation of threat appraisal.

All laboratory studies evaluated relations between primary appraisal and pain perception among persons undergoing nociception. Specifically, subjective pain intensity ratings at 30 seconds and/or tolerance of noxious stimulation were dependent measures in 21 samples, whereas 16 samples included dependent measures of pain tolerance in seconds or total trials of noxious stimulation endured. Effects of appraisal on coping responses were assessed in 9 studies.

Although pain intensity, tolerance, and coping were responses of interest here, Wiech et al[115] also examined neural activation underlying threat appraisals and found that participants biased to rate laser stimuli as more painful in a higher threat appraisal condition showed stronger activation of the midcingulate cortex. Aside from pain perception, Sharpe et al[7,60,84] assessed effects of threat on attention toward pain words or images. One other study examined how threat appraisal manipulations affected responses of persons undergoing noxious stimulation as well as responses of an acquaintance who was instructed to help them with coping.[42] Acquaintances exposed to more threatening orienting information were comparatively less likely to encourage their partner to reinterpret sensations, divert attention, or

Table 2. Associations Between Primary Appraisal and Responses to Laboratory Pain

		Effect Size and 95% Confidence Interval				Heterogeneity		
Appraisal-Outcome Relation	N	Hedges' g	Standard Error	Lower Limit	Upper Limit	Q Value	df (Q)	I-Square
Higher vs lower threat appraisal								
Pain intensity	1667	.23***	.06	.12	.30	41.52***	27	34.98
Pain tolerance	1458	−.28***	.09	−.45	−.11	53.83***	22	59.13
Active coping	762	−.21*	.09	−.39	−.04	11.98	9	24.88
Passive coping	1228	.45***	.13	.20	.70	64.99***	15	76.92
Higher vs lower challenge appraisal								
Pain intensity	487	.14	.13	−.12	.39	8.60	4	53.48
Pain tolerance	387	.41*	.15	.12	.71	4.01	2	50.17

*$P < .05$; ***$P \leq .001$.

ignore pain, a pattern that highlights how others' appraisals of pain influence their caregiving efforts toward a person in pain.

Effect Size and Moderator Analyses

Standard mean differences between lower and higher threat appraisal levels were significant for pain intensity, tolerance, and coping (Table 2). Specifically, more threatening appraisals of pain predicted elevations in reported pain intensity and use of passive coping strategies as well as reduced pain tolerance and use of active coping.

Significant heterogeneity was observed for 3 effect sizes, particularly those reflecting threat appraisal–passive coping relations. Moderating effects of methodologic differences between studies are presented in Table 3. For pain intensity, moderating effects of type and duration of noxious stimulation indicated that effect sizes were strongest for heat stimulation and presentation durations of less than 30 seconds. Heterogeneity in threat appraisal–pain intensity ratings was not significant after controlling for noxious stimulus type (Q_{within} = 28.75, P = .274) or presentation duration (Q_{within} = 41.23, P = .154). Conversely, proportion of female participants did not moderate relations between threat appraisal and pain intensity (point estimate of slope = −.002, P = .760). For threat appraisal–pain tolerance relations, neither methodologic factors (Table 3) nor gender (point estimate of slope = .009, P = .300) had moderating effects.

For threat appraisal–passive coping relations, type of appraisal measure was a moderator, with larger effect sizes found for self-reports than for experimental manipulations (Table 3). After controlling for appraisal measure type, heterogeneity was not significant (Q_{within} = 22.074, P = .077). Threat appraisal–passive coping associations were also attenuated as the proportion of women in a study increased (point estimate of slope = −.0673, P = .001). After controlling for moderating effects of gender, heterogeneity was not significant ($Q_{residual}$ = 13.61, P = .479).

Challenge appraisals had a significant overall association with pain tolerance but not pain intensity (Table 2). Only 1 study evaluated how challenge appraisal was related to coping,[59] so no effect size calculations were performed.

Table 3. Moderating Effects of Methodologic Factors on Associations Between Threat Appraisal and Laboratory Pain Responses

Appraisal-Outcome Relation	Q Between	Moderator	Subgroup	K†	Hedges' g	Standard Error	Lower Limit	Upper Limit
Threat–pain intensity	12.17**	Stimulus type	Cold	20	.16**	.06	.04	.28
			Heat	3	.92***	.21	.50	1.34
			Other	6	.31*	.13	.05	.57
	6.69**	Stimulus duration	More than 30 s	27	.17**	.05	.07	.27
			Less than 30 s	8	.50***	.12	.27	.73
	1.47	Appraisal measure	Manipulation	18	.17*	.08	.02	.32
			Self-report	10	.32***	.09	.14	.49
Threat–pain tolerance	1.90	Stimulus type	Cold	19	−.34***	.08	−.49	−.19
			Other	4	.23	.41	−.57	1.03
	.00	Appraisal measure	Manipulation	19	−.27**	.11	−.48	−.06
			Self-report	4	−.28*	.12	−.52	−.05
Threat–active coping	2.12	Appraisal measure	Manipulation	9	−.26**	.09	−.43	−.08
			Self-report	1	.09	.22	−.34	.51
Threat–passive coping	6.69**	Appraisal measure	Manipulation	13	.25***	.07	.12	.38
			Self-report	3	1.32***	.41	.52	2.13

*$P < .05$; **$P < .01$; ***$P \leq .001$.

†Degrees of freedom for some analyses exceeded the number of studies included for meta-analyses because effect sizes were calculated separately for each threat subgroup in a study.

Table 4. Overview of Studies Included in Meta-Analysis on Associations Between Primary Appraisal and Chronic Pain Outcomes

								Outcome Measure			
First Author	Year	N	Age	Pain Condition	Pain Duration	Appraisal Type	Appraisal Measure	Pain Coping	Pain Intensity	Disability	Emotional Distress
Alschuler[1]	2011	9 F, 11 M	46.1	CLBP	3.4	Thr	TSK	PCS	—	RMDQ, WLK, DA	CES-D
Boersma[5]	2005	34 F, 13 M	42.8	CMP	2	Thr	TSK	—	NRS	OSQ	—
		61 F, 28 M	45.6	CMP	9	Thr	TSK	—	NRS	OSQ	—
Cook[10]	2006	295 F, 174 M	46.3	MCP	6.2	Thr	TSK	CSQ	NRS	PDI	CES-D
Crombez[12]	1999	20 F, 15 M	36.1	CBP	6.7	Thr	TSK	—	VAS	RMDQ	NES
		25 F, 13 M	40.8	CBP	6.4	Thr	TSK	—	VAS	—	NES
		16 F, 15 M	41.6	CBP	8.9	Thr	TSK	PCS	VAS	RMDQ, LFT	NES
Crombez[11]	1999	27 F, 11 M	36.8	MCP	6.6	Thr	TSK	—	VAS	—	NES
Dehghani[21]	2010	106 F, 101 M	45.2	MCP	6.25	Thr	TSK	PRSS	MPI	RMDQ	DASS-D
De Rooij[19]	2011	124 F, 10 M	45.5	MCP	7	Thr	TSK	CSQ	—	—	—
French[28]	2007	108 F, 92 M	40	MCP	1.4	Thr	TSK	PCS	VAS	QBPD, RUN, LFT	BDI
Geisser[30]	2000	58 F, 75 M	41.7	CBP	5.44	Thr	TSK	—	PRI	PILE, BIKE	CES-D
Geisser[31]	2004	42 F, 34 M	40.6	CLBP	7.1	Thr	TSK	—	VAS	FRR	—
Gómez-Pérez[29]	2011	101 F, 24 M	58.3	MCP	11.7	Thr	TSK	PCS	NRS	IFI	HADS
Goubert[33]	2005	44 F, 40 M	40.3	CLBP	5	Thr	TSK	PCS	MPI	TEF	—
Helmes[34]	2007	50 F, 46 M	47	MCP	12.5	Thr	SOPA	—	VAS	SIP	CES-D
Herrero[35,*]	2008	56 F, 35 M	55	MCP	13	Cha	CAI	—	—	—	HADS
Huijnen[38,*]	2009	25 F, 17 M	45.4	CLBP	13	Thr	TSK	—	—	QBPD	—
Jensen[47]	1999	67 F, 54 M	42.18	MCP	4.59	Thr	SOPA	—	—	SIP	CES-D
Jensen[48]	2000	66 F, 60 M	43.11	MCP	5.52	Thr	SOPA	CPCI	—	RMDQ	CES-D
Jensen[49]	2003	72 F, 69 M	44.7	MCP		Thr	SOPA	—	NRS	RMDQ	CES-D
Jensen[46,*]	1994	135 F, 106 M	42.7	MCP	4.2	Thr	SOPA	—	—	SIP	—
Knussen[51]	2009	86 F, 9 M	66.2	MCP	16	Thr	SOPA	CSQ	NRS	RMDQ	GHQ
Koho[52]	2001	27 F, 24 M	44.6	MCP	5.81	Thr	TSK	—	VAS	ODI	Zung
Lewis[57]	2012	29 F, 18 M	46.2	CLBP	7.2	Thr	TSK	PCS	NRS	RMDQ	HADS
Meeus[61]	2012	88 F, 15 M	40.5	CMP	8.25	Thr	TSK	—	VAS	CFS-APQ	—
Meredith[62]	2005	58 F, 83 M	38.9	MCP	3.75	Thr, Cha	PAI	CSQ	NRS	ODI	DASS
Monticone[64]	2012	77 F, 103 M	44.1	CLBP	—	Thr	TSK	PCS	—	—	—
Nicholas[66]	2006	157 F, 95 M	50.3	MCP	7.8	Thr	TSK	PRSS	MPI	RMDQ	DASS
Nijs[67]	2004	58 F, 6 M	39.6	MCP	5.3	Thr	TSK	—	—	CFS-APQ, BIKE	
Osborne[69]	2007	94 F, 31 M	50.8	MS	12.85	Thr	SOPA	—	NRS	BPI	SF-36
Pellino[70,*]	1992	20 F, 20 M	43	CBP	6.75	Cha	AIS	—	—	—	POM-S
Peters[71]	2005	56 F, 44 M	49.9	CLBP	6.5	Thr	TSK	PCS	VAS	QBPD	—
Preuper[72]	2008	32 F, 60 M	38.5	CLBP	—	Thr	TSK	—	—	RMDQ, LFT	—
Raichle[73]	2007	35 F, 92 M	48.5	SCI	16.6	Thr	SOPA	—	—	BPI	SF-36
Ramírez-Maestre[74]	2008	86 F, 49 M	55.7	MCP	9.6	Thr, Cha	CAI	VPMI	—	IFI	—
Ramírez-Maestre[75]	2008	80 F, 42 M	56	MCP	9	Thr, Cha	CAI	VPMI	—	IFI	—
Reneman[76]	2003	10 F, 54 M	38	CLBP	.81	Thr	TSK	—	—	LFT	—
Reneman[77]	2007	30 F, 49 M	37.8	CLBP	—	Thr	TSK	—	—	LFT	—
Roelofs[78]	2004	140 F, 85 M	50	CLBP	6.25	Thr	TSK	PCS	—	QBPD, BIKE, LFT	—
Roth[79,*]	2002	204 F, 95 M	39.6	MCP	3.49	Thr	SOPA	—	—	PDI	—
Samwel[81]	2008	108 F, 61 M	47.1	MCP	5.8	Thr	TSK	PCI	VAS	PDI	SCL-90
		116 F, 65 M	48.7	MCP	5.3	Thr	TSK	—	VAS	PDI	—
		70 F, 40 M	48.1	MCP	5.2	Thr	TSK	—	VAS	PDI	SCL-90
Schütze[83]	2010	71 F, 33 M	54.5	MCP	—	Thr	TSK	PCS	BPI-PS	BPI-FD	PNAS
Soer[85]	2006	21 F, 32 M	40.2	CLBP	6.4	Thr	TSK	—	—	LFT	—
Stubbs[86]	2010	259 F, 241 M	59	CMP	—	Thr	TSK	—	—	BPI	—
Sullivan[88]	2009	44 F, 46 M	40.6	CLBP	7.3	Thr	TSK	PCS	PRI	LFT	BDI
Tait[89]	1997	249 F, 146 M	47.1	MCP	6.3	Thr	SOPA	VPMI	NRS	PDI	CES-D
Thomas[91]	2010	15 F, 35 M	50.2	CLBP	9.74	Thr	TSK	—	—	RMDQ	HADS
Thompson[92]	2010	52 F, 41 M	51.1	CNP	4	Thr	TSK	PCS	NDI	NDI	—
Turk[97]	2004	209 F, 24 M	43.8	MCP	10.3	Thr	TSK	—	MPI	ODI	CES-D
Turner[98]	2000	91 F, 78 M	43.4	MCP	2.9	Thr	SOPA	—	—	RMDQ	CES-D
Turner[99]	2001	155 F, 32 M	38.8	TMD	6.23	Thr	SOPA	—	—	BPI	BDI
Verbunt[106]	2003	11 F, 26 M	45.2	CLBP	11.7	Thr	TSK	—	—	RMDQ	BDI
Vernon[108]	2011	42 F, 49 M	41.7	MCP	.78	Thr	TSK	—	VAS	NDI	—

Table 4. Continued

								Outcome Measure			
First Author	Year	N	Age	Pain Condition	Pain Duration	Appraisal Type	Appraisal Measure	Pain Coping	Pain Intensity	Disability	Emotional Distress
Vlaeyen[109]	1995	58 F, 45 M	40.7	CLBP	10.17	Thr	TSK	CSQ	—	—	BDI
Vlaeyen[110]	1995	79 F, 50 M	40.1	CLBP	9.9	Thr	TSK	PCL	MPQ	—	—
		17 F, 16 M	37.4	CLBP	7.6	Thr	TSK	PCL	VAS	RMDQ	—
Waxman[113]	2008	30 F, 24 M	50.5	CLBP	13.2	Thr	TSK	PCS	—	—	CES-D
Wicksell[114]	2007	457 F, 154 M	49	MCP	10	Thr	TSK	—	—	CPG	—
Woby[117]	2007	56 F, 127 M	43.9	CLBP	—	Thr	TSK	CSQ	VAS	RMDQ	HADS
Woby[118]	2007	52 F, 50 M	43.9	CLBP	—	Thr	TSK	CSQ	VAS	RMDQ	—
Wong[119]	2010	113 F, 103 M	39.7	MCP	5	Thr	TSK	—	NRS	CPG	HADS
		60 F, 49 M	54.7	MCP	7.3	Thr	TSK	—	NRS	CPG	HADS
Wong[120]	2011	113 F, 95 M	41	MCP	4.15	Thr	SOPA	PCS	—	CPG	CES-D

Abbreviations: F, female; M, male; CLBP, chronic low back pain; Thr, threat; PCS, Pain Catastrophizing Scale; RMDQ, Roland Morris Disability Questionnaire; WLK, walking; DA, daily activity; CES-D, Center for Epidemiologic Studies Depression Scale; CMP, chronic musculoskeletal pain; NRS, numerical rating scale; OSQ, Orebo Screening Questionnaire; MCP, mixed types of chronic pain; CSQ, Coping Strategies Questionnaire; PDI, Pain Disability Index; CBP, chronic back pain; VAS, visual analog scale; NES, Negative Emotionality Scale; LFT, lifting; PRSS, Pain Response Self-statements Scales; MPI, Multidimensional Pain Inventory; DASS-D, Depression Anxiety Stress Scale - Depression subscale; QBPD, Quebec Back Pain Disability Scale; RUN, running; BDI, Beck Depression Inventory; PRI, Pain Rating Index; PILE, The Progressive Isoinertial Lifting Evaluation; BIKE, bicycling; FRR, maximum electromyographic in flexion and average electromyographic in full flexion; IFI, Impairment and Functioning Inventory; HADS, Hospital Anxiety and Depression Scale; TEF, trunk extension-flexion test; SIP, Sickness Impact Profile; CPCI, Chronic Pain Coping Inventory; GHQ, General Health Questionnaire; Zung, Modified Zung Depression Questionnaire; CFS-APQ, Chronic Fatigue Syndrome–Activities and Participation Questionnaire; ODI, Oswestry Disability Index; DASS, Depression Anxiety Stress Scale; MS, multiple sclerosis; BPI, Brief Pain Inventory; SF-36, SF-36 Mental Health Scale; POM-S, Profile of Mood States; SCI, spinal cord injury; VPMI, Vanderbilt Pain Management Inventory; PCI, Pain Coping Inventory; SCL-90, The Symptoms Checklist-90; BPI-PS, Brief Pain Inventory–Pain Severity subscale; BPI-FD, Brief Pain Inventory–Functional Disability subscale; PNAS, The Positive and Negative Affect Schedule; CNP, chronic neck pain; NDI, Neck Disability Index; TMD, temporomandibular disorders; PCL, Pain Cognition List; MPQ, McGill Pain Questionnaire; CPG, Chronic Pain Grade.
*Measures of association were based on standardized regression coefficients or partial correlation coefficients.

Effects of Publication Bias

Trim and fill analyses based on random effects models identified asymmetrical effect size distributions for 1) threat appraisal–passive coping and 2) threat appraisal–pain intensity. Five studies with larger than average effect sizes were estimated to be missing from the distribution of threat appraisal–passive coping effect sizes. Their addition would result in a substantial increase from the observed (g = .45) to the adjusted value, g = .62 (95% confidence interval [CI] = .39, .85). Four studies with smaller than average effect sizes were estimated to be missing from the distribution of threat appraisal–pain intensity effect sizes. Their inclusion would result in a decrease from the observed effect size (g = .23) to an adjusted value, g = .15 (95% CI = .026, .28). Publication bias was also evaluated by comparing effect sizes for samples from published studies (n = 19) versus unpublished theses (n = 3). No differences were found for associations between threat appraisal and responses (all *P*'s > .290) or challenge appraisals and pain perception (all *P*'s > .350).

Meta-Analysis of Chronic Pain Studies

Descriptions of Studies

For chronic pain studies (Table 4), n's varied from 20 to 611 (M = 138.41, SD = 112.01). On average, samples were middle-aged (M = 45.25 years, SD = 6.07) and had more women (M = 57.43%, SD = 16.15, range = 15.63–92.54%) than men. Samples comprising heterogeneous pain conditions (n = 32) outnumbered those with back pain (n = 26), musculoskeletal pain (n = 4), TMD pain (n = 1), multiple sclerosis (n = 1), neck pain (n = 1), and spinal cord injury (n = 1). Mean pain duration of samples was 7.26 years (SD = 3.51, range = .78 years to 16.60 years). The average quality of included studies was 3.96 (SD = 1.12, range = 1–6), a finding indicating that many studies did not report details relevant to evaluating external and internal validity.

The TSK[63] assessed pain beliefs reflecting threat appraisals in 41 studies. The SOPA[45] Harm subscale was used in 13 other studies; its items tap beliefs that pain is a signal of potential damage and exercise/activity avoidance, in line with Lazarus'[54] view of threat appraisal (ie, potential damage) rather than harm-loss appraisal (ie, damage already done). Hence, for our purposes, SOPA Harm scale results were included in analyses of threat appraisal. In 1 study that used 3 versions of the SOPA,[48] only results for the longest version (SOPA-57) were used. Three studies used the CAI,[75] a multidimensional measure that has fidelity with the transactional model and separate subscales assessing perceptions of threat or potential future damage to lifestyle functioning, potential challenge in maintaining lifestyle functioning, and current harm/losses to various aspects of functioning as a result of having chronic pain. As described above, the PAI examined threat and challenge appraisals in 1 other study. Finally, the Appraisal of Illness Scale (AIS),[68] a measure of harm/loss, threat, challenge, positive, and benign appraisals, was used in 1 sample.[70] Studies using other popular measure of pain-related fear (eg, Fear-Avoidance Beliefs Scale, Pain Anxiety Sensitivity Scale) were excluded because substantial item content was not relevant or reflected damage already incurred from

Table 5. Association Between Primary Appraisal and Outcomes Related to Chronic Pain

Appraisal-Outcome Relation	N	r	95% Confidence Interval	Q Value	df (Q)	I-Square
Threat						
Active coping	1,114	−.19**	−.29 to −.081	17.54**	6	65.80
Passive coping	4,758	.45***	.40 to .51	140.45***	28	80.07
Pain intensity	5,036	.24***	.21 to .27	38.83	37	4.72
Impairment	8,266	.29***	.25 to .32	172.50***	59	65.80
Affective distress	5,035	.34***	.30 to .39	107.97***	36	66.66
Challenge						
Active coping	257	.48***	.31 to .62	2.57	2	61.08
Passive coping	398	−.36**	−.56 to −.12	13.19***	2	84.84
Impairment	398	−.40**	−.60 to −.15	14.43***	2	86.14
Affect distress	272	−.37*	−.63 to −.04	14.60***	2	86.30

*$P < .05$; **$P < .01$; ***$P \leq .001$.

pain (harm appraisals), not pain as a source of *potential* future damage or harm (threat appraisals).

Regarding outcome measures, 53 studies assessed impairment, whereas fewer studies assessed coping (n = 29) or pain intensity (n = 33). Thirty-five studies examined affective distress, particularly depressive symptoms, which were the focus in all but 9 studies that tapped general mood disturbances instead (Table 4).

Effect Size and Moderator Analyses

Effect sizes for all threat appraisal–outcome associations were small to medium and significant (Table 5). For relations between threat appraisal and impairment, the effect size was unchanged when results based on standard regression or partial correlation coefficients were omitted (r = .29, $P < .001$). Heterogeneity was also significant for associations between threat appraisal and all outcomes except pain intensity (Table 5).

Moderator analyses for threat appraisal–active coping relations indicated that studies using the CAI and SOPA had significant medium and small effect sizes, respectively, whereas the effect size for studies using the TSK was not significant. Heterogeneity in these relations was not significant after controlling for appraisal measure ($Q_{within} = 6.45$, $P = .168$). For age ($Q = 5.75$, $P = .017$), threat appraisal–active coping relations were higher in older (r = −.26, $P < .001$) as opposed to younger (r = −.08, $P = .134$) than average groups. Heterogeneity was not significant after controlling for age ($Q_{within} = 7.63$, $P = .178$). Neither sex nor pain duration had moderating effects (P's > .300).

For threat appraisal–passive coping relations, studies using the PAI, CAI, and TSK had medium to large effect sizes, whereas those using the SOPA had small effect sizes. Heterogeneity remained significant after controlling for appraisal measure ($Q_{within} = 73.74$, $P < .001$). Links between threat-appraisal and passive coping were attenuated as the proportion of women in a study rose (slope = −.008, $P = .006$). After controlling for gender, heterogeneity was not significant ($Q_{residual} = 29.69$, $P = .328$). Neither age nor pain duration moderated these relations (all P's > .750).

Threat appraisal–impairment effect sizes were moderated by type of impairment measure, Q = 19.51, $P < .001$; the correlation was higher for self-report (r = .32, $P < .001$) than for behavior performance (r = .15, $P < .001$) indices. However, heterogeneity remained significant after controlling for measure type ($Q_{within} = 155.06$, $P < .001$). Furthermore, neither the appraisal scale used (Table 6) nor sample characteristics moderated these associations (all P's > .100).

For affective distress, studies using the PAI and TSK to assess threat appraisal had medium to large effect sizes, whereas those using the SOPA had a relatively small effect size. Heterogeneity was significant after controlling for appraisal measure ($Q_{within} = 58.67$, $P = .005$). Threat-distress relations were attenuated as the proportion of women in a study increased (slope = −.005, $P = .009$), and heterogeneity was not significant after controlling for gender ($Q_{residual} = 31.07$, $P = .66$). Age and pain duration did not moderate these associations ($P > .510$).

For challenge appraisal–outcome relations, effect sizes, were typically medium in strength and significant (Table 5). Studies with associations based on standard regression or partial correlation coefficients were retained to ensure that a sufficient number of studies were available for analyses. Heterogeneity was high and significant for all outcomes except active coping.

Moderator analyses for challenge appraisal–passive coping relations indicated that studies using the CAI had a larger effect size than those using the PAI. Heterogeneity was reduced after controlling for measure used ($Q_{within} = .01$, $P = .911$). Relations between challenge appraisal and passive coping were stronger in samples that comprised more women than men (point of slope = −.016, $P < .001$). Heterogeneity was not significant after controlling for gender ($Q_{residual} = .01$, $P = .904$). Effects of age ($Q = 13.18$, $P < .001$) indicated that relations were stronger among older (r = −.466, $P < .001$) as opposed to younger (r = −.12, $P = .157$) than average groups. Heterogeneity was not significant after controlling for age ($Q_{within} = .01$, $P = .911$). Moderator analyses for pain duration were identical to those conducted for age because samples above and below the mean pain duration were the same.

For challenge appraisal–impairment associations, studies using the CAI had a larger effect size than those

Table 6. Moderating Effects of Pain Appraisal Measure on Associations Between Primary Appraisal and Chronic Pain Outcomes

Appraisal-Outcome Relation	Q Between	Appraisal Measure	k	r
Threat–active coping	10.45**	CAI	2	−.32***
		SOPA	3	−.19*
		TSK	2	−.04
Threat–passive coping	60.20***	CAI	2	.42***
		PAI	1	.65***
		SOPA	4	.21***
		TSK	22	.49***
Threat–pain intensity	3.94	PAI	1	.36***
		SOPA	6	.21***
		TSK	31	.25***
Threat–impairment	4.71	CAI	2	.38***
		PAI	1	.39***
		SOPA	12	.25***
		TSK	45	.29***
Threat–affect distress	38.25***	PAI	1	.61***
		SOPA	11	.23***
		TSK	25	.38***
Challenge–passive coping	13.18**	CAI	2	−.47**
		PAI	1	−.12
Challenge–impairment	7.82*	CAI	2	−.49**
		PAI	1	−.17*

*$P < .05$; **$P < .01$; ***$P < .001$.

using the PAI. Heterogeneity was reduced after controlling for appraisal scale used ($Q_{within} = 2.54$, $P = .111$). Relations were also stronger in samples that had more women than men (point of slope = −.016, $P = .001$), and heterogeneity was not significant after controlling for gender ($Q_{residual} = 1.00$, $P = .317$). For age ($Q = 7.82$, $P = .005$), challenge appraisal–impairment relations were stronger in older ($r = -.49$, $P < .001$) rather than younger ($r = -.17$, $P = .044$) than average samples. Heterogeneity was attenuated after controlling for age ($Q_{within} = 2.54$, $P = .111$). As above, findings for pain duration were identical to those for age.

Finally, for challenge appraisal–affective distress relations, effect sizes were stronger in samples having more women than men (slope = −.02, $P < .001$); heterogeneity was reduced after controlling for gender ($Q_{residual} = 1.00$, $P = .317$). Links between challenge appraisals and distress were stronger in older ($r = -.61$, $P < .001$) compared to younger ($r = -.21$, $P = .005$) than average groups ($Q = 14.56$, $P < .001$). Heterogeneity was not significant after controlling for age ($Q_{within} = .04$, $P = .847$). Results for pain duration were the same as those for age.

Effects of Publication Bias

Trim and fill analyses revealed asymmetrical effect size distributions for 1) threat appraisal–active coping, 2) threat appraisal–passive coping, and 3) threat appraisal–pain intensity relations. Two studies with larger than average effect sizes were estimated to be missing from the distribution of threat appraisal–active coping effect sizes. Their addition would result in an increase from r = −.19 to the adjusted value, r = −.24 (95% CI = −.33, −.14). Six studies with smaller than average effect sizes were estimated as missing from the distribution of threat appraisal–passive coping effect sizes. Their inclusion would result in a decrease from the observed (r = .45) to the adjusted value of r = .39 (95% CI = .33, .46). Two studies with larger than average effect sizes were estimated to be missing from the distribution of threat appraisal–pain intensity effect sizes. Their addition would result in a negligible change from the observed (r = .240) to the adjusted value, r = .243 (95% CI = .22, .27).

Discussion

In sum, separate meta-analyses on laboratory pain and chronic noncancer pain samples provided robust support for predictions derived from the transactional model of stress.[53,54,95] Specifically, within each set of studies, threat appraisals were related to increased pain perception and more passive coping, whereas challenge appraisals corresponded to less aversive responses to pain and less passive pain coping. However, also consistent with the transactional perspective, unique situation and person characteristics moderated associations between primary appraisals and responses to nociceptive laboratory stimuli and ongoing chronic pain.

In the meta-analysis of laboratory pain studies, heightened threat appraisals predicted reductions in pain tolerance and elevations in reported pain. Significant effect sizes based on experimental manipulations suggested that such judgments have causal effects on these responses, particularly tolerance. That is, beliefs that pain might threaten physical integrity may cause increased pain, a reduced capacity to bear pain, and associated escape tendencies[2,41] that are 1) potentially adaptive when threats of tissue damage are realistic but 2) potentially problematic when the odds of actual tissue damage are low or absent.

Moderator analyses for stimulus type indicated that threat appraisal–pain intensity relations were stronger for heat than cold or nonthermal nociceptive stimuli, in line with Dannecker et al,[17] who assessed various noxious stimuli. These authors found that adjectives used to describe heat pain ("flashing," "intense," "burning") differed from descriptors of ischemic pain ("tingling," "numb") or muscle pain ("tight," "sore," "tender," "annoying"); as such, quality of predominant sensations may have contributed threat appraisal differences. In addition, a priori ideas about the threat value of heat versus cold versus nonthermal stimuli may have had an impact based on Arntz and Claassens'[2] work. Moderator analyses also implicated effects of threat appraisal on pain intensity more strongly in studies featuring briefly applied noxious stimuli, perhaps because habituation was less possible.[41] Together, these results indicate that brief presentations of nociceptive heat may be best for laboratory research on appraisal–intensity relations. Conversely, when noxious stimuli, especially cold, persist, threat appraisals may continue to affect tolerance despite attenuated effects on intensity over time, perhaps because severity of pain has already peaked and/or the quality of pain sensations has changed when intensity is rated at tolerance.

Significant effect sizes for threat appraisal–coping relations highlighted how more defensive or protective coping approaches are adopted when pain sensations are viewed as signs of potential tissue damage. Significant interactions in studies of structured interventions including sensory focusing,[7] mindful acceptance,[44] and upward social comparison information[43] underscore how distinct strategies facilitate tolerance in less threatening conditions but are no more beneficial than control interventions in higher threat conditions. Small yet significant effect sizes for studies that used experimental manipulations suggest that threat appraisal is a causal influence on laboratory coping responses, consistent with the transactional approach.[53] However, because included studies assessed coping via self-reports *after* noxious stimuli had ceased, extensions should assess effects on coping efforts *during* painful stimulation.

Finally, threat appraisals were related more strongly to passive coping when samples had proportionately more men than women, an effect that extended to the chronic pain meta-analysis. Previously, Tamres et al[90] concluded that men are less likely than women to view stressors as threats and use a smaller variety of strategies in managing such demands. The present findings suggest that men who appraise pain as a threat focus more narrowly on passive coping responses than women who view pain as a threat do. As such, changing distorted beliefs could be especially useful in helping these men to manage the negative effects of pain in a flexible manner.

Challenge appraisals of laboratory nociception corresponded to better pain tolerance but were not related to overall intensity. Nonetheless, moderator analyses revealed that heightened challenge appraisals correspond to *higher* intensity ratings of noxious heat and nonthermal stimuli but are unrelated to intensity of cold pressor pain, paralleling the pattern of moderator effects of stimulus type on threat appraisals. Reasons for this effect are unclear, but a plausible hypothesis is that exacerbations in pain intensity reflected both increased anxiety or arousal resulting from a desire to persevere (ie, high challenge appraisal) and increased escape tendencies triggered by beliefs that possible damage was more likely from heat than other sources of pain. Challenge appraisals were more clearly related to pain tolerance than intensity, yet firm conclusions about their causal impact are premature because only 1 included study manipulated the meaning of pain as a challenge.[105] Given that this manipulation had a significant impact on tolerance, replications and extensions based on varying perceived opportunities for future profit, psychological growth, or mastery should proceed to clarify causal effects of challenge appraisal on laboratory pain responses more fully.

In chronic pain samples, threat appraisals of pain were linked to elevations in passive coping, pain intensity, impairment, and affective distress but not active coping, whereas challenge appraisals typically had complementary relations with these outcomes. Overall effect sizes were generally larger than those reported in a meta-analysis on appraisal and coping in cancer patients[27] and draw support from Lazarus and Folkman's[53] contention that people are more likely to engage in defensive coping when stressors are seen as potential threats or resistant to positive change.

Threat appraisals had particularly strong associations with passive coping, even adjusting for missing studies. Of note, pain catastrophizing measures were included within the passive coping category, and researchers have debated whether catastrophizing is a construct that best reflects primary (or secondary) appraisals rather than coping.[87,94] Arguably, the manner and context in which catastrophizing is used can reflect either appraisal or coping. For example, catastrophic interpretations of current and future events are in line with Lazarus'[54] operationalization of harm and threat appraisals, respectively, yet the expression of catastrophic thoughts can reflect coping efforts via venting or soliciting others' social support.[87] Although none of the individual associations between threat appraisal and catastrophizing indicated they were measuring the same construct, conceptual and content overlaps between these measures may have contributed to their stronger effect overall compared to other appraisal–outcomes relations.

Regardless, entrenched beliefs that pain is potentially damaging may perpetuate impairment and affective distress as a partial result of their impact on coping. Williams and Keefe[116] noted that clinical pain patients who misunderstand the nature of their pain do not view coping skills training as appropriate. However, given that threat appraisals contribute to disability and depression after controlling for coping, demographics, pain intensity, and catastrophizing,[99] relations between pain beliefs and functional outcomes may not be mediated entirely by coping. Nonetheless, evidence that treatment-induced decreases in the view that pain signals damage correspond to reductions in pain behavior, physical disability, and depression between baseline and follow-up[47] suggests that targeting maladaptive pain beliefs for identification and change may improve treatment efficacy compared to adopting coping as a sole intervention focus.

Moderating effects of appraisal scale used were widespread in chronic pain samples. Specifically, effect sizes for threat appraisal–outcome relations measured with the CAI[75] and PAI[100] were typically larger than those examined with the TSK[63] or SOPA,[45] whereas challenge appraisal–outcome relations were stronger when the CAI was used instead of the PAI. In part, larger effect sizes for the CAI and PAI could reflect content overlaps between measures of appraisal (eg, potential interference with lifestyle) and outcomes (eg, current interference with lifestyle) relative to the TSK and SOPA, which focus on pain and movement or exercise as sources of potential physical damage. The overall pattern suggests that the CAI may have particular utility when clinicians or researchers wish to evaluate primary stress appraisals that follow from the transactional model. On the other hand, the TSK and SOPA Harm subscale also had significant correlations with outcomes and have been used more extensively in research. As such, the TSK most clearly has utility in studies based on fear-avoidance frameworks or those that focus exclusively on effects of threat appraisal, whereas the SOPA is likely most useful

when coverage of a wider array of pain beliefs, including those aligned with threat appraisal, is the thrust.

Other moderator analyses suggested that beliefs about pain as a potential threat corresponded to outcomes more strongly when samples had more men, were older than average, or had pain for longer than average durations. Conversely, links between challenge appraisal and outcomes were stronger within samples having proportionately more women, pain for longer than average durations, and/or older than average ages. Within such subgroups, interventions that address these beliefs[18,111] may be especially important in improving functioning, albeit this conclusion is tentative for the challenge appraisal findings that were based on only a handful of studies.

Finally, although use of psychometrically sound primary appraisal and outcome measures as inclusion criteria likely bolstered the reliability of findings within each meta-analysis, on average the quality of studies in the chronic pain meta-analysis was disappointing. By and large, low-quality scores were a function of failing to assess or explicitly report information about sample characteristics such as education level, inclusion and exclusion criteria, recruitment and cover story, and management of missing data. Such omissions would not likely influence effect sizes directly compared to using psychometrically weak measures, but information about generalizability is compromised by these oversights. Other studies were excluded from the chronic pain meta-analysis altogether because of missing details about essential sample characteristics (eg, pain duration) or effect size calculations or because nonvalidated measures/procedures were used. Vigilance in reporting complete information, including details about nonsignificant effect sizes, is needed as a matter of course to enhance the quality of individual studies, increase understanding of their external validity, and improve the veracity of general conclusions drawn about the overall literature.

Despite its potential implications, the main caveats of this research warrant attention. First, given the focus on adult samples, conclusions may not generalize to children, acute pain experiences, or particular pain conditions. Second, most chronic pain studies relied on cross-sectional designs, so it is unclear whether elevated threat or challenge appraisal preceded or followed increases in impairment, affective distress, or passive coping among those with ongoing pain. Prospective studies may clarify the status of primary appraisals as risk/protective factors for later outcomes and predictors of treatment responses. Third, although heterogeneity in most appraisal–outcome associations was not significant after controlling for specific moderators, other potential moderators warrant consideration in future work. For example, in research on chronic pain, the scope of potential moderators might be expanded to include other correlates of adjustment, including socioeconomic status,[80] employment status,[39,40] specific pain sites,[24] and effects of attention focus, that is, distraction versus sensory focusing.[44,84,107]

Fourth, use of the transactional approach as the guiding model resulted in the selection of studies that highlighted the unique role of threatening or challenging primary appraisals of pain on key aspects of adjustment. Nonetheless, recent reviews and related studies[13,14,25,55,101,102,104] have shown how pain or its anticipation are threats in themselves that disrupt attention toward other goals or ongoing behavior; however, when the threat value of pain is high, disengaging from pain or its anticipated location can interfere with directing attention toward other environmental stimuli, ultimately resulting in impaired functioning. Hence, as data summarized in these accounts demonstrate, the role of attention and alternative conceptualizations of threat are also likely essential to fully elucidating the nature and impact of threat on pain. Finally, although primary appraisals derived from the transactional model were emphasized here, other types of pain beliefs also affect functioning.[34,45-49] For example, studies using the SOPA highlight links between other types of pain beliefs (eg, control, medication, solicitude) and various outcomes.[48] Perhaps this theory-guided evaluation of appraisal-outcomes relations can be an impetus for measure-based meta-analyses on links between various types of pain beliefs and functioning.

In conclusion, syntheses of results from 2 meta-analyses highlighted robust overall relations between primary appraisals of threat or challenge and outcomes of laboratory pain and ongoing chronic pain. Findings indicate that responses to pain in each context may be clarified by considering pain appraisals or beliefs within assessments. In addition, toward explaining variability in each literature, the moderating effects of key sample and methodologic factors were identified and can help to guide research designs, sample selection, measurement choices, and intervention targets for research and practice related to appraisals of pain.

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References

1. Alschuler KN, Hoodin F, Murphy SL, Geisser ME: Ambulatory monitoring as a measure of disability in chronic low back pain populations. Clin J Pain 27:707-715, 2011

2. Arntz A, Claassens L: The meaning of pain influences its experienced intensity. Pain 109:20-25, 2004

3. Büssing A, Ostermann T, Lüdtke R, Michalsen A: Effects of yoga interventions on pain and pain-associated disability: A meta-analysis. J Pain 13:1-9, 2012

4. Bishop MD, Horn ME, George SZ, Robinson ME: Self-reported pain and disability outcomes from an endogenous model of muscular back pain. BMC Musculoskelet Disord 12:35, 2011

5. Boersma K, Linton SJ: How does persistent pain develop? An analysis of the relationship between psychological variables, pain and function across stages of chronicity. Behav Res Ther 43:1495-1507, 2005

6. Borenstein M, Hedges L, Higgins J, Rothstein H: Comprehensive Meta-Analysis Version 2. Englewood, NJ, Biostat, 2005

7. Boston A, Sharpe L: The role of threat-expectancy in acute pain: Effects on attentional bias, coping strategy effectiveness and response to pain. Pain 119:168-175, 2005

8. Brown GK, Nicassio PM: Development of a questionnaire for the assessment of active and passive coping strategies in chronic pain patients. Pain 31:53-64, 1987

9. Cohen J: A power primer. Psychol Bull 112:155-158, 1992

10. Cook AJ, Brawer PA, Vowles KE: The fear-avoidance model of chronic pain: Validation and age analysis using structural equation modeling. Pain 121:195-206, 2006

11. Crombez G, Eccleston C, Baeyens F, Van Houdenhove B, Van Den Broeck A: Attention to chronic pain is dependent upon pain-related fear. J Psychosom Res 47:403-410, 1999

12. Crombez G, Vlaeyen JW, Heuts PH, Lysens R: Pain-related fear is more disabling than pain itself: Evidence on the role of pain-related fear in chronic back pain disability. Pain 80: 329-339, 1999

13. Crombez G, Van Damme S, Eccleston C: Hypervigilance to pain: An experimental and clinical analysis. Pain 116: 4-7, 2005

14. Crombez G, Dimitri M, Eccleston C, Van Damme S: Attentional bias to pain-related information: A meta-analysis. Pain 154:497-510, 2012

15. Crombez G, Viane I, Eccleston C, Devulder J, Goubert L: Attention to pain and fear of pain in patients with chronic pain. J Behav Med 36:1-8, 2013

16. Cunningham J: The Role of Pain Catastrophizing and Threat/Harm Appraisals in Pain Responsivity. Tuscaloosa, University of Alabama, 2011

17. Dannecker EA, Price DD, O'Connor PD, Robinson ME: Appraisals of pain from controlled stimuli: Relevance to quantitative sensory testing. Br J Health Psychol 3:537-550, 2008

18. De Jong JR, Vlaeyen JW, van Eijsden M, Loo C, Onghena P: Reduction of pain-related fear and increased function and participation in work-related upper extremity pain (WRUEP): Effects of exposure in vivo. Pain 153: 2109-2118, 2012

19. De Rooij A, Steultjens M, Siemonsma P, Vollebregt J, Roorda L, Beuving W, Dekker J: Overlap of cognitive concepts in chronic widespread pain: An exploratory study. BMC Musculoskelet Disord 12:218, 2011

20. DeGood DE, Cook AJ: Psychosocial assessment, in Turk DC, Melzack R (eds): Handbook of Pain Assessment. New York, NY, Guilford, 2011, pp 67-97

21. Dehghani M, Sharpe L, Nicholas MK: Structural evaluation of the contemporary psychological models of chronic pain: Does fear of pain work for all? Cogn Behav Ther 39: 214-224, 2010

22. Duquette J, McKinley PA, Litowski J: Test-retest reliability and internal consistency of the Quebec-French version of the Survey of Pain Attitudes. Arch Phys Med Rehabil 86:782-788, 2005

23. Duval S, Tweedie R: Trim and fill: A simple funnel plot–based method of testing and adjusting for publication bias in meta-analysis. Biometrics 56:455-463, 2000

24. Dworkin RH: Which individuals with acute pain are most likely to develop a chronic pain syndrome? Pain Forum 6: 148-150, 1997

25. Eccleston C, Crombez G: Pain demands attention: A cognitive–affective model of the interruptive function of pain. Psychol Bull 125:356-366, 1999

26. Forsythe LP, Thorn B, Day M, Shelby G: Race and sex differences in primary appraisals, catastrophizing, and experimental pain outcomes. J Pain 12:563-572, 2011

27. Franks HM, Roesch SC: Appraisals and coping in people living with cancer: A meta-analysis. Psychooncology 15: 1027-1037, 2006

28. French DJ, France CR, Vigneau F, French JA, Evans RT: Fear of movement/(re)injury in chronic pain: A psychometric assessment of the original English version of the Tampa Scale for Kinesiophobia (TSK). Pain 127:42-51, 2007

29. Gómez-Pérez L, López-Martínez AE, Ruiz-Párraga GT: Psychometric Properties of the Spanish Version of the Tampa Scale for Kinesiophobia (TSK). J Pain 12:425-435, 2011

30. Geisser ME, Haig AJ, Theisen ME: Activity avoidance and function in persons with chronic back pain. J Occup Rehabil 10:215-227, 2000

31. Geisser ME, Haig AJ, Wallbom AS, Wiggert EA: Pain-related fear, lumbar flexion, and dynamic EMG among persons with chronic musculoskeletal low back pain. Clin J Pain 20:61-69, 2004

32. George SZ, Dover GC, Fillingim RB: Fear of pain influences outcomes after exercise-induced delayed onset muscle soreness at the shoulder. Clin J Pain 23:76-84, 2007

33. Goubert L, Crombez G, Lysens R: Effects of varied-stimulus exposure on overpredictions of pain and behavioural performance in low back pain patients. Behav Res Ther 43:1347-1361, 2005

34. Helmes E, Goburdhun A: Cognitions related to chronic pain: Revision and extension of the cognitive evaluation questionnaire. Clin J Pain 23:53-61, 2007

35. Herrero A, Ramírez Maestre C, González V: Personality, cognitive appraisal and adjustment in chronic pain patients. Span J Psychol 11:531-541, 2008

36. Higgins JP, Thompson SG, Deeks JJ, Altman DG: Measuring inconsistency in meta-analyses. BMJ 327:557, 2003

37. Hoffman BM, Papas RK, Chatkoff DK, Kerns RD: Meta-analysis of psychological interventions for chronic low back pain. Health Psychol 26:1-7, 2007

38. Huijnen IP, Verbunt JA, Roelofs J, Goossens M, Peters M: The disabling role of fluctuations in physical activity in patients with chronic low back pain. Eur J Pain 13:1076-1079, 2009

39. Jackson T, Iezzi A, Lafreniere K: The differential effects of employment status on chronic pain and healthy comparison groups. Int J Behav Med 3:354-369, 1996

40. Jackson T, Iezzi A, Lafreniere K: The impact of psychosocial features of employment status on emotional distress in chronic pain and healthy comparison samples. J Behav Med 20:241-256, 1997

41. Jackson T, Pope L, Nagasaka T, Fritch A, Iezzi T, Chen H: The impact of threatening information about pain on coping and pain tolerance. Br J Health Psychol 10:441-451, 2005

42. Jackson T, Huang X, Chen H, Phillips H: Effects of threatening information on interpersonal responses to pain. Eur J Pain 13:431-438, 2009

43. Jackson T, Phillips H: Social comparison performance standards, threat, and tolerance for experimentally-induced pain. Eur J Pain 15:1081-1086, 2011

44. Jackson T, Yang Z, Li X, Chen H, Huang X, Meng J: Coping when pain is a potential threat: The efficacy of acceptance versus cognitive distraction. Eur J Pain 16:390-400, 2012

45. Jensen MP, Karoly P: Pain-specific beliefs, perceived symptom severity, and adjustment to chronic pain. Clin J Pain 8:123-130, 1992

46. Jensen MP, Turner JA, Romano JM, Lawler BK: Relationship of pain-specific beliefs to chronic pain adjustment. Pain 57:301-309, 1994

47. Jensen MP, Romano JM, Turner JA, Good AB, Wald LH: Patient beliefs predict patient functioning: Further support for a cognitive-behavioural model of chronic pain. Pain 81: 95-104, 1999

48. Jensen MP, Turner JA, Romano JM: Pain belief assessment: A comparison of the short and long versions of the survey of pain attitudes. J Pain 1:138-150, 2000

49. Jensen MP, Keefe FJ, Lefebvre JC, Romano JM, Turner JA: One- and two-item measures of pain beliefs and coping strategies. Pain 104:453-469, 2003

50. Karsdorp PA, Ranson S, Schrooten MGS, Vlaeyen JWS: Pain catastrophizing, threat, and the informational value of mood: Task persistence during a painful finger pressing task. Pain 153:1410-1417, 2012

51. Knussen C, McParland JL: Catastrophizing, ways of coping and pain beliefs in relation to pain intensity and pain-related disability. J Pain Manag 2:203-215, 2009

52. Koho P, Aho S, Watson P, Hurri H: Assessment of chronic pain behaviour: Reliability of the method and its relationship with perceived disability, physical impairment and function. J Rehabil Med 33:128-132, 2001

53. Lazarus RS, Folkman S: Stress, Appraisal, and Coping. New York, NY, Springer, 1984

54. Lazarus RS: Stress and Coping: A New Synthesis. New York, NY, Springer, 1999

55. Legrain V, Van Damme S, Eccleston C, Davis KD, Seminowicz DA, Crombez G: A neurocognitive model of attention to pain: Behavioral and neuroimaging evidence. Pain 144:230-232, 2009

56. Lewis GN, Rice DA, McNair PJ: Conditioned pain modulation in populations with chronic pain: A systematic review and meta-analysis. J Pain 3:936-944, 2012

57. Lewis S, Holmes P, Woby S, Hindle J, Fowler N: The relationships between measures of stature recovery, muscle activity and psychological factors in patients with chronic low back pain. Man Ther 17:27-33, 2012

58. Li X: The Influence of Threatening Information on Cold Pressor Pain. Chongqing, China, Southwest University, 2010

59. Machin A: Appraisal and Coping Styles of Perfectionists in Achievement Situations. Townsville, James Cook University, 2012

60. McGowan N, Sharpe L, Refshauge K, Nicholas M: The effect of attentional re-training and threat expectancy in response to acute pain. Pain 142:101-107, 2009

61. Meeus M, Nijs J, Van Mol E, Truijen S, De Meirleir K: Role of psychological aspects in both chronic pain and in daily functioning in chronic fatigue syndrome: A prospective longitudinal study. Clin Rheum 31:921-929, 2012

62. Meredith P, Strong J, Feeney J: Evidence of a relationship between adult attachment variables and appraisals of chronic pain. Pain Res Manag 10:191-200, 2005

63. Miller RP, Kori SH, Todd DD: The Tampa Scale: A measure of kinesiophobia. Clin J Pain 7:51-52, 1991

64. Monticone M, Baiardi P, Ferrari S, Foti C, Mugnai R, Pillastrini P, Rocca B, Vanti C: Development of the Italian version of the Pain Catastrophising Scale (PCS-I): Cross-cultural adaptation, factor analysis, reliability, validity and sensitivity to change. Qual Life Res 21:1045-1050, 2012

65. Moskowitz JT, Hult JR, Bussolari C, Acree M: What works in coping with HIV? A meta-analysis with implications for coping with serious illness. Psychol Bull 135:121-141, 2009

66. Nicholas MK, Asghari A: Investigating acceptance in adjustment to chronic pain: Is acceptance broader than we thought? Pain 124:269-279, 2006

67. Nijs J, Vanherberghen K, Duquet W, De Meirleir K: Chronic fatigue syndrome: Lack of association between pain-related fear of movement and exercise capacity and disability. Phys Ther 84:696-705, 2004

68. Oberst MT, Hughes SH, Chang AS, McCubbin MA: Self-care burden, stress appraisal, and mood among persons receiving radiotherapy. Cancer Nurs 14:71-78, 1991

69. Osborne TL, Jensen MP, Ehde DM, Hanley MA, Kraft G: Psychosocial factors associated with pain intensity, pain-related interference, and psychological functioning in persons with multiple sclerosis and pain. Pain 127:52-62, 2007

70. Pellino TA, Oberst MT: Perception of control and appraisal of illness in chronic low back pain. Orthop Nurs 11:22-26, 1992

71. Peters ML, Vlaeyen JW, Weber WE: The joint contribution of physical pathology, pain-related fear and catastrophizing to chronic back pain disability. Pain 113:45-50, 2005

72. Preuper HS, Reneman M, Boonstra A, Dijkstra P, Versteegen G, Geertzen J, Brouwer S: Relationship between psychological factors and performance-based and self-reported disability in chronic low back pain. Eur Spine J 17: 1448-1456, 2008

73. Raichle KA, Hanley M, Jensen MP, Cardenas DD: Cognitions, coping, and social environment predict adjustment to pain in spinal cord injury. J Pain 8:718-729, 2007

74. Ramírez-Maestre C, Esteve R, López AE: Cognitive appraisal and coping in chronic pain patients. Eur J Pain 12:749-756, 2008

75. Ramírez-Maestre C, Esteve R, López AE: Development of a questionnaire of cognitive appraisal in chronic pain. Psicol Cond 16:55-68, 2008

76. Reneman MF, Jorritsma W, Dijkstra SJ, Dijkstra PU: Relationship between kinesiophobia and performance in a functional capacity evaluation. J Occup Rehabil 13:277-285, 2003

77. Reneman MF, Preuper HRS, Kleen M, Geertzen JH, Dijkstra PU: Are pain intensity and pain related fear related to functional capacity evaluation performances of patients

with chronic low back pain? J Occup Rehabil 17:247-258, 2007

78. Roelofs J, Goubert L, Peters ML, Vlaeyen JW, Crombez G: The Tampa Scale for Kinesiophobia: Further examination of psychometric properties in patients with chronic low back pain and fibromyalgia. Eur J Pain 8:495-502, 2004

79. Roth RS, Geisser ME: Educational achievement and chronic pain disability: Mediating role of pain-related cognitions. Clin J Pain 18:286-296, 2002

80. Saastamoinen P, Leino-Arjas P, Laaksonen M, Lahelma E: Socio-economic differences in the prevalence of acute, chronic and disabling chronic pain among ageing employees. Pain 114:364-371, 2005

81. Samwel JJA: Chronic Pain Treatment: From Psychological Predictors to Implementation. Wageningen, Netherlands, Pensen and Looyen, 2008

82. Sanford SD, Kersh BC, Thorn BE, Rich MA, Ward LC: Psychosocial mediators of sex differences in pain responsivity. J Pain 3:58-64, 2002

83. Schütze R, Rees C, Preece M, Schütze M: Low mindfulness predicts pain catastrophizing in a fear-avoidance model of chronic pain. Pain 148:120-127, 2010

84. Sharpe L, Nicholson Perry K, Rogers P, Dear B, Nicholas M, Refshauge K: A comparison of the effect of attention training and relaxation on responses to pain. Pain 150:469-476, 2010

85. Soer R, Poels BJ, Geertzen JH, Reneman MF: A comparison of two lifting assessment approaches in patients with chronic low back pain. J Occup Rehabil 16:639-646, 2006

86. Stubbs D, Krebs E, Bair M, Damush T, Wu J, Sutherland J, Kroenke K: Sex differences in pain and pain-related disability among primary care patients with chronic musculoskeletal pain. Pain Med 11:232-239, 2010

87. Sullivan MJ, Thorn B, Haythornthwaite JA, Keefe F, Martin M, Bradley LA, Lefebvre JC: Theoretical perspectives on the relation between catastrophizing and pain. Clin J Pain 17:52-64, 2001

88. Sullivan MJ, Thibault P, Andrikonyte J, Butler H, Catchlove R, Larivière C: Psychological influences on repetition-induced summation of activity-related pain in patients with chronic low back pain. Pain 141:70-78, 2009

89. Tait CR, Chibnall JT: Development of a brief version of the Survey of Pain Attitudes. Pain 70:229-235, 1997

90. Tamres LK, Janicki D, Helgeson VS: Sex differences in coping behavior: A meta-analytic review and an examination of relative coping. Pers Soc Psychol Rev 6:2-30, 2002

91. Thomas E-N, Pers Y-M, Mercier G, Cambiere J-P, Frasson N, Ster F, Hérisson C, Blotman F: The importance of fear, beliefs, catastrophizing and kinesiophobia in chronic low back pain rehabilitation. Ann Phys Rehabil Med 53:3-14, 2010

92. Thompson DP, Urmston M, Oldham JA, Woby SR: The association between cognitive factors, pain and disability in patients with idiopathic chronic neck pain. Disabil Rehabil 32:1758-1767, 2010

93. Thompson SG, Higgins J: How should meta-regression analyses be undertaken and interpreted? Stat Med 21: 1559-1573, 2002

94. Thorn BE, Rich MA, Boothby JL: Pain beliefs and coping attempts: Conceptual model building. Pain Forum 8: 169-171, 2000

95. Tomaka J, Blascovich J, Kelsey RM, Leitten CL: Subjective, physiological, and behavioral effects of threat and challenge appraisal. J Pers Soc Psychol 65:248-260, 1993

96. Trost Z, France CR, Thomas JS: Pain-related fear and avoidance of physical exertion following delayed-onset muscle soreness. Pain 152:1540-1547, 2011

97. Turk DC, Robinson JP, Burwinkle T: Prevalence of fear of pain and activity in patients with fibromyalgia syndrome. J Pain 5:483-490, 2004

98. Turner JA, Jensen MP, Romano JM: Do beliefs, coping, and catastrophizing independently predict functioning in patients with chronic pain? Pain 85:115-125, 2000

99. Turner JA, Dworkin SF, Mancl L, Huggins KH, Truelove EL: The roles of beliefs, catastrophizing, and coping in the functioning of patients with temporomandibular disorders. Pain 92:41-51, 2001

100. Unruh A, Ritchie J: Development of the pain appraisal inventory: Psychometric properties. Pain Res Manag 3: 105-110, 1998

101. Van Damme S, Crombez G, Eccleston C, Roelofs J: The role of hypervigilance in the experience of pain, in Asmundson GJG, Vlaeyen JWS, Crombez G (eds): Understanding and Treating Fear of Pain. Oxford, Oxford University Press, 2004, pp 71-90

102. Van Damme S, Crombez G, Lorenz J: Pain draws visual attention to its location: Experimental evidence for a threat-related bias. J Pain 8:976-982, 2007

103. Van Damme S, Crombez G, Van Nieuwenborgh-De Wever K, Goubert L: Is distraction less effective when pain is threatening? An experimental investigation with the cold pressor task. Eur J Pain 12:60-67, 2008

104. Van Damme S, Legrain V, Vogt J, Crombez G: Keeping pain in mind: A motivational account of attention to pain. Neurosci Biobehav Rev 34:204-213, 2010

105. Van Damme S, Van Ryckeghem DML, Wyffels F, Van Hulle L, Crombez G: No pain no gain? Pursuing a competing goal inhibits avoidance behavior. Pain 153: 800-804, 2012

106. Verbunt JA, Seelen HA, Vlaeyen JW, van der Heijden GJ, Knottnerus JA: Fear of injury and physical deconditioning in patients with chronic low back pain. Arch Phys Med Rehabil 84:1227-1232, 2003

107. Verhoeven K, Crombez G, Eccleston C, Van Ryckeghem DML, Morley S, Van Damme S: The role of motivation in distracting attention away from pain: An experimental study. Pain 149:229-234, 2010

108. Vernon H, Guerriero R, Soave D, Kavanaugh S, Puhl A, Reinhart C: The relationship between self-rated disability, fear-avoidance beliefs, and nonorganic signs in patients with chronic whiplash-associated disorder. J Manipulative Physiol Ther 34:506-513, 2011

109. Vlaeyen JW, Kole-Snijders AM, Boeren RG, Van Eek H: Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. Pain 62:363-372, 1995

110. Vlaeyen JW, Kole-Snijders AM, Rotteveel AM, Ruesink R, Heuts PH: The role of fear of movement/(re)injury in pain disability. J Occup Rehabil 5:235-252, 1995

111. Vlaeyen JW, de Jong J, Geilen M, Heuts PH, van Breukelen G: The treatment of fear of movement/(re)injury in chronic low back pain: Further evidence on the effectiveness of exposure in vivo. Clin J Pain 18:251-261, 2002

112. Vlaeyen JWS, Hanssen M, Goubert L, Vervoort T, Peters M, Van Breukelen G, Sullivan MJL, Morley S: Threat of pain influences social context effects on verbal pain report and facial expression. Behav Res Ther 47:774-782, 2009

113. Waxman SE, Tripp DA, Flamenbaum R: The mediating role of depression and negative partner responses in chronic low back pain and relationship satisfaction. J Pain 9:434-442, 2008

114. Wicksell RK, Olsson GL, Melin L: The Chronic Pain Acceptance Questionnaire (CPAQ): Further validation including a confirmatory factor analysis and a comparison with the Tampa Scale of Kinesiophobia. Eur J Pain 13: 760-768, 2007

115. Wiech K, Lin CS, Brodersen KH, Bingel U, Ploner M, Tracey I: Anterior insula integrates information about salience into perceptual decisions about pain. J Neurosci 30:16324-16331, 2010

116. Williams DA, Keefe FJ: Pain beliefs and the use of cognitive-behavioral coping strategies. Pain 46:185-190, 1991

117. Woby SR, Roach NK, Urmston M, Watson PJ: The relation between cognitive factors and levels of pain and disability in chronic low back pain patients presenting for physiotherapy. Eur J Pain 11:869-877, 2007

118. Woby SR, Urmston M, Watson PJ: Self-efficacy mediates the relation between pain-related fear and outcome in chronic low back pain patients. Eur J Pain 11:711-718, 2007

119. Wong WS, Kwok HY, Luk KD, Chow YF, Mak KH, Tam BK, Wong ET, Fielding R: Fear of movement/(re) injury in Chinese patients with chronic pain: Factorial validity of the Chinese version of the Tampa Scale for Kinesiophobia. J Rehabil Med 42:620-629, 2010

120. Wong WS, Jensen MP, Mak KH, Fielding R: Pain-related beliefs among Chinese patients with chronic pain: The construct and concurrent predictive validity of the Chinese version of the survey of pain attitudes-14 (ChSOPA-14). J Pain Symptom Manage 42:470-478, 2011

Appendix

Classification of Coping Strategies

Active Coping

VMPI–active coping, CPCI–relaxation, CPCI–task persistence, CPCI–exercise/stretching, CPCI–seeking social support, CPCI–coping self statements, CSQ–diverting attention, CSQ–reinterpreting, CSQ–ignoring sensations, CSQ–coping self statements, CSQ–increasing behavior, CSQ–control, CSQ–acceptance, COPE–active coping, COPE–planning, COPE–positive reinterpretation.

Passive Coping

VMPI–passive coping, CPCI–guarding, CPCI–resting, CPCI–asking for assistance, CSQ–catastrophizing, CSQ–praying, CSQ–denial, COPE–venting emotion, COPE–denial, COPE–disengagement, PCS, PRSS–catastrophizing, PCL–catastrophizing, PCI–catastrophizing, PCI–retreating, PCI–resting.

Abbreviations: VMPI, Vanderbilt Pain Management Inventory; CPCI, Chronic Pain Coping Index; CSQ, Coping Strategies Questionnaire; PCS, Pain Catastrophizing Scale; PRSS, Pain Response Self-statements Scales; PCL, Pain Cognition List; PCI, Pain Coping Inventory.