Journal of Psychosomatic Research 168 (2023) 111208

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

journal homepage: www.elsevier.com/locate/jpsychores

Improvements in pain coping predict treatment success among patients with chronic primary pain

Alina Scheidegger [a,b,*], Juan Martín Gómez Penedo [c], Larissa Tatjana Blättler [a], Selma Aybek [a], Nina Bischoff [a], Martin grosse Holtforth [a,b]

[a] Psychosomatic Medicine, Department of Neurology, Inselspital, Bern University Hospital, University of Bern, Switzerland
[b] Department of Psychology, University of Bern, Bern, Switzerland
[c] CONICET Universidad de Buenos Aires, Facultad de Psicología, Buenos Aires, Argentina

ARTICLE INFO

Keywords:
Chronic pain
Hierarchical linear models
Interdisciplinary pain treatment
Pain coping
Pain processing

ABSTRACT

Objective: Given the increasing incidence and prevalence of chronic pain, effective treatments for chronic pain are needed. This study aimed to investigate the role of cognitive and behavioral pain coping regarding the prediction of treatment outcomes among inpatients with chronic primary pain participating in an interdisciplinary multimodal treatment program.

Methods: At intake and discharge, 500 patients with chronic primary pain completed questionnaires on pain intensity, pain interference, psychological distress, and pain processing.

Results: Patients' symptoms, cognitive and behavioral pain coping improved significantly after treatment. Similarly, separate cognitive and behaviroal coping skills improved significantly after treatment. Hierarchical linear models revealed no significant associations of pain coping with reductions in pain intensity. Whereas the overall level and improvements in *cognitive* pain coping predicted reductions in pain interference and psychological distress, the overall level and improvements in *behavioral* pain coping were associated with reductions in pain interference alone.

Discussion: Since pain coping seems to influence both pain interference and psychological distress, improving cognitive and behavioral pain coping during an interdisciplinary multimodal pain treatment seems to be a key component in the successful treatment of inpatients with chronic primary pain, enabling them to function better physically and mentally despite their chronic pain. Clinically, it might be worth fostering and exercising *cognitive restructuring* as well as *action planning* in treatment to reduce both pain interference and psychological distress levels post-treatment. In addition, practicing *relaxation techniques* might help reduce pain interference post-treatment, whereas making *experiences* of personal *competence* might help reduce psychological distress post-treatment.

1. Introduction

The increasing incidence and prevalence of chronic pain suggest that more and more people worldwide suffer from chronic pain, resulting in severe psychological, social, and physical consequences [1,2]. Physical and psychological consequences are strongly interrelated and can also reinforce each other [2]. It is estimated that 20–50% of people who suffer from chronic pain also suffer from anxiety and depression [3,4]. Due to the high burden of chronic pain on the individual and society, it is crucial to find appropriate and effective treatment options for chronic pain [4].

The biopsychosocial approach of interdisciplinary multimodal treatment is considered particularly suitable for chronic pain, as it combines different treatment modalities (e.g., psychological treatment, physical therapy, occupational therapy, relaxation techniques) [5]. A major goal of psychological treatment is to identify and change dysfunctional pain coping that potentially contributes to the chronification of pain via maladaptive thoughts and behaviors (e.g., catastrophizing, fear avoidance behaviors, and beliefs) and to promote effective coping strategies. In psychoeducation, as an early part of

* Corresponding author at: Psychosomatic Medicine, Department of Neurology, Inselspital, Bern University Hospital, University of Bern, Switzerland.
E-mail addresses: alina.scheidegger@insel.ch (A. Scheidegger), jmgomezpenedo@gmail.com (J.M. Gómez Penedo), larissa.blaettler@insel.ch (L.T. Blättler), selma.aybek@insel.ch (S. Aybek), nina.bischoff@insel.ch (N. Bischoff), martin.grosse@unibe.ch (M. grosse Holtforth).

https://doi.org/10.1016/j.jpsychores.2023.111208
Received 6 December 2022; Received in revised form 21 February 2023; Accepted 26 February 2023
Available online 2 March 2023

psychological treatment, therapists aim to convey the biopsychosocial model of pain to the patient and help them identify such maladaptive coping thoughts and behaviors [6]. In addition, it is often necessary to set new, more realistic goals to cope with the pain, since patients are mostly focused on the physical symptoms and want a reduction in pain, which is challenging to improve during an interdisciplinary multimodal pain treatment [5]. To find these new, more realistic goals, clinicians support patients and frame therapies so that patients experience accomplishments based on smaller steps on the way to long-term goal attainment. Physical therapy and occupational therapy aim to experiment with new behaviors and activities, serving to actively reduce maladaptive behaviors and to build build new and effective habits [6]. In addition, various relaxation techniques (e.g., biofeedback, muscle relaxation, and mindfulness) are taught and practiced to help patients cope with stressful situations and their pain [6].

In sum, the general aims of chronic pain treatment are to improve physical and psychological symptoms, e.g., reduce pain intensity and pain interference, and enhance patients' emotional well-being. For this, learning and implementing new cognitive and behavioral pain coping skills or adapting current (potentially inefficient) coping skills [5–7] aim to help patients function better physically and mentally despite their chronic pain.

Although changes in coping strategies have been associated with treatment outcomes in interdisciplinary multimodal treatment [8,9], it is unclear how specific strategies relate to change over time. Insights about specific cognitive and behavioral strategies and how they relate to positive outcomes might help target the most effective strategies in the treatment of patients with chronic pain.

Considering the importance of learning new or adapting current pain coping strategies in the treatment of chronic pain, we aimed to investigate the prediction of treatment outcome by pain coping among inpatients with chronic primary pain participating in an interdisciplinary multimodal treatment. Using hierarchical linear models allowed for disaggregating within (the effects of variations in cognitive and behavioral coping on treatment outcomes) and between patients (the effects of the overall level of cognitive and behavioral coping on treatment outcomes) effects. Furthermore, we explored which single pain coping strategies are most predictive and might be particularly worth fostering to improve treatment outcomes.

2. Methods

2.1. Sample

The sample consisted of 500 inpatients with chronic primary pain treated between December 2015 and July 2022 in a tertiary psychosomatic university clinic. Patients were included in the sample if they (a) fulfilled the diagnostic criteria of chronic primary pain (MG30.0) according to the ICD-11 [10], (b) were at least 18 years old, (c) with sufficient German-language proficiency, and (d) gave general consent to further use their data.

2.2. Ethics statement

This research is in accordance with the Declaration of Helsinki and has been approved by the ethics committee of the Canton of Bern, Switzerland (project ID 2018–00493, ID 2021–02214). All patients in this sample agreed and signed informed consent to further use their anonymized data for research and publication.

2.3. Procedures

All patients received inpatient care in a tertiary psychosomatic university clinic for three weeks. As part of interdisciplinary multimodal pain treatment, each patient received an individualized selection of interventions from various available treatments: psychotherapy, medical interventions, pharmacotherapy, physiotherapy, and occupational therapy [6]. At intake and discharge, patients completed psychometric assessments for quality management purposes. During three 45-min psychometry sessions, patients completed a battery of self-reported questionnaires with the assistance of a research assistant, including questionnaires on the patient's overall condition, psychopathological symptoms, clinically relevant behavior and experience, as well as other treatment-related psychological constructs.

2.4. Measures

Primary outcome measures for this research were defined in accordance with the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) recommendations [11,12], as well as the VAPAIN consensus statement [5], i.e., changes in pain intensity, pain interference, and psychological functioning.

2.4.1. BPI

The German version of the Brief Pain Inventory was used to assess pain intensity and pain interference (BPI) [13]. Four items measure the worst, least, average, and current pain on a Likert scale ranging from no pain at all (0) to the worst pain imaginable (10). These four items can be averaged to compute the pain intensity scale. Seven items measure pain interference during the last week regarding different aspects of life (e.g., general activity, mood, relations with other people, normal work) on a Likert scale ranging from no interference (0) to complete interference (10). Both subscales can result in a score between 0 and 10. The two-factor structure of the German version has been confirmed and showed good psychometric properties [13]. Both pain intensity (alpha = 0.88) and pain-related interference (0.80) show good internal consistency. In the current sample, 15% of patients reported a reduction in pain intensity larger than 30%, which can be regarded as a moderately important decrease during treatment according to the IMMPACT criteria. Regarding pain interference, 58% of all patients reported a reduction by at least one unit on the NRS scale, indicating a clinically significant reduction [11].

2.4.2. HADS-D

The German version of the Hospital Anxiety and Depression Scale was used to assess psychological functioning, respectively psychological distress during the past week (HADS-D) [14]. This questionnaire consists of 14 items and measures anxiety and depression symptoms as psychological distress on a four-point Likert scale from 0 to 3, leading to a possible total score of 0–42. Previous research shows good psychometric properties and confirms the two-factor structure of the German version of the HADS-D [14,15]. Cronbach's alpha for this sample's psychological distress total score can be considered good, with 0.87.

2.4.3. FESV

The German version of the questionnaire was used for the assessment of pain processing (FESV) [16]. This questionnaire consists of two parts, one measuring pain coping and the other pain-related mental interference with 38 items. Only the first part assessing pain coping, was used for this research. Pain coping can be further subdivided into cognitive and behavioral pain coping skills, measured by three skills. Cognitive pain coping is measured via *action planning*, *cognitive restructuring*, and *competence experience*. Behavioral pain coping includes *mental distraction*, *counteractive activities*, and *relaxation techniques*. Items can be answered on a six-point Likert scale ranging from 1 = "not at all true" to 6 = "completely true" to describe the typical pain in the last few days.

2.5. Statistical analyses

R and IBM SPSS Statistics (version 27) were used for statistical analyses [17,18]. Descriptive analyses were performed to describe this sample's demographic and clinical data. Paired *t*-tests were conducted to

determine differences between assessments at intake and discharge. Pearson correlations were used to assess possible associations of the variables under investigation.

As the repeated assessments were nested within the patients, hierarchical linear models (HLM) were used to handle the hierarchical structure of the data and test the effects of cognitive and behavioral pain coping on treatment outcomes [19,20]. Moreover, HLM allows the differentiation of effects within patients (the effects of variations in pain coping during treatment on outcomes) and between patients (the effects of the overall level of pain coping on outcome levels).

Generally, three measurement points are recommended for HLM. Since only intake and discharge assessments were conducted, the statistical procedures had to be slightly modified to adjust for the two measurement points [21,22]. Therefore, an approach usually applied in couple's research was used, having two measurements from one person of the couple [23]. In this process, the items of the outcome variables were matched based on their variance and randomly assigned to two scales. This procedure results in two parallel and equivalent subscales for each outcome variable at intake and discharge, providing enough variability to run two-level hierarchical linear models.

First, fully unconditional models were calculated for each treatment outcome. Then, time-as-only predictor models (TAOP) with time centered at intake were computed as an additional measure of change in each outcome measure. Next, conditional hybrid random effect models were calculated for each outcome measure, including level-1-predictors of the variation of the patients around their own mean of pain coping (person-mean centered) and level-2-predictors of the mean value over both measurement points (grand-mean centered) [24]. Then, conditional hybrid random effect detrended models were needed to address time effects due to the significant TAOP models, adjusting for time as an additional level-1 predictor [25]. Lastly, age, sex, pain duration, intensity, and interference were added as level-2 predictors (grand-mean centered). Due to singularity issues, random effects were fixed.

The predictive value of the single pain coping skills changes on treatment outcomes at post-treatment was investigated exploratorily using a linear regression analysis with a stepwise elimination technique using the same control and pain-related variables as in the HLM. Change scores were computed for pain intensity and pain interference as control variables and all pain coping scales. Bonferroni correction was applied due to multiple comparisons of the different pain coping scales.

3. Results

3.1. Demographics and clinical data

Descriptive characteristics of sociodemographic and pain-related variables are summarized in Table 1. On average, patients were 47 years old. Most patients were female and had suffered from their pain for 1–5 years. Almost two-thirds were not able to work part-time or full-time. On average, patients stayed for 23.3 days (SD = 4.9 days).

3.2. Comparisons between pre- and post-treatment

Pre-post comparisons are summarized in Tables 2 and 3. Table 2 shows that patients improved significantly ($p < .001$) over the course of treatment in terms of acquiring cognitive and behavioral pain coping strategies. Furthermore, pain intensity, pain interference, and psychological distress reduced significantly ($p < .001$) after treatment with effect sizes ranging mostly between medium to high. Only the effect of change in pain intensity was small. Table 3 shows detailed comparisons of the separate cognitive and behavioral pain coping skills. Patients improved all assessed skills in cognitive and behavioral pain coping significantly ($p < .001$) with effect sizes ranging mostly between medium to high.

Table 1
Descriptive characteristics of the sociodemographic and pain-related variables.

	Overall sample N (500)	
Age – *M* (*SD*)	47.3	(14.3)
Sex – N (%)		
Female	310	(62.0)
Male	190	(38.0)
Treatment duration – M (*SD*)	23.9 days	(5.0 days)
Pain duration – N (%)		
0–3 months	7	(1.4)
4–6 months	20	(4.0)
7–11 months	23	(4.6)
1–5 years	227	(45.4)
6–10 years	80	(16.0)
> 10 years	143	(28.6)
Inability to work – N (%)		
0%	185	(37.2)
≤ 25%	6	(1.2)
≤ 50%	32	(6.4)
≤75%	18	(3.6)
≤100%	256	(51.5)

Abbreviations: N = number of patients; *M* = mean; *SD* = standard deviation.

Table 2
Number of patients, mean, standard deviation, pre-post comparison, and effect size of different outcome measures.

		Pre-treatment		Post-treatment			
	N	*M*	*SD*	*M*	*SD*	*t*	*d*
Cognitive coping FESV	500	14.2	4.0	16.1	4.1	23.0***	0.51
Behavioral coping FESV	500	11.9	3.6	13.5	3.8	22.6***	0.51
Pain intensity BPI	500	5.4	1.7	5.1	1.9	−8.0***	0.18
Pain interference BPI	500	5.7	1.9	4.4	2.0	−31.9***	0.71
Psychological distress HADS-D	500	19.9	8.2	14.8	8.2	−36.4***	0.81

Notes: *$p < .05$, **$p < .01$, ***$p < .001$.
Abbreviations: N = number of patients; *M* = mean; *SD* = standard deviation; *t* = *t* value; *d* = Cohen's *d*; BPI: Brief Pain Inventory - German version; HADS-D: Hospital Anxiety and Depression Scale - German version; FESV: Pain Processing Questionnaire.

Table 3
Dependent *t*-tests of the separate cognitive and behavioral pain coping skills between pre- and post-treatment.

		Pre-treatment		Post-treatment			
	N	*M*	*SD*	*M*	*SD*	*t*	*d*
Cognitive coping							
Action planning	500	14.7	5.2	17.0	4.5	20.1***	0.45
Cognitive restructuring	500	13.6	4.7	15.4	4.7	17.6***	0.39
Competence experience	500	14.3	4.7	15.9	4.7	16.8***	0.38
Behavioral coping							
Mental distraction	500	11.9	4.9	13.0	4.9	11.5***	0.26
Counteractive activities	500	11.8	5.1	12.7	4.9	9.5***	0.21
Relaxation techniques	500	12.1	5.2	14.9	4.9	25.8***	0.58

Notes: *$p < .05$, **$p < .01$, ***$p < .001$.
Abbreviations: N = number of patients; *M* = mean; *SD* = standard deviation; *t* = *t* value; *d* = Cohen's *d*; FESV: Pain Processing Questionnaire.

3.3. Correlation analysis

Table 4 shows Pearson correlations of relevant study variables. All study variables correlated significantly ($p < .001$) except behavioral pain coping pre-treatment and pain intensity pre- ($p = .958$) and post-

Table 4
Correlation of study variables.

		1	2	3	4	5	6	7	8	9
1	Cognitive coping FESV pre-treatment									
2	Behavioral coping FESV pre-treatment	0.509***								
3	Pain intensity BPI pre-treatment	−0.071**	−0.001							
4	Pain interference BPI pre-treatment	−0.324***	−0.267***	0.476***						
5	Psychological distress HADS-D pre-treatment	−0.460***	−0.329***	0.246***	0.572***					
6	Cognitive coping FESV post-treatment	0.588***	0.451***	−0.141***	−0.331***	−0.454***				
7	Behavioral coping FESV post-treatment	0.374***	0.633***	−0.085***	−0.230***	−0.307***	0.646***			
8	Pain intensity BPI post-treatment	−0.123***	−0.043	0.699***	0.404***	0.211***	−0.271***	−0.190***		
9	Pain interference BPI post-treatment	−0.250***	−0.227***	0.397***	0.575***	0.430***	−0.515***	−0.404***	0.564***	
10	Psychological distress HADS-D post-treatment	−0.394***	−0.329***	0.232***	0.470***	0.714***	−0.624***	−0.461***	0.336***	0.659***

Notes: *$p < .05$, **$p < .01$, ***$p < .001$.
Abbreviations: FESV: Pain Processing Questionnaire; BPI: Brief Pain Inventory – German version; HADS-D: Hospital Anxiety and Depression Scale – German version.

treatment ($p = .053$).

3.4. Hierarchical linear modeling predicting outcome measures

All computed hierarchical linear models predicting outcome measures are summarized in Tables 5–7. A detailed description and evaluation of all models can be found in the supplementary material.

The unconditional models showed an estimated average pain intensity of 5.25 (γ_{00}= 5.25, SE = 0.07, Cl_{95} = [5.10, 5.40], $t(1997)$ = 70.03, $p < .001$), pain interference of 5.06 (γ_{00}= 5.06, SE = 0.08, Cl_{95} = [4.91, 5.22], $t(1997) = 64.25$, $p < .001$), and psychological distress of 1.25 (γ_{00}= 1.25, SE = 0.02, Cl_{95} = [1.20, 1.30], $t(1997) = 51.47$, $p < .001$) across treatment. The time-as-only-predictor models (TAOP) showed a significant negative time effect on pain intensity ($\gamma_{10} = -0.25$, SE = 0.06, Cl_{95} = [−0.38, 0.13], $t(1996) = -4.04$, $p < .001$), pain interference ($\gamma_{10} = -1.29$, SE = 0.07, Cl_{95} = [−1.43, −1.15], $t(1996)$ = −18.13, $p < .001$) and psychological distress ($\gamma_{10} = -0.34$, SE = 0.03, Cl_{95} = [−0.37, −0.30], $t(1996) = -19.53$, $p < .001$). This indicated that during treatment pain intensity decreased by 0.25 units, pain interference by 1.29 units, and psychological distress by 0.34 units from intake to discharge.

The best-fitting model regarding the prediction of pain intensity revealed significant effects of sex ($\gamma_{01} = 0.27$, SE = 0.13, Cl_{95} = [0.01, 0.53], $t(1988) = 2.08$, $p = .039$), pain duration ($\gamma_{02} = 0.13$, SE = 0.06, Cl_{95} = [0.02, 0.24], $t(1988) = 2.37$, $p = .018$) and pain interference (γ_{03} = 0.29, SE = 0.02, Cl_{95} = [0.25, 0.33], $t(1988) = 14.55$, $p < .001$). Therefore, none of the pain coping skill dimensions (i.e., between patient effects of cognitive ($p = .113$) and behavioral ($p = .321$) coping, as well as within patient effects of cognitive ($p = .966$) and behavioral (p = .813) coping) showed significant effects on pain intensity,

For the prediction of pain interference, the best-fitting model revealed significant effects of the control variable pain intensity (γ_{01} = 0.35, SE = 0.02, Cl_{95} = [0.31, 0.39], $t(1991) = 15.86$, $p < .001$) and time ($\gamma_{10} = -0.85$, SE = 0.08, Cl_{95} = [−1.00, −0.69], $t(1991) = -10.75$, $p <$ .001). Furthermore, significant between patient effects of cognitive pain coping ($\gamma_{02} = -0.16$, SE = 0.02, Cl_{95} = [−0.20, −0.12], $t(1991)$ = −7.57, $p < .001$) and behavioral pain coping ($\gamma_{03} = -0.06$, SE = 0.02, Cl_{95} = [−0.11, −0.02], $t(1991) = -2.87$, $p = .004$) on pain interference, as well as significant within patient effects of cognitive pain coping (γ_{20} = −0.11, SE = 0.02, Cl_{95} = [−0.15, −0.07], $t(1991) = -5.32$, $p < .001$) and behavioral pain coping ($\gamma_{30} = -0.09$, SE = 0.02, Cl_{95} = [−0.14, −0.05], $t(1991) = -3.94$, $p < .001$) were found. Therefore, this model indicates that a one-unit increase in the sample's cognitive pain coping mean score was associated with a reduction of 0.16 in pain interference and a reduction of 0.06 in behavioral pain coping. A one-unit decrease from the patient's own mean was associated with a reduction of 0.11 in pain interference for cognitive and a reduction of 0.09 in behavioral pain coping.

The best-fitting model regarding the prediction of psychological distress revealed significant effects of the control variable pain interference ($\gamma_{01} = 0.05$, SE = 0.01, Cl_{95} = [0.04, 0.06], $t(1990) = 8.79$, $p <$ .001) and time ($\gamma_{10} = -0.21$, SE = 0.02, Cl_{95} = [−0.25, −0.17], $t(1990)$ = −10.22, $p < .001$). Significant between ($\gamma_{02} = -0.07$, SE = 0.01, Cl_{95} = [−0.08, −0.06], $t(1990) = -10.71$, $p < .001$) and within ($\gamma_{20} = -0.03$, SE = 0.01, Cl_{95} = [−0.04, −0.02], $t(1990) = -4.92$, $p < .001$) patient effects of cognitive pain coping could be found for psychological distress. This model suggests that a one-unit increase in the sample's cognitive pain coping mean score was associated with a reduction of 0.07 in psychological distress. A one-unit decrease from the patient's own cognitive pain coping mean was associated with a reduction of 0.03 in psychological distress.

3.5. Exploratory regression analyses

Exploratory regression analyses using a stepwise elimination strategy were conducted to determine which pain coping skills of the FESV were associated with treatment success. Pain interference and psychological distress post-treatment were chosen as dependent variables, as they were significantly reduced, and their reduction could be predicted by pain coping. Due to multiple comparison of the separate pain coping skills, Bonferroni correction was applied. Change scores for all pain coping skills, as well as the control variables pain interference and pain intensity, were computed. Table 8 summarizes the exploratory regression analyses regarding the prediction of different treatment outcomes post-treatment by change scores of the separate pain coping skills with Bonferroni correction. The adjusted p-value for the prediction of pain interference levels post-treatment was $p < .008$ since both changes in cognitive and behavioral pain coping skills were considered predictor variables. The adjusted p-value for the prediction of psychological distress levels post-treatment was $p < .017$ since only changes in cognitive pain coping skills were considered predictor variables.

The first analysis predicting pain interference post-treatment, including change in pain intensity and pain interference levels pre-treatment as control variables, was significant, $F(2, 1997) = 725.71$, $p < .001$. In the next step, the separate cognitive and behavioral pain coping skill dimensions of the FESV questionnaire were added. The change in *cognitive restructuring* was significant $F(3, 1996) = 634.48$, $p <$ .001, the additional outcome variance explained 6.7%, $R^2 = 0.49$, F_{change} (1, 1996) = 262.20, $p < .001$, and resulted in an adjusted R^2 of 0.49. The change in the scale *relaxation techniques* was also significant $F(4, 1995) = 507.89$, $p < .001$, the additional outcome variance explained 1.7%, $R^2 = 0.51$, F_{change} (1, 1995) = 66.06, $p < .001$, and resulted in an adjusted R^2 of 0.65. The change in the scale *action planning* was also significant $F(5, 1994) = 409.27$, $p < .001$, the additional outcome variance explained 0.1%, $R^2 = 0.51$, F_{change} (1, 1994) = 7.82, $p = .005$, and resulted in an adjusted R^2 of 0.65.

The second analysis predicting psychological distress post-treatment, including change in pain intensity and pain interference, as well as

Table 5
Summary of the unconditional, time-as-only predictor, conditional random effect, and conditional random effect detrending models analyzing the effect of cognitive and behavioral coping on pain intensity.

	Pain intensity		
	γ	*SE*	*t*
Unconditional model			
Intercept	5.25	0.07	70.03***
Time-as-only predictor model			
Intercept	5.12	0.08	62.98***
Time	−0.25	0.06	−4.04***
Model comparison	$\Delta\chi^2(1) = 16.25$, $p < .001$		
Conditional random effect model			
Intercept	6.52	0.34	19.35***
Between patient effects of cognitive coping	−0.09	0.03	−3.64***
Between patient effects of behavioral coping	0.01	0.03	0.44
Within patient effects of cognitive coping	−0.05	0.02	−2.50*
Within patient effects of behavioral coping	−0.05	0.02	−2.19*
Model comparison	$\Delta\chi^2(3) = 26.11$, $p < .001$		
Conditional random effect model detrending			
Intercept	6.46	0.34	19.05***
Time	−0.13	0.07	−1.76
Between patient effects of cognitive coping	−0.09	0.03	−3.64***
Between patient effects of behavioral coping	0.01	0.03	0.44
Within patient effects of cognitive coping	−0.04	0.02	−1.91
Within patient effects of behavioral coping	−0.04	0.02	−1.64
Model comparison	$\Delta\chi^2(1) = 3.08$, $p = .079$		
Conditional random effect model detrending			
Intercept	4.01	0.34	11.72***
Time	0.13	0.07	1.81
Between patient effects of cognitive coping	−0.04	0.02	−1.63
Between patient effects of behavioral coping	0.03	0.02	1.22
Within patient effects of cognitive coping	0.01	0.02	−0.03
Within patient effects of behavioral coping	0.01	0.02	−0.23
Pain interference	0.29	0.02	14.64***
Model comparison	$\Delta\chi^2(1) = 195.27$, $p < .001$		
Conditional random effect model detrending			
Intercept	2.64	0.49	5.33***
Time	0.13	0.07	1.79
Between patient effects of cognitive coping	−0.04	0.02	−1.59
Between patient effects of behavioral coping	0.02	0.02	0.99
Within patient effects of cognitive coping	0.01	0.02	−0.04
Within patient effects of behavioral coping	−0.01	0.02	−0.24
Pain interference	0.29	0.02	14.55***
Age	0.01	0.01	1.78
Sex	0.27	0.13	2.07*
Pain Duration	0.13	0.06	2.37*
Model comparison	$\Delta\chi^2(3) = 14.16$, $p = .003$		

Notes: *$p < .05$, **$p < .01$, ***$p < .001$.
Abbreviations: γ = regression coefficient; *SE* = standard error; *t* = *t* value.

Table 6
Summary of the unconditional, time-as-only predictor, conditional random effect, and conditional random effect detrending models analyzing the effect of cognitive and behavioral coping on pain interference.

	Pain interference		
	γ	*SE*	*t*
Unconditional model			
Intercept	5.06	0.08	64.25***
Time-as-only predictor model			
Intercept	4.42	0.09	51.09***
Time	−1.29	0.07	−18.13***
Model comparison	$\Delta\chi^2(1) = 297.33$, $p < .001$		
Conditional random effect model			
Intercept	8.74	0.32	27.5***
Between patient effects of cognitive coping	−0.19	0.02	−7.87***
Between patient effects of behavioral coping	−0.06	0.03	−2.3*
Within patient effects of cognitive coping	−0.19	0.02	−8.92***
Within patient effects of behavioral coping	−0.18	0.02	−7.35***
Model comparison	$\Delta\chi^2(3) = 98.18$, $p < .001$		
Conditional random effect model detrending			
Intercept	8.29	0.32	25.89***
Time	−0.89	0.08	−11.06***
Between patient effects of cognitive coping	−0.19	0.02	−7.87***
Between patient effects of behavioral coping	−0.06	0.03	−2.3*
Within patient effects of cognitive coping	−0.12	0.02	−5.8***
Within patient effects of behavioral coping	−0.10	0.02	−4.37***
Model comparison	$\Delta\chi^2(1) = 117.62$, $p < .001$		
Conditional random effect model detrending			
Intercept	6.04	0.31	19.49***
Time	−0.85	0.08	−10.75***
Between patient effects of cognitive coping	−0.16	0.02	−7.57***
Between patient effects of behavioral coping	−0.06	0.02	−2.87**
Within patient effects of cognitive coping	−0.11	0.02	−5.32***
Within patient effects of behavioral coping	−0.09	0.02	−3.94***
Pain intensity	0.35	0.02	15.86***
Model comparison	$\Delta\chi^2(1) = 223.72$, $p < .001$		
Conditional random effect model detrending			
Intercept	5.63	0.45	12.48***
Time	−0.85	0.08	−10.75***
Between patient effects of cognitive coping	−0.16	0.02	−7.48***
Between patient effects of behavioral coping	−0.06	0.02	−2.81**
Within patient effects of cognitive coping	−0.11	0.02	−5.32***
Within patient effects of behavioral coping	−0.09	0.02	−3.95***
Pain intensity	0.35	0.02	15.67***
Age	0.01	0.01	0.22
Sex	−0.09	0.12	−0.75
Pain Duration	0.11	0.05	2.01*
Model comparison	$\Delta\chi^2(3) = 4.66$, $p = .199$		

Notes: *$p < .05$, **$p < .01$, ***$p < .001$.
Abbreviations: γ = regression coefficient; *SE* = standard error; *t* = *t* value.

psychological distress levels pre-treatment as control variables, was significant, $F(3, 1996) = 1108.48$, $p < .001$. In the next step, the separate cognitive pain coping skill dimensions of the FESV questionnaire were added. The change in *cognitive restructuring* was significant $F(4, 1995) = 897.00$, $p < .001$, the additional outcome variance explained 1.9%, $R^2 = 0.64$, $F_{change}(1, 1995) = 99.11$, $p < .001$, and resulted in an adjusted R^2 of 0.64. The change in the scale *action planning* was also significant $F(5, 1994) = 735.92$, $p < .001$, the additional outcome variance explained 0.6%, $R^2 = 0.65$, $F_{change}(1, 1994) = 33.37$, $p < .001$, and resulted in an adjusted R^2 of 0.65. The change in the scale *competence experience* was also significant $F(6, 1993) = 618.47$, $p < .001$, the additional outcome variance explained 0.2%, $R^2 = 0.65$, $F_{change}(1, 1993) = 11.62$, $p < .001$, and resulted in an adjusted R^2 of 0.65.

4. Discussion

This study aimed to investigate the role of pain coping in the prediction of treatment outcomes among inpatients with chronic primary pain. Using hierarchical linear models, we were able to underscore the importance of improving cognitive and behavioral pain coping during interdisciplinary multimodal pain treatment to more successfully treat inpatients with chronic primary pain. Moreover, exploratory regression analyses revealed single cognitive and behavioral strategies that are associated with positive outcomes as worthwhile targets to promote during the interdisciplinary multimodal treatment of inpatients with chronic pain.

After interdisciplinary multimodal pain treatment, inpatients with chronic pain reported significantly lower pain intensity, pain interference, and psychological distress levels, with effect sizes ranging mostly

Table 7
Summary of the unconditional, time-as-only predictor, conditional random effect, and conditional random effect detrending models analyzing the effect of cognitive and behavioral coping on psychological distress.

	Psychological distress		
	γ	*SE*	*t*
Unconditional model			
Intercept	1.25	0.02	51.47***
Time-as-only predictor model			
Intercept	1.08	0.03	41.99***
Time	−0.34	0.02	−19.53***
Model comparison	$\Delta\chi^2(1) = 339.80$, $p < .001$		
Conditional random effect model			
Intercept	2.65	0.09	29.40***
Between patient effects of cognitive coping	−0.08	0.01	−11.30***
Between patient effects of behavioral coping	−0.02	0.01	−2.24*
Within patient effects of cognitive coping	−0.05	0.01	−9.62***
Within patient effects of behavioral coping	−0.04	0.01	−6.07***
Model comparison	$\Delta\chi^2(3) = 126.39$, $p < .001$		
Conditional random effect model detrending			
Intercept	2.52	0.07	27.83***
Time	−0.25	0.02	−12.84***
Between patient effects of cognitive coping	−0.08	0.01	−11.30***
Between patient effects of behavioral coping	−0.02	0.01	−2.24*
Within patient effects of cognitive coping	−0.03	0.01	−6.12***
Within patient effects of behavioral coping	−0.02	0.01	−2.70**
Model comparison	$\Delta\chi^2(1) = 156.32$, $p < .001$		
Conditional random effect model detrending			
Intercept	2.16	0.10	21.93***
Time	−0.21	0.02	−10.22***
Between patient effects of cognitive coping	−0.07	0.01	−10.70***
Between patient effects of behavioral coping	−0.01	0.01	−1.95
Within patient effects of cognitive coping	−0.03	0.01	−4.92***
Within patient effects of behavioral coping	−0.01	0.01	−1.83
Pain intensity	−0.01	0.01	−1.71
Pain interference	0.05	0.01	8.79***
Model comparison	$\Delta\chi^2(2) = 71.42$, $p < .001$		
Conditional random effect model detrending			
Intercept	2.19	0.14	15.54***
Time	−0.21	0.02	−10.22***
Between patient effects of cognitive coping	−0.07	0.01	−10.66***
Between patient effects of behavioral coping	−0.01	0.01	−1.87
Within patient effects of cognitive coping	−0.03	0.01	−4.92***
Within patient effects of behavioral coping	−0.01	0.01	−1.83
Pain intensity	−0.01	0.01	−1.68
Pain interference	0.05	0.01	8.77***
Age	−0.01	0.01	−0.35
Sex	−0.02	0.04	−0.60
Pain Duration	0.01	0.02	0.30
Model comparison	$\Delta\chi^2(3) = 0.52$, $p = .915$		

Notes: *$p < .05$, **$p < .01$, ***$p < .001$.
Abbreviations: γ = regression coefficient; *SE* = standard error; *t* = *t* value.

between medium to high. Only the effect of change in pain intensity was small. This is not surprising since large reductions in pain intensity are rather improbable among patients with chronic pain suffering from their pain and the associated impairments for at least three months [5]. As pain intensity is challenging to improve, interdisciplinary multimodal pain treatment usually focuses more on increasing physical and psychological functioning so that reducing pain interference and psychological distress can be considered more adequate outcomes in short-term pain treatment [5]. Moreover, after treatment patients reported higher levels of cognitive and behavioral pain coping in general, as well as in every single pain coping skill. Therefore, most patients in this sample seem to have benefitted from the inpatient stay, underscoring the suitability of interdisciplinary multimodal pain treatment of chronic primary pain.

Using hierarchical linear models, we did not find any significant associations between pain coping with reductions in pain intensity when control variables were included. This finding might also be due to the small changes in pain intensity after the three weeks mentioned above. However, hierarchical linear models revealed that the overall level and improvements in *cognitive* pain coping were associated with reductions in both pain interference and psychological distress above and beyond improvements in pain-related factors and controlling for time. However, the overall level and improvements in *behavioral* pain coping were associated with reductions in pain interference alone when controlled for time, as well as changes in pain intensity and pain interference. Therefore, pain interference seems to be influenced by both, cognitive and behavioral pain coping, whereas psychological distress seems to be influenced only by cognitive pain coping. Taken together, these results align with previous research [8,9] and strengthen the general notion that experiencing less pain interference and psychological distress over treatment might be partially explained by better pain coping.

The change of both, cognitive and behavioral pain coping skills seem worthwile targests for inpatient pain treatment as the overall level of cognitive and behavioral coping and according changes over treatment may have substantial impacts on treatment outcomes. Fostering and exercising *cognitive restructuring* as well as engaging in *action planning,* might be worthwhile to reduce both pain interference and psychological distress levels, as changes in these cognitive pain coping skills predicted the outcome levels post-treatment. Moreover, practicing and promoting *relaxation techniques* might help reduce pain interference post-treatment, whereas *experiencing competence* might help reduce psychological distress post-treatment.

Psychotherapy sessions might have helped patients identify maladaptive behaviors, maintaining factors, or negative thoughts that may be partly responsible for triggering or worsening the pain. Thus, patients may have realized why they need to adjust their maladaptive thoughts and behaviors and how this adjustment might change their perception of pain, allowing them to reframe their pain experience, i.e., engage in cognitive restructuring.

Since all involved disciplines aim for patients to regain competencies in various ways, individual goals usually need to be adapted, and new, more realistic goals need to be set. In order to achieve those goals, clinicians assist patients in engaging in action planning and help them practice effective coping strategies. Through physiotherapy and occupational therapy, patients have the opportunity to further practice action planning and experience competence via own successes despite also experiencing pain while working and moving. Moreover, patients practiced biofeedback, muscle relaxation, and mindfulness during the inpatient stay, which might have further improved the implementation of relaxation techniques in daily life. Thus, patients might have made more experiences of personal competence due to changing initially maladaptive strategies and practicing new and effective coping strategies, i.e., via engaging in cognitive restructuring, implementing action planning, and practicing relaxation techniques.

The results of this study suggest that it is the synergy of the different therapeutic modalities within the inpatient pain treatment rather than a single modality or strategy that makes for successfully adjusting one's coping strategies. Even though these regression analyses were exploratory and should be interpreted cautiously, these findings suggest promising treatment targets and avenues for further research.

5. Limitations

Several limitations need to be addressed. Our findings might not be representative of all patients with chronic pain since consent was required to use the data, and we have only included patients from one clinic with chronic primary pain. Future studies might benefit from further differentiating between the various primary chronic pain diagnoses and the different pain locations. Furthermore, our study design

Table 8
Exploratory regression analyses regarding the prediction of treatment outcomes post-treatment by change scores of the separate pain coping skills with Bonferroni correction.

	B	*SE*	*β*	*t*	R^2	adj. R^2	R^2ch
Pain interference post-treatment							
Step 1: Control variables					0.42	0.42	
Step 2: Cognitive and behavioral coping FESV					0.51	0.51	0.09***
Control variables							
Change in Pain intensity	0.62	0.02	0.58	36.69***			
Pain interference pre-treatment	0.36	0.02	0.25	15.74***			
Cognitive and behavioral coping FESV							
Change in *cognitive restructuring*	−0.10	0.01	−0.21	−11.71***			
Change in *relaxation techniques*	−0.05	0.01	−0.13	−7.41***			
Change in *action planning*	−0.02	0.01	−0.05	−2.80**			
Psychological distress post-treatment							
Step 1: Control variables					0.63	0.63	
Step 2: Cognitive coping FESV					0.65	0.65	0.02***
Control variables							
Change in Pain intensity	0.42	0.08	0.07	5.23***			
Change in Pain interference	1.14	0.07	0.26	16.96***			
Psychological distress pre-treatment	0.74	0.01	0.75	55.76***			
Cognitive coping FESV							
Change in *cognitive restructuring*	−0.15	0.03	−0.08	−5.28***			
Change in *action planning*	−0.12	0.03	−0.07	−4.79***			
Change in *competence experience*	−0.11	0.03	−0.06	−3.41***			

Notes: *$p < .05$, **$p < .01$, ***$p < .001$.
Abbreviations: B = unstandardized beta; SE = standard error; β = standardized beta; t = t value.

does not allow for any causal or sustainable conclusions due to the two measuring points at intake and discharge. As interdisciplinary multimodal pain treatment includes different treatment methods, it was not possible to control for or manipulate all potentially confounding variables. Future studies should use controlled and experimental longitudinal designs with larger samples to draw conclusions on the sustainability and causality of effects, as well as to disentangle mediating effects. Moreover, future studies might elaborate on which interventions are related to the most significant changes in pain coping strategies and evaluate additional treatment outcomes relevant for patients with chronic pain.

6. Conclusions

Overall, improving cognitive and behavioral pain coping seems to be a key component in the successful interdisciplinary multimodal pain treatment of inpatients with chronic primary pain, enabling them to function better physically and mentally despite their chronic pain.

Funding

We did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors for this research.

Ethics approval (include appropriate approvals or waivers)

This research has been approved by the ethics committee of the Canton of Bern, Switzerland (project ID 2018–00493, ID 2021–02214) and is in accordance with the Declaration of Helsinki.

Consent to participate (include appropriate consent statements)

All patients were informed about the use of their data for research purposes and provided informed general consent.

Consent for publication

Patients signed informed consent regarding publishing their data.

Authorship

Authorship has been granted only to those individuals who have contributed substantially to the research and manuscript.

Declaration of Competing Interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychores.2023.111208.

References

[1] J. Gardner, H. Sachdeva, Causes of pain worldwide, in: A. Abd-Elsayed (Ed.), Pain Rev. Guide, Springer International Publishing, Cham, 2019, pp. 1191–1192, https://doi.org/10.1007/978-3-319-99124-5_253.
[2] A.M. Velly, S. Mohit, Epidemiology of pain and relation to psychiatric disorders, Prog. Neuro-Psychopharmacol. Biol. Psychiatry 87 (2018) 159–167, https://doi.org/10.1016/j.pnpbp.2017.05.012.
[3] P. Knaster, H. Karlsson, A.-M. Estlander, E. Kalso, Psychiatric disorders as assessed with SCID in chronic pain patients: the anxiety disorders precede the onset of pain, Gen. Hosp. Psychiatry 34 (2012) 46–52, https://doi.org/10.1016/j.genhosppsych.2011.09.004.
[4] S.E.E. Mills, K.P. Nicolson, B.H. Smith, Chronic pain: a review of its epidemiology and associated factors in population-based studies, Br. J. Anaesth. 123 (2019) 273–283, https://doi.org/10.1016/j.bja.2019.03.023.
[5] U. Kaiser, C. Kopkow, S. Deckert, K. Neustadt, L. Jacobi, P. Cameron, V. Angelis, C. Apfelbacher, B. Arnold, J. Birch, A. Bjarnegård, S. Christiansen, A. Williams, G. Gossrau, A. Heinks, M. Hueppe, H. Kiers, U. Kleinert, P. Martelletti, C. Terwee, Developing a core outcome-domain set to assessing effectiveness of interdisciplinary multimodal pain therapy: the VAPAIN consensus statement on core outcome-domains, PAIN. 159 (2018) 673–683, https://doi.org/10.1097/j.pain.0000000000001129.
[6] B. Arnold, T. Brinkschmidt, H.-R. Casser, A. Diezemann, I. Gralow, D. Irnich, U. Kaiser, B. Klasen, K. Klimczyk, J. Lutz, B. Nagel, M. Pfingsten, R. Sabatowski, R. Schesser, M. Schiltenwolf, D. Seeger, W. Söllner, Multimodal pain therapy for treatment of chronic pain syndrome. Consensus paper of the ad hoc commission on multimodal interdisciplinary pain management of the German pain society on treatment contents, Schmerz. 28 (2014) 459–472, https://doi.org/10.1007/s00482-014-1471-x.
[7] M. Butz, C. Braun, A. Böger, Was ist Schmerzpsychotherapie? Osteopat. Med. 19 (2018) 34–37, https://doi.org/10.1016/S1615-9071(18)30086-8.
[8] M.P. Jensen, J.A. Turner, J.M. Romano, Changes in beliefs, catastrophizing, and coping are associated with improvement in multidisciplinary pain treatment,

J. Consult. Clin. Psychol. 69 (2001) 655–662, https://doi.org/10.1037/0022-006X.69.4.655.
[9] M.P. Jensen, J.A. Turner, J.M. Romano, Changes after multidisciplinary pain treatment in patient pain beliefs and coping are associated with concurrent changes in patient functioning, Pain. 131 (2007) 38–47, https://doi.org/10.1016/j.pain.2006.12.007.
[10] World Health Organization, International Statistical Classification of Diseases and Related Health Problems (ICD-11), 2019.
[11] R.H. Dworkin, D.C. Turk, J.T. Farrar, J.A. Haythornthwaite, M.P. Jensen, N.P. Katz, R.D. Kerns, G. Stucki, R.R. Allen, N. Bellamy, D.B. Carr, J. Chandler, P. Cowan, R. Dionne, B.S. Galer, S. Hertz, A.R. Jadad, L.D. Kramer, D.C. Manning, S. Martin, C.G. McCormick, M.P. McDermott, P. McGrath, S. Quessy, B.A. Rappaport, W. Robbins, J.P. Robinson, M. Rothman, M.A. Royal, L. Simon, J.W. Stauffer, W. Stein, J. Tollett, J. Wernicke, J. Witter, Core outcome measures for chronic pain clinical trials: IMMPACT recommendations, Pain. 113 (2005) 9–19, https://doi.org/10.1016/j.pain.2004.09.012.
[12] D.C. Turk, R.H. Dworkin, D. Revicki, G. Harding, L.B. Burke, D. Cella, C. S. Cleeland, P. Cowan, J.T. Farrar, S. Hertz, M.B. Max, B.A. Rappaport, Identifying important outcome domains for chronic pain clinical trials: an IMMPACT survey of people with pain, PAIN. 137 (2008) 276–285, https://doi.org/10.1016/j.pain.2007.09.002.
[13] L. Radbruch, G. Loick, P. Kiencke, G. Lindena, R. Sabatowski, S. Grond, K. A. Lehmann, C.S. Cleeland, Validation of the German version of the brief pain inventory, J. Pain Symptom Manag. 18 (1999) 180–187, https://doi.org/10.1016/S0885-3924(99)00064-0.
[14] F. Petermann, Hospital anxiety and depression scale, deutsche version (HADS-D), Z. Für Psychiatr. Psychol. Psychother. 59 (2011) 251–253, https://doi.org/10.1024/1661-4747/a000077.
[15] C. Herrmann-Lingen, U. Buss, R.P. Snaith, Hospital Anxiety and Depression Scale - Deutsche Version, Hans Huber, Bern, 2011.
[16] E. Geissner, Fragebogen zur Erfassung der Schmerzverarbeitung FESV – Manual und Testkit, Hogrefe, Göttingen, 2001.
[17] IBM Corp, IBM SPSS Statistics for Windows, Version 27.0,, IBM Corp, Armonk, NY, 2020, www.ibm.com.
[18] R Core Team, R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Austria, Vienna. https://www.R-project.org/, 2021.
[19] J.M. Gómez Penedo, R. Muiños, P. Hirsch, A. Roussos, La aplicación de modelos lineales jerárquicos para el estudio de la eficacia en psicoterapia, Rev. Argent. Cienc. Comport. 11 (2019) 25–37, https://doi.org/10.32348/1852.4206.v11.n1.20412.
[20] S.W. Raudenbush, A.S. Bryk, Hierarchical Linear Models: Applications and Data Analysis Methods, SAGE Publications Inc., 2002. https://us.sagepub.com/en-us/nam/hierarchical-linear-models/book9230 (accessed June 17, 2022).
[21] R.C. Barnett, N.L. Marshall, S.W. Raudenbush, R.T. Brennan, Gender and the relationship between job experiences and psychological distress: a study of dual-earner couples, J. Pers. Soc. Psychol. 64 (1993) 794–806, https://doi.org/10.1037//0022-3514.64.5.794.
[22] A.-C. Pfeifer, J.M. Gómez Penedo, J.C. Ehrenthal, E. Neubauer, D. Amelung, C. Schroeter, M. Schiltenwolf, Impact of attachment behavior on the treatment process of chronic pain patients, J. Pain Res. 11 (2018) 2653–2662, https://doi.org/10.2147/JPR.S165487.
[23] J.Z. Smith, A.G. Sayer, Multilevel modeling approaches to the study of LGBT-parent families: Methods for dyadic data analysis, in: A.E. Goldberg (Ed.), LGBT-Parent Fam. Innov. Res. Implic, Pract., Springer Science + Business Media, New York, NY, US, 2013, pp. 307–323, https://doi.org/10.1007/978-1-4614-4556-2_20.
[24] F. Falkenström, S. Finkel, R. Sandell, J.A. Rubel, R. Holmqvist, Dynamic models of individual change in psychotherapy process research, J. Consult. Clin. Psychol. 85 (2017) 537–549, https://doi.org/10.1037/ccp0000203.
[25] L.P. Wang, S.E. Maxwell, On disaggregating between-person and within-person effects with longitudinal data using multilevel models, Psychol. Methods 20 (2015) 63–83, https://doi.org/10.1037/met0000030.