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Electronic Momentary Assessment in Chronic Pain II: Pain and Psychological Pain Responses as Predictors of Pain Disability

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ABSTRACT

Objectives and Methods: More than 7100 electronic diaries from 80 patients with chronic pain (mean: 89.3, range 30–115) entered multilevel analyses to establish the statistical prediction of disability by pain intensity and by psychological functioning (fear avoidance, cognitive, and spousal pain responses). We also tested the differences between prechronic, recently chronic, and persistently chronic pain in the prediction of disability (impaired physical and mental capacity, pain interference with activities, immobility due to pain). **Results:** Pain intensity explained 8% to 19% of the disability variance. Beyond this psychological functioning explained 7% to 16%: particularly fear-avoidance and cognitive pain responses predicted chronic pain disorder disability; spousal responses predicted immobility better than other aspects of disability. Immobility due to actual pain occurred infrequently. When it did, however, it was better predicted by avoidance behavior in the patient and by spousal discouragement of movement than by actual pain intensity. The prediction of immobility due to pain by, respectively, avoidance behavior and catastrophizing was better in chronic pain (>6 months) and that of physical impairment by catastrophizing better in persistently chronic pain (>12 months) than in pain of shorter duration.

Discussion: The psychological prediction of chronic pain disorder disability was determined beyond that accounted for by pain intensity. Nonetheless, psychological functioning explained substantial variance in chronic pain disorder disability. The psychological prediction of immobility and physical impairment was stronger with longer pain duration. Patient characteristics and momentary states of disability and in particular of immobility—should be carefully distinguished and accounted for in chronic pain disorder.

INTRODUCTION

Focus of the Study

Real-time momentary assessment with an electronic diary was employed to investigate the role of psychological functioning in chronic pain. The aims were to: 1) establish the relationships between psychological pain responses and, respectively, pain intensity and disability in 80 pain patients; and 2) test whether these associations differ in the persistently chronic, recently chronic, and prechronic phases of a chronic pain disorder (CPD). Part I of the study focused on CPD pain intensity, regarding its psychological prediction and potential differences induced in these predictions by pain duration.¹ The present part II focuses on CPD disability and covers the same issues. The existing knowledge of psychological functioning in CPD is largely based on cross-sectional and retrospective self-report, which entails potential problems. First, recall biases the retrospective assessment of pain²⁻⁵ and generally produces an overestimation.^{2,3,6,7} Second, pain, psychological responses and disability are fluctuating states, and this can at best be partly captured by cross-sectional self-report. Paper diaries do not offer an optimal solution to these issues because of instrument reactivity⁸⁻¹⁰ and low adherence.¹¹ Electronic diaries are clearly superior: reactivity is absent,¹² compliance and patient satisfaction are high,¹²⁻¹⁴ and, when employed to sample real-time data in response to randomized programmed signals, recall bias is avoided and momentary fluctuation adequately seized.² The method we refer to is known as “experience sampling method” (ESM) or “ecological momentary assessment” (EMA).¹ In contrast to paper diaries,¹⁵⁻¹⁷ data obtained electronically with these methods produce only moderate concordance with cross-sectional assessments of pain, even when pain recall and momentary pain report cover the same week.^{18,19} Methods thus matter and cross-sectional and real-time report simply are not equivalent.² We therefore intended to corroborate the existing evidence of psychological functioning in CPD with momentary real-time data, a new effort gaining ground in CPD research.^{20,21} Part I of the present study showed that 40% of the total variance in pain intensity was explained by the patients’ fear-avoidance and cognitive pain responses and, to a lesser extent, by spousal responses to pain.¹ These results substantiate the impact of psychological functioning in CPD and underscore the dimension of suffering in chronic pain.²² Pain duration had no impact on these associations. This may be taken to accord with the focus of CPD theory on the role of fear-avoidance and other aspects of psychological functioning in initiating and maintaining chronic pain disability,²³ whereas potential changes in the psychological prediction of chronic pain intensity in the course of CPD development seem to receive less attention. The present part II of the study will establish the degree to which psychological pain responses explain variance in CPD disability and test whether the impact of psychological functioning on disability differs according to the chronicity of the pain problem.

Disability in Chronic Pain

Chronic pain disorder is a public health problem in western countries,²⁴⁻²⁸ and CPD disability fortifies the human, societal, and economic burden induced by the disorder. Central in its development is the “disuse syndrome,”^{29,30} referring to detrimental changes in the musculoskeletal system due to prolonged avoidance of movement and activity. The process at stake is “deconditioning,” the progressive worsening of physical fitness as a result of reduced muscular activity and (bed) rest.²³ The sparing of the body, adequate to recover from acute pain, is counterproductive in chronic pain. Fear of pain and movement—although understandable from the patients’ point of view—may be essential in steering chronic pain disability and its maintenance.^{23,31,32} In CPD, impaired physical capacity and immobility seem to persist relatively independent from the level of pain.^{33,34} Self-reported physical capacity³⁵ and activity³⁶ was shown to be weakly related to pain levels, whereas actual mobility was independent of pain intensity in a test situation, even in patients with CPD who had acknowledged the connection between pain and immobility in an interview.³⁷

Psychological Pain Responses and Chronic Pain Disability

Three sets of psychological pain responses were distinguished in the present study.¹ Fear-avoidance responses are related to CPD disability.³⁸⁻⁴⁰ According to behavioral learning theory, pain-related fear (fear of pain and of movement inducing pain) is the key conditioned stimulus in CPD and avoidance behavior the key conditioned response.^{41,42} With time, fear-induced overprediction of pain is thought to fuel generalized and excessive avoidance behavior in the absence of nociceptive stimulation, which is resistant to change as long as avoidance sustains the overprediction.⁴² Pain-related fear was also found to be associated with the reporting of nonspecific bodily sensations⁴³ and attention to pain.⁴⁴ More specifically, it was shown that patients with chronic pain with elevated pain-related fear habitually attend to somatic sensations,⁴⁵ have difficulty disengaging from pain information,⁴⁶ and exhibit more selective attention to pain with higher pain intensity.⁴⁷ Thus, bodily vigilance, the increased attention to body sensations and pain, may interact with fear in steering CPD disability. Cognitive responses to pain are also relevant to CPD disability. There is considerable evidence that catastrophizing, proposed as one of the main determinants of fear avoidance,²³ is related to CPD disability^{21,39,40,48-51} even when the analysis controlled for the impact of pain. We identified it as the dominant predictor of CPD pain intensity in part I of this study and suggested that it may, in concert with fear and vigilance, drive the downward spiral of behavioral avoidance, immobility, and disability in CPD.¹ Other maladaptive cognitive responses, which are thought to aggravate the suffering from pain and to influence pain behavior, are negative self-statements,⁵² hopelessness/helplessness⁵³ (for a review, see Jensen et al⁵⁴), and lack of control over the pain.^{39,55} Last, spousal solicitous and punishing responses are important. Solicitous spousal reinforcement of pain behavior may inadvertently maintain the patient's disability.⁵⁶ It was found to reduce actual physical functioning^{57,58} and to be associated with interference of pain with the patients' lives.⁵⁹ On the other hand, spousal punishment of pain behavior, defined as "passive positive spousal reinforcement" or "low spousal solicitude," was found to increase physical activity in CPD.^{58,60,61} Spousal responses to the well behavior of the patients have been less investigated. According to one study, spousal reinforcement of well behavior increased actual walking speed in CPD.⁶²

Focus of the Present Study

The present part II of the study concerns the association between fear avoidance, cognitive, and spousal responses to pain and 4 aspects of disability (physical capacity, mental capacity, pain interference with activities, and immobility due to pain), established with methods that control for recall bias and account for different sources of variance in the data. The research issues concern: 1) the extent to which psychological pain responses statistically predict CPD disability; and 2) the differences in these predictions between patients with pain in the chronic (.12 months), recently chronic (6- 12 months), and prechronic (3-6 months) phase of CPD development. Regarding issue 1, we expect to confirm the general consensus that psychological functioning predicts disability in chronic pain with results derived from real-time data (eg, without reliance on retrospective study.)⁶³ We also expect that pain intensity predicts disability in CPD. Consequently, we will control for the impact of pain intensity when establishing the impact of psychological pain responses on CPD disability. Regarding issue 2, we expect the association between psychological functioning and CPD disability to build up and strengthen with longer pain duration. We acknowledge in advance that the present study cannot produce psychological predictors of transitions from prechronic to recently and persistently chronic pain. Nevertheless, prediction differences between groups of different pain duration can shed light on which aspects of psychological functioning and disability in CPD should primarily be pursued to approach the issue of CPD maintenance.

MATERIALS AND METHODS

We refer to part I of the study for detailed information regarding the materials and methods, in particular regarding the construction and content of the electronic diary and characteristics of the method, sampling process, and diary data.¹ The sections below are confined to summaries, supplemented with information specific to part II of the study.

Patients

Eighty patients (71% female) aged 18 to 60 years with various forms of International Association for the Study of Pain (IASP) classified pain of an unknown nociceptive substrate were recruited until 2 groups, matched for pain location, age, gender, marital status and education were formed who suffered from chronic pain (N = 40, mean pain duration: 125.6 months) or recently chronic pain (N = 40, mean pain duration: 7.2 months).⁴⁵ Of the present sample, 31% suffered from cervical pain, 21% from pain in lower back and spine, 19.5% from pain in head/face/shoulders and upper limbs, 9% from pain in lower limbs or abdomen, and 19.5% from pain in more than 3 major sites. The latter group was broken down in 2 subgroups of recently chronic (N = 25, mean pain duration: 8.9 months) and prechronic pain (N = 15, mean pain duration: 4.3 months), comparable with respect to age, gender, and marital status, whereas differences in educational level and extent of full-time work were not significant. In the 3 groups, pain severity was equal, medication use (mostly nonsteroid analgesics) and comorbid conditions were similar, but pain location according to the IASP classification⁶⁴ differed: pain in more than 3 major sites of the body was reported by, respectively, 32% of the patients with persistently chronic, 8.3% of those with recently chronic, and 6.7% of those with prechronic pain. Multiple pain locations were not significantly associated with pain intensity, however, and had no impact on the psychological prediction of pain intensity.¹

Electronic Momentary Assessment Measurements

Diary data were collected with palmtop computers during 4 weeks, 4 times per day, which prompted the recording with a beeping signal that occurred randomly within 2-hour time frames between, respectively, 8:00 and 11:00_{AM}, 11:30_{AM} and 2:30_{PM}, 3:00 and 6:00_{PM}, and 6:30 and 9:30_{PM}. Unanswered signals were repeated after 5 minutes and, when not answered, were automatically coded as missing. Per day, patients were allowed to skip 1 signal in succession in case of inconvenience. The diary contained 84 items and took about 5 minutes to be completed. Table 1 summarizes the diary items for psychological pain responses and 4 aspects of disability. The items for pain intensity, fear-avoidance responses, and physical and mental capacity occurred in each diary (N = 7121). The items for cognitive pain responses, pain interference with activities, and immobility (sitting or lying down due to pain) occurred only when the patient was in actual pain (N = 5057). Spousal responses were assessed only when the spouse was actually present and the patient was in actual pain at the moment of recording (N = 1469). The construction of the ESM items for pain intensity and the fear avoidance, cognitive, and spousal pain responses was outlined in part I of the study.¹ The items for physical capacity were partly adapted from the MOS short-form health survey (SF-36).⁶⁵ The remaining items were self-designed and subjected to a procedure of interjudge concordance. A pilot study established the feasibility and acceptability of the ESM diary and method.

[TABLE 1]

Data Preparation

The total data set included 7121 diaries exclusive of 17.2% signals that were missed. Cronbach α coefficients secured the reliability of pain responses assessed by more than 1 ESM item (Table 1; range: 0.43–0.93). Scores of these items were summed after reversing of the polarity where appropriate. Immobility due to pain was rated by assigning score 1 to sitting and score 2 to lying down because of the pain. Score 0 was assigned to all other entries, when the patient was either in pain but not sitting or lying down because of it or when the patient was sitting or lying down but this was not due to the pain. Pain duration was coded with a dummy variable for 2 separate comparisons of, respectively, patients with pain for 3 to 6 months ($N = 15$; code 0) to those with pain more than 6 months ($N = 65$; code 1) and of patients with pain ≤ 12 months ($N = 40$, code 0) to those with pain more than 12 months ($N = 40$; code 1).

Data Analysis

The diary measurements vary among patients but also within patients, both in days and in time throughout the day. A multilevel regression approach,⁶⁶ recommended for these types of data,⁶⁷ was used to adequately account for the hierarchical nesting of the data in 1 between-patient and 2 within-patient levels (day and beep signal). Multilevel modeling (MLn) fits a curve for the dependent variable (here: the respective aspects of disability) for each patient. This is necessary because of the interdependency of the within-patient measures at the day or beep level. The analysis consists of fitting a fixed set of models for the separate testing of the 3 sets of, respectively, fear-avoidance, cognitive, and spousal pain responses as predictors of each of the disability variables. The term ‘‘predictor’’ is used in the statistical sense and refers to the power of a given psychological variable to significantly explain variance in CPD disability. The intercept-only or empty model (model 1) decomposed the total variance in the dependent disability variable into 3 proportions, representing the random variance occurring at the patient, day, and beep level of the data. Model 2 accounted for trends in the disability variable induced by time of day and served as basis for the subsequent testing of the predictor variables. Model 3 established the disability variance explained, per level, by pain intensity. In model 4, the psychological pain responses were added to pain intensity as predictors of disability. The 3 sets of psychological pain responses were first tested separately; significant predictors were then entered simultaneously into the model 4 testing. The impact of pain intensity on disability was controlled for by subtracting, per level, the proportions of variance explained by pain intensity (model 3) from the proportions of variance explained by pain and the psychological variables (model 4). The last step was to calculate the percentages of disability variance explained by pain intensity and explained by psychological pain responses while controlling for the impact of pain intensity as proportions of the total random variance as established in model 2. To determine the impact of pain duration, 2 separate comparisons were conducted to assess: 1) differences among the 15 patients with prechronic pain versus the remaining 65 patients; and 2) differences among the 40 patients with prechronic or recently chronic pain versus the 40 patients with persistently chronic pain. For this purpose, the variables that had emerged from model 4 as significant disability predictors were centered (which was required because none of the variables contained zero values) and interactions between pain duration and the centered predictor variables were established. These interaction terms were then entered into the equation.

RESULTS

Characteristics of the Diary Variables

Presented here are the descriptive characteristics of the diary ratings of disability, computed after data aggregation per patient to account for the within-patient dependency in the diary data (Table 2). Average physical and mental capacity decreased, and pain interference with activities as well as immobility due to pain increased with pain duration, but between-group differences were not significant. Pain intensity and psychological pain responses also did not differ significantly between the groups (see Table 2 of part I of the study), although, as in disability, the scores were more favorable with shorter pain duration. Only in immobility due to pain did variability increase substantially when pain entered the chronic stage. Table 3 presents Pearson product-moment (PM) correlations for the disability variables. Immobility due to pain, the behavioral disability measure, is highly independent of the other measures. Physical and mental capacity share 25% ($r = 0.48$) of the variance and share, respectively, about 6% ($r = 0.37$) and 5% ($r = 0.23$) with pain interference. Significant MLN results regarding the prediction of the 4 disability variables are presented in the Tables 4 through 7; the beta coefficients reflect the relative predictive power of pain intensity and the psychological pain responses. Displayed are the distribution of the random or unexplained disability variance over the patient, day, and beep level (model 1) controlled for time-dependent trends (model 2), as well as the percentages of disability variance (R_2) explained, per level, by pain intensity (model 3) and by pain intensity as well as the psychological pain responses (model 4).

Prediction of Disability by Fear-Avoidance, Cognitive, and Spousal Pain Responses, Controlled for the Impact of Pain Intensity (Issue 1)

The beta coefficients show that pain intensity clearly predicts CPD disability but psychological pain responses did so as well. Compared to pain intensity: 1) avoidance behavior predicted immobility due to pain better (beta: 0.20 versus 0.16 in the separate and 0.16 versus 0.13 in the simultaneous testing) as did spousal punishment of well behavior (0.15 versus 0.13 in the simultaneous testing); 2) pain-related fear predicted pain interference with activities more strongly (beta: 0.30 versus 0.21 and 0.26 versus 0.20) and catastrophizing predicted it equally strong; and 3) negative self-statements, optimism, and catastrophizing predicted mental capacity better (0.14, 0.13, 0.10, respectively, versus 0.10 in the separate testing), which was confirmed for optimism (0.15 versus 0.12) in the simultaneous testing. Tables 4 through 7 also show that the distribution of the random variance differed between the disability variables. In physical and mental capacity, the variance was mainly due to between-patient differences (76% to 82% and 63% to 66%, respectively). In pain interference with activities and in immobility due to pain, anchored to pain and actual activities or resting behavior, most of the variance was due to differences in time of day within patients (56% to 59% and 72% to 80%, respectively). So far, the percentages of explained variance (R_2 in Tables 4 through 7) were calculated per level, whereas the crucial outcomes are the explained proportions of the total random variance in disability. This was established by calculating the percentage of explained variance per level as a proportion of the random variance attributed to that level for the significant predictor variables. (For example: according to model 4 in Table 4, pain intensity and psychological pain responses explained 18% of the total variance in physical capacity (22% {variance explained at the patient level} \times 76% {proportion of the total random variance attributed to the patient level}). To control for the impact of pain intensity on the psychological prediction of disability, the variance explained by pain intensity (model 3) was subtracted from the variance explained in the same disability measure by pain and the psychological predictors (model 4). Table 8 summarizes these calculations for the outcomes of the simultaneous testing, presented as the last analyses in Tables 4 through 7. According to Table 8, pain

intensity explained 5% to 13% of the between-patient variance and 9% to 19% of the total random variance in CPD disability. Beyond or on top of this, psychological pain responses explained 2.5% to 12.5% of the between-patient and 7.5% to 16.5% of the total disability variance. In immobility due to pain, the behavioral disability measure, the variance accounted for by psychological pain responses almost equaled that explained by pain in the first place. In impaired physical capacity and pain interference with activities, psychological pain responses added about 50% to the variance accounted for by pain intensity, and in impaired mental capacity, the variance explained by psychological pain responses was almost twice that already explained by pain intensity.

Differences in Prediction Between Patients With Chronic, Recently Chronic, and Prechronic Pain Duration (Issue 2)

The testing of between-group differences in the prediction of disability yielded 3 significant interaction effects ($P = 0.000$) that added, however, only about 1% to the variance explained at the patient level, implying that the between-group differences are small. In patients with recently and persistently chronic pain (.6 months), immobility due to pain was better predicted by, respectively, avoidance behavior (beta: 0.27) and catastrophizing (0.19) than in patients with prechronic pain. And in patients with persistently chronic pain (.12 months), catastrophizing predicted impaired physical capacity better than in patients with pain of shorter duration.

[TABLE 2 UP TO 8]

DISCUSSION

The present results regarding the psychological prediction of CPD disability were obtained with an electronic ESM diary that produced no instrument reactivity, was well tolerated, and kept with high compliance. The method yielded more than 7100 reliable recordings in 80 patients with CPD.¹⁹ Special care was taken to disseminate to what extent 4 aspects of CPD disability were explained by, respectively, pain intensity and psychological pain responses exhibited by the patients and their spouses and whether differences in these predictions occurred in patients differing in pain duration. The following discussion in our view is equally relevant to CPD research and clinical practice. Therefore, we will not systematically distinguish between the two. Between-patient differences accounted for most of the random variance in physical (about 80%) and mental (about 65%) capacity. To a lesser extent, this also applied to pain intensity (about 56%).¹ These percentages reflect the degree to which the variables depended on patient characteristics that were relatively stable over the 4 weeks of diary recording. In the other 2 disability variables, however, differences in time of day accounted for most of the random variance: 58% in pain interference with activities and 76% in immobility due to pain. Three reasons may account for this difference between the disability variables. First, physical and mental capacity pertained to subjective states, whereas the latter variables pertained to behavior. Actual activity and mobility or resting behavior depend in part on daily routines with fixed schedules, such as household chores, preparing or having meals, watching TV or taking walks, breaks, and naps. Although the diary keeping was randomized within 2-hour time frames and thus varied between days, fixed routines could have induced some similarity in the time dependencies across the patients. Second, pain interference and immobility were anchored to actual pain, and time variance may also be due to the fact that 30% of the pain intensity variance depended on time of day.¹ Third, although pain intensity increased across the day, immobility did not. The entries showed that immobility due to pain occurred mostly in the morning, which added to the time variance. Most likely, this predominance was due to morning stiffness, which

cannot be ascertained from the present data—that in turn may be a consequence of disuse or “deconditioning” and thus be pain-related. In summary, the disability variables differed intrinsically regarding whether or not actual pain and behavioral functioning was tapped, and this explains differences in the amount of momentary variance. Thus, if CPD disability depends on CPD pain, which was shown to be the case, then pain will unavoidably produce built-in “true” momentary variance in the disability variables. Supposing that the assessment of CPD disability should be tailored specifically to the pain that induced it, and presuming that behavioral measures of decreased motor activity and mobility should be at the core of this assessment, then momentary realtime measurement may be essential to CPD research and clinical practice and may in the future prove to be indispensable to both areas. In the present study, pain intensity explained 9% to 19% of the disability variance, and beyond this, psychological pain responses explained 7.5% to 16.5%. These findings exceed those of previous studies on the role of pain intensity in impaired physical capacity³⁵ and self-reported³⁶ or actual activity level³⁷ and indicate that pain intensity and psychological functioning both predict CPD disability. This challenges the finding that pain-related fear is more disabling than pain itself.³⁸ Although the latter was shown in chronic back pain, and the present study involved patients with chronic pain not confined to the musculoskeletal system, recent work in chronic back pain also detected relatively strong associations between pain intensity and disability^{40,68,69}; one study in particular found that pain intensity accounted for 22% of the disability variance, on top of which 24% was accounted for by psychological functioning.⁴⁰ In the present study, distinct associations between psychological pain responses and CPD disability stood out. Compared to pain intensity: 1) avoidance behavior was stronger in predicting immobility due to pain, and this was also true for spousal punishment of well behavior in the simultaneous testing; 2) pain-related fear was stronger and catastrophizing equally strong in predicting pain interference with activities; and 3) negative self-statements and optimism were stronger or equalized pain intensity in predicting impaired mental capacity. Of the 4 aspects of CPD disability in the present study, immobility due to pain may be viewed as the most important, because it is positioned at the core of CPD “deconditioning,” the progressive worsening of physical fitness due to reduced muscular activity, immobilization, and (bed) rest.²³ Immobility due to pain, intended to spare the body, is counterproductive in CPD and is considered crucial to CPD maintenance. Therefore, the immobility prediction in our view deserves most attention in the present outcomes. We underscore in particular that the patients’ avoidance behavior as well as the spousal responses were weak predictors of pain intensity,¹ whereas avoidance behavior and spousal punishment of well behavior were the best predictors of immobility due to pain. The spousal response at issue is tailored to immobility and concerns discouragement of movement through comments that the patient is demanding too much of his/her body and should take rest. The fact that both predictor variables are directly targeted at behavior and also that the dependent variable is behavioral may have contributed to strengthen the association. It must be acknowledged, however, that the psychological variables predicted actual pain behavior and not just behavior in general. In addition, it seems that the psychological prediction of immobility could have been far stronger given restrictions in the data that are inherent to the sampling method. According to the electronic recordings, pain intensity was not severe nor consistently present in all patients, and immobility due to pain was highly infrequent: the patients sat in 10% (N = 503) and lied down because of pain in 8% (N = 415) of the pain occasions. (Mean pain intensity ranged from 0.4 to 6.0; no pain was recorded in 0% to 88% of the diaries and 33% of the participants were free of pain in half or more of their diary recordings.¹⁹) The diary data thus indicated that the pain and the immobility induced by it was considerably less severe in the present sample than was assumed on the basis of cross-sectional diagnostics.^{1,19,70} This may have clinical implications to be addressed below. The methodological implication is that a skewed data distribution, induced by 82% zero responses in the immobility variable, very likely hampered the association between avoidance behavior and immobility due to pain. With regard to the spousal responses the

obstruction may have been even more severe, because the measurement was confined to 21% of the diary data, when the spouse was actually present while the patient was in pain. We take this as evidence that avoidance in the patient and discouragement of movement expressed by the spouse are important in CPD immobility and should be pursued and accounted for in CPD disability. But the findings also substantiated the role of pain-related fear³⁸⁻⁴⁰ and catastrophizing.^{21,39,40,48-51} These cognitive-affective pain responses were shown to be relevant to pain interference in particular, based on measurements taken while the patients were in pain and conducted everyday life activities that did not, however, necessarily strain the musculoskeletal system. Furthermore, the relevance of psychological functioning in CPD-related functional state was supported, especially regarding the role of pain-related fear in physical impairment, and the findings added emphasis to negative self-statements and optimism in the prediction of mental impairment in CPD. We therefore conclude that our study firmly corroborates the role of psychological factors in CPD disability. Regarding the relative importance of the variables, immobility due to pain and pain interference with activity, (both anchored to actual pain and behavior) in our view are the most important measures of disability, whereas both the patients' and the spouses' pain responses emerged from our study as relevant predictors in CPD. We underscore again¹ that spousal pain responses are intrinsically difficult to measure because these pertain to pain behavior in the patient as observed by the spouse. Real-time measurement approaches in vivo observation as closely as possible and may offer an important contribution to the measurement of responses of significant others to pain behavior in CPD. The present study also dealt with predictor differences between patients with shorter and longer pain duration. Immobility due to pain was better predicted by avoidance behavior and by catastrophizing in patients with chronic (.6 months) than in those with prechronic pain. And in patients with persistently chronic pain (.12 months), catastrophizing predicted impaired physical capacity more strongly than in those with shorter pain duration. The results were highly significant ($P = 0.000$), but between-group differences were small. Still, we will reflect on 2 aspects of these findings, given the relevance of identifying predictors of transition in chronic pain stages⁶³ for the prevention of chronicity. First, the patients' internal pain responses were almost equal in the groups, but pain intensity tended to be higher in those that had passed the 6-month threshold for chronicity (see Table 2 of part I¹) and the same occurred in immobility due to pain: patients with prechronic pain sat or lied down because of pain in 6% of the pain diaries, whereas this was 15% to 16% in patients with chronic pain (see Table 2). With this doubling of immobility due to pain when pain entered the chronic stage, which remained stable thereafter, the impact of psychological functioning on immobility also increased significantly. We take this to indicate that the association between immobility and, respectively, catastrophizing (the exaggerated negative interpretation of pain that may account for its "overprediction") and avoidance behavior appears to not exist from the onset of the pain problem but seems to build up within the first months, of which the third to sixth month of pain existence may be particularly relevant. Second, the spousal pain responses were highly independent from those exhibited by the patients.¹ Of these, spousal discouragement of movement tended to be higher in chronic than in prechronic pain [as did spousal reinforcement of pain behavior, which shared 50% in variance ($r = 0.71$) with discouragement of movement] and, in addition, predicted immobility due to pain. Could it thus be that spousal responses also affect immobility due to pain not from the start but gain impact after pain enters the chronic stage? We acknowledge that the above ideas are highly speculative, but in our view, they deserve further study. For that purpose, it is important to review limitations of the present study, which pertain in part to these issues. The most important limitations of this study concern the construction of some of the diary variables and the relatively small numbers of patients, particularly in the group with prechronic pain. The small number of 15 patients unmistakably hampers conclusions concerning differences between prechronic and chronic pain and the meaning of the predictions detected in this regard. This is the case notwithstanding the fact that valid answers to the issue of "transition

predictors” in our view require longitudinal prospective investigations in the same patients following pain from its onset through at least the first year of existence. Regarding the diary variables, we must emphasize that strong developments in the field of attentional processes in chronic pain produced new and challenging knowledge and include the development of an instrument (The Pain Vigilance and Awareness Questionnaire, or PVAQ⁷¹), which was not yet available when we designed the present electronic diary. Consequently, the covering of (increased) attention was rather rudimentary as well as incomplete, with the eminent shortcoming that attention to pain was not distinguished from attention to bodily symptoms and thus not separately measured. Notwithstanding this limitation, however, the present variable for “bodily vigilance” was shown to be important to the prediction of CPD pain intensity.¹ Second, of the spousal pain responses, punishment of pain behavior was not relevant to the present predictions, whereas the remaining spousal variables shared 38% to 50% in variance, indicating 1 underlying type of response. These spousal variables predicted pain intensity and disability differentially; however, the polarity of the variable “reinforcement of well behavior” was consistently opposite to that of the other 2 variables. Last, the study did not cover immobility in response to anticipated pain, which in retrospect is regrettable. Immobility was assessed exclusively when pain was perceived, and avoidance behavior predicted this type of immobility. The addition of diary items directly inquiring about immobility in response to anticipated pain (that is, without pain nociception) could have clarified whether excessive avoidance behavior continued to affect immobility in the absence of nociceptive stimulation in this group of patients with chronic pain not restricted to the musculoskeletal system. It is an intriguing finding that immobility due to pain occurred in only 18% of the occasions that the present patients were in actual pain. With regard to CPD theory, one could argue that this finding questions the general importance of “deconditioning” or disuse in broadly classified chronic pain. If disuse were at stake in these patients, it might be confined to primarily inducing morning stiffness. And if disuse were not at the core of broadly defined chronic pain, this could imply for clinical practice that the nonpharmacological treatment of these patients could focus primarily on the amelioration or prevention of maladaptive suffering.¹ This may include acceptance to counteract catastrophizing,⁷² exposure in vivo to lower fear-avoidance,⁷³ and attentional strategies to modify vigilance,⁷⁴ to name a few approaches that are recently being developed.

CONCLUSION

In conclusion, the present study singled out pain intensity as a predictor of CPD disability, but fear-avoidance, cognitive, and spousal predictors also emerged, added independently to the prediction, and should therefore be carefully assessed in diagnosing CPD. Immobility due to pain was better predicted in chronic (>6 months) than in prechronic pain, and physical impairment, a subjective measure of functional state, was best predicted in persistently chronic pain (>12 months). Keeping in mind that the analyses established associations, not causal relations, between psychological functioning and disability in CPD, we conclude from this study that pain and psychological variables explain CPD disability and that the results substantiate the relevance of psychological functioning in CPD disability.

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TABLES

TABLE 1. ESM Items for Pain Intensity, Psychological Pain Responses, and Disability in the Electronic Diary

Variables	Geared by	C- α	Item(s)	Rating	Occurrence
Pain intensity	MPI	—	How much pain do I feel right now?	7-point scale*	In all diaries
Psychological responses					
Fear-avoidance responses			Right now...		
Pain-related fear	FABQ; TSK	0.79	I am afraid to move because of the pain (with pain) I am afraid to move, because this may provoke my pain (with no pain) the pain will become worse if I move just a little bit (with pain) the pain will reoccur if I move just a little bit (with no pain)	7-point scale†	In all diaries
Bodily vigilance	—	—	I feel everything that is happening in my body		
Avoidance behavior	—	—	I avoid physical exertion that may worsen my pain (with pain) I avoid physical exertion that may trigger my pain (with no pain)		
Cognitive responses			Right now...		
Catastrophizing	CSQ	0.61	I believe that I will never get rid of my pain I think it is terrible to have such pain the pain is too much for me	7-point scale†	When pain was experienced
Negative self-statements	PCQ; INTPR	0.43	I blame myself for having pain I burden others with my pain I feel useful		
Optimism	PCQ; PCL	—	I continue to be optimistic in spite of the pain		
Control over the pain	MPI	—	there is nothing/can do to ease my pain		
Spousal responses			How does he/she respond to my pain? Right now he/she...		
Reinforcement of pain behavior	MPI	0.96	is particularly kind spares me takes over duties takes care of me	7-point scale†	When pain was experienced and the spouse was present
Punishment of pain behavior	MPI	0.55	ignores my pain is annoyed with me		
Reinforcement of well behavior	—	0.89	encourages me to go on encourages me to be active		
Punishment of well behavior	—	0.93	indicates that I should take rest notes that I demand too much of my body		
Disability					
Physical capacity	SF-16	0.88	Right now I am able to... sit stand upright walk walk stairs walk fast or run do moderately strenuous work (like vacuum cleaning) do very strenuous work (like moving furniture)	7-point scale†	In all diaries
Mental capacity	—	0.92	Right now I am able to... do mental work concentrate on my work	7-point scale†	In all diaries
Pain interference with activities	—	—	(after responding to an open item regarding the activity at the moment of the beep) the pain interfered with this activity	7-point scale†	When pain was experienced
Immobility due to pain	—	—	(after responding to items regarding sitting or lying down at the moment of the beep) I was sitting because of the pain I was lying down because of the pain	Yes/no	When pain was experienced

*Anchored 1 (none), 4 (moderate), 7 (severe).

†Anchored 1 (not at all), 4 (moderately), 7 (very much).

TABLE 2. Mean (\pm SD) of Disability Variables Assessed With the Electronic Diary

		Group 1 Pain 3-6 months (N = 15)	Group 2 Pain 6-12 months (N = 25)	Group 3 Pain > 12 months (N = 40)
Physical capacity (1-7)	N = 7121	4.47 (0.09)	3.93 (1.18)	3.77 (1.10)
Mental capacity (1-7)	N = 7121	5.61 (0.90)	5.10 (1.34)	4.79 (1.35)
Pain interference with activities (1-7)	N = 5057	3.22 (0.93)	3.32 (1.17)	3.44 (1.05)
Immobility due to pain (0-2)	N = 5057	0.13 (0.15)	0.28 (0.25)	0.33 (0.30)

Tested with ANOVA for 3 groups and post hoc *t* tests; between-group differences not significant.

TABLE 3. Pearson PM Correlations Between Disability Variables Assessed With the Electronic Diary (N = 1469)

	1	2	3
1. Physical capacity			
2. Mental capacity	0.48*		
3. Pain interference with activities	-0.37*	-0.23*	
4. Immobility due to pain	0.08†	0.05‡	0.07‡

* $P < 0.001$; † $P < 0.01$; ‡ $P < 0.05$.

TABLE 4. Variance in Physical Capacity Explained Separately and Simultaneously by Fear-Avoidance, Cognitive, and Spousal Pain Responses

Fear-Avoidance Responses (Based on 7121 Diaries)	Model 1 (Intercept-Only)		Model 2			Model 3			Model 4			
	Estimate	SE	Estimate	SE	Beta*	Estimate	SE	Beta*	Estimate	SE	Beta*	
Intercept	3.951	(0.125)	4.332	(0.127)		4.906	(0.111)		5.496	(0.104)		
Time			0.000	(0.000)	-0.080†	0.000	(0.000)	-0.063†	0.000	(0.000)	-0.050†	
Pain intensity						-0.198	(0.005)	-0.402†	-0.137	(0.005)	-0.278†	
Pain-related fear									-0.074	(0.003)	-0.244†	
Avoidance behavior									-0.058	(0.004)	-0.110†	
Bodily vigilance									-0.042	(0.006)	-0.082†	
	Random‡		Random‡			Random‡			Explained (R ²)§		Random‡	Explained (R ²)§
Variance												
Patient level	1.240		1.241	(76%)		0.932	25%		0.780	37%		
Day level	0.151		0.153	(9%)		0.113	26%		0.098	36%		
Beep level	0.250		0.236	(15%)		0.194	18%		0.172	27%		
Model fit	13053.7		12764.3	(<i>P</i> = 0.000)		11214.6	(<i>P</i> = 0.000)		10307.0	(<i>P</i> = 0.000)		

Cognitive Responses (Based on 5057 Diaries)	Model 1 (Intercept-Only)		Model 2			Model 3			Model 4			
	Estimate	SE	Estimate	SE	Beta*	Estimate	SE	Beta*	Estimate	SE	Beta*	
Intercept	3.735	(0.118)	4.075	(0.120)		4.903	(0.117)		4.934	(0.129)		
Time			0.000	(0.000)	-0.076†	0.000	(0.000)	-0.046†	0.000	(0.000)	-0.040†	
Pain intensity						-0.207	(0.008)	-0.232†	-0.136	(0.009)	-0.152†	
Catastrophizing									-0.036	(0.003)	-0.124†	
Negative self-statements									-0.031	(0.004)	-0.075†	
Optimism									0.034	(0.007)	0.042†	
Control									0.013	(0.005)	0.017†	
	Random‡		Random‡			Random‡			Explained (R ²)§		Random‡	Explained (R ²)§
Variance												
Patient level	1.103		1.101	(77%)		0.954	13%		0.920	16%		
Day level	0.149		0.152	(11%)		0.129	15%		0.111	27%		
Beep level	0.184		0.174	(12%)		0.156	19%		0.151	13%		
Model fit	8213.4		8010.1	(<i>P</i> = 0.000)		7412.8	(<i>P</i> = 0.000)		7119.1	(<i>P</i> = 0.000)		

Spousal Responses (Based on 1469 Diaries)	Model 1 (Intercept-Only)		Model 2			Model 3			Model 4			
	Estimate	SE	Estimate	SE	Beta*	Estimate	SE	Beta*	Estimate	SE	Beta*	
Intercept	3.729	(0.131)	4.067	(0.141)		4.980	(0.143)		4.996	(0.144)		
Time			0.000	(0.000)	-0.067†	0.000	(0.000)	-0.049†	0.000	(0.000)	-0.044†	
Pain intensity						-0.220	(0.014)	-0.260†	-0.203	(0.014)	-0.240†	
Reinforcement of pain behavior									-0.010	(0.003)	-0.075†	
Reinforcement of well behavior									0.018	(0.001)	0.054†	
Punishment of well behavior									-0.009	(0.006)	-0.037†	
	Random‡		Random‡			Random‡			Explained (R ²)§		Random‡	Explained (R ²)§
Variance												
Patient level	1.162		1.174	(82%)		1.007	14%		1.005	14%		
Day level	0.123		0.123	(9%)		0.092	25%		0.087	29%		
Beep level	0.137		0.132	(9%)		0.120	9%		0.120	9%		
Model fit	2314.5		2271.2	(<i>P</i> = 0.000)		2041.9	(<i>P</i> = 0.000)		2015.2	(<i>P</i> = 0.000)		

All Pain Responses (Based on 1469 Diaries)	Model 1¶	Model 2¶	Model 3¶	Model 4	
	Estimate	SE	Estimate	SE	Beta*
Intercept	5.456	(0.140)			
Time	0.000	(0.000)			-0.037†
Pain intensity	-0.105	(0.016)			-0.124†
Pain-related fear	-0.061	(0.007)			-0.117†
Catastrophizing	-0.022	(0.005)			-0.077†
Negative self-statements	-0.027	(0.006)			-0.065†

TABLE 4. (continued) Variance in Physical Capacity Explained Separately and Simultaneously by Fear-Avoidance, Cognitive, and Spousal Pain Responses

All Pain Responses (Based on 1469 Diaries)	Model 1¶	Model 2¶	Model 3¶	Model 4		
				Estimate	SE	Beta*
Reinforcement of pain behavior				-0.006	(0.002)	-0.044†
Avoidance behavior				-0.027	(0.009)	-0.042†
				Random‡	Explained (R ²)§	
Variance						
Patient level				0.909	22%	
Day level				0.071	42%	
Beep level				0.110	16%	
Model fit				1842.4	(P = 0.000)	

*Beta coefficients are standardized [SE (independent variable) × estimate (dependent variable)/SE (dependent variable)].

†P < 0.05 [estimate (Dependent variable) > 2 × SE (dependent variable)].

‡The proportions are calculated relative to the total random variance.

§Per level, the difference in explained variance as compared to the previous model is calculated as proportion of the random variance attributed to that level.

||Significance of the model with respect to the previous model.

¶See the outcomes of the previous analysis based on the same number of diary observations.

TABLE 5. Variance in Mental Capacity Explained Separately and Simultaneously by Fear-Avoidance, Cognitive, and Spousal Pain Responses

Fear-Avoidance Responses (Based on 7121 Diaries)	Model 1 (Intercept-Only)		Model 2			Model 3			Model 4		
	Estimate	SE	Estimate	SE	Beta*	Estimate	SE	Beta*	Estimate	SE	Beta*
Intercept	5.038	(0.145)	4.927	(0.207)		5.356	(0.199)		5.991	(0.104)	
Time			0.001	(0.000)	0.017†	0.001	(0.000)	0.022†	-0.001	(0.000)	-0.021†
Time‡			0.000	(0.000)	0.021†	0.000	(0.000)	-0.030†	0.000	(0.000)	-0.028†
Pain intensity						-0.185	(0.008)	-0.277†	-0.128	(0.008)	-0.159†
Pain-related fear									-0.055	(0.006)	-0.113†
Avoidance behavior									-0.071	(0.011)	-0.083†
Bodily vigilance									-0.053	(0.006)	-0.064†
	Random‡		Random‡			Random‡			Explained (R ²)§		
Variance											
Patient level	1.651		1.650 (63%)			1.451 12%			1.408 15%		
Day level	0.329		0.334 (13%)			0.298 11%			0.291 13%		
Beep level	0.650		0.614 (24%)			0.578 6%			0.555 10%		
Model fit	19584.5		19271.4 (P = 0.000)			18770.6 (P = 0.000)			18501.2 (P = 0.000)		

Cognitive Responses (Based on 5057 Diaries)	Model 1 (Intercept-Only)		Model 2			Model 3			Model 4		
	Estimate	SE	Estimate	SE	Beta*	Estimate	SE	Beta*	Estimate	SE	Beta*
Intercept	4.821	(0.152)	5.456	(0.157)		6.326	(0.162)		5.844	(0.180)	
Time			-0.000	(0.000)		-0.000	(0.000)	-0.077†	0.000	(0.000)	-0.067†
Pain intensity						-0.218	(0.015)	-0.169†	-0.087	(0.016)	-0.067†
Negative self-statements									-0.083	(0.007)	-0.142†
optimism									0.153	(0.013)	0.130†
Catastrophizing									-0.040	(0.006)	-0.095†
Control									0.020	(0.010)	0.019†
	Random‡		Random‡			Random‡			Explained (R ²)§		
Variance											
Patient level	1.808		1.821 (66%)			1.660 9%			1.430 21%		
Day level	0.340		0.343 (13%)			0.333 3%			0.279 19%		
Beep level	0.593		0.559 (21%)			0.535 4%			0.497 11%		
Model fit	13707.9		13483.3 (P = 0.000)			13272.2 (P = 0.000)			12785.4 (P = 0.000)		

Spousal Responses (Based on 1469 Diaries)	Model 1 (Intercept-Only)		Model 2			Model 3			Model 4		
	Estimate	SE	Estimate	SE	Beta*	Estimate	SE	Beta*	Estimate	SE	Beta*
Intercept	4.778	(0.168)	5.359	(0.96)		6.383	(0.223)		6.477	(0.144)	
Time			0.000	(0.000)	-0.078†	0.000	(0.000)	-0.064†	0.000	(0.000)	-0.058†
Pain intensity						-0.246	(0.029)	-0.169†	-0.221	(0.014)	-0.178†
Punishment of well behavior									-0.037	(0.011)	-0.093†
Reinforcement of well behavior									0.022	(0.013)	0.049†
Punishment of pain behavior									-0.034	(0.016)	-0.040†
	Random‡		Random‡			Random‡			Explained (R ²)§		
Variance											
Patient level	1.824		1.832 (65%)			1.651 10%			1.607 12%		
Day level	0.427		0.425 (15%)			0.389 8%			0.388 9%		
Beep level	0.565		0.548 (20%)			0.534 3%			0.525 4%		
Model fit	4250.1		4218.1 (P = 0.000)			4147.2 (P = 0.000)			4129.5 (P = 0.000)		

All Pain Responses (Based on 1469 Diaries)	Model 1 [¶]		Model 2			Model 3			Model 4		
	Estimate	SE	Estimate	SE	Beta*	Estimate	SE	Beta*	Estimate	SE	Beta*
Intercept									5.795	(0.281)	
Time									0.000	(0.000)	-0.040†
Pain intensity									-0.221	(0.014)	-0.120†
Optimism									0.177	(0.024)	0.153†
Negative self-statements									-0.074	(0.013)	-0.121†

TABLE 5. (continued) Variance in Mental Capacity Explained Separately and Simultaneously by Fear-Avoidance, Cognitive, and Spousal Pain Responses

All Pain Responses (Based on 1469 Diaries)	Model 1¶	Model 2¶	Model 3¶	Model 4		
				Estimate	SE	Beta*
Avoidance behavior				-0.085	(0.018)	-0.088†
Punishment of well behavior				-0.023	(0.008)	-0.058†
Control				0.061	(0.020)	0.055†
Catastrophizing				-0.023	(0.011)	-0.053†
	Random‡	Random‡	Random‡	Explained (R ²)§	Random‡	Explained (R ²)§
Variance						
Patient level					1.308	29%
Day level					0.317	25%
Beep level					0.493	10%
Model fit					3967.0	(P = 0.000)

*Beta coefficients are standardized [SE (independent variable) × estimate (dependent variable)/SE (dependent variable)].

†P < 0.05 [estimate (dependent variable) > 2 × SE (dependent variable)].

‡The proportions are calculated relative to the total random variance.

§Per level, the difference in explained variance as compared to the previous model is calculated as proportion of the random variance attributed to that level.

||Significance of the model with respect to the previous model.

¶See the outcomes of the previous analysis based on the same number of diary observations.

TABLE 6. Variance in Pain Interference Explained Separately and Simultaneously by Fear-Avoidance, Cognitive, and Spousal Pain Responses

Fear-Avoidance Responses (Based on 5057 Diaries)	Model 1 (Intercept-Only)		Model 2, NS	Model 3			Model 4		
	Estimate	SE		Estimate	SE	Beta*	Estimate	SE	Beta*
Intercept	3.366	(0.118)		1.337	(0.147)		0.708	(0.156)	
Pain intensity				0.437	(0.022)	0.320†	0.280	(0.024)	0.210†
Pain-related fear							0.169	(0.011)	0.304†
Bodily vigilance							0.132	(0.021)	0.146†
Avoidance behavior							-0.086	(0.014)	-0.084†
				Random‡		Random‡	Random‡		Explained (R ²)§
Variance						Explained (R ²)§			
Patient level	1.050	(33%)		0.773	26%		0.680	35%	
Day level	0.258	(8%)		0.144	44%		0.117	55%	
Beep level	1.876	(59%)		1.835	2%		1.745	7%	
Model fit¶	18392.7			18046.2	(<i>P</i> = 0.000)		17741.7	(<i>P</i> = 0.000)	

Cognitive Responses (Based on 5057 Diaries)	Model 1¶	Model 2¶	Model 3¶	Model 4		
				Estimate	SE	Beta*
Intercept				0.854	(0.150)	
Pain intensity				0.283	(0.026)	0.207†
Catastrophizing				0.096	(0.009)	0.215†
Negative self-statements				0.028	(0.011)	0.045†
				Random‡		Explained (R ²)§
Variance						
Patient level				0.661	37%	
Day level				0.125	51%	
Beep level				1.802	4%	
Model fit¶				17874.1	(<i>P</i> = 0.000)	

Spousal Responses (Based on 1469 Diaries)	Model 1 (Intercept-Only)		Model 2, NS	Model 3			Model 4		
	Estimate	SE		Estimate	SE	Beta*	Estimate	SE	Beta*
Intercept	3.134	(0.141)		0.819	(0.217)		0.676	(0.226)	
Pain intensity				0.503	(0.040)	0.379†	0.496	(0.040)	0.374†
Reinforcement of well behavior							-0.030	(0.014)	-0.062†
				Random‡		Random‡	Random‡		Explained (R ²)§
Variance						Explained (R ²)§			
Patient level	1.169	(37%)		0.764	35%		0.759	35%	
Day level	0.198	(7%)		0.122	38%		0.126	38%	
Beep level	1.789	(56%)		1.690	6%		1.681	6%	
Model fit¶	5327.8			5178.0	(<i>P</i> = 0.000)		5173.4	(<i>P</i> = 0.000)	

All Pain Responses (Based on 1469 Diaries)	Model 1¶	Model 2¶	Model 3¶	Model 4		
				Estimate	SE	Beta*
Intercept				0.573	(0.257)	
Pain intensity				0.267	(0.047)	0.200†
Pain-related fear				0.144	(0.019)	0.261†
Catastrophizing				0.088	(0.015)	0.197†
Avoidance behavior				-0.099	(0.027)	-0.096†
Reinforcement of well behavior				-0.030	(0.014)	-0.068†
				Random‡		Explained (R ²)§
Variance						
Patient level				0.553	53%	
Day level				0.109	45%	
Beep level				1.583	12%	
Model fit¶				5062.9	(<i>P</i> = 0.000)	

*Beta coefficients are standardized [SE (independent variable) × estimate (dependent variable)/SE (dependent variable)].

†*P* < .05 [estimate (dependent variable) > 2 × SE (dependent variable)].

‡The proportions are calculated relative to the total random variance.

§Per level, the difference in explained variance as compared to the previous model is calculated as proportion of the variance attributed to that level.

¶Significance of the model with respect to the previous model.

¶¶See the outcomes of the previous analysis based on the same number of diary observations.

TABLE 7. Variance in Immobility Explained Separately and Simultaneously by Fear-Avoidance, Cognitive, and Spousal Pain Responses

Fear-Avoidance Responses (Based on 5057 Diaries)	Model 1 (Intercept-Only)		Model 2			Model 3			Model 4			
	Estimate	SE	Estimate	SE	Beta*	Estimate	SE	Beta*	Estimate	SE	Beta*	
Intercept	0.265	(0.027)	0.038	(0.040)		-0.463	(0.051)		-0.705	(0.056)		
Time			0.000	(0.000)	0.069†	0.000	(0.000)	0.070†	0.000	(0.000)	0.053†	
Pain intensity						0.123	(0.009)	0.271†	0.074	(0.009)	0.163†	
Avoidance behavior									0.066	(0.005)	0.197†	
Pain-related fear									0.030	(0.004)	0.166†	
	Random‡		Random‡			Random‡			Explained (R ²)§			
Variance												
Patient level	0.053		0.053	(15%)		0.042	20%		0.043	20%		
Day level	0.015		0.017	(5%)		0.010	39%		0.009	45%		
Beep level	0.287		0.281	(80%)		0.276	2%		0.263	6%		
Model fit	8384.3		8320.9	(<i>P</i> = 0.000)		8122.0	(<i>P</i> = 0.000)		7878.6	(<i>P</i> = 0.000)		
										Model 4¶		
Cognitive Responses (Based on 5057 Diaries)	Model 1¶		Model 2¶			Model 3¶			Estimate	SE	Beta*	
Intercept									-0.387	(0.078)		
Time									0.000	(0.000)	0.063†	
Pain intensity									0.080	(0.010)	0.182†	
Catastrophizing									0.015	(0.003)	0.109†	
Negative self-statements									0.020	(0.004)	0.107†	
Optimism									-0.038	(0.008)	-0.063†	
									Explained (R ²)§			
Variance												
Patient level									0.038	27%		
Day level									0.010	41%		
Beep level									0.271	4%		
Model fit									8022.9	(<i>P</i> = 0.000)		
Spousal Responses (Based on 1469 Diaries)	Model 1 (Intercept-Only)		Model 2			Model 3			Model 4			
	Estimate	SE	Estimate	SE	Beta*	Estimate	SE	Beta*	Estimate	SE	Beta*	
Intercept	0.261	(0.036)	-0.105	(0.070)		-0.693	(0.091)		-0.675	(0.092)		
Time			0.000	(0.000)	0.142†	0.000	(0.000)	0.120†	0.000	(0.000)	0.109†	
Pain intensity						0.139	(0.014)	0.316†	0.117	(0.015)	0.266†	
Reinforcement of well behavior									-0.026	(0.006)	-0.159†	
Punishment of well behavior									0.021	(0.007)	0.149†	
Reinforcement of pain behavior									0.007	(0.003)	0.108†	
	Random‡		Random‡			Random‡			Explained (R ²)§			
Variance												
Patient level	0.065		0.067	(20%)		0.052	23%		0.049	26%		
Day level	0.030		0.029	(8%)		0.016	44%		0.016	44%		
Beep level	0.256		0.250	(72%)		0.247	1%		0.241	3%		
Model fit	2425.8		2389.4	(<i>P</i> = 0.000)		2300.7	(<i>P</i> = 0.000)		2270.1	(<i>P</i> = 0.000)		
										Model 4		
All Pain Responses (Based on 1469 Diaries)	Model 1¶		Model 2¶			Model 3¶			Estimate	SE	Beta*	
Intercept									-0.617	(0.123)		
Time									0.000	(0.000)	0.094†	
Pain intensity									0.057	(0.017)	0.130†	
Avoidance behavior									0.053	(0.010)	0.157†	
Punishment of well behavior									0.021	(0.006)	0.150†	
Reinforcement of well behavior									-0.015	(0.006)	-0.098†	
Pain-related fear									0.018	(0.007)	0.098†	
Optimism									-0.038	(0.012)	-0.098†	
Catastrophizing									0.013	(0.006)	0.088†	

TABLE 7. (continued) Variance in Immobility Explained Separately and Simultaneously by Fear-Avoidance, Cognitive, and Spousal Pain Responses

All Pain Responses (Based On 1469 Diaries)	Model 1¶	Model 2¶	Model 3¶	Model 4	
				Random‡	Explained (R ²)§
Variance					
Patient level				0.045	35%
Day level				0.009	69%
Beep level				0.237	5%
Model fit				2208.1	(P = 0.000)

*Beta coefficients are standardized [SE (independent variable) × estimate (dependent variable)/SE (dependent variable)].

†P < .05 [estimate (dependent variable) > 2 × SE (dependent variable)].

‡The proportions are calculated relative to the total random variance.

§Per level, the difference in explained variance as compared to the previous model is calculated as proportion of the random variance attributed to that level.

||Significance of the model with respect to the previous model.

¶See the outcomes of the previous analysis based on the same number of diary observations.

TABLE 8. Proportion of the Total Variance in Disability Explained by Pain and Explained on Top of This Fear-avoidance, Cognitive, and Spousal Pain Responses (N = 1469)

Disability Variables	Predictor Variables	Patient Level	Day Level	Beep Level	Total (All Levels)
Physical capacity	Pain intensity	11.5%	2.3%	0.8%	14.6%
	Fear-avoidance, cognitive, and spousal responses	6.6%	1.5%	0.6%	8.7%
Mental capacity	Pain intensity	6.5%	1.2%	0.6%	8.3%
	Fear-avoidance, cognitive, and spousal responses	12.4%	2.6%	1.4%	16.4%
Pain interference	Pain intensity	13.0%	2.7%	3.4%	19.1%
	Fear-avoidance, cognitive, and spousal responses	6.7%	0.5%	3.4%	10.6%
Immobility	Pain intensity	4.6%	3.5%	0.7%	8.8%
	Fear-avoidance, cognitive, and spousal responses	2.4%	2.0%	2.9%	7.3%