The role of pain acceptance on function in individuals with disabilities

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The role of pain acceptance on function in individuals with disabilities:

A longitudinal study

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Running Head: Acceptance of Pain

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Abstract

Having higher levels of pain acceptance has been shown to be associated positively with quality of life in patients with chronic pain, but its role in adjustment to chronic pain among individuals with physical disabilities living in the community is not known. Moreover, issues related to item overlap between measures of pain acceptance and measures of patient function have limited the conclusions that can be drawn from previous research in this area. To better understand the role that pain acceptance plays in patient function, we administered measures of pain acceptance, pain intensity, depressive symptoms, and function to 392 individuals with physical disabilities, and the pain, symptom and function measures were re-administered 3.5 years later. Analyses evaluated the main and interaction effects of initial pain acceptance on subsequent changes in pain and function. Having higher levels of pain acceptance – in particular as reflected by a willingness to engage in activities despite pain – resulted in less of an increase in pain intensity, and more improvements in pain interference, physical function, depressive symptoms, and sleep quality. The findings indicate that previous research supporting the importance of pain acceptance to function in patients from health care settings extends to individuals with chronic pain living in the community. Moreover, they indicate that pain acceptance may have long-lasting (up to 3.5 years) beneficial effects on subsequent pain and function and on the association between change in pain and depression. Research to examine the potential benefits of community-based treatments that increase pain acceptance is warranted.

Keywords: Chronic pain; Acceptance; Pain intensity; Physical Function; Sleep quality

1. Introduction

Chronic pain is a common problem for many individuals with physical disabilities [18; 44], including individuals with spinal cord injury [17], multiple sclerosis, post-polio-syndrome [33], and muscular dystrophy [27]. Moreover, chronic pain in individuals with disabilities is refractory to many biomedical treatments [20], and can be detrimental to function and quality of life [44]. There continues to be an urgent need to understand the modifiable factors that influence chronic pain and mitigate its impact in this population.

Pain-related beliefs and coping responses have been shown to influence pain, and to respond to psychosocial interventions [32]. Historically, however, research has focused disproportionately on the prevention of responses thought to be maladaptive, such as distorted cognitions, beliefs, and coping behaviors. In more recent years there has been an increased interest in identifying and fostering *adaptive* responses that predict more positive outcomes.

One potentially important psychosocial factor that could contribute to better adjustment to chronic pain is pain acceptance [41]. Pain acceptance can be defined as (1) a willingness to experience pain while also (2) engaging in behaviors consistent with one's values despite pain [36;39;42]. Greater pain acceptance, as operationalized by measures of these two domains, has been shown to be associated with less pain intensity, pain-related anxiety, avoidant behavior, depression, and physical disability in cross-sectional studies [38;55]. Acceptance has also been shown to buffer the effect of pain intensity on daily function [25] and to buffer the effects of catastrophic thinking on anxiety, depression and disability [53]. Intervention studies show that treatments such as Acceptance and Commitment Therapy, Cognitive Behavioral Therapy,

Interdisciplinary Pain treatment, and Mindfulness Based Stress Reduction increase pain acceptance [1;6;11;19;35;52;54], and that these increases are associated with better treatment outcomes [6;40;52]. Maintenance of these improvements in acceptance has also been shown to be associated with maintenance of treatment-related gains in mood and function [7].

However, most studies to date have relied on cross-sectional data and are therefore unable to examine several important issues, such as the extent to which pain acceptance domains assessed at one point in time prospectively predict important outcomes assessed later. Moreover, the items usually used to assess the pain acceptance domain of willingness to engage in activities despite pain have conceptual and item overlap with measures assessing outcome domains reflecting disability and pain interference [36]. This confound can inflate the associations found in cross-sectional studies, and therefore limit the conclusions that can be drawn. To address these issues, we sought to determine if pain acceptance at one point in time predicts a variety of key pain-related domains assessed 3.5 years later using an approach that statistically controls for the potential confound due to item overlap. We also sought to determine if pain acceptance has a moderating effect on the associations between a change in pain intensity and change in symptoms and in function over time. We hypothesized significant main effects, such that those individuals reporting higher initial levels of acceptance would report better function (or less increases in dysfunction) over time, and significant interaction effects, such that those endorsing higher levels of acceptance would evidence weaker associations between subsequent changes in pain and function.

2. Methods

2.1. Participants

Study participants were recruited to participate in a longitudinal survey examining secondary conditions in a sample of adults living with long-term physical disability. Eligible individuals were 18 years of age or older, were able to read and understand English, and self-reported a physician's diagnosis of multiple sclerosis (MS), muscular dystrophy (MD), post-polio syndrome/late effects of polio (PPS), or spinal cord injury (SCI). All study procedures were reviewed and approved by the University of Washington Human Subjects Division (HSD# 35664).

2.2. Procedures

Participants were recruited through three sources: (1) invitation letters sent to disability-specific research registries (e.g., the University of Washington Participant Pool and the University of Rochester MD Registry), (2) invitation letters to former research participants at the University of Washington, and (3) web and print advertisements. After completion of an over-the-phone eligibility screen and information statement, participants were mailed an initial (T1) survey along with a postage-paid return envelope and informed consent form. Research staff then reviewed completed surveys for incomplete or missing information, collected missing data over the phone if necessary, and mailed participation payments of $25. All participants who provided responses to the T1 survey were sent a follow-up survey approximately 3.5 years later (here called

the T2 survey).[1] Complete data was available for 1,877 individuals at T1 and 1,594 individuals at T2.

Surveys at both time points included key outcomes, including measures of pain intensity, pain interference, physical function, depressive symptoms, and sleep disturbance (see below). However, in order to minimize participant burden, a measure of pain acceptance (the Chronic Pain Acceptance Questionnaire; CPAQ [42]) was provided only to a randomly selected subset of approximately half of the T1 participants, and was not included in the T2 survey. Of the 1,877 T1 participants, 928 were selected to receive the CPAQ, and of these, 484 endorsed the presence of chronic pain and completed this measure. Of these 484 individuals, 392 completed both the CPAQ at T1 and subsequent survey at T2, and made up the sample for the present analyses.

2.3. Measures

Pain acceptance. Pain acceptance was assessed using the 20-item Chronic Pain Acceptance Questionnaire (CPAQ),[21;42] which can be scored to provide a total pain acceptance score and was originally designed and thought to assess two pain acceptance domains: (1) the degree to which an individual engages in activities regardless of pain (Activity Engagement) and (2) the respondent's willingness to experience pain (Pain Willingness). Although the CPAQ has generally demonstrated acceptable reliability and validity,[21;42] a recent content analysis of the CPAQ noted two problems with the CPAQ family of measures. First, most of the items on the Activity Engagement scale have conceptual and item overlap with self-report measures of pain

[1] A secondary aim of the longitudinal research project was to collect in-depth data on health and functioning in middle-aged participants, and as a result individuals between the ages of 45 and 65 also completed two additional surveys (spaced between T1 and T2). However, these surveys did not contain variables relevant to the present analysis, came from a much smaller number of participants, and are therefore not included here.

interference and disability. Examples of such items include, “Although things have changed, I am living a normal life despite my chronic pain” and “I am getting on with the business of living no matter what my level of pain is.” As a result, the assocaitions between the CPAQ Activity Engagement scale and meaures of pain interference/disability are likely to be artificially inflated. In order to determine the true (unbiased) association between Activity Enagement and function, it would be necessary to either (1) stasticially control for item overlap in the analyses or (2) use criterion measures assessing function domains that do not have item overlap with the Activity Engagmement items (e.g., measures of sleep quality or depression). We use both of these strategies to address the issue of item overlap in the current study.

A second problem associated with the CPAQ and many other pain acceptance meaures is that *all* of the items assessing Pain Willingness in fact ask the respondent to rate the extent to which they think it is important or necessary to control pain, which is a different construct than Pain Willingness.[36] The CPAQ scoring instructions require that all of the items be reverse scored before summing. Thus, the CPAQ Pain Willingness scale score represents “Not believing that pain control is necessary” more than “Willingness to experience pain.” Lauwerier and colleagues recommend that the scales using such items should be labeled based on what they are actually measuring, and suggest that the items not be reverse-scoreed, and the resulting scale be called *Pain Control*.[36] Because this label is also used for measures assessing pain control attributions, [32] in order to minimize the chances of confusion, here we use the label *Need for Pain Control*, and computed the scale score by summing the items in this scale (i.e., we did not reverse-score them).

Average Pain intensity. Average pain intensity in the past week was assessed using a 0-10 numerical rating scale with 0 = "*None*" and 10 = "*Very severe*." Numerical rating scales are commonly used in pain research and have a great deal of evidence supporting their reliability and validity as measures of pain intensity.[29;31] We subtracted the T2 from T1 ratings to create an average pain intensity change score, with positive values representing a decrease in pain intensity and negative values representing an increase in pain intensity.

Pain interference. We used 10 items from the PROMIS Pain Interference item bank to assess pain interference, using a 6-item short-form at T1 (example items, "How much did pain interfere with your day to day activities?", "How much did pain interfere with your enjoyment of life?", rated "in the past 7 days," on a 1 ["Not at all"] to 5 ["Very much"]) and the 4 pain interference items from the PROMIS profile 29 at T2 (example items, "How much did pain interfere with your day to day activities?", "How much did pain interfere with your household chores?", rated "in the past 7 days," on a 1 ["Not at all" to 5 ["Very much"] scale).[2;12] As with all PROMIS instruments, the scores are on a *t*-score metric, with a score of 50 representing the mean of the normative sample (in the case of pain interference, the normative sample was representative of the general U.S. population). Higher scores indicate greater pain interference. The PROMIS pain interference item bank has been validated for its use in adults with MD, MS, PPS and SCI.[5;16]

Physical function. We assessed physical function using the PROMIS Physical Function item bank.[12] In the T1 survey, we used 10 items from the item bank that the investigators determined would best reflect a broad area of physical function domains in

the population being studied (items included, “Are you able to walk more than a mile?”, “Are you able to wash and dry your body?”, “Are you able to do housework like vacuuming or sweeping floors?” rated as a participant’s “usual or average performance” on a 1 [“unable to do”] to 5 [“without any difficulty”] scale), because at the time, the PROMIS short forms had not yet been created. In the T2 survey, we used the 12-item short form that had been developed for mobility aid users (items included, “Are you able to wash and dry your body?”, “Are you able to cut your food using eating utensils?”, “Are you able to get on and off the toilet?”, rated on a 1 [“Without any difficulty”] to 4 [“With much difficulty”] scale).[3] The 10 items in the T1 survey were scored with IRTPRO software, using published item parameters and transformed into the t-metric. The T2 survey was scored following published instructions. Scores based on any subset of items from IRT-calibrated item banks are directly comparable. The reliability and validity of scores based on the Physical Function item bank has been demonstrated in disability populations and in samples of individuals with chronic pain.[9;26]

Depressive symptoms. We assessed depressive symptoms using items from the PROMIS Depression item bank.[46;50] Version 1 of the 8-item short form [13] was used in the T1 survey, and the 4-item Profile 29 short form [12] was used in T2 survey (example items shared on both measures, “In the past 7 days…I felt worthless”, “…I felt helpless”, “…I felt depressed”, “…I felt hopeless”, rated on a 1 [“Never”] to 5 [“Always”] scale). Both short forms have exhibited excellent validity and reliability.[4;5]

Sleep disturbance. Items to assess sleep disturbance were selected from the PROMIS Sleep Disturbance Item Bank.[10] The version 1 8-item short form [10] was in the T1 survey, and the 4-item short form from the Profile 29 [12] was used in the T2

survey (example items, “In the past 7 days…My sleep quality was…”, rated on a 1 [“Very poor”] to 5 [“Very good”] scale, and “…My sleep was refreshing”, rated on a 1 [“Not at all”] to [“Very much”] scale).

2.4. Data analyses

We first computed descriptive statistics (means, standard deviations, percentages, as appropriate) for the demographic and study variables to describe the sample. Next, we examined the predictor and criterion variables to ensure that they met the assumptions required for the planned regression analyses. We then conducted 10 hierarchical linear regression analyses to test the study hypotheses. Measures of pain, symptoms and function (i.e., average pain intensity, pain interference, physical function, depressive symptoms, and sleep disturbance) measured 3.5 years (i.e., T2 survey) from T1 were the criterion variables. We centered the predictor variables prior to these analyses, in order to avoid multicolinearity that would be created by the use of interaction terms. For each equation, we first entered the T1 score on the criterion domain in the first step. Any predictor variable entered after this step then predicts essentially the T1 to T2 change in the criterion variable (i.e., the residual of the T2 criterion controlling for T1 levels; [14]), while controlling for the potential confounding effects of the initial levels of the criterion variables. Importantly, this analytic approach addresses the significant issue of item overlap (between measures of acceptance and criterion measures assessing pain interference and disability, specifically [36]), because the residual – what is predicted following control for initial criterion variable scores – no longer represents *amount* of the criterion (e.g., disability or pain interference), but *change* in the criterion, and has any variance associated with item overlap with the

CPAQ scales removed. The T1 pain acceptance scales (Activity Engagement or Need for Pain Control) were then entered in step 2 (to test for the main effects of pain acceptance on change in symptoms and function) for all of the analyses, followed by the T1 to T2 change in pain intensity (step 3) for all of the analyses except those predicting T2 pain intensity. Finally, the Change in Pain X Activity Engagement or Change in Pain X Need for Pain Control interaction terms, as appropriate, were entered as a block, to test for the hypothesized interaction effects of initial pain acceptance on the associations between change in pain intensity and change in function over time (for all analyses except those predicting T2 pain intensity). In these analyses, we computed variance inflation factors (VIFs) to check for possible multicolinearity. A VIF of 10 or greater is indicative of high multicolinearity among the predictors, which can result in unreliable estimates [8;34;47]. In order to balance the need for control for the increased risks of Type 1 error (determining that an effect is present when in fact it is not present in the population) against the risks for Type 2 error (concluding that an effect is not present, when in fact it is present in the population), we set the alpha level at $P < .01$ to determine statistical significance, and alpha levels of $.01 < P < .05$ to identify trends. In the event that an interaction term was significant or demonstrated a trend, we planned to compute correlation coefficients between change in pain and change in the criterion variable(s) separately for individuals above and below the median in the pain acceptance measures, to help understand the effect.

3. Results

3.1. Participant description and study variable means and standard deviations

Sample descriptive information are presented in Table 1, and the means and standard deviations of the study variables from the T1 and T2 surveys are presented in Table 2. As can be seen, the average age of the sample was about 56 years, and the majority (62%) were female. About the same numbers of participants had spinal cord injury (31%), post-polio syndrome (28%), and multiple sclerosis (26%), but there were fewer participants with muscular dystrophy (15%). Most of the participants described themselves as White (93%).

[Insert Tables 1 and 2 about here]

Initial pain intensity scores indicated that the sample reported moderate (5.09 on the 0-10 scale) pain intensity levels, on average. Higher than normative (50.00) initial scores on the PROMIS pain interference (60.10), depression (54.02), and sleep disturbance (54.59) measures, and lower than normative values on the PROMIS physical function (34.87) measure are consistent with them being a sample of individuals with both chronic pain and physical disabilities.[4;9;22;43] Average pain increased substantially (about 1.13 points, or a little over a half a standard deviation unit) from T1 to T2, but little systematic change was observed on the other symptom and function domains, on average. However, the SDs approached or exceeded a full SD unit for the measures of all of the variables, indicating substantial change in these measures between individual participants; that is, many of the participants reported large changes in these variables over time, with some reporting increases and others decreases on the pain intensity and PROMIS measures. This supports the planned use of regression analyses to identify the personal factors that predict subsequent change

over time in pain intensity, pain interference, physical function, depression, and sleep disturbance.

3.2. Regression analyses

Assumptions testing. Based on the criterion requiring that (1) the variables to be used in the regression analyses did not have significant skew, kurtosis, outliers, or heteroscedasticity (based on skew < 2.0, kurtosis < 2.0, and a visual inspection of the scatterplot of residuals), and that (2) a lack of multicolinearity among the predictor variables (based on correlation coefficients < .70; [49]), all of the variables met the assumptions of multiple regression.

Pain acceptance main effects. The results of the planned regression analyses are presented in Tables 2 and 3. For each step of each analysis, the VIF hovered around 1, indicating that multicolinearity was not having a biasing influence on the results. Significant ($P < .01$) main effects for pain acceptance at T1 predicting change in the criterion variables were found for four the 10 regression analyses performed; trends ($.01 < P < .05$) were found for two more (see Tables 3 and 4). In every case, higher initial levels of pain acceptance (as reflected by higher scores on Activity Engagement and lower scores on Need for Pain Control) was associated with better outcomes over time; that is, more improvement in depressive symptoms and sleep disturbance, and less of an increase in pain intensity and pain interference.

[Insert Tables 3 and 4 about here]

Pain acceptance interaction effects. Significant interaction effects, indicating a moderating effect of pain acceptance on the association between change in pain intensity and change in function, did not emerge. However, a trend ($.01 < P < .05$) did

emerge in one of the regression equations: Activity Engagement X Change in Pain predicting change in depressive symptoms. Correlation analyses performed to examine the nature of this relationship indicated that, as predicted, a positive and significant association between change in pain and change in depression among those with relatively low activity engagement acceptance ($r = .17$, $p < .05$), and a weaker association between changes in pain and depression among those with relative high activity engagement acceptance ($r = .00$, $p = NS$).

4. Discussion

The findings are consistent with models that hypothesize pain acceptance is an adaptive stance for living with chronic pain. All of the findings were in the hypothesized directions, with (1) higher initial willingness to engage in activities despite pain moderating the strength of the association between subsequent changes in pain intensity and changes in depression, and (2) higher initial pain acceptance predicting subsequent improvements or lack of deterioration in important symptom and function domains over a 3.5 year period. The findings have important clinical and research implications.

From a clinical perspective, the findings suggest that pain acceptance may play a role in determining the trajectory of subsequent function in individuals with disabilities and pain. Prior research suggesting that pain acceptance is associated with important quality of life domains [21;38] and mediates the effect of pain on quality of life [24; 52] and the effects of chronic pain treatment [1;6;11;40;52;54] has focused primarily on individuals seeking treatment for chronic pain. Conclusions from these findings were also limited by the problem of significant item overlap between measures of acceptance

and measures of function [36]. The current findings extend this work by showing that pain acceptance may also play a role in individuals with chronic pain who are living in the community (i.e., individuals not necessarily receiving pain treatment). Importantly, significant effects emerged even when controlling for initial scores on the criterion measures, which controls for the possibility of artificial inflation of associations due to the overlap of items assessing acceptance and function at the same time.[36]

The findings suggest the possibility that individuals with chronic pain who are not in active treatment could potentially benefit from community-based interventions that target pain acceptance. Such interventions could include web-based learning programs that teach simple well-being exercises and that require few resources to maintain once they are established (e.g., [45]). Clinicians who interact with these individuals when providing basic or general health care could be taught strategies that could enhance pain acceptance, such as pain neuroscience education interventions (e.g., [37]), or skills to let go of efforts to control pain, when such efforts are actually interfering with valued activities. The current findings also suggest that the treatment needs of individuals who are already relatively high in acceptance may differ from those who are low in acceptance, which is consistent with previous research [53].

One of the interesting patterns that emerged from the current study was a tendency for the Activity Engagement scale to evidence a more consistent pattern of significant associations with the symptom and function domains assessed relative to the Need for Pain Control scale. Although most of the research in this area has used the total CPAQ score in their analyses (e.g., [7;25;38;40;52-55]), a number of studies have examined the two subscales individually. Two studies have shown similar patterns of

associations between the two CPAQ scales and measures of function [42;53]. However, other recent studies have shown – as we did here – stronger relationships between the Activity Engagement scale and measures of pain-related outcomes, relative to the Pain Willingness scale (here labeled the Need for Pain Control scale) [6;21]. The stronger association between activity engagement and outcomes could potentially have been explained by the conceptual overlap between the CPAQ items that measure activity engagement, and the criterion variables examined in this research assessing pain interference or disability [36]. However, in the current study, we controlled for the initial measures of the outcome domains (which would include the variance associated with shared item overlap) before examining pain acceptance as a predictor – and significant effects, including significant effects for predicting pain interference from the Activity Engagement scale still emerged.

Moreover, studies examining the immediate effects of psychosocial treatments on both of the pain acceptance domains show substantially greater effects on the CPAQ Activity Engagement scale than Pain Willingness scale [6;35;52]. These findings suggest that it may be easier to foster acceptance in concrete behavioral ways, such as engaging in activities, than to directly alter an individaul's stance towards pain. The findings are also consistent with the idea that contextual factors may play an important role in what (and how much) a patient is willing to accept. For example, one study has found that less pain-related behavioral avoidance occurred when subjects were offered a reward for making painful movement then when they were not offered a reward [15]; contexts that provide rewards for greater activity may be more plentiful than those that provide rewards for pain willingness.

Encouraging pain acceptance – in particular engaging in activities despite pain – is also a central focus of most psychosocial pain treatments, including operant treatment approaches [23], Acceptance and Commitment Therapy [41], Motivational Interviewing [28], hypnosis treatments that include suggestions for activity engagement [30], in vivo desensitization [51], interdisciplinary pain treatment [24], and many others. This fact provides even more support for the importance of the construct, as well as the idea that pain acceptance may indeed be a shared mechanism of a number of psychosocial pain treatments [1;6;11;40;52;54].

The findings pointing to larger effects of activity engagement acceptance also suggest that it may be more beneficial to focus on this observable expression of pain acceptance than on an expressed willingness to experience pain, in order to have the most beneficial effects. Thus, simple "acceptance" without a behavioral expression or component may be less likely to lead to positive changes in function. The relative importance of the two pain acceptance sub-factors (and how they might or might not influence each other) remains an important topic of further study.

The study has a number of limitations that should be considered. First, although the findings supported a role for pain acceptance as a predictor of subsequent changes in a number of important pain-related outcomes, the effect sizes were generally weak. However, it may be useful to keep in mind that these reflect the ability of pain acceptance to predict changes in outcomes over the course of 3.5 years – a relatively long time period where many factors could intervene to influence domains such as pain interference, depression, and sleep quality. The fact that significant effects emerged despite the 3.5 year time span supports the importance of the construct, consistent with

its centrality in so many chronic pain theoretical models and treatments. Moreover, we controlled for T1 to T2 change in pain intensity in all of the analyses (except in the analyses predicting change in pain intensity). While this approach provides a conservative test for these effects, it also reduces their potential explanatory power. An additional limitation is that this study was performed in the context of a longitudinal and ongoing survey of individuals with disabilities living in the community. Thus, the sample may not be entirely representative of the populations of individuals with disabilities and chronic pain, and these differences could have potentially affected the results in ways we are not able to determine. Also, because the study was observational, the changes we observed in both the predictor and criterion variables may not have been as large as one might expect in a clinical trial, further reducing our ability to detect true effects due to relatively low levels of variation. The study design also involved the exclusive use of self-report measures, which could have potentially artificially increased the strength of the associations found. Future research should include the use of observational measures of outcomes to better understand the role that pain acceptance plays in function.

As mentioned previously, a significant limitation of research in this area is the conceptual and item overlap between measures of the activity engagement domain of acceptance (i.e., willingness to engage in activities despite pain) and measures of patient function [36]. We attempted to address this issue in the current analyses by controlling for the initial scores of the criterion variables, which should control for the variance in the criterion measure due to item overlap, because by definition that variance would be included in the initial measure. Still, having a measure of

"willingness to engage in activities" as a predictor of measures of criterion variables that themselves reflect activity level is clearly problematic. Future researchers should be sure to include measures of criterion variables that have minimal conceptual overlap with the measure(s) of acceptance whenever possible.

Finally, although the results of the current prospective longitudinal study provide some support for a causal influence of pain acceptance on pain, symptoms, and function in individuals with chronic pain, the present study's design is still based on observational data. Research to evaluate (1) the causal effects of pain acceptance on patient function and (2) a potentially greater role for the activity engagement component of acceptance is warranted. For example, procedures or treatments could be designed that selectively target activity engagement more than pain willingness and vice versa, and patients could be randomly assigned to each condition in an experiment to determine the causal impact of the procedures, and whether any observed changes in pain acceptance explain the benefits found.

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References

[1] Åkerblom S, Perrin S, Fischer MR, McCracken LM. The mediating role of acceptance in multidisciplinary cognitive-behavioral therapy for chronic pain. Journal of Pain 2015;16:606-615.

[2] Amtmann D, Cook KF, Jensen MP, Chen WH, Choi S, Revicki D, Cella D, Rothrock N, Keefe F, Callahan L, Lai JS. Development of a PROMIS item bank to measure pain interference. Pain 2010;150:173-182.

[3] Amtmann D, Cook KF, Johnson KL, Cella D. The PROMIS initiative: involvement of rehabilitation stakeholders in development and examples of applications in rehabilitation research. Arch Phys Med Rehabil 2011;92:S12-19.

[4] Amtmann D, Kim J, Chung H, Bamer AM, Askew RL, Wu S, Cook KF, Johnson KL. Comparing CESD-10, PHQ-9, and PROMIS depression instruments in individuals with multiple sclerosis. Rehabil Psychol 2014;59:220-229.

[5] Bamer AM, Cook KF, Amtmann D. Reliability and validity of pain, fatigue, depression, and social roles participation PRO measures in populations of individuals aging with a physical disability. Quality of Life Research 2012;20:66.

[6] Baranoff J, Hanrahan SJ, Kapur D, Connor JP. Acceptance as a process variable in relation to catastrophizing in multidisciplinary pain treatment. Eur J Pain 2013;17:101-110.

[7] Baranoff J, Hanrahan SJ, Kapur D, Connor JP. Six month post-treatment deterioration in acceptance (CPAQ-8) and cognitions following multidisciplinary pain treatment. J Behav Med 2014;37:469-479.

[8] Belsley DA, Kuh E, Welsch RE. Regression diagnostics: identifying influential data and sources of collinearity. New York: John Wiley, 1980.

[9] Broderick JE, Schneider S, Junghaenel DU, Schwartz JE, Stone AA. Validity and reliability of patient-reported outcomes measurement information system instruments in osteoarthritis. Arthritis Care Res (Hoboken) 2013;65:1625-1633.

[10] Buysse DJ, Yu L, Moul DE, Germain A, Stover A, Dodds NE, Johnston KL, Shablesky-Cade MA, Pilkonis PA. Development and validation of patient-reported outcome measures for sleep disturbance and sleep-related impairments. Sleep 2010;33:781-792.

[11] Cederberg JT, Cernvall M, Dahl J, von Essen L, Ljungman G. Acceptance as a mediator for change in Acceptance and Commitment Therapy for persons with chronic pain? International Journal of Behavioral Medicine 2015; e-pub ahead of print, doi: 10.1007/s12529-015-9494-y.

[12] Cella D, Riley W, Stone A, Rothrock N, Reeve B, Yount S, Amtmann D, Bode R, Buysse D, Choi S, Cook K, Devellis R, DeWalt D, Fries JF, Gershon R, Hahn EA, Lai JS, Pilkonis P, Revicki D, Rose M, Weinfurt K, Hays R. The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005-2008. J Clin Epidemiol 2010;63:1179-1194.

[13] Choi SW, Reise SP, Pilkonis PA, Hays RD, Cella D. Efficiency of static and computer adaptive short forms compared to full-length measures of depressive symptoms. Qual Life Res 2010;19:125-136.

[14] Cohen J, Cohen P, West SG, Aiken LS. Applied multiple regression/correlation analyses for the behavioral sciences, 3rd edition. New York: Routledge, 2003.

[15] Claes N, Karos K, Meulders A, Crombex G, Vlaeyen JWS. Competing goals attenuate avoidance behavior in the context of pain. Journal of Pain 2014;15:1120-1129.

[16] Cook KF, Bamer AM, Amtmann D, Molton IR, Jensen MP. Six patient-reported outcome measurement information system short form measures have negligible age- or diagnosis-related differential item functioning in individuals with disabilities. Arch Phys Med Rehabil 2012;93:1289-1291.

[17] Dijkers M, Bryce T, Zanca J. Prevalence of chronic pain after traumatic spinal cord injury: a systematic review. Journal of Rehabilitation Research and Development 2009;46:13-29.

[18] Ehde DM, Jensen MP, Engel JM, Turner JA, Hoffman AJ, Cardenas DD. Chronic pain secondary to disability: A review. Clin J Pain 2003;19:3-17.

[19] Esmer G, Blum J, Rulf J, Pier J. Mindfulness-Based Stress Reduction for failed back surgery syndrome: a randomized controlled trial. JAOA 2010;110:646-652.

[20] Finnerup NB, Jensen TS. Spinal cord injury pain--mechanisms and treatment. Eur J Neurol 2004;11:73-82.

[21] Fish RA, McGuire B, Hogan M, Morrison TG, Stewart I. Validation of the chronic pain acceptance questionnaire (CPAQ) in an Internet sample and development and preliminary validation of the CPAQ-8. Pain 2010;149:435-443.

[22] Fogelberg DJ, Vitiello MV, Hoffman JM, Bamer AM, Amtmann D. Comparison of self-report sleep measures for individuals with multiple sclerosis and spinal cord injury. Arch Phys Med Rehabil 2015;96:478-483.

[23] Fordyce WE. Behavioral methods for chronic pain and illness. St. Louis: Mosby, 1976.

[24] Gatchel RJ, McGeary DD, McGeary CA, Lippe B. Interdisciplinary chronic pain management: past, present, and future. Am Psychol 2014;69:119-130.

[25] Gillanders DT, Ferreira NB, Bose S, Esrich T. The relationship between acceptance, catastrophizing and illness representations in chronic pain. Eur J Pain 2013;17:893-902.

[26] Hinchcliff M, Beaumont JL, Thavarajah K, Varga J, Chung A, Podlusky S, Carns M, Chang RW, Cella D. Validity of two new patient-reported outcome measures in systemic sclerosis: Patient-Reported Outcomes Measurement Information System 29-item Health Profile and Functional Assessment of Chronic Illness Therapy-Dyspnea short form. Arthritis Care Res (Hoboken) 2011;63:1620-1628.

[27] Jensen M, Hoffman AJ, Stoelb BL, Abresch RT, Carter GT, McDonald CM. Chronic pain in persons with myotonic dystrophy and facioscapulohumeral dystrophy. Arch Phys Med Rehabil 2008;89:320-328.

[28] Jensen MP. Enhancing motivation to change in pain treatment. In: DC Turk, RJ Gatchel, editors. Psychological approaches to pain management: A practitioner's handbook. New York Guilford Publications, 2002. pp. 71-93.

[29] Jensen MP. Measurement of pain. In: SM Fishman, JC Ballantyne, JP Rathmell, editors. Bonica's management of pain. Media, PA: Williams & Wilkins, 2010. pp. 251-270.

[30] Jensen MP. Hypnosis for chronic pain management: Therapist guide. Oxford: Oxford University Press, 2011.

[31] Jensen MP, Karoly P. Self-report scales and procedures for assessing pain in adults. In: DC Turk, R Melzack, editors. Handbook of pain assessment, Vol. 3. New York: Guilford Press, 2011. pp. 19-44.

[32] Jensen MP, Moore MR, Bockow TB, Ehde DM, Engel JM. Psychosocial factors and adjustment to chronic pain in persons with physical disabilities: a systematic review. Arch Phys Med Rehabil 2011;92:146-160.

[33] Jubelt B. Post-Polio Syndrome. Curr Treat Options Neurol 2004;6:87-93.

[34] Kutner MH, Nachtsheim CJ, Neter J. Applied linear regression models, 4th ed. New York: McGraw-Hill Irwin, 2004.

[35] la Cour P, Peterson M. Effects of mindfulness meditation on chronic pain: a randomized controlled trial. Pain Medicine 2015;16:641-652.

[36] Lauwerier E., Caes L., Van Damme S, Goubert L, Rosseel Y, Crombez G. Acceptance: what's in a name? A content analysis of acceptance intruments in individuals with chronic pain. Journal of Pain 2015;16:306-317.

[37] Louw A, Diener I, Butler DS, Puentedura EJ. The effect of neuroscience education on pain, disability, anxiety, and stress in chronic musculoskeletal pain. Arch Phys Med Rehabil 2011;92:2041-2056.

[38] McCracken LM. Learning to live with the pain: acceptance of pain predicts adjustment in persons with chronic pain. Pain 1998;74:21-27.

[39] McCracken LM, Carson JW, Eccleston C, Keefe FJ. Acceptance and change in the context of chronic pain. Pain 2004;109:4-7.

[40] McCracken LM, Gutierrez-Martinez O. Processes of change in psychological flexibility in an interdisciplinary group-based treatment for chronic pain based on Acceptance and Commitment Therapy. Behav Res Ther 2011;49:267-274.

[41] McCracken LM, Vowles KE. Acceptance and commitment therapy and mindfulness for chronic pain: model, process, and progress. Am Psychol 2014;69:178-187.

[42] McCracken LM, Vowles KE, Eccleston C. Acceptance of chronic pain: component analysis and a revised assessment method. Pain 2004;107:159-166.

[43] Molton I, Cook KF, Smith AE, Amtmann D, Chen WH, Jensen MP. Prevalence and impact of pain in adults aging with a physical disability: comparison to a US general population sample. Clin J Pain 2014;30:307-315.

[44] Molton IR, Terrill AL, Smith AE, Yorkston KM, Alschuler KN, Ehde DM, Jensen MP. Modeling secondary health conditions in adults aging with physical disability. J Aging Health 2014;26:335-359.

[45] Müller R, Gertz KJ, Molton IR, Terrill AL, Bombardier CH, Ehde DM, Jensen MP. Effects of a Tailored Positive Psychology Intervention on Well-being and Pain in Individuals with Chronic Pain and a Physical Disability: A Feasibility Trial. Clin J Pain, in press.

[46] Pilkonis PA, Choi SW, Reise SP, Stover AM, Riley WT, Cella D. Item banks for measuring emotional distress from the Patient-Reported Outcomes

Measurement Information System (PROMIS(R)): depression, anxiety, and anger. Assessment 2011;18:263-283.

[47] Robinson C, Schumacker RE. Interaction effects: centering, variance inflation factor, and interpretation issues. Multiple Linear Regression Viewpoints 2009;35:6-11.

[48] Rose M, Bjorner JB, Gandek B, Bruce B, Fries JF, Ware JE, Jr. The PROMIS Physical Function item bank was calibrated to a standardized metric and shown to improve measurement efficiency. J Clin Epidemiol 2014;67:516-526.

[49] Tabachnick BG, Fidell LS. Using multivariate statistics. New York: HarperCollins College Publishers, 1996.

[50] Teresi JA, Ocepek-Welikson K, Kleinman M, Eimicke JP, Crane PK, Jones RN, Lai JS, Choi SW, Hays RD, Reeve BB, Reise SP, Pilkonis PA, Cella D. Analysis of differential item functioning in the depression item bank from the Patient Reported Outcome Measurement Information System (PROMIS): An item response theory approach. Psychol Sci Q 2009;51:148-180.

[51] Vlaeyen JW, de Jong J, Geilen M, Heuts PH, van Breukelen G. Graded exposure in vivo in the treatment of pain-related fear: a replicated single-case experimental design in four patients with chronic low back pain. Behav Res Ther 2001;39:151-166.

[52] Vowles KE, McCracken LM, Eccleston C. Processes of change in treatment for chronic pain: the contributions of pain, acceptance, and catastrophizing. Eur J Pain 2007;11:779-787.

[53] Vowles KE, McCracken LM, Eccleston C. Patient functioning and catastrophizing in chronic pain: the mediating effects of acceptance. Health Psychol 2008;27:S136-143.

[54] Vowles KE, McCracken LM, O'Brien JZ. Acceptance and values-based action in chronic pain: a three-year follow-up analysis of treatment effectiveness and process. Behaviour Research and Therapy 2011;29:748-775.

[55] Vowles KE, Witkiewitz K, Sowden G, Ashworth J. Acceptance and commitment therapy for chronic pain: evidence of mediation and clinically significant change following an abbreviated interdisciplinary program of rehabilitation. J Pain 2014;15:101-113.

Table 1. Number (and rates) of categorical descriptive variables and mean and SD of participant age.

Variable	N	(%)	Mean (SD)
Sex			
Men	148	(38%)	
Women	244	(62%)	
Age			55.66 (12.21)
Diagnosis			
Muscular Dystrophy	58	(15%)	
Multiple Sclerosis	103	(26%)	
Post-Polio Syndrome	111	(28%)	
Spinal Cord Injury	120	(31%)	
Race/Ethnicity			
White	366	(93%)	
Black	10	(3%)	
Asian	3	(1%)	
American Indian/ Native American	2	(1%)	
Other	10	(3%)	

Table 2. Means and standard deviations of the study variables assessed at T1 and T2.

Variable	T1 Mean (SD)	T2 Mean (SD)	T1-T2 Δ Mean (SD)
Need for Pain Control	24.87 (11.00)		
Activity Engagement	43.94 (12.13)		
Average pain intensity	5.09 (1.93)	6.21 (2.45)	-1.13 (2.32)
Pain interference	60.10 (6.29)	59.42 (8.60)	0.67 (7.05)
Physical function	34.87 (8.76)	35.79 (9.93)	-0.92 (5.82)
Depression symptoms	54.02 (8.64)	51.06 (9.11)	2.96 (8.39)
Sleep disturbance	54.59 (9.45)	52.20 (9.02)	2.39 (7.97)

Note: T1-T2 difference scores that are negative indicate an increase in the variable and scores that are positive indicate a decrease in the variable from T1 to T2 (3.5 years later).

Table 3. Regression models predicting T2 measures of function from the Pain Willingness scale, controlling for initial measures function (N = 392)

Step: predictor variable	R^2 Δ	F (R^2Δ)	β	*t*	*p*	VIF
T2 average pain intensity (Overall model: *F* (2,389) = 53.54, *p* <.001)						
Step 1: Initial average pain intensity	.21	105.11	.46	10.25	<.001	1.00
Step 2: Need for Pain Control	.00	1.77	.06	1.33	.185	1.14
T2 pain interference (Overall model: *F* (4,387) = 80.80, *p* <.001)						
Step 1: Initial pain interference	.35	208.69	.59	14.45	<.001	1.00
Step 2: Need for Pain Control	.01	3.32	.09	1.82	.069	1.54
Step 3: Change in pain intensity	.10	69.63	-.31	8.35	<.001	1.00
Step 4: Need for Pain Control X Change in Pain	.00	1.92	-.05	1.39	.167	1.01
T2 physical function (Overall model: *F* (4,387) = 198.28, *p*<.001)						
Step 1: Initial physical function	.66	759.76	.81	27.56	<.001	1.00
Step 2: Need for Pain Control	.00	2.93	.05	1.71	.088	1.03
Step 3: Change in pain intensity	.01	9.95	.09	3.16	.002	1.01
Step 4: Need for Pain Control X Change in Pain	.00	0.36	.02	0.60	.547	1.01
T2 depressive symptoms (Overall model: *F* (4,387) = 48.96, *p*<.001)						
Step 1: Initial depressive symptoms	.31	173.48	.56	13.17	<.001	1.00
Step 2: Need for Pain Control	.02	9.73	.14	3.12	.002	1.11
Step 3: Change in pain intensity	.01	5.40	-.10	2.32	.021	1.01
Step 4: Need for Pain Control X Change in Pain	.00	1.16	.05	1.08	.283	1.01
T2 sleep disturbance (Overall model: *F* (4,387) = 77.40, *p*<.001)						
Step 1: Initial sleep disturbance	.40	254.59	.63	15.96	<.001	1.00
Step 2: Need for Pain Control	.02	11.84	.14	3.44	.001	1.04
Step 3: Change in pain intensity	.03	19.46	-.17	4.41	<.001	1.01
Step 4: Need for Pain Control X Change in Pain	.00	2.49	.06	1.58	.115	1.02

Note: VIF = Variance inflation factor.

Table 4. Regression models predicting T2 measures of function from the from the Activity Engagement scale (N = 392)

Step: predictor variable	R^2 Δ	F (R^2Δ)	β	*t*	*p*	*VIF*
T2 average pain intensity (Overall model: *F* (2,389) = 56.14, *p* <.001)						
Step 1: Initial average pain intensity	.21	105.11	.46	10.25	<.001	1.00
Step 2: Activity Engagement	.01	5.87	-.12	0.42	.016	1.13
T2 pain interference (Overall model: *F* (4,387) = 85.97, *p* <.001)						
Step 1: Initial pain interference	.35	208.69	.59	14.45	<.001	1.00
Step 2: Activity Engagement	.03	15.26	-.20	3.91	<.001	1.64
Step 3: Change in pain intensity	.09	68.81	-.31	-8.30	<.001	1.00
Step 4: Activity Engagement X Change in Pain	.00	0.00	-.00	0.02	.986	1.02
T2 physical function (Overall model: *F* (4,387) = 199.59, *p*<.001)						
Step 1: Initial physical function	.66	759.76	.81	27.56	<.001	1.00
Step 2: Activity Engagement	.00	2.93	-.05	1.71	.088	1.06
Step 3: Change in pain intensity	.01	10.48	.09	3.24	.001	1.00
Step 4: Activity Engagement X Change in Pain	.00	1.57	-.04	1.25	.210	1.03
T2 depressive symptoms (Overall model: *F* (4,387) = 48.19, *p* <.001)						
Step 1: Initial depressive symptoms	.31	173.48	.56	13.17	<.001	1.00
Step 2: Activity Engagement	.01	5.30	-.11	2.30	.022	1.36
Step 3: Change in pain intensity	.01	4.58	-.09	2.14	.033	1.00
Step 4: Activity Engagement X Change in Pain	.01	4.25	.09	2.06	.040	1.02
T2 sleep disturbance (Overall model: *F* (4,387) = 74.13, *p*<.001)						
Step 1: Initial sleep disturbance	.40	254.59	.63	15.96	<.001	1.00
Step 2: Activity Engagement	.01	8.18	-.12	2.86	.004	1.10
Step 3: Change in pain intensity	.03	17.55	-.16	4.19	<.001	1.00
Step 4: Activity Engagement X Change in Pain	.00	0.51	.03	0.71	.476	1.02

Note: VIF = Variance inflation factor. The statistics associated with Step 2 predicting T2 physical function (with the exception of VIF) appear to be the same as those associated with this step (but with the Need for Pain Control as the predictor) presented in Table 3. However, the results of the two analyses were slightly different, although they rounded to the same numbers.