An analysis of within-treatment change trajectories in valued activity in relation to treatment outcomes following interdisciplinary Acceptance and Commitment Therapy for adults with chronic pain

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ABSTRACT

A key issue in chronic pain treatment concerns changes necessary for reduced pain-related distress and disability. Acceptance and Commitment Therapy (ACT), a behavior change approach, theorizes several important treatment processes. Increased engagement in valued activities appears highly relevant as previous work has indicated it is related to current and future functioning and to treatment outcomes. This study sought to examine change trajectory in valued activity over the course of an interdisciplinary program of ACT and its relation to outcomes at treatment conclusion and three-month follow-up ($N = 242$). Latent change trajectories of valued activity were assessed weekly over four weeks of treatment and analyzed via latent growth curve and growth mixture modeling. A single latent trajectory with an increasing linear slope was indicated. Overall, slope of change in valued activity was predictive of improvement in psychosocial outcomes at post-treatment, including psychosocial disability, depression, pain anxiety, and discrepancy between values importance and success. Slope was not related to change in pain intensity or physical disability at post-treatment, nor was it related to change in any variable at follow-up. Findings are discussed in relation to the ACT model, in that support was provided in relation to post-treatment improvements for psychosocial variables.

1. Introduction

Chronic pain, typically defined as the experience of at least moderate intensity pain on most days per week for a period of three months or more, is a common condition (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006; Kennedy, Roll, Schraudner, Murphy, & McPherson, 2014; Nahin, 2015). It is often associated with significant disruptions in social, vocational, and emotional functioning (Breivik et al., 2006; Jensen & Turk, 2014). Psychological and behavioral interventions have a longstanding history of utility in reducing these disruptions, particularly when integrated interdisciplinary treatments are offered (Fordyce, 1976; Gatchel, McGeary, McGeary, & Lippe, 2014; Main, Keefe, Jensen, Vlaeyen, & Vowles, 2014; Turk & Burwinkle, 2005).

Over the past two decades, research has supported the utility of one specific form of behavioral intervention for chronic pain, that of Acceptance and Commitment Therapy (ACT; S. Hayes, Strosahl, & Wilson, 2012). The effectiveness of ACT for chronic pain has been supported in both unidisciplinary clinical psychology (Dahl, Wilson, &

Nilsson, 2004; Luciano et al., 2014; Wetherell et al., 2011) and in interdisciplinary interventions (McCracken, Vowles, & Eccleston, 2005; Vowles, Witkiewitz, Sowden, & Ashworth, 2014c; Wicksell et al., 2013), through follow-ups of as long as three years (Vowles, McCracken, & O'Brien, 2011a). Currently, ACT for chronic pain is graded by the American Psychological Association's Division of Clinical Psychology as having "strong" empirical support (Society of Clinical Psychology, 2015). Given this established database of effectiveness, a crucial next step is to examine how ACT works in those with chronic pain. If key so-called "treatment mechanisms" can be identified and empirically supported, then it should be possible to more precisely target these mechanisms in future interventions to improve treatment effect.

One plausible behavioral process that has been identified as a mechanism in ACT concerns changes in engagement in values-related activities (Hayes et al., 2012; Wilson, Sandoz, Kitchens, & Roberts, 2010). Values-related activities can be simply defined as actions that contribute to more meaningful, vital, and successful living in important life domains or as actions that contribute to improved quality of life (Hayes

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et al., 2012; Lundgren, Luoma, Dahl, Strosahl, & Melin, 2012; Wilson et al., 2010). Within ACT for chronic pain, increasing values-related behaviors within a context of continued and persistent pain is a cornerstone objective of treatment (McCracken & Vowles, 2014). To date, the literature has produced three consistent findings regarding the relevance of values in chronic pain. First, greater success in valued activities and smaller discrepancies between functioning (Jensen, Vowles, Johnson, & Gertz, 2015; McCracken & Yang, 2006). Second, ACT for chronic pain reliably increases values success and decreases the importance-success discrepancy (McCracken & Gutiérrez-Martínez, 2011; Vowles & McCracken, 2008; Vowles et al., 2011; Vowles et al., 2014c). Third, correlation and regression-based approaches have indicated that pre-treatment to post-treatment changes in valued activity are related to improvements in pain-related distress and disability at post-treatment and through follow-up (McCracken & Gutiérrez-Martínez, 2011; Vowles & McCracken, 2008; Vowles et al., 2011; Vowles et al., 2014c).

In order to more fully investigate the role of changes in valued activity over the course of treatment, however, it is necessary to examine how changes in valued activity *during* treatment predict changes in functioning *after* treatment. Such an analysis would help illuminate the temporal relations between treatment-related changes. Furthermore, there are modern statistical methods that allow for a more detailed assessment of the relation between within-treatment changes in valued activity and changes in functioning at post-treatment and follow-up. For example, latent growth curve modeling (LGCM) is particularly useful, as it allows for both within- and between-person assessment of change over time (Duncan & Duncan, 2009; Ram & Grimm, 2009). Specifically, LGCM allows for an assessment of the shape of change over time (e.g., linear, quadratic) and can be used in conjunction with Growth Mixture Modeling (GMM) to determine whether there are distinct classes or subgroups of participants with different trajectories of change.

The current analysis was intended to evaluate these issues in a sample of individuals taking part in a four-week program of interdisciplinary ACT for chronic pain. Engagement in values was assessed weekly during treatment. Both LGCM and GMM were used to examine change trajectories in valued activity during treatment and assess the relevance of these trajectories to outcomes at post-treatment and follow-up. Outcome measures included pain intensity, physical and psychosocial disability, depression, pain-related anxiety, and the discrepancy between values importance and values success. These measures of pain-related functioning assess relevant constructs in chronic pain and their assessment has been recommended by both consensus statements (Dworkin et al., 2005) and reviews (Turk, Fillingim, Ohrbach, & Patel, 2016; Kevin E; Vowles, McCracken, Gross, & McCracken, 2007b). It was hypothesized that slope of change in valued activities during treatment would be related to the magnitude of change following treatment, such that steeper positive slopes, indicating increasing engagement in valued activities, would be statistically related to greater improvements in pain-related functioning.

2. Methods

2.1. Participants

Participants included individuals with chronic pain who began a four-week course of interdisciplinary ACT for chronic pain located in the midlands of the United Kingdom. Participants completed a battery of self-report measures on the first and last day of treatment, as well as at a three-month follow-up visit. A two item measure of engagement in valued activity, the Values Tracker (VT; Pielech et al., 2016), described below, was completed weekly by participants. Data collection was approved by the local UK National Health Service Research Ethics Board and informed consent occurred when participants completed an initial assessment appointment.

In total, data were collected from all individuals (*n* = 272) who began treatment over a five-year interval (July 2012–November 2017).

Each individual had been referred to the interdisciplinary treatment program and had completed an evaluation with a program clinical psychologist, as well as a physical health examination with either a program physician or physical therapist. Exclusion criteria included: 1) evidence of harmful opioid or other substance use that required substance abuse treatment prior to program participation, 2) evidence of acute psychosis, or 3) unwillingness to participate in a group-based outpatient program of treatment. Thirty individuals dropped out of treatment early (11%), thus analyses used data from 242 individuals. Further, 162 individuals (66.9% of the 242 individuals who completed treatment) attended a three-month follow-up visit.

The majority of participants were female (62%), White European (98%), and married or co-habitating: 65% (single: 21%, divorced: 11%, widowed: 3%). Average age was 48.0 years (*SD*: 11.2). Only 27% of participants were working on a full or part-time basis. Regarding educational achievement, 41% of participants reported completion of compulsory education, 23% had attended some college or university courses, 3% completed a bachelor's degree, and 1% completed a postgraduate degree. The remaining 32% of individuals did not complete compulsory education.

Average pain duration was 60.0 months (*SD:* 58.3; Median: 43.0; range: 6.0–344.0). Primary reported pain location included: low back: 45%, full body: 21%, lower extremity: 12%, neck: 11%, middle back: 3%, upper extremity: 4%, abdomen: 2%, or hips/pelvis: 2%. Most of the sample, 65%, reported more than one site of chronic pain, with secondary sites including: lower extremity: 52%, low back 16%; upper extremity: 13%, neck: 4%, middle back: 4%, abdomen: 3%, full body 3%, hips/pelvis: 3%, and head: 2%.

A proportion of the sample in the present analyses provided data reported in two previous papers. The first, which reported on treatment outcome and process, included 12 participants from the present sample (5% of treatment completers; Vowles et al., 2014c), and the second, which reported a GMM analysis of changes in pain intensity and pain-related distress, included 102 participants from the present sample (42% of treatment completers; Vowles, Witkiewitz, Levell, Sowden, & Ashworth, 2017). As noted, the primary objective of the present analysis was to examine whether within-treatment changes observed on the VT had a relation with distal outcomes at post-treatment and follow-up. The VT was consistently used within the treatment service from the July 2012 treatment cohort onwards.

2.2. Treatment program

Treatment was an interdisciplinary course of pain rehabilitation offered from the ACT theoretical framework. Disciplines included clinical psychology, anesthesiology, physical therapy, and nursing. Treatment included 44 h of intervention offered on two consecutive days per week for four weeks. Each treatment day included 5.5 h of intervention, including 2 h of physical therapy, 1 h of clinical psychology content (e.g., behavior change rationale and intervention, formal defusion and acceptance exercises, generalization training), 30 min of formal mindfulness practice, 1 h of values clarification and goal setting activities (e.g., identifying values and establishing values-consistent goals for behavior), and 1 h of "healthy living" content, which included sessions on health and medical education, analgesic medications, and skills training (e.g., effective communication, relapse preparation/planning, activity management for valued activity).

The bulk of intervention was delivered in a group format, although individual meetings occurred at least once per week. The ACT model has been presented in detail elsewhere (Hayes et al., 2012; Hayes, Villatte, Levin, & Hildebrandt, 2011; McCracken, 2005; McCracken & Vowles, 2014; Wicksell & Vowles, 2015). In brief, treatment aimed to increase patient engagement in meaningful and valued activity with the ongoing experience of pain and pain-related distress. Each of the disciplines involved in treatment offered interventions consistent with this overarching goal. For example, physical therapy sessions revolved

around using exercise and physical activity for the consistent pursuit of valued activities and nursing-led sessions primarily involved values clarification and values-related goal setting. Anesthesiology-led sessions primarily involved education regarding pain neurophysiology, effective analgesic use, and interactions with healthcare providers, although these sessions also focused upon some of the negative impacts experienced in relation to pain control-focused interventions and offered the pursuit of consistent engagement in values-based action as an alternative. Treatment did not include any interventions directly aimed at pain reduction or pain control, nor did it include interventions directly aimed at cognitive change or restructuring.

Earlier portions of treatment were directed at values clarification and examining the long-term impact of pain control efforts on overall quality of life. Middle parts of treatment continued to include values clarification exercises and transitioned into effective goal setting for the pursuit of values. Treatment also included formal cognitive defusion, present-focused awareness, and self-as-context exercises. These exercises were intended to decrease problematic influences of aversive thoughts and feelings by expanding patient's repertoire of available behavioral responses, cultivation of willingness to have thoughts and feelings in the service of values, and broaden awareness of ongoing experience to allow for more effective responding overall. The latter parts of treatment explicitly focused upon generalization and maintenance of within-treatment gains to patient's home environment. Treatment fidelity was supported by manualization of all treatment sessions, 60-min team meetings on each day of treatment to discuss patient progress and session content, a once-monthly 60-min continuing education meeting, and periodic cross-disciplinary session observation.

2.3. Measures

2.3.1. Demographic and pain-related information

Participants completed a battery of self-report questionnaires on the first and last days of treatment, as well as at a three-month follow-up assessment. Collected demographic information included gender, age, educational achievement, and work status. Pain related information included pain duration and primary and secondary pain locations.

2.3.2. Values tracker

Participants completed the Values Tracker (VT; Pielech et al., 2016) each week during treatment at the end of the first day's treatment content or beginning of the second day's. The VT was used to quantify changes in valued activities occurring over the course of treatment and consisted of two items, "*Rate how effective you were in taking actions that contributed to a better, more vital, quality of living in the past week*" and "*Rate how effective you were this past week in making progress in the areas of your life that matter to you*". Each item was rated on a 0 (least effective/progress possible) to 10 (most effective/progress possible) Numerical Rating Scale (NRS) and the items were summed to obtain a total score. The initial cross-sectional analysis of the VT indicated reliable relations between the total score and measures of pain-related functioning, including psychosocial disability, depression, pain-related anxiety, acceptance, and values success, even after controlling for pain duration and intensity (Pielech et al., 2016). These same data indicated that the VT was not related to physical disability. In the measure development sample, the two VT items were significantly correlated, $r = 0.71$, $p < .001$. Within the present sample, the VT items were significant correlated with one another when examined each week, $r = 0.64$ (week 1), $r = 0.60$ (week 2), $r = 0.74$ (week 3), and $r = 0.72$ (week 4), all $p < .001$.

2.3.2.1. Measures of outcome. As noted, all other measures were completed on three occasions, pre-treatment, post-treatment, and three-month follow-up. Details for each measure are provided below.

2.3.2.2. Pain intensity. Usual pain intensity over the previous week was assessed using a 0 (no pain) to 10 (maximum pain possible) NRS. This method of assessing pain intensity is well established within the chronic pain literature (Campbell & Vowles, 2008; Jensen, Turner, Romano, & Fisher, 1999).

2.3.2.3. Physical and psychosocial disability. The Sickness Impact Profile – Chronic Pain (SIP-CP; McEntee, Vowles, & McCracken, 2016) was used to quantify self-reported Physical and Psychosocial Disability. Scores on the Physical Disability and Psychosocial Disability scales range from 0 to 1 with higher scores indicating greater levels of disability. All items are dichotomous with the Physical Disability scale consisting of 16 items and the Psychosocial Disability scale consisting of 26 items. Internal consistency, Kuder-Richardson Formula 20 for dichotomous items, in the present data ranged from 0.80 to 0.82 across the three assessment points for Physical Disability and from 0.82 to 0.86 for Psychosocial Disability.

2.3.3. Depression

The British Columbia Major Depression Inventory (BCMDI; Iverson & Remick, 2004) evaluated the severity of depressive symptoms. The BCMDI items are based on the diagnostic criteria for a Major Depressive Disorder (American Psychiatric Association, 2000). Scores on the 16 items of the BCMDI range from 0 to 80 with higher scores indicating more severe symptoms. Internal consistency, Cronbach's α, ranged from 0.82 to 0.87 across the three assessment points.

2.3.3.1. Pain-related anxiety. The short form of the Pain Anxiety Symptoms Scale (PASS; McCracken & Dhingra, 2002) was used to measure pain-related fear. The PASS is a well-established and psychometrically sound measure (Leeuw et al., 2007; McCracken & Dhingra, 2002; Roelofs et al., 2004) with 20 items and scores ranging from 0 to 100. Internal consistency in the present data ranged from Cronbach's α = 0.92 to 0.95.

2.3.3.2. Values discrepancy. Discrepancy between success and importance in valued activity was evaluated using the Chronic Pain Values Inventory (CPVI; McCracken & Yang, 2006). The CPVI evaluates importance and success across six domains, which include family, intimate/close interpersonal relations, friends, work, health, and personal growth and learning. The average discrepancy between importance and values success across domains was calculated. More negative scores indicate greater levels of discrepancy, while scores closer to zero or moving in the positive range indicate lesser discrepancy. Internal consistency for this scale ranged from Cronbach's α = 0.79 to 0.85 across assessment points.

2.4. Statistical approach

All analyses were conducted using Mplus version 8 (Muthén & Muthén, 2017). Across all analyses, maximum likelihood (ML) estimation was used to address missing data, as it makes use of all available data in the variance-covariance matrix and generally produces unbiased estimates under the assumption that data are missing at random (Enders, 2001; Schafer & Graham, 2002). There were three primary steps to data analysis.

First, the effectiveness of treatment was evaluated using multilevel structural equation modeling (SEM; Preacher, Zyphur, & Zhang, 2010). While the effectiveness of interdisciplinary ACT for chronic pain is established (Society of Clinical Psychology, 2015), which includes evaluations of the service providing data for the present analysis (Vowles et al., 2017; Vowles et al., 2014c), it was felt that a determination of treatment outcome was a necessary pre-requisite to examine how changes in the VT over the course of treatment influenced outcomes. Because patients were treated in groups, we also examined the role of treatment cohort on outcomes (i.e., "nesting" patients into treatment

group).

Second, LGCM and GMM were used to evaluate trajectory and number of classes of change for the VT over the course of the four weeks of treatment. Model fit for both linear and linear plus quadratic change were investigated, as were multiple classes of change. Model fit was determined using the Root Mean Square Error of Approximation (RMSEA), the Standardized Root Mean Square Residual (SRMR), and the Comparative Fit Index (CFI). Adequate model fit was defined as RMSEA of ≤ 0.08, SRMR ≤ 0.08, and CFI ≥ 0.95 (Bryne, 2001; Hu & Bentler, 1999; MacCallum, Browne, & Sugawara, 1996).

We also evaluated for heterogeneous classes of latent growth by adding a categorical latent class variable indicated by the latent growth factors from the LGCM, beginning first with two classes and then adding additional classes until comparative analyses between models indicated a lack of improvement in fit. These analyses allowed an examination of whether there were different groups of participants that could be classified by change trajectory. For example, it could be hypothesized that there may be two groups of participants, one with no change in the VT during treatment and one with substantial linear or quadratic increase.

Model fit for single and multiple class models was evaluated using the Bayesian information criterion (BIC; Nylund, Asparouhov, & Muthén, 2007; Schwarz, 1978), sample size adjusted BIC (aBIC; Sclove, 1987), Vuong-Lo-Mendell-Rubin test (VLMR: Asparouhov & Muthén, 2012; Lo, Mendell, & Rubin, 2001; Vuong, 1989), and entropy. For BIC and aBIC, smaller values indicate better fit. The VLMR offers a significance test for the improvement in model fit of a k-class model versus a $k-1$ class model. Values for entropy range from 0 to 1, with higher values indicating better classification precision. The best fitting latent growth trajectory and number of latent classes of change was retained for subsequent analyses.

The third and final step of analyses used GMM to evaluate how aspects of VT trajectory related to the magnitude of change in distal outcome variables at post-treatment and at follow-up. A GMM analysis can be used to determine how aspects of the identified trajectories and classes of change relate to treatment-related improvements in functioning following treatment. Two specific aspects of change are potentially relevant, intercept and slope. A significant finding for intercept would indicate that the starting point of the VT was relevant for treatment outcomes, for example, higher baseline engagement in values could be related to greater improvements in functioning. A significant finding for slope would indicate that the rate of change in values-based action was relevant for treatment outcomes, for example, steeper positive slope may be related to greater improvements in functioning. Distal outcomes included all outcome measures detailed in the measures section. The primary distal outcome analyses used raw change in these outcome variables. Residualized changes in distal outcomes were also examined and are reported in supplementary materials.

3. Results

3.1. Assessment of treatment effectiveness

Data were initially nested at three hierarchical levels: (level 1) repeated assessment at pre-treatment, post-treatment, and three-month follow-up (time), (level 2) within participant change, and (level 3) within treatment cohort. Cohort size ranged from 5 to 12 individuals (Mean: 7.0; SD: 1.8). When the effect of treatment cohort (level 3) on treatment outcomes was evaluated using intraclass correlations (*ICC*), results indicated only a small amount of variance in outcome was explained by cohort, *ICC* range 0.001 (Physical Disability, Psychosocial Disability, & Depression) to 0.06 (Pain Intensity). Given this minimal effect, and to simplify results, multilevel modeling of treatment effect proceeded using two levels: time and within-participant change.

Descriptive information for all measures is displayed in Table 1. The multilevel SEM models indicated a significant effect of time on all outcomes. Specifically, over time, individuals reported significant improvements in pain intensity (B [standard error, SE] = - 0.32 [0.07], $p < .001$), physical disability (B [SE] = - 0.03 [0.01], $p < .001$), psychosocial disability (B [SE] = - 0.06 [0.01], $p < .001$), depression (B [SE] = - 4.02 [0.42], $p < .001$), pain-related anxiety (B [SE] = - 6.7 [0.68], $p < .001$), and values discrepancy (B [SE] = 0.38 [0.04], $p < .001$).

Table 1 also displays the results of pairwise comparisons across the three assessment points. For the pre-treatment to post-treatment comparisons, all outcome variables significantly improved. For the pre-treatment to follow-up comparisons, all outcome variables with the exception of pain intensity significantly improved. Finally, for the post-treatment to follow-up comparisons, all outcome variables with the exception of pain intensity were not significantly different, suggesting maintenance of treatment gains. For pain intensity specifically, follow-up ratings were significantly greater than post-treatment and did not significantly differ from pre-treatment, indicating pain intensity had decreased by the end of treatment, but was no longer significantly decreased at follow-up.

Finally, effect sizes are also shown in Table 1, using the formula of Morris and Deshon (2002) which corrects for between mean dependence across the different assessment points. Across most outcomes, effect sizes were in the medium or large range using the interpretative criteria suggested by Cohen (1988). The only exceptions were for physical disability, for which a small effect, approaching medium ($d = 0.49$), was evident at both post-treatment and follow-up, and for pain intensity, for which a less than small effect ($d = .10$) was indicated at follow-up.

3.2. Latent growth curve modeling

The LGCM of the VT with a linear growth trajectory provided good fit to the data [RMSEA = 0.08 (90% CI: 0.03–0.14), SRMR = 0.04, CFI = 0.96] and was better than a model including linear growth with quadratic change [RMSEA = 0.13 (90% CI: 0.04 - 0.25), SRMR = 0.05, CFI = 0.96]. In addition, as shown in Table 2, both BIC and aBIC were slightly lower for the linear model in comparison to the linear plus quadratic model, suggesting that the addition of a quadratic change to the model slightly worsened fit to the data. Fig. 1 displays the expected and observed increases in VT scores across the four weeks of treatment. Linear change was significant (Mean: 1.2; *SE*: 0.31, $p < .001$). Descriptive information is also displayed in Fig. 1. Mean VT scores increased from 9.9 ($SD = 4.3$) at treatment onset to 13.3 ($SD = 4.0$) at treatment's end. The corrected effect size (Morris & Deshon, 2002) was of a medium magnitude, 0.68. The corrected effect sizes for week-by-week changes in VT were as follows: 0.40 for week 1 to week 2, 0.09 for week 2 to week 3, and 0.21 for week 3 to week 4.

3.3. Growth mixture models (GMM)

As also shown in Table 2, the GMM of the VT indicated that neither the 2- or 3-class model fit significantly better than a 1-class model. While the fit of the two-class linear model had reasonable entropy (0.82), a slightly lower aBIC than the one class model (5188 vs. 5195), and a VLMR value that approached significance (13.2, $p < .07$), follow-up analyses indicated that the second class consisted of only 22 participants (9.1% of the sample) and distal outcomes analysis indicated that outcomes for this group did not differ from the larger first class on measures at post-treatment or follow-up (full details available upon request from the authors). Considering the reasonable fit of the single class linear LGCM and the lack of useful information provided by including a two class GMM model, the single class linear model, defined by one average trajectory (Fig. 1), was retained.

Table 1

Means (SD's) for measures of outcome.

Measure	Pre-Treatment	Post-treatment	3 mo. Follow-up	Effect Size (Cohen's d)[a]	
				Pre/Post-Treatment	Pre-Treatment/3 mo. Follow-up
Pain Intensity	6.6 (2.1)[a]	5.4 (2.3)[b]	6.4 (2.0)[a]	.54	.10
Physical Disability	.26 (.20)[a]	.20 (.19)[b]	.20 (.19)[b]	.49	.49
Psychosocial Disability	.34 (.19)[a]	.23 (.18)[b]	.22 (.19)[b]	.65	.78
Depression	33.6 (12.3)[a]	25.2 (12.7)[b]	26.1 (13.1)[b]	.85	.75
Pain-Related Anxiety	50.0 (20.3)[a]	36.4 (20.3)[b]	38.5 (20.5)[b]	.83	.67
Values Discrepancy	−1.7 (1.0)[a]	−1.0 (0.8)[b]	−1.1 (0.8)[b]	.69	.67

Different superscripts denote significant pairwise differences at a Bonferroni corrected alpha, $p \leq .004$.

[a] Effect sizes corrected for between time mean dependence (Morris & Deshon, 2002).

Table 2

Criteria used to assess fit for number of classes and trajectory.

Distress # classes	Linear				Quadratic			
	BIC	aBIC	VLMR	Entropy	BIC	aBIC	VLMR	Entropy
1	5223	5195	n/a	n/a	5237	5196	n/a	n/a
2	5225	5188	2v1: 13.2, $p = .07$	.82	5243	5189	2v1: 15.3, $p = .36$	.83
3	5237	5190	3v2: 4.7, $p = .38$	.61	5254	5188	3v2: 10.7, p = .31	.80

BIC = Bayesian Information Criteria, aBIC = Sample-size adjusted BIC; VLMR = Vuong-Lo-Mendell-Rubin Likelihood Ratio Test for *k* versus *k*-1 classes. For BIC and aBIC, smaller values indicate better fit. For entropy, higher values indicated better classification precision (possible range: 0–1).

3.4. Distal outcome analysis

Finally, we examined the role of the latent trajectories of growth in VT over the four weeks of treatment on distal outcomes (i.e., change in measures of outcome between pre and post-treatment and between pre-treatment and three-month follow-up). For each outcome variable, change was regressed onto the model parameters of VT intercept and slope. A significant effect of intercept indicates that the initial score on the VT was related to the amount of change in the outcome. A significant slope indicates that the linear slope of change in the VT across the four weeks of treatment was related to the amount of change in the outcome.

As noted, analyses of raw change in distal outcomes were performed and are presented in the present manuscript. Analyses of residualized change in distal outcome were also performed to allow for a supplementary test of study aims. These supplementary results are described in brief in the present manuscript, specifically when the pattern of findings differed from raw change, and full information is provided in supplementary materials.

As shown in Table 3, VT intercept was not significantly related to raw change in outcome for the majority of outcome variables at post-treatment or follow-up, including pain intensity, physical disability, psychosocial disability, pain-related anxiety, and depression. The only exceptions to this pattern was for values discrepancy, for which the intercept was significant, indicating that lower VT values at treatment onset were associated with greater reductions in values discrepancy at post-treatment. Intercept was not related to change in values discrepancy at follow-up.

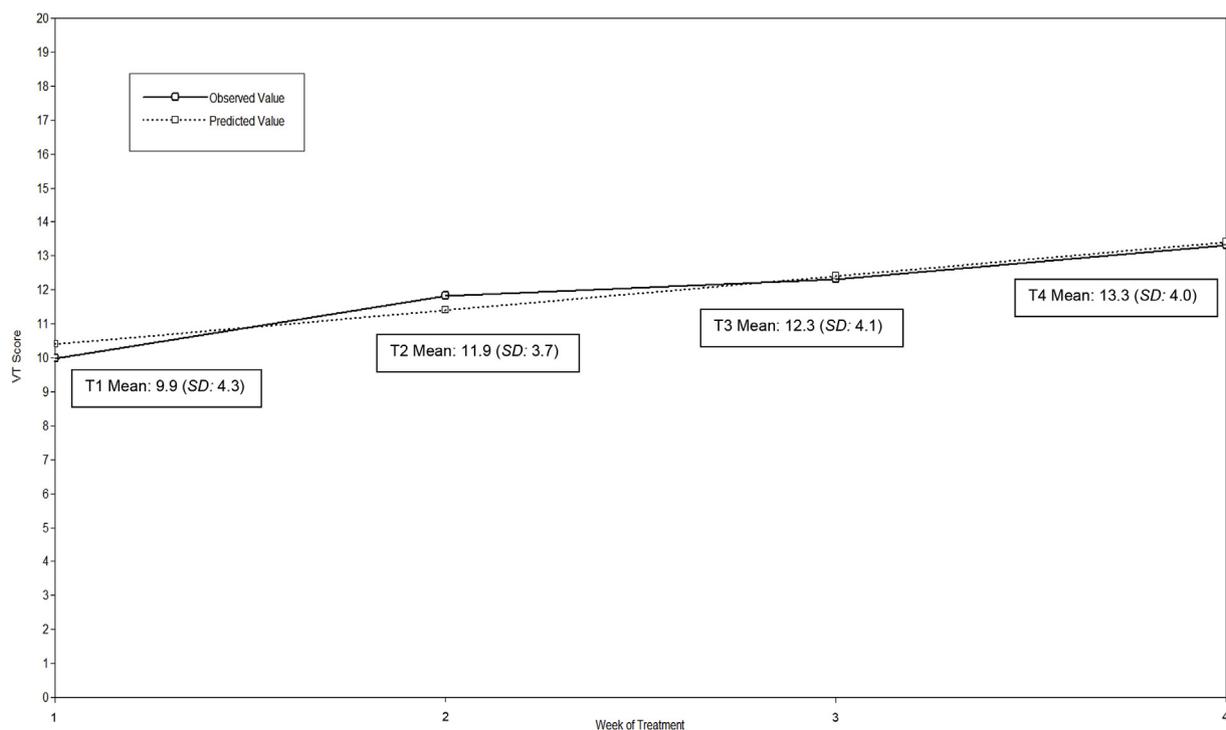As also shown in Table 3, VT slope was significantly associated with

Fig. 1. Observed and estimated means for a single class model of linear change for the Values Tracker across the four weeks of treatment.

Table 3
Standardized effects of linear change (Standard Error) in valued activity on raw change in distal outcomes.

Measure	Pre-treatment/Post-treatment		Pre-treatment/Follow-up	
	Intercept	Slope	Intercept	Slope
Δ Pain Intensity	.04 (.11)	-.12 (.13)	-.06 (.16)	-.06 (.17)
Δ Physical Disability	- .04 (.11)	.02 (.12)	-.20 (.16)	-.05 (.17)
Δ Psychosocial Disability	.06 (.11)	-.30 (.14)*	-.16 (.18)	-.05 (.22)
Δ Depression	.02 (.13)	-.37 (.18)*	-.06 (.18)	-.09 (.24)
Δ Pain-Related Anxiety	.21 (.12)	-.38 (.17)*	.01 (.01)	.01 (.01)
Δ Values Discrepancy	-.28 (.13)*	.53 (.24)*	-.08 (.18)	.35 (.40)

*$p \leq .05$.

change in four of six outcome variables at post-treatment, including psychosocial disability, depression, pain-related anxiety, and values discrepancy. In each case, greater slope in VT over the four weeks of treatment was associated with greater improvements in the outcome variables. Slope was non-significant for post-treatment change in pain intensity and physical disability. Slope was also non-significant for all outcome variables at follow-up.

The pattern of findings was essentially identical for residualized change scores (see Supplementary Table 1 for details). The only difference was that intercept for the VT was not significantly associated with residualized change in any of the outcome measures at either assessment interval. With regard to VT slope, significant relations were indicated at post-treatment for the same four of the six outcome measures for which raw change was significant and non-significant for residualized change in pain intensity and physical disability at post-treatment and residualized change in all outcomes at follow-up.

3.5. Post-hoc analyses

In order to more fully explore relations among treatment outcomes, a series of post-hoc correlation coefficients were calculated for each outcome measure across the three assessment intervals (i.e., pre-treatment to post-treatment, pre-treatment to follow-up, post-treatment to follow-up). While these analyses were not planned, it was felt that they would help provide insight into the unexpected finding that slope in the VT was not related to improvement in distal outcomes during the pre-treatment to follow-up period. These correlations are displayed in Table 4. All correlations across all three time periods were significantly correlated, all $r > 0.39$, all $p < .001$. Across the post-treatment to follow-up period specifically, all correlations exceeded $r > .48$.

In addition to the above, to further explore potential reasons for differing results at follow-up, we explored whether there were baseline differences in treatment completers versus non-completers or baseline or treatment-related differences in follow-up attendees vs. non-attendees. Treatment completers did not differ from treatment non-completers across any variable measured at treatment onset, including gender, age, education, pain duration, physical or psychosocial

Table 4
Correlations among outcomes at pre-treatment, post-treatment, and follow-up.

Measure	Pre-treatment/ Post-treatment	Pre-treatment/ Follow-up	Post-treatment/ Follow-up
Pain Intensity	.49	.54	.60
Physical Disability	.80	.80	.80
Psychosocial Disability	.58	.66	.63
Depression	.69	.69	.78
Pain-Related Anxiety	.67	.65	.75
Values Discrepancy	.39	.50	.48

All $p < .001$.

disability, depression, pain-related anxiety, or values discrepancy; for gender, chi^2 (1, $N = 272$) = 0.04, $p = .84$; for all other comparisons, all $F < 2.67$, all $p > .11$. Correspondingly, follow-up attendees did not differ from follow-up non-attendees on any of these same pre-treatment variables; for gender, chi^2 (1, $N = 162$) = 0.01, $p = .92$; for all other comparisons, all $F < 2.02$, all $p > .16$, nor did they differ for post-treatment values on any of the treatment outcome measures, all $F < 1.55$, all $p > .22$. Follow-up attendance was also examined in relation to VT intercept and slope to determine if attendance was a significant co-variate. Results were not statistically significant for either intercept or slope, standardized effect (SE): .01 (0.11), $p = .94$, and .14 (0.13), $p = .28$, respectively.

Next, a series of sensitivity analyses were performed to examine whether the overall pattern of distal outcomes analyses for post-treatment differed when only follow-up attendees were included in the analyses. The pattern of findings was identical to those that included the full sample (displayed in Table 3) with only one exception – when only follow-up attendees were included, VT slope was no longer significantly associated with pre-to post-treatment change in pain anxiety, although the observed p value, .064, was just below the level traditionally used for statistical significance.

4. Discussion

The present analyses examined patterns of change in values over the course of four weeks of interdisciplinary ACT for chronic pain and evaluated whether aspects of change were related to treatment outcomes at post-treatment and a three-month follow-up. Overall, findings indicated that change in values, as assessed by the VT, was best characterized by a single linear latent growth trajectory, indicating that participants' individual VT scores improved in a consistent fashion each week across the four weeks of treatment. Furthermore, steeper positive VT slope was significantly associated with greater improvement in psychosocial aspects of functioning (i.e., psychosocial disability, depression, pain-related anxiety, values discrepancy) at post-treatment. The practical utility of these findings is that increasing engagement in valued activity across interdisciplinary ACT was associated with a larger magnitude of improvement at post-treatment in psychosocial variables. This finding provides support for the ACT model itself and the importance it places on values clarity and committed action in the service of values (Hayes et al., 2012).

There were three areas where non-significant findings were indicated. The first was that the slope of the VT was not related to change in pain intensity at post-treatment or follow-up, which is not unexpected given that ACT for chronic pain does not explicitly target this variable for change. There is active debate in the field regarding whether pain reduction is a necessary pre-requisite for improvement in physical and psychosocial functioning in those with chronic pain. While meta-analyses indicate that pain reduction does occur following psychological interventions for chronic pain, at least immediately post-treatment (Williams, Eccleston, & Morley, 2012), other work indicates that pain reduction does not appear to be a necessary prerequisite for improved functioning. For example, in a previous examination of this issue using the same methods as used here, we found that trajectory of change in pain intensity during treatment was not statistically related to treatment outcomes (Vowles et al., 2017). Further, in a small case series of 21 patients, we found no reliable relation between change in pain intensity during treatment and treatment success (defined as reliable change in disability (Vowles, Fink, & Cohen, 2014a). Conceptually, the ACT model suggests that improvement in functioning, and specifically in valued living, can occur even with ongoing symptoms and this suggestion is somewhat at odds with mainstream treatments for chronic pain, which implicitly or explicitly suggest that pain reduction is necessary for treatment success. Future work may benefit from additional explicit tests of this issue.

The second area of non-significant findings was that VT slope was

unrelated to changes in physical disability at post-treatment or follow-up, which is explicitly targeted by ACT for chronic pain, as well as other interdisciplinary chronic pain programs (Gatchel et al., 2014). Given that physical disability improved overall at both post-treatment and follow-up, at a magnitude descriptively consistent with previous work examining efficacy of ACT for chronic pain (i.e., a small to medium effect size; Hughes, Clark, Colclough, Dale, & McMillan, 2017; Öst, 2014), it can be hypothesized that some other aspect of treatment contributed to this outcome. For example, treatment included approximately 16 h of physical activity intervention from physical therapy and it is plausible that some aspect of that specific aspect of treatment had a role in the decreases in physical disability observed here. Further work may help illuminate the treatment mechanisms that predict improved physical functioning following interdisciplinary rehabilitation for chronic pain.

The final area of non-significant relations between VT slope and outcomes is the most noteworthy, as the lack of relations between VT slope and change in outcomes at follow-up was unexpected. While our sample size of 162 at follow-up is fairly adequate for LGM analyses, it may be that the follow-up analyses were underpowered to detect an effect. That being noted, inspection of the data displayed in Table 3 indicates a substantial reduction in standardized effects of slope across all outcome measures when the pre-treatment/post-treatment period is compared with the pre-treatment/follow-up period, thus there are possibly other factors influencing maintenance of treatment-related gains. Furthermore, the magnitude of standard errors at follow-up are descriptively much larger than at post-treatment, indicating that there was more variability in the relation between VT slope and outcome change. Thus, it seems reasonable to conclude that degree of improvement in valued activity during treatment may not be sufficient to maintain larger improvements in functioning at three-month follow-up. On the other hand, the significant correlation between post-treatment and follow-up scores suggests there is perhaps an indirect relation between within-treatment change in values and functioning, such that steeper positive slope of values change within treatment is associated with greater improvement in psychosocial functioning at post-treatment and functioning at post-treatment is significantly correlated with functioning at three-month follow-up. This supposition is conjectural and correlational; thus it is offered here mainly as a hypothesis to be more fully explored in future work.

The investigation of treatment process within interdisciplinary ACT for chronic pain is important. The model specifies that there are key processes that are theorized to affect how one lives with chronic pain. These processes have been briefly termed as "open", "aware", and "active" (Hayes et al., 2011). Used within the ACT model, "open" refers to willingness and acceptance in relation to ongoing experiences without engaging in ineffective behavioral attempts to control them. "Aware" refers to aspects of mindfulness, specifically ongoing observation of experiences occurring in the present. Finally, "active" refers to engaging in an adaptive and flexible pattern of activity in pursuit of values. While other work has provided cross-sectional support for the entire model as it relates to chronic pain (Scott, Hann, & McCracken, 2016; Vowles, Sowden, & Ashworth, 2014b; Vowles et al., 2014c) or of specific parts of the model (McCracken & Gutiérrez-Martínez, 2011; McCracken et al., 2005; Vowles & McCracken, 2008; Vowles, McCracken, & Eccleston, 2007a; Vowles et al., 2011; Wicksell et al., 2013; Wicksell, Olsson, & Hayes, 2010, 2011), this work has predominately been limited to either cross-sectional data or longitudinal data where both process and outcome measures were collected at the same assessment point, meaning that temporal relations could not be examined.

The present study examined only the latter treatment process, as it specifically examined the role of within-treatment changes in valued activity on treatment outcome. To our knowledge, only one other study has performed a similar type of analysis, that of Kemani and colleagues (Kemani, Hesser, Olsson, Lekander, & Wicksell, 2016), where session by

session changes in openness to the pain experience were examined in a small sample of individuals receiving interdisciplinary ACT ($n = 30$). That study indicated that session-by-session changes in the treatment process mediated changes in pain interference at the end of treatment. Thus, the findings of these two studies together provide support for two of the three overall treatment mechanisms proposed by the ACT model. Clearly there is a need for more work specifically examining the utility of proposed treatment processes, both in ACT and other psychological models used in the treatment of chronic pain.

In addition to studies examining treatment mechanism, it is important to examine the issue of patient selection. The identification of patient characteristics that predict the probably of treatment success or failure is an important endeavor. In regard to interdisciplinary ACT for chronic pain, it is not clear whether any relevant patient selection criteria are present. In a previous study using data from a separate clinic and treatment team, we performed a series of discriminant analyses to determine if there were any baseline characteristics that identified "treatment responders". Variables examined included gender, age, pain duration, pain acceptance, engagement in values-based action, pain intensity, depression, pain-related anxiety, physical and psychosocial disability, and pain-related medical visits. None of these variables were associated with treatment response. These ACT-specific data are concordant with the findings of a previous review of predictors of treatment response to psychological interventions for chronic pain more broadly, which also noted the absence of reliable predictors across treatment studies (McCracken & Turk, 2002).

There are limitations to acknowledge. First, these data are from an uncontrolled clinical trial, thus the effectiveness of treatment in comparison to alternative interventions cannot be surmised. A recent meta-analysis of 11 randomized controlled trials of ACT for chronic pain indicated small to medium effects for functioning, anxiety, and depression, and the effect sizes documented in the present study are similar (Hughes et al., 2017). Second, treatment was guided by a specific theoretical framework, that of ACT, and entailed 44 h of intervention provided by an interdisciplinary team of providers to patients with longstanding chronic pain. These facets of treatment may also decrease the generalizability of findings to interventions from different theoretic frameworks or provided in different settings. Third, treatment dropouts did not provide any data at post-treatment or follow-up, and just over one-third of treatment completers did not provide follow-up data. It is possible that more complete set of data would provide a different set of findings, although our relatively large sample size provides some assurance regarding reliability of findings. Fourth, we did not formally track treatment attendance or adherence. While informal clinical observation is that less than 10% of patients missed any treatment, adherence is an important variable to measure formally. Fifth, our analyses did not allow us to identify which specific components of the treatment model were responsible for change, nor were we able to include all variables that were possibly relevant to treatment outcome (e.g., analgesic use, post-treatment use of additional treatment modalities, social support).

In conclusion, one of the central goals of ACT is to enable individuals suffering from disabling and distressing chronic pain conditions to engage in lives that are more successful in relation to values, even with persisting pain. The weak effect of the intervention investigated here on pain intensity and fairly robust effect on other measures of functioning, suggests that this goal of ACT is feasible. The present data indicated greater slope of increasing engagement in valued activity was statistically useful in predicting outcomes for a subset of measures, specifically those that concern psychosocial functioning, which provides support both theoretically and pragmatically for the ACT model.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.brat.2018.10.012.

References

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, D.C: Author.

Asparouhov, T., & Muthén, B. O.. *MPlus web notes: No 14 - using MPlus TECH11 and TECH14 to test the number of latent classes. (2012)*. Retrieved from http://www.statmodel.com/examples/webnotes/webnote14.pdf on August 21, 2018.

Breivik, H., Collett, B., Ventafridda, V., Cohen, R., & Gallacher, D. (2006). Survey of chronic pain in europe: Prevalence, impact on daily life, and treatment. *European Jounal of Pain, 10*, 287–333.

Bryne, B. M. (2001). *Structural equation modeling with AMOS: Basic concepts, applications, and programming*. Mahwah, NJ: Lawrence Erlbaum.

Campbell, W. I., & Vowles, K. E. (2008). Practical methods for pain intensity measurements. In A. Rice, H. Breivik, W. I. Campbell, & M. K. Nicholas (Eds.). *Clinical pain management: Practice and procedures* (pp. 12–27). (2nd ed.). New York: Hodder Arnold.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Dahl, J., Wilson, K. G., & Nilsson, A. (2004). Acceptance and commitment therapy and the treatment of persons at risk for long-term disability resulting from stress and pain symptoms: A preliminary randomized trial. *Behavior Therapy, 35*, 785–801.

Duncan, T. E., & Duncan, S. C. (2009). The ABC's of LGM: An introductory guide to latent variable growth curve modeling. *Social and Personality Psychology Compass, 3*, 979–991.

Dworkin, R. H., Turk, D. C., Farrar, J. T., Haythornthwaite, J. A., Jensen, M. P., Katz, N. P., ... Witter, J. (2005). Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. *Pain, 113*, 9–19.

Enders, C. K. (2001). A primer on Maximum Likelihood algorithms available for use with missing data. *Structural Equation Modeling, 8*, 128–141.

Fordyce, W. E. (1976). *Behavioral methods for chronic pain and illness*. St Louis: C. V. Mosby.

Gatchel, R. J., McGeary, D., McGeary, C. A., & Lippe, B. (2014). Interdisciplinary chronic pain management. *American Psychologist, 69*, 119–130.

Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (2012). *Acceptance and Commitment Therapy: The process and practice of mindful change* (2nd ed.). New York: Guilford Press.

Hayes, S., Strosahl, K., & Wilson, K. (2012). *Acceptance and committment therapy: The process and practice of mindful change* (2nd ed.). New York: Guilford Press.

Hayes, S. C., Villatte, M., Levin, M., & Hildebrandt, M. (2011). Open, aware, and active: Contextual approaches as an emerging trend in the behavioral and cognitive therapies. *Annual Review of Clinical Psychology, 7*, 141–168.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1–55.

Hughes, L. S., Clark, J., Colclough, J. A., Dale, E., & McMillan, D. (2017). Acceptance and commitment therapy (ACT) for chronic pain: A systematic review and meta-analysis. *The Clinical Journal of Pain, 33*, 552–568.

Iverson, G. L., & Remick, R. (2004). Diagnostic accuracy of the british columbia major depression inventory. *Psychological Reports, 95*, 1241–1247.

Jensen, M. P., & Turk, D. C. (2014). Contributions of psychology to the understanding and treatment of people with chronic pain: Why it matters to ALL psychologists. *American Psychologist, 69*, 105–118.

Jensen, M. P., Turner, J. A., Romano, J. M., & Fisher, L. D. (1999). Comparative reliability and validity of chronic pain intensity measures. *Pain, 83*, 157–162.

Jensen, M. P., Vowles, K. E., Johnson, L. E., & Gertz, K. J. (2015). Living well with pain: Development and preliminary evaluation of the valued living scale. *Pain Medicine, 16*, 2109–2120.

Kemani, M. K., Hesser, H., Olsson, G. L., Lekander, M., & Wicksell, R. K. (2016). Processes of change in acceptance and commitment therapy and applied relaxation for long-standing pain. *European Journal of Pain, 20*, 521–531.

Kennedy, J., Roll, J. M., Schraudner, T., Murphy, S., & McPherson, S. (2014). Prevalence of persistent pain in the U.S. adult population: New data from the 2010 national health interview survey. *The Journal of Pain, 15*, 979–984.

Leeuw, M., Goossens, M. E. J. B., Linton, S. J., Crombez, G., Boersma, K., & Vlaeyen, J. W. S. (2007). The fear-avoidance model of musculoskeletal pain: Current state of scientific evidence. *Journal of Behavioral Medicine, 30*, 77–94.

Lo, Y., Mendell, N., & Rubin, D. (2001). Testing the number of components in a normal mixture. *Biometrika, 88*, 767–778.

Luciano, J. V., Guallar, J. a, Aguado, J., López-Del-Hoyo, Y., Olivan, B., Magallón, R., ... Garcia-Campayo, J. (2014). Effectiveness of group Acceptance and commitment therapy for fibromyalgia: A 6-month randomised controlled trial (EFFIGACT study). *Pain, 155*, 693.

Lundgren, T., Luoma, J. B., Dahl, J., Strosahl, K., & Melin, L. (2012). The bull's-eye values

survey: A psychometric evaluation. *Cognitive and Behavioral Practice, 19*, 518–526.

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods, 1*, 130–149.

Main, C. J., Keefe, F. J., Jensen, M. P., Vlaeyen, J. W. S., & Vowles, K. E. (Eds.). (2014). *Fordyce's behavioral methods for chronic pain and illness*. New York: Walters-Kluwer.

McCracken, L. M. (2005). *Contextual cognitive-behavioral therapy for chronic pain*. Seattle, WA, WA: IASP Press.

McCracken, L. M., & Dhingra, L. (2002). A short version of the pain anxiety symptoms scale (PASS-20): Preliminary development and validity. *Pain Research and Management, 7*, 45–50.

McCracken, L. M., & Gutiérrez-Martínez, O. (2011). Processes of change in psychological flexibility in an interdisciplinary group-based treatment for chronic pain based on Acceptance and Commitment Therapy. *Behaviour Research and Therapy, 49*, 267–274.

McCracken, L. M., & Turk, D. C. (2002). Behavioral and cognitive-behavioral treatment for chronic pain: Outcome, predictors of outcome, and treatment process. *Spine, 27*, 2564–2573.

McCracken, L. L. M., & Vowles, K. E. (2014). Acceptance and Commitment Therapy and mindfulness for chronic pain: Model, process, and progress. *American Psychologist, 69*, 178–187.

McCracken, L. M., Vowles, K. E., & Eccleston, C. (2005). Acceptance-based treatment for persons with complex, long standing chronic pain: A preliminary analysis of treatment outcome in comparison to a waiting phase. *Behaviour Research and Therapy, 43*, 1335–1346.

McCracken, L. M., & Yang, S. (2006). The role of values in a contextual cognitive-behavioral approach to chronic pain. *Pain, 123*, 137–145.

McEntee, M. L., Vowles, K. E., & McCracken, L. M. (2016). Development of a chronic pain specific version of the sickness impact profile. *Health Psychology, 35*, 228–237.

Morris, S. B., & Deshon, R. P. (2002). Combining effect size estimates in meta-analysis with repeated measures and independent-groups designs. *Psychological Methods, 7*, 105–125.

Muthén, L. K., & Muthén, B. O. (2017). *Mplus users guide (Version 8)*. CA: Muthén & Muthén.

Nahin, R. L. (2015). Estimates of pain prevalence and severity in adults: United States, 2012. *The Journal of Pain, 16*, 769–780.

Nylund, K. L., Asparouhov, T., & Muthén, B. O. (2007). Deciding on the number of classes in latent class Analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling, 14*, 535–569.

Öst, L.-G. (2014). The efficacy of Acceptance and Commitment Therapy: An updated systematic review and meta-analysis. *Behaviour Research and Therapy, 61*.

Pielech, M., Bailey, R. W., McEntee, M. L., Ashworth, J., Levell, J., Sowden, G., & Vowles, K. E. (2016). Preliminary evaluation of the values tracker: A two-item measure of engagement in valued activities in those with chronic pain. *Behavior Modification, 40*, 239–256.

Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods, 15*, 209–233.

Ram, N., & Grimm, K. J. (2009). Methods and measures: Growth mixture modeling: A method for identifying differences in longitudinal change among unobserved groups. *International Journal of Behavioral Development, 33*, 979–991.

Roelofs, J., McCracken, L., Peters, M. L., Crombez, G., van Breukelen, G., & Vlaeyen, J. W. (2004). Psychometric evaluation of the pain anxiety symptoms scale (PASS) in chronic pain patients. *Journal of Behavioral Medicine, 27*, 167–183.

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods, 7*, 147–177.

Schwarz, G. (1978). Estimating the dimension of a model. *Annals of Statistics, 6*, 461–464.

Sclove, S. L. (1987). Application of model-selection criteria to some problems in multivariate analysis. *Psychometrika, 52*, 333–343.

Scott, W., Hann, K. E. J., & McCracken, L. M. (2016). A comprehensive examination of changes in psychological flexibility following Acceptance and Commitment Therapy for chronic pain. *Journal of Contemporary Psychotherapy, 46*, 139–148.

Society of Clinical Psychology, & Division 12 of the American Psychological Association. Acceptance and committment therapy for chronic pain. (2015). Retrieved from http://www.div12.org/psychological-treatments/treatments/acceptance-and-commitment-therapy-for-chronic-pain/ on May 25, 2015.

Turk, D. C., & Burwinkle, T. M. (2005). Clinical outcomes, cost-effectiveness, and the role of psychology in treatments for chronic pain sufferers. *Professional Psychology: Research and Practice, 36*, 602–610.

Turk, D. C., Fillingim, R. B., Ohrbach, R., & Patel, K. V. (2016). Assessment of psychosocial and functional impact of chronic pain. *The Journal of Pain, 17*, T21–T49.

Vowles, K., Fink, B., & Cohen, L. (2014a). Acceptance and commitment therapy for chronic pain: A diary study of treatment process in relation to reliable change in disability. *Journal of Contextual Behavioral Science, 3*, 74–80.

Vowles, K. E., & McCracken, L. M. (2008). Acceptance and values-based action in chronic pain: A study of treatment effectiveness and process. *Journal of Consulting and Clinical Psychology, 76*, 397–407.

Vowles, K. E., McCracken, L. M., & Eccleston, C. (2007a). Processes of change in treatment for chronic pain: The contributions of pain, acceptance, and catastrophizing. *European Jounal of Pain, 11*, 779–787.

Vowles, K. E., McCracken, L. M., Gross, R. T., & McCracken, L. L. (2007b). Evaluating outcomes in the interdisciplinary treatment of chronic pain: A guide for practicing clinicians. In M. Schatman, & A. Campbell (Eds.). *Chronic pain management: Guidelines for multidisciplinary program development* (pp. 203–220). New York: Informa.

Vowles, K. E., McCracken, L. M., & O'Brien, J. Z. (2011). Acceptance and values-based action in chronic pain: A three-year follow-up analysis of treatment effectiveness and process. *Behaviour Research and Therapy, 49*, 748–755.

Vowles, K. E., Sowden, G., & Ashworth, J. (2014b). A comprehensive examination of the

model underlying Acceptance and Commitment Therapy for chronic pain. *Behavior Therapy, 45*, 390–401.

Vowles, K. E., Witkiewitz, K., Levell, J., Sowden, G., & Ashworth, J. (2017). Are reductions in pain intensity and pain-related distress necessary? An analysis of within-treatment change trajectories in relation to improved functioning following interdisciplinary acceptance and commitment therapy for adults with chronic pain. *Journal of Consulting and Clinical Psychology, 85*, 87–98.

Vowles, K. E., Witkiewitz, K., Sowden, G., & Ashworth, J. (2014c). Acceptance and Commitment Therapy for chronic pain: Evidence of mediation and clinically significant change following an abbreviated interdisciplinary program of rehabilitation. *The Journal of Pain, 15*, 101–113.

Vuong, Q. (1989). Likelihood ratio tests for model selection and non-nested hypotheses. *Econometrica, 57*, 307–333.

Wetherell, J. L., Afari, N., Rutledge, T., Sorrell, J. T., Stoddard, J. A., Petkus, A. J., ... Hampton Atkinson, J. (2011). A randomized, controlled trial of Acceptance and Commitment Therapy and Cognitive-Behavioral Therapy for chronic pain. *Pain, 152*, 2098–2107.

Wicksell, R. K., Kemani, M., Jensen, K., Kosek, E., Kadetoff, D., Sorjonen, K., ... Olsson, G. L. (2013). Acceptance and commitment therapy for fibromyalgia: A randomized controlled trial. *European Journal of Pain, 17*, 599–611.

Wicksell, R. K., Olsson, G. L., & Hayes, S. C. (2010). Psychological flexibility as a mediator of improvement in Acceptance and Commitment Therapy for patients with chronic pain following whiplash. *European Journal of Pain, 14*, 1059.e1–1059.e11.

Wicksell, R. K., Olsson, G. L., & Hayes, S. C. (2011). Mediators of change in Acceptance and Commitment Therapy for pediatric chronic pain. *Pain, 152*, 2792–2801.

Wicksell, R. K., & Vowles, K. E. (2015). The role and function of acceptance and commitment therapy and behavioral flexibility in pain management. *Pain Management, 5*(5).

Williams, A. C. de C., Eccleston, C., & Morley, S. (2012). Psychological therapies for the management of chronic pain (excluding headache) in adults. *Cochrane Database of Systematic Reviews, 11*, CD007407.

Wilson, K. G., Sandoz, E. K., Kitchens, J., & Roberts, M. (2010). The Valued Living Questionnaire: Defining and measuring valued action within a behavioral framework. *Psychological Record, 60*, 249–272.