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Trajectories of Change During a Randomized Controlled Trial of Internet-delivered Psychological Treatment for Adolescent Chronic Pain: How does Change in Pain and Function Relate?

Tonya M. Palermo, PhD^{1,2}, Emily F. Law, PhD^{1,2}, Chuan Zhou, PhD^{1,2}, Amy Lewandowski Holley, PhD³, Deirdre Logan, PhD⁴, and Gabrielle Tai, MPH²

¹University of Washington

²Seattle Children's Hospital

³Oregon Health & Science University

⁴Boston Children's Hospital and Harvard Medical School

Abstract

Although pain and function improve at immediate post-treatment for youth receiving cognitive-behavioral therapy for chronic pain, limited data are available to understand changes that youth make during psychological treatment. We sought to characterize distinct trajectory patterns of change in pain and function in order to understand the temporal association of these changes during internet-delivered cognitive-behavioral treatment. Weekly repeated assessments of pain and function were conducted during eight weeks of treatment among 135 adolescents, ages 11 to 17 years, with chronic pain who were randomized to the cognitive-behavioral intervention (CBT) arm of an ongoing trial of internet-delivered CBT (Web-Based Management of Adolescent Pain; Web-MAP2). Using random effects growth mixture models we characterized pain and functional disability trajectories finding distinct trajectory groups indicating patterns of both linear as well as quadratic effects. Trajectories of change showed that some patients' pain and functional disability was improving, others worsened, or changed minimally. Paired t-tests compared the within-subject relative change rate in pain and function demonstrating similar change range for pain and function during the treatment period. There was no support for improvements in either pain or function to precede changes in the other domain. Findings may be useful in informing future studies of psychosocial treatments for pediatric chronic pain to consider how to target treatment strategies to distinct patient response profiles. This may lead to the development of intervention strategies that can both more effectively target children's pain and function during treatment, and lead to sustained changes following treatment.

Corresponding author: Tonya M. Palermo, PhD, Seattle Children's Research Institute, M/S CW8-6, P. O. Box 5371, Seattle, WA 98145-5005. Tel (206.884.4208), Fax (206.985.3262), (tonya.palermo@seattlechildrens.org).

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Keywords

chronic pain; function; adolescents; pediatric; cognitive behavioral therapy; Internet-delivered; trajectories

Introduction

Cognitive-behavioral therapy (CBT) for pediatric chronic pain produces significant and large effects for pain reduction and small effects in improving function at post-treatment [7]. However, in clinical practice using a rehabilitative approach, the primary focus of treatment is on increasing function [15]. Clinical anecdotes suggest improvements in function may occur in the absence of changes in pain or that pain reduction may subsequently follow. Surprisingly little data are available to support or refute this position. Post-treatment or follow up data alone fails to capture change that patients may make during psychological treatment to understand the short-term trajectories of pain and function.

Data from single case designs provides an opportunity to understand the temporal sequence of changes in pain and function in individual patients. For example, in case studies of psychological treatment with graded exposure in adults with back pain [1] and complex regional pain syndrome [4], findings from daily diaries demonstrated that improvements in function and targeted treatment variables (e.g., fear) temporally preceded decreases in pain.

We are aware of only one published study to examine changes in pain and function during treatment in children [11]. Longitudinal trajectories of disability and pain were examined among pediatric patients receiving outpatient CBT for chronic pain. Their finding showed that rate of change in disability was significantly greater than rate of change in pain. However, in this uncontrolled trial, youth received usual clinical care, so findings are limited by the lack of uniform treatment approach and exposure.

Increased understanding of trajectories of change in pain and function during treatment would help guide future psychological treatment research in pediatric chronic pain. Such data may clarify the likely range of patient response to intervention and the optimal time period to assess potential mechanisms of change. For example, in order to capture changes in pain-specific or general (e.g., therapeutic alliance) treatment mechanisms, these data need to be gathered early enough in treatment before changes occur in the outcomes of interest [2]. Investigators have often measured treatment mechanisms either at the end of treatment or during one time point during treatment (e.g., mid-treatment). However, if changes in pain and/or function are divergent, a single assessment would not be adequate. Understanding distinct patterns of change for different outcomes (e.g., pain and function) may guide the choice of time intervals for testing mechanisms of change in future studies, and may help in understanding patient short-term response to CBT.

Therefore, the goal of this study was to examine the temporal sequence of changes in pain and function over an 8–10 week treatment period within a group of youth randomized to the internet-delivered CBT arm of a randomized controlled trial. We aim to 1) characterize trajectories of pain and function to understand subgroups reflecting different recovery

profiles during treatment, and 2) examine linear slopes and within-subject changes in these subgroups to compare temporally which changes occur earlier or later (i.e., whether changes in pain precede changes in function and vice versa).

Methods

Participants and Setting

Participants included 135 children and adolescents, aged 11–17 years, with chronic pain and their parents enrolled in the active treatment arm of an ongoing randomized controlled trial of online psychological treatment for pain management (Web-MAP2; Web-based Management of Adolescent Pain, ClinicalTrials.gov Identifier NCT013165471). Children presenting as new patients were recruited over a 3-year period from one of 14 participating multidisciplinary pediatric pain clinics at academic medical centers across the United States and Canada. The study was approved by our Institutional Review Board as well as the Institutional Review Boards at each referring center.

Inclusion/Exclusion Criteria

Inclusion criteria consisted of: (a) ages 11–17 years, (b) chronic idiopathic pain present over the previous 3 months, (c) pain at least once per week, (d) parent report of pain interfering with at least one area of daily functioning, and (e) the adolescent received a new patient evaluation in one of the participating pain clinics.

Participants were excluded for any of the following reasons: (a) the adolescent had a serious co-morbid psychiatric illness or chronic medical condition such as diabetes, cancer or sickle cell disease, (b) the adolescent had a developmental disability per parent report, (c) the parent or adolescent was non-English speaking, (d) the family did not have regular access to the Internet on a desktop, phone, or laptop computer, and (e) the adolescent had received more than four sessions of cognitive-behavioral therapy for pain management within the last six months.

Recruitment

Providers at referring centers gave potential participants a flyer about the study and asked if they were willing to be contacted via phone by study staff to undergo additional screening. Providers then entered potential participants' contact information into a secure website to transfer referral information to study staff. Potential participants could also contact study staff directly by calling a toll-free number provided on the study flyer. Study staff screened potential participants via telephone and then obtained verbal parent consent and adolescent assent for study participation.

Enrollment Statistics

In total, 527 adolescents with chronic pain and their parents were referred for study participation. Of those who were referred to participate, 109 were excluded because they failed to meet inclusion criteria (e.g., age out of range, had a chronic medical condition). Of those who were eligible to participate, 137 were randomly assigned to the cognitive-behavioral arm of the trial, 138 were randomly assigned to the education control arm of the

trial, and 69 participants declined participation. This manuscript includes the final sample of youth enrolled into the trial and randomly assigned to the cognitive-behavioral therapy condition ($n = 135$) and provided pain and function data during treatment. Because the trial is ongoing and follow-up data are currently being collected, primary treatment outcome data at post-treatment, 6 month, and 12-month follow-up have not yet been published.

Procedures

All participants in this report were randomized to the active treatment arm and received the cognitive-behavioral intervention in addition to the medical care recommended by their multidisciplinary pain clinic, which could include visits for physical therapy, psychology, and/or medication management. Pre-treatment and post-treatment ratings of pain intensity and functional disability were completed via a 7-day secure online diary. During treatment, participants also rated average weekly pain intensity and functional disability at 6 intervals. Specifically, participants received automated prompts as part of the web program to rate pain intensity and functional disability upon completion of lessons that taught different coping skills (Modules 2–7). This resulted in a total of 8 possible time points for consideration of trajectories of change in pain and function: pre-treatment, during treatment (6 time points; Modules 2–7), and post-treatment.

The treatment program is based on cognitive-behavioral and social learning theories and incorporates behavioral self-regulation skills, cognitive skills, and operant and communication skills. It consisted of two separate secure websites, one for adolescents and one for parents. The design and treatment content of Web-MAP2 was adapted from a pilot version of the program which has been described elsewhere [17]. Web-MAP2 has five main sections that are accessible from the participant home page: treatment modules, assessment center, compass (downloadable audio files of relaxation exercises), message center, and passport (weekly tracker of progress on pain and functional goals). The eight modules completed by adolescents included: education about chronic pain; recognizing stress and negative emotions; relaxation, deep breathing, and imagery; school; cognitive skills; sleep and lifestyle; staying active; and maintenance and prevention. The eight modules completed by parents included: education about chronic pain; recognizing stress and negative emotions; operant strategies I; operant strategies II; modeling; sleep and lifestyle; communication; and maintenance and prevention. Adolescents and parents were asked to complete one module per week, which were designed to be about 30 minutes in length. Total treatment duration was approximately 9 hours per family.

Measures

Demographics—Information on adolescents' age, sex, race/ethnicity, and family income was obtained via parental report.

Functional Disability

Pre-post treatment: The Child Activity Limitations Interview (CALI) [16] was administered via a 7-day online diary to assess functional disability over the monitoring period at pre-treatment and post-treatment. Adolescents provided difficulty ratings for each item (e.g., going to school, doing things with friends, running) on a 5-point scale (0=no

difficulty, 4=extremely difficult), with higher scores indicating greater functional limitations. The CALI has been previously validated for assessment of pain-related disability in children and adolescents [18; 16]. Moreover, the CALI has been used as an outcome measure in similar psychological intervention studies (e.g., [17]).

During Treatment: In the first module of the treatment program, adolescents were asked to select two activities from the CALI to target as their personal goals to work on during treatment. During treatment, participants rated difficulty completing each of these activities. Scores on those two items were summed to create a function score ranging from 0 to 8, with higher scores indicating more functional disability. Pearson correlations between the sum of CALI scores during treatment and regular length diary CALI scores were moderate ($r = .51$). For analyses examining associations between change in pain and change in function during treatment, scores on those two items were extracted from the pre-treatment and post-treatment CALI to provide a total of 8 time points (pre-treatment, during treatment: 6 time points, post-treatment).

Pain Intensity—A 7-day online diary was used to assess average self-reported pain intensity at the pre-treatment and post-treatment assessments. Pain intensity was rated on an 11-point numerical rating scale (NRS), with higher ratings indicating more intense pain (0 = no pain, 10 = worst pain). During treatment, participants rated average pain intensity over the past week at the same 6 intervals where they reported on functional disability, resulting in a total of 8 time points (pre-treatment, during treatment: 6 time points, post-treatment).

Data Analysis Plan

Demographic characteristics were summarized using descriptive statistics. For categorical variables frequency statistics are reported, and for continuous variables we reported means and standard deviations. We examined within-subject changes in pain and function between pre- and post-treatment using paired t-tests. We checked pattern and amount of missingness on pain and function, and compared age, gender, pain location, baseline pain and function between subjects with and without missing data. Upon finding no significant differences between subjects with and without missing data on pain and function, we proceeded with the following growth curve mixture model assuming data were missing at random. Next we applied random effects growth mixture models[14] [13] to examine the trajectories of pain and function separately. Under this modeling framework, we posited that the pain/function trajectories were from a finite mixture of curve groups, with each group characterized by a mean trajectory that followed a group-specific trend. These mixture models allow for trends in pain and function to be heterogeneous across groups, and should capture the real underlying patterns more accurately than single group growth curve models.

We applied a three-step procedure to build models separately for pain and function trajectories. In the first step, we determined the number of mixtures and group labels. Given the limited number of time points we a priori restricted the shapes to be quadratic or linear. For each trajectory, we started with a quadratic regression model. If the coefficient of the quadratic term was significant, i.e., with a p-value less than 0.05, then the trajectory was classified into either “downward quadratic trend” group or “upward quadratic trend” group.

If there was no significant quadratic trend, then we fitted a linear regression model to the trajectory. Based on the slope estimate, the trajectory was classified into one of the three groups for classifying change in pain/function over the treatment period: “Substantial Improvement - strong linear trend” group ($p\text{-value} < 0.05$), “Moderate Improvement - moderate linear trend” group ($0.05 \leq p\text{-value} < 0.2$), and “No or Little Improvement - weak linear trend” group. Trajectories with no consistent trend were classified into the “weak linear trend” group. Thus, there were potentially 5 mixture groups. In the second step, we fitted random effects regression models to each mixture group. The mixed effects models allowed us to use all available data for the estimation even if subjects missed some function and pain assessments. Based on the group designation, linear or quadratic models were assumed. For each group, we fitted three sets of random effects models: model with random intercept only, model with uncorrelated random intercept and random slope; model with correlated random intercept and random slope. We conducted likelihood ratio tests to determine the best fitted model for each group. In the third step, potential confounding baseline covariates (age, sex, and pain location) were added to the model selected in Step 2, and reported as the final models. Parameter estimation was based on maximum likelihood.

To compare the rates of change in pain and function during CBT, we had to first address the issue of scaling because the variables representing function and pain were measured on different numeric scales. Given that one unit change in scores may represent very different magnitudes of changes in terms of clinical significance, direct comparison of slope estimates for pain and function trajectories are difficult to make sense of. Therefore, we decided to calculate percent changes relative to baseline for all the post-baseline pain and function scores. We then used paired t-tests to compare the within-subject relative change rates in pain and function at each post-baseline time point. This analysis is intended to address the temporal question of when changes in each variable occurred and to examine which variable had the largest relative change earliest in treatment.

All data analyses were conducted in R Version 3.1.1 [20]. The random effects models were fitted using the R packages lmer and lmerTest.

Results

Descriptive Statistics

Participants included 135 youth with chronic pain, between the ages of 11 and 17 years ($M = 14.65$, $SD = 1.63$). Sample characteristics are shown in Table 1. Participants were primarily female (77.8%) and Caucasian (80.6%). Adolescents presented with various pain conditions including musculoskeletal pain (37.0%), abdominal pain (11.9%), and headache (8.2%), with many youth having multiple pain conditions (43.0%). The majority of youth (78.5%) completed all 8 online treatment modules; 95.6% of youth completed at least half of the 8 pain ratings and 93.3% of youth completed at least half of the function ratings. Due to technical issues, functional disability scores were missing for 34 subjects at immediate post-treatment resulting in 101 subjects for analyses involving post-treatment scores. No statistically significant differences were detected on age, gender, pain location, baseline pain and function scores between subjects with and without missing data on pain and function.

Within-subject changes in pain and function between pre- and post-treatment

Functional disability significantly improved from pre-treatment ($M = 3.95$, $SD = 2.15$) to post-treatment ($M = 2.81$, $SD = 2.07$), paired $t(100) = 5.40$, $p < 0.001$ for 101 subjects with both baseline and post-treatment values. Pain intensity also significantly improved from pre-treatment ($M = 5.72$, $SD = 2.24$) to post-treatment ($M = 4.53$, $SD = 3.05$), paired $t(134) = 5.66$, $p < 0.001$ for 135 subjects with both baseline and post-treatment values. The effect size (Cohen's d) was 0.52 for function between pre- and post-treatment, and 0.45 for pain.

Trajectories of pain and function during treatment: Random effects growth mixture models

We examined trajectory groups that classified changes in pain and functioning during the treatment period using growth mixture modeling. A 4-class solution provided the best fit to the data for pain intensity (see Figure 1). The largest group was labeled “No or Little Improvement - weak linear trend” ($n=84$, 62.2%); two smaller groups showed either “Substantial Improvement – strong linear trend” ($n=23$, 17.0%) or “Moderate Improvement – moderate linear trend” ($n=22$, 16.3%); while a very small group demonstrated an upward quadratic trend ($n=6$, 4.4%). Several covariates including baseline pain and pain location were predictive of subsequent pain values (see Table 2).

Five subgroups with different trajectory patterns were identified for functional disability trajectories (see Figure 2). As shown in Table 3, the largest group was labeled “No or Little Improvement - weak linear trend” ($n=77$, 57.0%); two smaller groups showed either “Substantial Improvement – strong linear trend” ($n=14$, 10.4%) or “Moderate Improvement – moderate linear trend” ($n=31$, 23.0%). Two very small groups demonstrated either a downward quadratic trend ($n = 7$, 5.2%) or an upward quadratic trend ($n=6$, 4.4%). Several covariates were identified that were predictive of subsequent function values, including baseline functional disability, age, sex, and pain location.

As seen in Tables 2 and 3, the slope coefficients for the trajectory subgroups with linear trends (Group #1–3) estimated rates of linear change per week (module) in pain and function. Slope coefficients are interpreted as absolute change on the scales of interest, pain intensity (0–10 scale) and functional disability (0–8 scale). For the “Substantial Improvement - strong linear trend” group (Group 3), pain reduced 0.82 ($p < .001$) units per week, and the functional disability score dropped 0.63 ($p < .001$) units per week. For the “Moderate Improvement – moderate linear trend” group (Group 2), pain dropped at the rate of 0.46 ($p < .001$) units per week, and the functional disability score dropped at 0.43 ($p < .001$) units per week. For the “No or little improvement – weak linear trend” group (Group 1), the pain and function dropped at 0.08 ($p < .05$) and 0.16 ($p < .001$) units per week, respectively. The larger intercept estimates for groups with moderate or strong linear trends suggest that participants who start with high pain or disability at the beginning of the treatment tend to have more rapid improvements during the treatment. This is likely because there is more room for these participants to improve thus they were more responsive to the treatment.

Percent changes relative to baseline for pain and function scores

We used paired t -tests to compare the within-subject relative change rate in pain and function at each post-baseline time point. Table 4 shows the pair-wise comparisons of

change rates of pain and functional disability scores. The results demonstrate that the within-subject difference in change rate of pain and functional disability is large at Module 1, which may reflect regression to the mean. However, after Module 1, there are no differences in rate of change in pain and disability. To further illustrate this pattern, as can be seen in Figure 3, after module 1, changes in pain and functional disability occur concurrently during the treatment period.

Discussion

Using random effects growth mixture models, we characterized pain and functional disability trajectories during an 8–10 week internet-delivered cognitive-behavioral treatment program for pediatric chronic pain. Distinct trajectory groups were found indicating patterns of both linear as well as quadratic effects. We found that improvements in adolescent pain and function occurred concurrently, tracking together temporally across the treatment period. There was no support for change in pain or function to precede the other domain. To our knowledge, these are the first data presented from a randomized clinical trial on changes in pain and function occurring during psychological treatment for chronic pain in youth. In general, our results are in line with several published outcome studies of psychological treatment for chronic pain in children (e.g., [17; 22; 19]) that report post-treatment changes in both primary outcome domains (pain and function). We extend these findings to changes in pain and function from repeated assessments during the treatment period, finding a similar rate of change along both outcomes.

Our findings are similar to those of Lynch-Jordan and colleagues[11] who found a significant linear random effect and a significant quadratic random effect for functional disability, indicating heterogeneity in responses during the treatment period with some patients improving, some declining, and others with no or minimal change. In contrast, they did not find specific variation in linear slope, nonlinear trend, or nonlinear variation for pain intensity.

Our analytic approach allowed us to improve upon several aspects of the previously reported study by Lynch-Jordan and colleagues. First, their analysis did not acknowledge the heterogeneity in the shapes of trajectories and assumed all pain and function trajectories followed a single overall mean curve. However, the single overall mean trajectory may not accurately capture the trend in individual trajectories due to large variation among them. Second, they used slope coefficients to compare the rates of change in pain and function. However, such comparison is only interpretable if both groups follow linear trends. Third, the slopes were estimated for pain trajectories and function trajectories separately, so their difference did not account for within-individual changes. Last, the comparison of slopes is sensitive to outliers, meaning a few cases where functional changes occur early or later could influence the conclusion dramatically. The advantage of our growth curve mixture model approach is that we allowed multiple subgroups with different profile patterns, which provided more accurate characterization and representation of underlying mechanism. As indicated in our data, about 70% of the trajectories did not follow a consistent trend, highlighting the potential biases in using a single group approach.

Our findings demonstrated both linear and quadratic effects such that some patients' pain and functional disability was improving, others worsened, or changed minimally. In fact our largest trajectory groups (representing slightly more than half of the sample) showed only small improvements (minimal linear change) over the treatment period. There were subsets of patients who showed a significant linear trend with more substantial improvement in pain and functional disability. This variation could not be well understood by simple examination of group-level mean pre-post change data indicating medium effect sizes for reduction in pain and disability. There has been increased emphasis on examining trajectories over time among individuals and groups completing psychosocial treatment for chronic pain as this approach may help to identify the heterogeneous patterns that would not be detected by examining group-level means only.

Researchers may be interested in our findings of concurrent changes during the treatment period which may be useful in future studies of psychosocial treatments for pediatric chronic pain. Understanding the distinct trajectories that classify patient response during treatment may help in considering how to target treatment strategies to patient characteristics or profiles (e.g., [12]). In addition, there have been calls for theory driven research to identify mechanisms of change in psychosocial treatments for chronic pain in order to ultimately enhance the effectiveness of this treatment approach [8; 3; 6]. Recommendations have been presented for how to derive suitable evidence for testing mechanisms of change within psychosocial intervention studies [21]. For example, Thorn and Burns [21] identified the need to use study designs that conduct multiple assessments of variables during treatment, allowing examination of lagged relationships over short periods. This provides data on whether early change in a mechanism predicts later change in the outcome.

However, these recommendations rely on the assumption that the trajectories of change in the major outcome variables in clinical trials are understood. If there are distinct patterns of change for different outcomes (e.g., pain and function) then this might demand that different approaches be used for testing mechanisms of change for each outcome domain. Our findings of concurrent change in pain and function suggest that these two outcomes could be studied together in research focused on assessing mechanisms of psychosocial treatments. Thus, lagged effects in mechanisms can be studied for both pain and function without the complication of differential change in the two outcomes, that is, pain and function can be expected to change together. Future studies are needed to examine rate of change in other common treatment outcomes in pediatric psychosocial trials including anxiety and depressive symptoms, parental behaviors, and pain catastrophizing to understand whether a similar or different pattern emerges.

Although clinical trials have most often included pain intensity as a primary treatment outcome, in clinical pediatric pain practice, function is most often emphasized. Interestingly, our findings that pain and function change together during treatment contradict a commonly expressed clinical adage that function improves before pain subsides [24]. This adage is often used in pediatric clinical practice to provide a rationale for encouraging children and parents to systematically increase physical activity and functional activity participation during treatment. It is unknown whether this adage reflects an aspirational goal among pediatric pain clinicians to encourage functional change or whether it reflects their own

clinical observations of functional change preceding pain reduction. There may also be differences between what patients report to their clinical providers and what they report in the more confidential, anonymous context of research. In clinical encounters, perhaps some patients minimize reports of improvement in pain to assure that clinicians continue to recognize and respond to their pain symptoms with ongoing treatment efforts. Or, patients may experience concerns that they will be pushed to function beyond their perceived limits if they report a certain extent of pain reduction. Clinicians may also be biased to attend to and place more emphasis on patient functional change than on patient reports of pain reduction.

There are a number of study limitations that should be considered in interpreting our findings. First, our measurement of functional disability during treatment was limited. We operationalized functional improvement as progress on participants' two self-selected functional goals during the treatment period. However, we acknowledge that there are not any data on the reliability and validity of this abbreviated measurement. Moreover, participants could choose different functional goals and we did not attempt to analyze the specific items chosen. It is possible that use of a full-length measure of functional disability would have produced different patterns of results. Moreover, functioning in a few self-selected areas may be more directly associated with the trajectory of changes in pain. A more comprehensive assessment of function may have led to differing rate and trajectory of change, and this will be important to examine in future studies. Second, we were also unable to examine trajectories of change in our attention control condition due to differences in assessments completed in the online treatment program during the treatment period. Third, our sample is also limited by the lack of ethnic diversity, which may influence generalizability to other populations.

Despite these limitations, the study has some important strengths and implications for future research. It represents the first study of repeated assessments to examine trajectories of pain and function over the course of internet-delivered cognitive-behavioral treatment for chronic pain among a relatively large and geographically diverse sample of adolescents. All participants received a consistent intervention to address their pain. The implications of our findings may help move pediatric psychosocial treatment research beyond simple efficacy trials. There is a gap in understanding of either moderators or mediators of treatment effects, particularly in pediatric psychosocial trials [5]. Very few studies have attempted to examine cognitive, affective, or behavioral mechanisms of change (see [23; 9; 10] for notable exceptions). And, even less pediatric research has focused on identifying treatment responders and non-responders (e.g., [9]), or focused on questions of whether early response to treatment is predictive of longer-term outcomes. Future research using rigorous methodologies and advanced statistical approaches are needed; most available studies have not conducted multiple assessments of variables during treatment to allow examination of lagged relationships between change processes and outcomes.

In addition, future studies could build on this preliminary work through examining rate of change during treatment in other outcome domains, by evaluating the trajectories of pain and function over a greater span of time, and by exploring moderators (e.g., patient and family characteristics) of different trajectories of both short-term and longer-term

improvement in pain and function. Future studies should also examine the possible predictive relationship between short-term treatment response and longer-term change in pain and functional outcomes. It will also be important to evaluate these patterns in additional treatment contexts that encompass the full multidisciplinary approach to pediatric pain rehabilitation as well as to evaluate whether similar patterns of change occur across a variety of single-treatment and combined-treatment approaches of varying intensities (e.g. inpatient, day hospital and outpatient settings).

In summary, the results of this study demonstrate that pain and function change concurrently during psychological treatment for pediatric chronic pain. We encourage other research groups to perform similar analyses to extend the study of trajectories in the context of other treatments.

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Figure 1.
Trajectory groups for change in pain scores during treatment

Figure 2.
Trajectory groups for change in function scores during treatment.

Figure 3.
Change rate in pain and function scores from baseline to end of treatment.

Table 1

Demographic and clinical characteristics of the sample (N = 135)

Demographic Characteristic		Statistics
Child age (years)	Mean(SD)	14.65 (1.64)
Child gender	N(%)	
Female		105 (77.8%)
Male		30 (22.2%)
Racial Background	N(%)	
White		124 (91.9%)
Black or African American		2 (1.5%)
Asian/Native Hawaiian/Pacific Islander		2 (1.5%)
American Indian/Alaska Native		2 (1.5%)
Other		5 (3.7%)
Pain Condition	N(%)	
Headache		11 (8.2%)
Abdominal pain		17 (12.6%)
Musculoskeletal pain		50 (37.0%)
Multiple pains		57 (42.2%)
Household Annual Income	N(%)	
<\$30,000		12 (8.9%)
\$30,000–\$49,000		20 (14.8%)
\$50,000–\$69,999		39 (28.9%)
\$70,000–\$100,000		18 (13.3%)
>\$100,000		38 (28.2%)
Not Reported		8 (5.9%)

Table 2

Model Summary for Pain Intensity Trajectories

Parameters	Group 1 [†] N=84 (62.2%)	Group 2 [†] N=23 (17.0%)	Group 3 [†] N=22 (16.3%)	Group 4 [‡] N=6 (4.4%)
Intercept	0.86	1.51	5.44 [*]	−0.47
Module	−0.08 [*]	−0.48 ^{***}	−0.82 ^{***}	−2.21 ^{***}
Module ²				0.26 ^{***}
Baseline pain	0.76 ^{***}	0.71 ^{***}	0.50 ^{***}	0.63
Age	0.005	0.19	−0.02	0.09
Sex				
Male	Reference	Reference	Reference	NA
Female	0.56	0.94	−0.47	
Pain location				
Headache	Reference	Reference	Reference	Reference
Stomach	0.20	0.06	NA	NA
Musculoskeletal	0.32	−2.11 ^{**}	0.14	4.17
Multiple	0.33	−1.47 [*]	0.30	4.82 [*]

Groups: 1=weak linear trend; 2=moderate linear trend; 3=strong linear trend; 4=quadratic upward trend

[†] Model with random intercept only;[‡] Model with *uncorrelated* random intercept and random slope NA: Not available due to lack of observations in the category***
p<.001;**
p<.01;*
p<.05

Table 3

Model Summary for Function (CALI) Trajectories

Parameters	Group 1 [†] N=77 (57.0%)	Group 2 [†] N=31 (23.0%)	Group 3 [†] N=14 (10.4%)	Group 4 [‡] N=6 (4.4%)	Group 5 [‡] N=7 (5.2%)
Intercept	-0.55	3.74	10.88*	3.49	1.03
Module	-0.16***	-0.45***	-0.63***	-2.67***	1.53***
Module ²				0.31***	-0.23***
Baseline function	0.56***	0.69***	-0.02	0.53***	-0.29
Age	0.20	0.09	-0.41	0.31*	-0.15
Sex					
Male	Reference	Reference	Reference	NA	Reference
Female	-0.17	-0.74	2.24*		2.79***
Pain location					
Headache	Reference	Reference	Reference	Reference	Reference
Stomach	-0.22	-1.64	NA	NA	NA
Musculoskeletal	-0.56	-2.08*	0.04	-2.45***	NA
Multiple	-0.42	-0.84	-0.20	-2.84***	3.79***

Groups: 1=weak linear trend; 2=moderate linear trend; 3=strong linear trend; 4=quadratic upward trend; 5=quadratic downward trend

[†] Model with random intercept;[‡] Model with *correlated* random intercept and random slope NA: Not available due to lack of observations in the category

*** p<.001;

** p<.01;

* p<.05

Table 4

Pair-wise comparisons of change rates of pain and functioning scores

Post-baseline Modules	N	% change in pain relative to baseline Mean (SD)	% change in functioning relative to baseline Mean (SD)	Within-subject difference function vs. pain Mean (SD)	P-value based on paired t-test
1	113	24.9 (85.4)	67.9 (234.0)	40.7 (219.6)	0.051
2	108	14.2 (69.4)	27.3 (95.0)	13.2 (109.4)	0.214
3	103	14.3 (64.9)	11.9 (84.6)	0.4 (100.6)	0.967
4	99	18.7 (101.4)	10.7 (85.0)	-5.0 (96.8)	0.611
5	94	0.8 (52.3)	6.3 (105.8)	8.6 (95.0)	0.381
6	87	0.3 (51.0)	15.1 (127.5)	14.4 (117.0)	0.255
7	98	-21.8 (51.1)	-21.3 (80.1)	-4.0 (76.9)	0.605