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RUNNING HEAD: COMPARATIVE META-ANALYSIS OF ACT

A Comparative Meta-Analysis of Unidisciplinary Psychology and Interdisciplinary Treatment
Outcomes Following Acceptance and Commitment Therapy for Adults with Chronic Pain

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Abstract

While much of the literature provides positive support for psychological interventions for chronic pain, two recent meta-analyses indicate small to moderate benefits only. This inconsistency in findings suggests that there are other treatment-related variables to consider. One possible consideration pertains to treatment format, as psychological models form the basis for both unidisciplinary psychology and integrated interdisciplinary treatments for chronic pain.

Therefore, a comparative meta-analysis of unidisciplinary and interdisciplinary treatments was performed to determine whether there were differences in treatment effect size (ES) at post-treatment and follow-ups of up to one year. One specific treatment model, Acceptance and Commitment Therapy (ACT), was investigated as it was felt that this literature was extensive enough to perform the planned analysis, while also being circumscribed enough in size to make it feasible. In total, 29 articles met inclusion criteria, 13 reported outcomes for unidisciplinary ACT and 15 for interdisciplinary ACT. At both post-treatment and follow-up, interdisciplinary ACT had a greater ES for physical disability, psychosocial impact and depression compared to unidisciplinary ACT. No differences in ES were observed for pain intensity, pain-related anxiety, or pain acceptance. Findings remained the same when study heterogeneity was considered. There was a significant difference observed between treatment format and treatment duration – on average, unidisciplinary interventions were of shorter duration than interdisciplinary interventions. Moderation analyses examining the relation between total treatment duration and ES generally indicated a moderate positive relation between treatment length and ES. This relation was strong for psychosocial impact.

Perspective: A comparative meta-analysis examined the relative ES of unidisciplinary (i.e., clinical psychology only) and interdisciplinary ACT for chronic pain in 29 studies. The ES for interdisciplinary ACT was larger than unidisciplinary ACT for physical disability, psychosocial impact, and depression. No differences were present for pain intensity, anxiety, and acceptance.

Introduction

Psychological interventions for chronic pain have a longstanding history of empirical support ²⁶. Support for psychological approaches can be found in both systematic reviews ^{18,29,33} and meta-analyses ^{22,45}. Two successive meta-analyses sponsored by the Cochrane Collaboration have, however, indicated that randomized controlled trials (RCTs) of psychological approaches for chronic pain have only small to moderate benefits, especially at follow-up ^{13,57}. Thus, there is an inconsistency in the literature, where one conclusion from the extant research is that psychological approaches for chronic pain work reasonably well while some meta-analytic results of RCTs suggests that psychological approaches have only limited effectiveness.

It is possible that there are important treatment-related variables to consider when evaluating the effectiveness of psychological approaches for chronic pain. One salient consideration pertains to treatment format, specifically treatment provided in a unidisciplinary format by clinical psychology alone in contrast to treatment offered by an interdisciplinary team. Thus far, the reviews and meta-analyses regarding psychological approaches ^{18,22,29,33,45} have included a mix of both types of treatment, which may be a complicating factor with regard to interpretation of findings.

Interdisciplinary approaches to chronic pain have long been considered a gold standard intervention when pain is associated with significant disability and distress and the treatment approach is grounded in psychological and behavioral models ¹⁷. For example, the seminal work of Fordyce and colleagues ^{14–16} provided a template for interdisciplinary intervention grounded in an operant behavioral model of psychology. More recent reviews, such as those by Morley ³⁸ and Jensen ²⁵, have documented the development of psychological approaches as they have expanded to include cognitive and acceptance-based approaches, and treatment guideline documentation for interdisciplinary treatment consistently highlights that psychological models of treatment are foundational (e.g., ⁴).

One specific approach to treatment is that of Acceptance and Commitment Therapy (ACT; ²⁰), a behavior change intervention that has been used for chronic pain for more than two decades ^{10,19,31}. The ACT model has been successfully implemented in both unidisciplinary psychology and within interdisciplinary teams. A recently published meta-analysis of 11 RCTs of ACT for chronic pain indicated small to medium effect sizes (ES) for functioning, anxiety and depression, and medium to large ES for ACT treatment process measures, such as pain acceptance ²³. The studies included in this meta-analysis were also a mix of treatment types (i.e., unidisciplinary psychology, interdisciplinary intervention, and telehealth).

In the present study, a comparative meta-analysis was performed to examine treatment effects of ACT when delivered by psychology alone, which we refer to as unidisciplinary ACT, or within an interdisciplinary intervention, which we refer to as interdisciplinary ACT. It was felt that the ACT treatment literature was developed enough to provide insight into whether type of treatment was a useful variable to consider when examining the effectiveness of psychological approaches for chronic pain, while also being circumscribed enough in size to make such an analysis feasible. To maximize the comparative analyses, both controlled and uncontrolled studies were included and only data from ACT treatment arms were included. In addition to examining comparative effect sizes (ES) between unidisciplinary and interdisciplinary ACT at post-treatment and follow-up assessment occurring up to one year following treatment's conclusion, total treatment duration (in hours) was examined as a potential ES moderator and study heterogeneity and quality were examined in relation to observed treatment effects.

Methods

Search Strategy

In April of 2018, published peer-reviewed studies were identified using the following keywords: ("*Acceptance and Commitment Therapy*" OR "*Acceptance-based*") AND ("*chronic pain*" OR "*persistent pain*") in the PsychInfo, PubMed, and Web of Science databases.

Reference lists were also reviewed to identify any articles missed by these search terms.

Abstract Screening

The abstracts of all studies identified in the literature search were read by a pair of reviewers to assess eligibility for full text data extraction. To be included, studies had to: (1) be a study of an ACT-based intervention (unidisciplinary or interdisciplinary), (2) have been performed in a sample of adults with chronic pain, (3) provide quantitative treatment outcome information at pre-treatment and post-treatment and/or pre-treatment and a follow-up of up to one year, and (4) consist primarily of face-to-face treatment (i.e., > 51% of treatment time face to face). A further inclusion criterion was present for interdisciplinary ACT, which was that the ACT model had to provide the foundation for treatment across all disciplines.

Full Text Data Extraction

All articles that met screening criteria were reviewed in full and coded by a minimum of two raters. Data extracted from each article included sample demographic and pain-related information (e.g., gender, age, pain duration, pain location); sample size at treatment onset, conclusion, and follow-up; treatment duration in hours and treatment type (i.e., unidisciplinary or interdisciplinary ACT); and information for several outcome domains, including measure names, means, and standard deviations. Outcome domains extracted included physical disability, psychosocial impact, depression, pain-related anxiety, anxiety (non-pain-related), pain-related healthcare utilization, and pain intensity. In addition, a range of ACT-relevant process measure domains were also extracted, including pain acceptance, general acceptance, values-based action, mindfulness, and committed action. Each rater provided an assessment of study quality, using the NIH Quality Assessment Checklist for Observational Cohort and Cross-Sectional Studies ⁴⁰.

Each study's data were extracted into a pre-piloted "fillable" pdf (Appendix 1) and then automatically uploaded for all raters into a spreadsheet stored within a web-based file, where discrepancies could be identified. All discrepancies were resolved via discussion amongst three authors (KEV, MP, & KAE).

Calculation of Effect Sizes and Comparative Analysis

Based on recent recommendations regarding meta-analyses of correlated within-subject data ²⁸, we calculated Hedges *g* for all outcome domains in the included studies, using the pooled standard error in the denominator. The advantages of using Hedges *g* for correlated data (cf. ³⁹) include the fact that it controls for small sample size bias ⁹ and does not risk inflation of the overall treatment effect when the data are correlated across time in excess of .50 ²⁸. Hedges *g* is viewed as more conservative than ES calculations that have previously been recommended for within-participant data ^{12,28,39}

The effects of unidisciplinary and interdisciplinary ACT were compared using the confidence interval (CI) based methods suggested by Cummings ⁹, which utilizes sample size information to calculate a confidence interval around each ES and to derive an overall weighted effect for each type of treatment. As we expected variability in treatment outcomes based on study methods and sample, random effects models were used. Once these results were calculated for each study, an overall meta-analytic result was calculated, including effects specifically for all studies, and separately for unidisciplinary ACT and interdisciplinary intervention studies. To be used in the comparative meta-analysis, we required that each outcome domain had been reported in at least three studies for each of the two types of treatment. Our primary outcome of interest was the ES comparison of unidisciplinary ACT and interdisciplinary ACT, as well as their respective 95% confidence intervals.

Assessment of Heterogeneity

Study variability was examined by calculating the I^2 statistic, which was calculated for each outcome measure. Values of I^2 that are above 50% indicate high heterogeneity. When high heterogeneity was indicated, potential outliers were identified and tested for influence on I^2 and overall ES.

Moderation Analyses

It was anticipated that overall treatment duration would vary significantly across studies and we hypothesized that unidisciplinary ACT interventions would have a shorter duration than interdisciplinary ACT. We planned to examine the influence of treatment duration on study outcomes in order to determine if any observed differences in treatment effect between the two intervention types could be explained as an effect of treatment contact time alone. Correlation coefficients (Pearson's r) were calculated for each outcome measure's overall ES and treatment duration.

Rating of Study Quality

As noted, the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies was used to evaluate study quality ⁴⁰. This tool rates 15 aspects of study quality, including recruitment and participation rates, eligibility criteria, study power, measures, analytic approach, treatment integrity and fidelity measurement, treatment standardization, blinding, and attrition rates. Scores range from 0-15 with higher scores indicating better study quality. In order to calibrate study personnel, study quality for four articles were initially rated by all authors and discussed to resolve discrepancies.

Results

Search Results and Data Extraction

Figure 1 provides flow of information throughout the search phases in a manner consistent with the PRISMA statement ³⁷. The initial search yielded a total of 105 records for screening after removing duplicates, with an additional 8 articles added during the second search in April of 2018.

As noted, a pair of readers then screened each abstract in relation to stated inclusion criteria. Inter-rater reliability in relation to abstract screening was good, Kappa = .80, with an overall raw inter-rater agreement of 90.4%. For all articles where there was disagreement amongst raters, a third reader evaluated the abstract as a tie-breaking vote. When the abstract did not provide sufficient detail for a clear decision, the article was retained for full text review.

After abstract screening, 63 records were excluded for not meeting inclusion criteria, leaving a total of 50 articles for full text review. Following this review, 21 additional articles were excluded for the reasons outlined in Figure 1, leaving a total of 29 articles for inclusion in the meta-analysis^{1,2,27,30,32,34–36,41–43,48,3,49–56,59,5,7,8,10,11,21,24}. Each article was read by a minimum of two raters for data extraction. There were up to 159 variables to code and extract from each article, meaning a total of over 4,500 possible variables across all articles. Disagreements across raters occurred a total of 49 times, yielding a raw discrepancy rate of 1.1%. All discrepancies were reviewed and resolved by a panel of three authors (KEV, MP, KAE).

One of the included articles⁵⁰ reported outcomes for two small treatment trials performed by different providers in different settings, therefore these data were analyzed separately as “Vowles 2009 (study 1)” and “Vowles 2009 (study 2)”. Three articles provided data from an overlapping sample^{41–43} and the study’s primary author provided combined outcome data for all three studies for use in the meta-analysis. These data are reported as “Scott 2015”. In some cases, full data could not be reported from published studies and the corresponding authors were contacted for further details.

Characteristics of Selected Studies

Of the included studies, 13 reported outcomes for unidisciplinary ACT and 15 for interdisciplinary ACT. Across studies, a total of 3,086 participants began treatment (Mean: 110.2, *SD*: 138.4; range: 6 – 590) and 2,672 participants completed treatment (Mean: 95.4, *SD*: 120.9, range: 6 – 476). Seventeen studies reported follow-up data for a total of 1,322 participants (Mean: 77.8, *SD*: 67.8, range: 10 – 213). Follow-up length ranged from 3 to 12 months, with an average of 5.0 months (*SD*: 2.8). There was no difference in follow-up length between unidisciplinary ACT and interdisciplinary ACT, $F(1, 16) = 3.1, p = .10$. The largest proportion of studies was from the United Kingdom (35.7%), followed by Sweden and the United States (both 21.4%), Spain (14.3%), and Australia and Iran (both 3.6%).

Treatment duration averaged 41.7 hours (*SD*: 42.0; range: 4 - 128) across all studies. For the interdisciplinary intervention studies, an average of 3.5 providers (*SD*: 1.5, range: 2-5) were involved in treatment. All interdisciplinary treatments included a clinical psychologist, 80.0% included a physician, 73.3% included a physical therapist, 53.3% included a nurse, and 46.7% included an occupational therapist. No other providers were reported as being involved.

Descriptively across studies, an average of 67.5% of participants were female (range 10% - 100%), 74.1% reported White European ethnicity (range: 0% – 100%), and 53.1% were unemployed (range: 0% - 100%). Reported demographic variables were averaged across studies. Average age was 50.3 (*SD*: 10.0) and average years of education was 12.4 (*SD*: 3.4). Most studies included individuals with mixed pain conditions or pain locations, 78.6%. Of the six studies that included specific types of pain, four included individuals with fibromyalgia, one included individuals with whiplash, and one included individuals with headache pain. Average pain duration was 12.4 years (*SD*: 8.1).

Outcome Domain Details

As noted, several domains were identified for data extraction. These included measures of physical disability, psychosocial impact, depression, pain-related anxiety, anxiety (non-pain-related), healthcare utilization, and pain intensity, as well as ACT-relevant process measures of pain acceptance, general acceptance, values-based action, mindfulness, and committed action. Across the 25 studies included in the meta-analysis, an average of 5.9 (*SD*: 2.0; range: 2 - 10) outcome domains were reported at post-treatment and an average of 6.2 (*SD*: 2.6; range: 1 - 12) were reported at follow-up.

For use in the meta-analyses, we required that each outcome domain had been reported in at least three studies for each treatment type for the follow-up assessment period. Thus, each domain was required to have been reported in at least six studies for inclusion. Seven measure domains met this requirement. These domains included physical disability, psychosocial impact,

depression, pain-related anxiety, pain intensity, and pain acceptance. A list of specific measures used within each domain can be found in **Supplementary** Table 1.

The remaining outcome domains were not reported in a sufficient number of studies for inclusion in the meta-analysis. Excluded domains and the total number of studies reporting them for unidisciplinary ACT and interdisciplinary ACT, respectively, were: General Anxiety: 2, 4; Pain-related Healthcare Visits: 1, 5; General Acceptance: 1, 1; Values-based Action: 0, 4; Mindfulness: 0, 4, and Committed Action: 0, 1.

Comparison of Treatment Effects

Physical Disability

Pre-treatment to post-treatment. A total of 10 unidisciplinary ACT and 13 interdisciplinary ACT studies reported post-treatment physical disability outcomes (see Figure 2a for details). The treatment effect for unidisciplinary ACT was below the typical cut-point used to denote a small effect (e.g., d), ES: .18 (CI: .02 - .34). The treatment ES for interdisciplinary intervention was of a medium magnitude, .55 (CI: .46 - .64). The confidence intervals for the two meta-analytic effects did not overlap, indicating larger treatment effects for interdisciplinary intervention relative to unidisciplinary ACT.

Pre-treatment to follow-up. A total of 4 unidisciplinary ACT and 9 interdisciplinary ACT studies reported follow-up outcomes for physical disability (see Figure 2b for details). The treatment effect for unidisciplinary ACT was .19 (CI: .02 - .43). The treatment ES for interdisciplinary intervention was of a medium magnitude, .53 (CI: .42 - .64). The overlap between the 95% CI's was minimal with an overlap of .01, indicating larger treatment effects for interdisciplinary intervention relative to unidisciplinary ACT.

Psychosocial Impact

Pre-treatment to post-treatment. A total of 5 unidisciplinary ACT and 13 interdisciplinary ACT studies reported post-treatment outcomes for psychosocial impact (see Figure 3a for details). The treatment effect for unidisciplinary ACT was small, ES = .40 (CI: .18 - .63). The

treatment ES for interdisciplinary intervention was medium, ES: .68 (CI: .55 - .82). The confidence intervals for the two meta-analytic effects had a moderate overlap, .05, suggesting larger treatment effects for interdisciplinary intervention relative to unidisciplinary ACT.

Pre-treatment to follow-up. A total of 3 unidisciplinary ACT and 10 interdisciplinary ACT studies reported follow-up outcomes for psychosocial impact (see Figure 3b for details). The treatment effect for unidisciplinary ACT was small, ES: .24 (CI: -.02 - .49). The treatment ES for interdisciplinary intervention was medium, ES: .69 (CI: .58 - .80). The 95% CI's for the two interventions did not overlap, indicating larger treatment effects for interdisciplinary intervention relative to unidisciplinary ACT.

Depression

Pre-treatment to post-treatment. A total of 5 unidisciplinary ACT and 10 interdisciplinary ACT studies reported post-treatment outcomes for depression (see Figure 4a for details). The treatment effect for unidisciplinary ACT was medium, ES: .52 (CI: .29 - .76). The treatment ES for interdisciplinary intervention was large, ES: .81 (CI: .66 - .97). The confidence intervals for the two meta-analytic effects had moderate overlap, .10, suggesting larger treatment effects for interdisciplinary intervention relative to unidisciplinary ACT.

Pre-treatment to follow-up. A total of 5 unidisciplinary ACT and 10 interdisciplinary ACT studies reported follow-up outcomes for depression (see Figure 4b for details). The treatment effect for unidisciplinary ACT was small, ES: .35 (CI: .15 - .55). The treatment ES for interdisciplinary intervention was medium, ES: .66 (CI: .53 - .78). The 95% CI's for the two overlapped minimally, .02, indicating relatively larger treatment effects for interdisciplinary intervention relative to unidisciplinary ACT.

Pain-related Anxiety

Pre-treatment to post-treatment. A total of 7 unidisciplinary ACT and 7 interdisciplinary ACT studies reported post-treatment outcomes for pain-related anxiety (see Figure 5a for details). The treatment effect for unidisciplinary ACT was medium, ES: .65 (CI: .38 - .91). The

treatment ES for interdisciplinary intervention was also medium, ES: .62 (CI: .40 - .84). The 95% CI's for the overlapped substantially, indicating no differences in treatment effect across the two treatment types. The overall treatment effect for both interventions was medium, ES: .63 (CI: .47 - .79).

Pre-treatment to follow-up. A total of 3 unidisciplinary ACT and 6 interdisciplinary ACT studies reported follow-up outcomes for pain-related anxiety (see Figure 5b for details). The treatment effect for unidisciplinary ACT was medium, ES: .52 (CI: .22 - .81). The treatment ES for interdisciplinary intervention was also medium, ES: .70 (CI: .52 - .89). The 95% CI's for the overlapped substantially, indicating no differences in treatment effect across the two treatment types. The overall treatment effect for both interventions was medium, ES: .65 (.50 - .81).

Pain Intensity

Pre-treatment to post-treatment. A total of 12 unidisciplinary ACT and 13 interdisciplinary ACT studies reported post-treatment pain intensity outcomes (see Figure 6a for details). The treatment effect for unidisciplinary ACT was small, ES: .46 (CI: .28 - .66). The treatment ES for interdisciplinary intervention was medium, ES: .55 (CI: .40 - .69). The 95% CI's for the overlapped substantially, indicating no differences in treatment effect across the two treatment types. The overall treatment effect for both interventions was medium, ES: .51 (CI: .40 - .62).

Pre-treatment to follow-up. A total of 6 unidisciplinary ACT and 10 interdisciplinary ACT studies reported follow-up pain intensity outcomes (see Figure 6b for details). The treatment effect for unidisciplinary ACT was small, ES: .37 (CI: .34 - .58). The treatment ES for interdisciplinary intervention was medium, ES: .50 (CI: .35 - .65). The 95% CI's for the overlapped substantially, indicating no differences in treatment effect across the two treatment types. The overall treatment effect for both interventions was small, ES: .46 (CI: .34 - .58).

Pain Acceptance

Pre-treatment to post-treatment. A total of 7 unidisciplinary ACT and 12 interdisciplinary ACT studies reported post-treatment outcomes pain acceptance (see Figure 7a for details). The

treatment effect for unidisciplinary ACT was large, ES: .80 (CI: .47 – 1.13). The treatment ES for interdisciplinary intervention was also large, ES: 1.00 (CI: .78 - 1.22). The 95% CI's for the overlapped substantially, indicating no differences in treatment effect across the two treatment types. The overall treatment effect for both interventions was large, ES: .93 (CI: .75 - 1.12).

Pre-treatment to follow-up. A total of 4 unidisciplinary ACT and 9 interdisciplinary ACT studies reported follow-up outcomes for pain acceptance (see Figure 7b for details). The treatment effect for unidisciplinary ACT was large, ES: .95 (CI: .65 – 1.26). The treatment ES for interdisciplinary intervention was also large, ES: 1.04 (CI: .86 – 1.23). The 95% CI's for the overlapped substantially, indicating no differences in treatment effect across the two treatment types. The overall treatment effect for both interventions was large, ES: 1.02 (CI: .87 – 1.17).

Assessment of Heterogeneity

Heterogeneity information is displayed in Table 1. High heterogeneity was indicated for five of the six outcome measures, with only physical disability having all I^2 values under 50%. Therefore, forest plots were visually inspected for potential outlier studies and the influence of these studies on overall and comparative effect was tested by removing them from analyses. For outcome measures where significant comparative differences were indicated (i.e., psychosocial impact, depression), heterogeneity analyses were performed in a manner specific to treatment format (i.e., unidisciplinary or interdisciplinary ACT) and for outcomes where comparative differences were not indicated (i.e., pain-related anxiety, pain intensity, pain acceptance), heterogeneity analyses were performed for all studies.

The heterogeneity analyses results can be summarized as follows. While high heterogeneity was indicated across most outcome measures, two studies accounted for this heterogeneity in most cases. The first was the unidisciplinary ACT study of Luciano and colleagues ³⁰, which had a larger treatment effect across a number of outcomes in comparison to other unidisciplinary ACT studies. The second was the interdisciplinary intervention of Baranoff and colleagues ³, which had a smaller treatment effect across a number of outcomes in

comparison to other interdisciplinary ACT studies. Together, the removal of these two studies from ES calculations decreased heterogeneity considerably for most outcomes. Specific findings for each of the outcome measures is detailed in the following paragraphs. Finally, after removing the studies that were contributing to significant heterogeneity, there were no changes in the overall pattern of findings regarding the presence or absence of differences in ES between the two treatment types.

For psychosocial impact, the removal of one study ³ from pre-post treatment interdisciplinary ACT calculations reduced heterogeneity to 36.5%. The removal of this study did not alter the pattern of findings regarding treatment effect for interdisciplinary ACT, nor the finding of differences in ES between the treatment types.

For pre-post treatment effect for depression, the removal of one study ³⁰ from the unidisciplinary ACT calculations reduced heterogeneity to 10.3% and the removal of one study ³ from the interdisciplinary ACT calculations reduced heterogeneity to 49.1%. The removal of both studies did not alter the pattern of findings regarding treatment effect for each treatment type, nor the finding of significant differences in ES between them. For the pre-treatment to follow-up effect for depression, the removal of one study ³⁰ from the unidisciplinary ACT calculations reduced heterogeneity to 0%. The removal of this study did not alter the pattern of findings regarding treatment effect for unidisciplinary ACT, nor the finding of differences in ES between treatment types.

For pre-post treatment effect for pain-related anxiety, the removal of one study ³ from the entire pool of studies reduced heterogeneity to 34.4%. The removal of this study did not alter the pattern of findings regarding treatment effect, nor the finding of substantial overlap in 95% CIs between treatment types. For pre-treatment to follow-up effect, the removal of one study ⁵³ reduced heterogeneity to 25.3%. The removal of this study did not alter the pattern of findings regarding treatment effect, nor the finding of substantial overlap 95% CIs between treatment

types, although it did reduce the number of unidisciplinary ACT studies for this variable from three to two.

For pain intensity, high heterogeneity was only indicated for unidisciplinary ACT studies for both the pre to post-treatment interval and the pre-treatment to follow-up interval. For the pre to post-treatment effect for pain intensity, the removal of one study ³⁰ reduced heterogeneity to 53.3%. The removal of this study did not alter the pattern of findings regarding treatment effect, nor the finding of non-significant differences between treatment types. For the pre-treatment to follow-up interval, the removal of this same study ³⁰ reduced heterogeneity to 0%. The removal of this study did not alter the pattern of findings regarding treatment effect, nor the finding of non-significant differences between treatment types.

For the pre to post treatment effect for pain acceptance, the removal of three studies ^{30,34,48} from the overall pool of studies reduced heterogeneity to 50.0%. The removal of these studies did not alter the pattern of findings regarding treatment effect, nor the finding of non-significant differences between treatment types. For pre-treatment to follow-up treatment effect for pain acceptance, the removal of one study ⁵³ reduced heterogeneity to 0%. The removal of these studies did not alter the pattern of findings regarding treatment effect, nor the finding of non-significant differences between treatment types.

Moderation Analyses for Treatment Duration

For studies of unidisciplinary ACT, treatment duration averaged 12.6 hours (*SD*: 5.0; range: 4 - 20) and for studies of interdisciplinary intervention, treatment duration averaged 67.0 hours (*SD*: 43.6; range: 10 - 128). The difference in treatment time was statistically significant, $F(1, 27) = 19.9, p < .001$.

In order to examine the impact of treatment duration on ES, we calculated correlation coefficients for treatment duration and ES to determine if the relation appeared robust. Because of the small *n* in a number of analyses, we elected to view these analyses as exploratory in

nature and to evaluate the overall magnitude of the correlation with the following guidelines: $r = \geq .10$ weak relation, $\geq .30$ moderate relation, $\geq .50$ strong relation ⁶.

See Table 2 for details. Overall, across the two treatment intervals, there was a weak relation between ES and treatment duration for five of the twelve outcomes (42%), a moderate relation for three of twelve outcomes (25%), and a strong relation for three of twelve outcomes (25%).

Rating of Study Quality

Across all included studies, average study quality was 9.5 (*SD*: 1.4; range: 7-12). There were a small number of quality indicators that were met by fewer than 50% of studies. These included providing a sample size justification/power analysis (criterion 5), quantitative measurement of treatment fidelity (criterion 11), blinding of assessors (criterion 13), having < 20% attrition from treatment onset to follow-up (criterion 14), and controlling for key potential confounding variables in outcome analysis (criterion 15).

Study quality ratings were correlated with ES across outcome domains (Table 3). When overall correlation magnitude was examined using the same gradings as in the treatment duration moderation analyses (i.e., $r = \geq .10$ weak relation, $\geq .30$ moderate relation, $\geq .50$ strong relation), study quality was weakly related to four of twelve outcomes (33%) and moderately related to three of twelve outcomes (25%). The remaining correlations were less than weak (i.e., $< .10$).

Discussion

The impetus for this meta-analysis came from the observed discrepancy regarding the effectiveness of psychological approaches for chronic pain, where one set of data indicate these approaches work reasonably well and another indicate they have weak effects only. Such a discrepancy in findings suggests the possibility of a third variable. We hypothesized that treatment format was one potentially influential variable and specifically examined treatment provided by clinical psychology alone in relation to treatment provided by an interdisciplinary

team. We specifically selected a sub-set of the broader chronic pain treatment literature, specifically interventions offered within the ACT framework. It was felt that this subset of the broader literature was large enough to allow for a meaningful analysis, while also being circumscribed enough to be feasible.

This primary set of results indicated that treatment effects were larger for interdisciplinary ACT in comparison to unidisciplinary ACT for three of six outcomes examined: Physical disability, psychosocial impact, and depression. For interdisciplinary ACT, treatment effects for these three variables were almost uniformly of a medium size, ranging from .53 (95% CI: .42 - .64) for follow-up physical disability follow-up to .72 (95% CI: .59 - .86) for post-treatment psychosocial impact. The only large effect of interdisciplinary treatments was for post-treatment depression, .81 (95% CI: .66 - .97). By comparison, treatment effects for unidisciplinary ACT for these three variables were almost uniformly of a small size, ranging from .18 (95% CI: .02 - .34) for post-treatment physical disability to .52 (95% CI: .29 - .76) for post-treatment depression.

There were no significant differences by type of treatment for the remaining three outcome variables: Pain-related anxiety, pain intensity, and pain acceptance. Descriptively, treatment effects for these three variables ranged from small for follow-up pain intensity, .46 (95% CI: .37 - .58), to large for post-treatment and follow-up pain acceptance, .93 (95% CI: .75 - 1.12) and 1.02 (95% CI: .87 - 1.17), respectively. The remaining effect sizes were of a medium magnitude.

Thus, the overarching answer to our question of whether treatment type influenced treatment outcomes is: For some outcomes. The difference in findings across outcomes is interesting and complicates conclusions that can be drawn. There are a few possible considerations that may assist in clarification.

The outcomes for which interdisciplinary ACT had a stronger effect can be grouped as measures of chronic pain's impact on physical and emotional functioning, while the measures

for which there was not a difference can be grouped as facets of the pain experience. For example, pain intensity is a measure of pain severity, while pain-related fear and acceptance are measures of how fearful or accepting, respectively, one is of the pain experience. It seems possible that the larger effects for interdisciplinary approaches on physical and emotional outcomes may be related to their inclusion of therapies which directly influence pain's impact on functioning, such as physical and occupational therapy, in the case of many of the included studies. It is possible that unidisciplinary ACT interventions are reasonably powered to move one's relation to the pain experience in a positive direction, but not as powerful as interdisciplinary ACT at moving pain's impact on functioning in that same direction.

In addition, an individual analysis of the outcomes for which differences in ES between treatment type was not significant may yield some utility. Given that ACT does not explicitly target pain intensity for reduction, it may be that the lack of differences in ES between the two treatment types was to be expected, as a medium effect was present at post-treatment and small effect at follow-up. On a similar note, both types of treatment had large effects on pain acceptance and perhaps this similar effect was the product of pain acceptance being directly targeted by ACT, regardless of treatment format. Finally, regarding pain-related fear, it is possible that participation in both unidisciplinary and interdisciplinary ACT entails significant opportunities for exposure to pain and pain-related emotions to an extent that pain-related fears decrease at a similar level. The extant literature on exposure for high fear of pain indicates that psychology only interventions may be sufficient to achieve significant reductions in problematic levels of fear avoidance ^{46,47,58}.

Finally, the correlation between treatment duration and ES was moderate, with an overall mean correlation of .33 ($SD = .18$), indicating that 10.9% of the variance (i.e., r^2) in ES was accounted for by treatment duration. Overall, this amount of variance is likely both modest and meaningful – on the one hand, there is a large amount of variance remaining and, on the other, a notable amount of the variance in outcome was accounted for by treatment length.

Further, while we used treatment duration as a proxy for treatment intensity, it may be that there are other markers of intensity that were not reported, such as percentage of time engaged in aerobic exercise, and these indicators of intensity may be important considerations for future study.

Perhaps more importantly, average correlation for the outcomes for which differences in ES were observed by treatment type were descriptively larger than average correlations for the outcomes for which differences in ES were not observed. Specifically, for physical disability, psychosocial impact, and depression, average correlation between ES and treatment length, $r = .40$ ($SD = .18$), was larger than for pain intensity, pain-related fear, and acceptance, $r = .26$ ($SD = .16$). These values correspond to 16.0% and 6.8%, respectively, of the variability in ES accounted for by treatment duration for these two groups of variables. While any comparisons of these percentages are descriptive only, and thus largely hypothetical, the difference in variance accounted for suggests that longer treatments were moderately more powerful in changing pain's impact on functioning.

Based on the above interpretation of the findings of this meta-analysis, we propose the following, both in relation to ACT for chronic pain specifically and, by extension, to psychological interventions for chronic pain more broadly. First, psychologically-based interventions for chronic pain which incorporate the skills of disciplines besides psychology may be more effective at reducing pain's negative impact on physical, psychological, and social functioning. Our clinical experience suggests, for example, that physical therapy intervention oriented towards facilitating willingness to have pain in the service of engaging in valued activity provides a powerful and synergistic addition to clinical psychology focused on pain acceptance and engagement in valued activity. Recent qualitative work by our group indicates that patients themselves also see the value of this integration⁴⁴. Second, consistent with the recent Cochrane reviews of psychological interventions^{13,57}, psychology alone may have limited effects on important aspects of the pain experience. In circumstances where interdisciplinary ACT are

not feasible, it may be possible to more directly focus psychological interventions on pain's impact on functioning which may, in turn, contribute to greater treatment effects. Third, treatment duration matters, such that a larger dose of integrated treatments may contribute to more efficacious and robust outcomes, particularly among patients with complex symptomatology. Fourth, the Cochrane reviews in this area have suggested that study methodological quality is increasing, while the quality and intensity of the interventions themselves may be decreasing, and that this is one potential reason for the decline in treatment effects of psychological interventions for chronic pain over time. It is possible that one reason for the reduced quality may be an increased focus on providing ever briefer treatments, even for those with very complex chronic pain conditions. For at least some patients and some treatment outcome domains, more intensive interdisciplinary treatments may have an advantage.

There are a number of limitations and recommendations. First, the conclusions drawn here regarding unidisciplinary and interdisciplinary ACT may be applicable to ACT for chronic pain only, rather than the broader literature on psychological approaches to chronic pain. That being noted, ACT shares a number of characteristics with other psychological approaches, including an emphasis on exposure, behavior change, and the promotion of adaptive responding to aversive experiences, thus we would hypothesize that at least some of the conclusions here will be relevant to the broader literature on this topic.

Second, there may be other facets of the included studies that influenced pattern of results, which were not measured here. For example, issues of therapist adherence to treatment protocols or the theoretical model, patient complexity at treatment admission, or facilitation of an effective therapeutic relationship were not reported with enough regularity across included studies to be examined as potential mediators of ES.

Third, all ES calculations were for within subjects data and do not allow an indication of the efficacy of ACT in comparison to alternative interventions. Given our primary objective of a comparative analysis based on treatment type, it seemed most logical to include only data from

ACT arms of treatment. We selected Hedges' g as our ES based on recent guidelines that indicate it is more conservative than previously recommended ES for use in correlated data, particularly for bias associated with small sample size ^{12,28,39}.

Fourth, while there was evidence of significant heterogeneity in findings across studies, much of the heterogeneity was accounted for by two studies ^{3,30}, and the pattern of findings was not changed when studies contributing to heterogeneity were removed. Nonetheless, there may be contributors to heterogeneity that are important to identify and isolate in future work. Further, for some follow-up comparisons, including physical disability, psychosocial impact, pain-related anxiety, and pain acceptance, only a few studies were available for unidisciplinary ACT and this places potential limits on the reliability of these ES calculations.

Finally, study quality, while generally high, was hindered by several deficits in methodology that were regularly observed across studies. These aspects of study quality are worth addressing in future work and included the need to perform an *a priori* power analysis to identify adequate sample size, assessment of clinician adherence to treatment model and protocol, blind assessment of outcomes, reducing rates of attrition, and controlling for potentially confounding variables in outcomes analysis. Many of these areas have been identified in other work as deficits in the broader treatment outcome literature (e.g., ⁹) and they represent important areas of study quality to improve upon.

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This paper is dedicated to the memory and legacy of Stephen Morley, as it grew out of a conversation with him in the Manchester airport many years ago. His wisdom, wit, and kindness was much appreciated and is sorely missed.

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Table 1

Heterogeneity information (I^2)

Outcome domain	<u>Pre to Post-Treatment</u>			<u>Pre-Treatment to Follow-up</u>		
	Overall	Unidisc.	Interdisc.	Overall	Unidisc.	Interdisc.
Physical Disability	40.4%	0.0%	24.4%	31.4%	0.0%	7.2%
Psychosocial Impact	57.3%	0.0%	54.4%	51.0%	0.0%	20.3%
Depression	67.4%	59.3%	62.1%	48.5%	58.3%	0.0%
Pain-related Anxiety	57.5%	45.7%	69.3%	44.5%	53.1%	39.9%
Pain Intensity	45.7%	67.8%	0.0%	28.7%	66.4%	0.0%
Pain Acceptance	74.5%	59.3%	72.2%	50.3%	75.0%	32.0%

Table 2

Correlations among Treatment Duration and Effect Size at Post-Treatment and Follow-up

Outcome Domain	Pre to Post-Treatment	Pre-Treatment to Follow-up
Physical Disability	.27 ^w	.30 ^m
Psychosocial Impact	.53 ^s	.70 ^s
Depression	.39 ^m	.22 ^w
Pain-related Anxiety	.23 ^w	.52 ^s
Pain Intensity	.07	.22 ^w
Pain Acceptance	.37 ^m	.14 ^w

Note: Superscripts denote strength of relation using the guidelines of Cohen [8], where ^w = a weak correlation of $\leq .10$, ^m = a moderate correlation of $\geq .30$, and ^s = a strong correlation of $\geq .50$.

Table 3

Correlations among Study Quality Scores and Effect Size at Post-Treatment and Follow-up

Outcome Domain	Pre to Post-Treatment	Pre-Treatment to Follow-up
Physical Disability	-.05	-.19 ^w
Psychosocial Impact	-.07	-.48 ^m
Depression	.04	.02
Pain-related Anxiety	.29 ^w	-.33 ^m
Pain Intensity	-.20 ^w	.03
Pain Acceptance	.38 ^m	-.10 ^w

Note: Superscripts denote strength of relation using the guidelines of Cohen [8], where ^w = a weak correlation of $\leq .10$, ^m = a moderate correlation of $\geq .30$, and ^s = a strong correlation of $\geq .50$.

Figure Legends

Figure 1: PRISMA flow chart

Figure 2a: Physical disability - Pre to post-treatment forest plot

Figure 2b: Physical disability - Pre-treatment to follow-up forest plot

Figure 3a: Psychosocial impact - Pre to post-treatment forest plot

Figure 3b: Psychosocial impact - Pre-treatment to follow-up forest plot

Figure 4a: Depression - Pre to post-treatment forest plot

Figure 4b: Depression - Pre-treatment to follow-up forest plot

Figure 5a: Pain-related anxiety - Pre to post-treatment forest plot

Figure 5b: Pain-related anxiety - Pre-treatment to follow-up forest plot

Figure 6a: Pain intensity - Pre to post-treatment forest plot

Figure 6b: Pain intensity - Pre-treatment to follow-up forest plot

Figure 7a: Pain acceptance - Pre to post-treatment forest plot

Figure 7b: Pain acceptance - Pre-treatment to follow-up forest plot

Figure 1: PRISMA flow chart

Figure 2a: Physical Disability (Pre to Post-Treatment Forest Plot)

Figure 2b: Physical Disability (Pre-treatment to Follow-up Forest Plot)

Figure 3a: Psychosocial Impact (Pre to Post-Treatment Forest Plot)

Figure 3b: Psychosocial Impact (Pre-treatment to Follow-up Forest Plot)

Figure 4a: Depression (Pre to Post-Treatment Forest Plot)

Figure 4b: Depression (Pre-treatment to Follow-up Forest Plot)

Figure 5a: Pain-Related Fear (Pre to Post-Treatment Forest Plot)

Figure 5b: Pain-related Fear (Pre-treatment to Follow-up Forest Plot)

Figure 6a: Pain Intensity (Pre to Post-Treatment Forest Plot)

Figure 6b: Pain Intensity (Pre-treatment to Follow-up Forest Plot)

Figure 7a: Pain Acceptance (Pre to Post-Treatment Forest Plot)

Figure 7b: Pain Acceptance (Pre-treatment to Follow-up Forest Plot)

Table 1

Specific measures used within each outcome domain

Domain	Measures
Physical Disability	Multi-Dimensional Pain Inventory (General Activity Scale) [35], Oswestry Disability Index [18], Pain Disability Index [8]; SF-12 [70] and SF-36 (physical functioning items) [69], Sickness Impact Profile (SIP) & SIP-Chronic Pain (Physical Disability scale) [5,47], and Work and Social Adjustment Scale [52].
Psychosocial Impact	Brief Pain Inventory (interference items) [9,59], Brief Symptom Inventory [16], SF-12 [70] and SF-36 (mental health items) [69], and SIP and SIP-Chronic Pain (Psychosocial Disability scale) [5,47].
Depression	Beck Depression Inventory [4], British Columbia Major Depression Inventory [30], Center for Epidemiological Studies – Depression Scale [54], Geriatric Depression Scale [78], Hospital Anxiety and Depression Scale (HADS; Depression scale) [80], and Patient Health Questionnaire – 9 [37].
Pain Anxiety	Pain Catastrophizing Questionnaire [58], Pain Anxiety Symptom Scale (PASS) [46] & PASS – Short Form [42], and Tampa Scale of Kinesiophobia [36].
Pain Intensity	Brief Pain Intensity (BPI; pain intensity items) [9,59], McGill Pain Questionnaire – Short Form [48], Numerical Rating Scale, SF-36 (bodily pain items) [69], Visual Analog Scale.
Pain Acceptance	Chronic Pain Acceptance Questionnaire (CPAQ) [45] & CPAQ – short form [19] and the Psychological Inflexibility in Pain Scale (Avoidance scale) [74].