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Latent Class Analysis of the Short and Long-Form of the Chronic Pain Acceptance

Questionnaire-

Further Examination of Patient Subgroups

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MeSH-terms: Chronic Pain, Chronic Pain/Rehabilitation; Acceptance & Commitment Therapy; Pain Measurement/therapeutic use; Pain Measurement/utilization; Clustering

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Highlights

- Patients with chronic pain can be clustered in four subgroups according to their pain acceptance levels.
- Each pain acceptance cluster is significantly associated with patterns of functioning.
- Both versions of the Chronic Pain Acceptance Questionnaire (CPAQ-20 and CPAQ-8) are useful instruments to identify cluster membership.

Abstract

A substantial literature indicates that pain acceptance is a useful behavioral process in chronic pain rehabilitation. Pain acceptance consists of willingness to experience pain and to engage in important activities even in the presence of pain and is often measured using the Chronic Pain Acceptance Questionnaire (CPAQ). Previous traditional cluster analyses of the 20-item CPAQ identified three patient clusters which differed across measures of patient functioning in meaningful ways. The aims of this study were to replicate the prior study in a new sample, using the more robust method of Latent Class Analysis (LCA), and to compare the cluster structure of the CPAQ and the shorter CPAQ-8. In total, 914 patients with chronic pain completed the CPAQ and a range of measures of psychological and physical function. Patient clusters identified via LCA were then used to compare patients across functional measures. Contrary to previous research, LCA demonstrated that a four-cluster structure was superior to a three cluster. Consistent with previous research, cluster membership based on patterns of pain willingness and activity engagement was significantly associated with specific patterns of psychological and physical function, in line with theoretical predictions. These cluster structures were similar for both CPAQ-20 and 8-items. These results provide further evidence of the relevance of chronic pain acceptance, and a more nuanced understanding of how the components of acceptance are related to function.

Perspective: Pain acceptance is important in chronic pain The findings of the present study, which included 914 individuals with chronic pain, provide support for four discrete groups of patients based on levels of acceptance: low, medium, and high, as well as a group that is high in activity engagement and low willingness to have pain.

These groups appear statistically robust and also differed in predictable ways across measures of functioning.

Introduction

The concept of acceptance of pain has now gained considerable evidence as to its applicability to chronic pain [e.g. 32; 35]. Pain acceptance is associated with less avoidance, anxiety, depression and healthcare visits and increased work capacity [27; 33]. Interventions that improve acceptance, such as Acceptance and Commitment Therapy [ACT: 19; 35], are effective in lowering psychological and physical disability, improving health, functioning and quality of life [5; 8; 30; 31; 62]. Chronic pain acceptance is typically measured via the Chronic Pain Acceptance Questionnaire [CPAQ: 12; 36]. The CPAQ is sensitive to treatment, psychometrically robust [45], and was developed in line with a “functional contextual” framework to reflect the particular emphasis of ACT on function and consequences of behavior. In addition to strong correlations with a number of key measures of patient functioning, the CPAQ offers an advantage of evaluating adaptive functioning, as opposed to a focus strictly on measuring ‘maladaptive’ functioning (e.g., pain-related distress, anxiety, “catastrophizing”) [29; 37].

The CPAQ consists of two subscales, each assessing different aspects of pain acceptance. The first of these, Activity Engagement (AE), assesses the degree to which respondents report being active with the continuing experience of pain. The second, Pain Willingness (PW), assesses the degree to which respondents report being open to the experience of pain without the need to engage in unsuccessful pain control efforts.

Using these two subscales, Vowles, McCracken, & Eccleston [59] performed hierarchical and k-means cluster analyses to investigate if patient subgroups could be

identified. These analyses indicated the presence of three discrete clusters of patients: high AE and PW (high acceptance), Low AE and PW (low acceptance), and a ‘mixed’ cluster, high in AE and low PW. The Vowles et al. cluster analysis has not been replicated, nor has a cluster analysis been performed using the short form of the CPAQ, the CPAQ-8 [11].

The objectives of the present analyses were to provide an updated analysis of cluster structure of the CPAQ-20 in a new sample of patients using a more advanced and empirically sound cluster analytic approach (Latent Class Analysis) and to evaluate the cluster structure of the CPAQ-8 in comparison to the CPAQ-20. Further, in order to assess the utility of cluster membership, differences in self-reported measures of physical and emotional functioning based on cluster membership were evaluated.

Methods

Participants

Over a 25 month period, 1391 patients were referred to the Pain and Rehabilitation Center (PRC) at the University Hospital, Linköping, Sweden, and 914 (66%) patients had complete CPAQ data. The CPAQ was not a compulsory part of the assessment questionnaire battery at that time, explaining the discrepancy between total referrals and current sample. Sociodemographic information and pain characteristics of the patients are summarized in **Table 1**.

[Insert Table 1 about here]

These patients, compared to all the patients with chronic pain registered at the Swedish Registry of Pain Rehabilitation [53] were 6 years younger and less educated (only 18.0% had university education while the SQRP reports 25.0%, and 26.4% had only elementary school while the SQRP reports 11.0%). Other than this, this population was similar in educational profile to those described in epidemiological studies and national reports [4; 14; 42]

Procedure

Data collection

Along with most of the pain rehabilitation clinics, the PRC gathers data for the Swedish Quality Registry for Pain Rehabilitation [SQRP: 53] which monitors assessment and outcome of pain rehabilitation clinics in Sweden. The SQRP includes diagnoses as well as descriptive self-report variables of the patient's background, pain characteristics, and other self-report measures of domains such as depression and anxiety, quality of life and attitudes towards pain.

Before the first assessment, all patients gave their written informed consent to be registered at the SQRP in accordance with the Declaration of Helsinki. This consent includes consenting for their data to be used in research studies such as the present one. The study was granted ethical clearance by the Regional Ethics Board in Gothenburg (approval #: 815-12).

Data of SQRP used in the present study

Demographic data included: Sex, years of education, work status, sick leave or insurance/work situation. Pain variables included current pain severity, duration, and frequency, as well as anatomical regions with worst pain (see **Table 1**).

Measures

The Chronic Pain Acceptance Questionnaire [CPAQ: 36] is a 20-item likert (0-6) scale, validated in Swedish [63]. The short version with 8-items' has been validated in English [1; 10; 11] and in Swedish [48]. In this article the 8 items for the CPAQ-8 were extracted from the long version (i.e., items 1, 6, 9, 13, 14, 15, 17 and 18). Both versions of CPAQ are composed of two factors "Activity Engagement" (score range 0–66 in the CPAQ-20 and 0-24 in the CPAQ-8) and "Pain Willingness" (score range 0–54 and 0-24, respectively). All items are rated on a scale from 0 (never true) to 6 (always true) indicating low levels of AE and or PW. There are no existing cutoffs for the CPAQ:

The Tampa Scale for Kinesiophobia [TSK: 39] measures fear of movement and re-injury [58]. The 17 items are rated from 1 '(strongly disagree) to 4 '(strongly agree). The total score has a range from 17 to 68 where higher scores indicate higher pain-related fear [46]. The cutoff score was developed by Vlaeyen et al. [58], where a score of 37 or over is considered as a high score, while scores below that are considered as low scores. The TSK appears to be a reliable assessment tool for

chronic pain [6; 58] across different samples. It has a stable factor structure across pain diagnoses and nationalities [13; 16; 25; 46; 50; 57].

Hospital Anxiety and Depression Scale [HAD: 64] yields two subscales of depression and anxiety symptoms with 7-items each. Each item has four response categories from 0 (no problem) to 3 (severe problem). The scale covers a period of the past week. The two subscale scores are summed with a score of <7 being interpreted as asymptomatic; a score of 8–10 indicating mild/moderate symptoms; and >10 or more suggesting clinically significant symptoms [52]. The Swedish translation has shown acceptable psychometric properties [23].

Multidimensional Pain Inventory (MPI) [2; 3; 55; 56]. The MPI measures pain and its impact, as well as coping. It has 61 items ranged 0 to 6 (the 6 indicating the maximum value in each scale) and is divided in three sections: 1) pain impact, (pain severity and interference, life control, affective distress and support) 2) responses by significant others (negative/ignoring, solicitous and distracting) and 3) common activities (household, outdoors, away from home and social activities), summarized in a general Activity Scale. The subscales range also from 0 to 6 and a change of 0.6 is considered as clinical significant change [7].

Statistical Analyses

Data screening

As the initial data analytic step, all dependent variables were evaluated for skewness and kurtosis. In addition, individual participant CPAQ subscale scores were inspected to identify statistical outliers, as outliers can substantially skew the results of the clustering approach that we used [43]. Correlation between the various measures was performed using Pearson correlation coefficient between all the scales.

Cluster analysis.

Next, Latent class analysis (LCA) was used to investigate cluster structure for both the 20 and 8-item CPAQ using MPlus Version 7.2 [41]. LCA is a technique that assesses patterns of responses in a dataset. It determines if individuals can be grouped into categorical class membership, based on their responses to two or more measured variables. It begins with the assumption that only one underlying latent class exists in the data set, and then generates a second, a third and fourth and so on. At each step probability of class membership is determined mathematically using Maximum Likelihood Estimates. This process continues until the addition of another latent class results in worse model fit than the previous step.

LCA represents a more robust approach to cluster analysis, compared to other methods such as hierarchical or k-means clustering. LCA determines number of clusters and cluster membership based upon probability, and statistical estimates of model fit, whereas other methods of clustering rely to a large extent on researcher judgment (e.g., inspection of dendrogram or agglomeration figures) and post-hoc analyses to determine the appropriate number of clusters [9; 38]. LCA also offers several statistical tools to aid in the determination of cluster structure.

First, LCA allows various cluster structures to be compared with one another in order to aid in the determination of cluster structure. Specifically, the Vuong-Lo-Mendell-Rubin test [VLMR; 24; 60] and the bootstrapped likelihood ratio test [BLR; 38] can be used to compare the differences in model fit between the hypothesized number of clusters, k , and a model testing $k - 1$ clusters. Therefore, the hypothesized number of clusters can be tested and compared successively with alternate possible cluster structures in order to identify the structure which provides the best fit with the

available data. In the MPlus statistical package, these two tests are the TECH11 and TECH14 options, respectively [see 40 for details].

Second, LCA uses maximum likelihood (ML) estimates, which is better able to accommodate cases that have missing data, as ML estimates make use of all available data to allocate cases into different clusters. In comparison, traditional cluster analytic techniques generally require complete data or some type of replacement (e.g., sample mean substitution) for missing data.

Finally, LCA allows the calculation of conditional probabilities of cluster membership for all cases in the dataset. These probabilities can then be inspected to determine which individuals have strong conditional probabilities for one group only and are thus more confidently assigned to one cluster (e.g., > 75% probability of membership in one cluster only) in relation to individuals whose cluster membership is less clear (e.g., >40% probability of membership in two clusters). As such, LCA offers an advantage over the previous study examining the cluster structure of the 20-item CPAQ, which used a traditional cluster analytic approach [59].

Between cluster comparisons

In order to examine the utility of cluster membership, between cluster differences across measures of functioning were evaluated. An omnibus test across clusters was performed via a Multivariate Analysis of Variance (MANOVA), with group membership as the independent variable and measures of patient functioning (i.e., depression, anxiety, pain-related fear, pain intensity, pain interference, general activity) as the dependent variables. A significant omnibus effect was followed by a series of ANOVA's for each measure of patient functioning, which were in turn followed up by pairwise comparisons when significant. In addition, because the LCA provided information with regard to the conditional probability of each individual's

cluster membership, the between group comparisons were repeated with a requirement of a baseline threshold for conditional probability of group membership. Required conditional probabilities of > 25%, > 50%, and > 75% were examined sequentially.

Concordance in cluster assignment for the CPAQ-20 and CPAQ-8

As the final analytic step, agreement in cluster membership was evaluated. For these analyses, percent agreement in cluster assignment when using the short and long form of the CPAQ was evaluated using an unrestricted conditional probability, as well as the > 25%, > 50%, and > 75% conditional probability.

Results

Data screening

All dependent variables appeared normally distributed and non-kurtotic with no value in excess of 1.1. Inspection of boxplot distributions for the CPAQ total and subscale scores identified a total of seven individuals as statistical outliers.

Descriptively, these individuals had maximal scores on either subscale of the CPAQ or on its total score. The data of these individuals was excluded from further analyses, leaving a total of 907 participants.

The correlation between scales (**Table 2**) showed coherent relationships across included measures. The four activity scales of the MPI were highly correlated with the MPI General Activity scale ($r > .64, p < .01$); HAD scales were highly correlated with the MPI scale of Affective distress and Life Control ($r > .53, p < .01$) and CPAQ Activity engagement was highly correlated with pain Interference scale of MPI ($r > .64, p < .01$).

[Insert Table 2 about here]

CPAQ-20

Latent Class Cluster Analysis

For the analyses evaluating the three cluster structure, the best loglikelihood value was replicated across analyses with both 20 and 100 random starts (value obtained = -6807 to -6819). When the three cluster structure was compared with a two cluster structure, both the VLMR and BLR tests were statistically significant, $p < .005$ and $p < .001$, respectively, suggesting that the three cluster structure was superior to the two cluster structure.

Next, a four cluster structure was investigated. The best loglikelihood value was replicated across analyses with both 20 and 100 random starts (values obtained

ranged from -6798 to -6800). When the cluster structures were compared, both the VLMR and BLR tests were statistically significant, $p < .05$ and $p < .001$, respectively, suggesting that the four cluster structure was superior to the three cluster structure.

Finally, a five cluster structure was investigated. For these analyses, the best loglikelihood value was not replicated. The VLMR test was not statistically significant, $p = .17$, and the BLR test was therefore not performed. Given these results, the five cluster structure was rejected and four cluster structure retained.

As noted, individual patients were classified based on the highest conditional probability with regard to cluster membership. All three of the cluster groups indicated by Vowles et al (2008) were apparent in the present data set, including a group with high scores on both the AE and PW subscales, a group with low scores on both subscales, and a 'mixed' group with a high AE and low PW scores. In contrast to previous analyses, another cluster group emerged that had scores on both subscales in a middle range. This was cluster was labeled 'medium'.

CPAQ-20 scores were compared across the four groups via MANOVA, yielding a significant omnibus effect, Wilks' $\lambda = 0.13$, $F(6, 1804) = 540.4$, $p < .001$. Follow-up oneway comparisons indicated significant differences across the groups for both CPAQ-20 subscales, as well as for the total score, all F 's > 394.2 , all p 's $< .001$. Descriptive information for the clusters is displayed in **Table 3**. Pairwise comparisons indicated significant between group differences across all analyses, with the sole exception of AE scores for the high scoring and mixed groups. For all other comparisons, the low scoring group had the lowest CPAQ-20 scores, followed sequentially by the medium, mixed, and high scoring groups.

[Insert Table 3 about here]

Cluster comparisons on measures of functioning

The measures of patient functioning, included self-reported levels of depression and anxiety (via the HADS), pain-related fear (via the TSK), as well as impact and responses to pain, activity and social support and participation level (via the MPI). A significant effect of group membership was indicated for the overall omnibus test, Wilks' $\lambda = 0.56$, $F(48, 1841) = 8.37$, $p < .001$ and followed by significant results for all follow-up oneway ANOVA's, all F 's > 4.01 , all $p < .008$. The results of the pairwise comparisons were comparable to those obtained for the CPAQ-20 for the low, medium, and high scoring groups, which differed significantly from one another, with the low scoring group reporting the highest levels of distress and disrupted functioning and the high scoring group reporting the lowest. The pattern of findings for the mixed group was more complicated, with a lack of significant differences indicated in comparison to the medium scoring group on measures of anxiety, pain-related fear, and pain intensity severity, social support or responses, as well as in comparison to the high scoring group on measures of depression and general activity. These findings suggest that the mixed group reported better functioning compared to the low and medium scoring groups, and somewhat worse in comparison to the high scoring group. Significant differences across all groups were indicated for pain interference. Means and SD's are displayed in **Table 4a**.

[Insert Table 4a about here]

Comparisons using more stringent conditional probabilities

All between group comparisons were repeated including only those individuals who showed stronger conditional probabilities. As four groups were

indicated, required conditional probabilities of > 25%, > 50%, and > 75% were examined sequentially.

With regard to the > 25% requirement, all 907 participants had a probability exceeding that threshold. Therefore, further analyses were not done with regard to between group differences.

With respect to the > 50% requirement, a total of 54 individuals (6%) were excluded. The pattern of between cluster differences was identical to those which included the full sample across all analyses.

In the case of the most stringent > 75% requirement, a total of 372 individuals (41%) were excluded. When cluster differences were examined in the remaining 535 individuals, the pattern was identical to that obtained using the full sample for the CPAQ and its subscales, as well as for all measures of functioning, with the exception of pain impact scales. For pain intensity, a lack of significant difference between the high and mixed scoring groups was indicated, in addition to the lack of difference between the medium and mixed scoring groups which was indicated within the full sample. For pain interference, a marginally non-significant ($p = .057$) difference was indicated between the high and mixed scoring groups. The difference in findings is detailed in the notes at the bottom of **Table 4a**.

CPAQ-8

Latent Class Cluster Analysis.

The results of the cluster analysis for the CPAQ-8 were highly consistent with those performed for the CPAQ-20. Overall, a four-cluster structure was indicated as the most appropriate.

For analyses evaluating the three-cluster structure, the best loglikelihood value was replicated across analyses with both 20 and 100 random starts (value obtained =

-557 to -5567). The three cluster structure appeared superior to a two cluster structure, with both the VLMR and BLR tests indicating statistical significance, $p < .001$ for both tests.

For the four-cluster structure, the best loglikelihood value was replicated across analyses with both 20 and 100 random starts (values obtained ranged from -5557 to -5560). The VLMR and BLR tests were both statistically significant, $p < .05$ and $p < .001$, respectively, suggesting that the four cluster structure was superior to the three cluster structure.

A five cluster structure was problematic. The best loglikelihood value was not replicated and the VLMR test was not statistically significant, $p = .58$. Therefore, the four cluster structure was retained.

As was the case with the CPAQ-20, the four groups consisted of high, medium, and low scoring groups, as well as a mixed group with high AE and low PW scores. The comparison of CPAQ-8 scores across the clusters indicated a significant omnibus effect, Wilks' $\lambda = 0.10$, $F(6, 1804) = 636.2$, $p < .001$ and all follow-up oneway comparisons indicated significant differences for both subscales and the total score, all F 's > 645.9 , all p 's $< .001$. Pairwise comparisons indicated significant group differences across all analyses with the sole exception of AE scores for the high scoring and mixed groups. Descriptive information is detailed in **Table 3**.

Cluster comparisons on measures of functioning

In brief, the pattern of between cluster differences for the CPAQ-8 was almost identical to the pattern for the CPAQ-20. The only difference was with regard to pain intensity, for which nonsignificant differences were indicated between both the medium and mixed group (as was the case with the CPAQ-20) and the high and mixed group (which was not the case with the CPAQ-20). The results of all pairwise

comparisons are detailed in the following paragraphs. Means and *SD*'s are displayed in **Table 4b**.

A significant omnibus effect of cluster membership was indicated, Wilks' $\lambda = 0.50$, $F(48, 1841) = 10.0$, $p < .001$, and all one way ANOVA comparisons were significant, all F 's > 3.4 , all p 's $< .017$. Pairwise comparisons indicated significant differences for all comparisons for the low, medium, and high scoring groups. As was the case with the CPAQ-20 comparisons, the pattern of findings for the mixed group was more irregular, with a lack of significant differences indicated in comparison to the medium scoring group on measures of anxiety, movement-related fear, and pain severity, as well as in comparison to the high scoring group on measures of depression and general activity. As noted above, the sole difference in group comparisons was with regard to the comparison of pain severity for the high and mixed scoring groups, which was nonsignificant for the CPAQ-8 comparisons, although the p value of .07 approached significance.

[Insert Table 4b about here]

Comparisons using more stringent conditional probabilities.

When the requirement for conditional probabilities of $> 25\%$, $> 50\%$, and $> 75\%$ were examined sequentially, the pattern of findings was highly concordant with both the CPAQ-8 analyses that did not require a threshold probability as well as the CPAQ-20 analyses that used the more stringent probabilities.

With regard to the $> 25\%$ requirement, all 907 participants had conditional probabilities exceeding that threshold. Therefore, further analyses were not performed.

With regard to the > 50% requirement, a total of 64 individuals (7%) were excluded. The pattern of between cluster differences were identical to those which included the full sample across all analyses.

With regard to the most stringent > 75% requirement, a total of 337 (37%) were excluded. In the analyses including the remaining 570 individuals, the pattern of between cluster differences in CPAQ scores was identical to the pattern using the full sample, as well as for all measures of functioning, with the sole exception of pain interference. For this latter measure, the difference between the high and mixed scoring groups failed to reach significance. The difference in findings is detailed in the notes at **Table 4b**.

Concordance in cluster assignment for the CPAQ-20 and CPAQ-8

Finally, we calculated the proportion of patients assigned to the same cluster when data scores from the CPAQ-20 and CPAQ-8 were used to independently assign cluster membership. These data are displayed in **Table 5**. Overall concordance in cluster assignment was 80.1% for the unrestricted and > 25% probabilities (as these both included all 907 participants), 86.1% for the > 50% probabilities, and 97.5% for the > 75% probability.

Discussion

A revision and comparison of the cluster structure of the CPAQ-20 and CPAQ-8 was performed with the intention to develop a cluster membership model that would be robust across the different versions of the CPAQ, using the more robust method of clustering. Latent class analysis demonstrated that a four cluster structure was superior to the three cluster structure, in contrast to the findings of Vowles et al. [59]. Ideally, the derivation of such a cluster structure would allow allocation of patients to groups that distinctly differentiate their measures of functioning and therefore their potential treatment needs.

Our findings show that [similarly to 59] the cluster with high acceptance in both Pain Willingness (PW) and Activity Engagement (AE) had lower depression, anxiety, and fear of movement than the other clusters. Furthermore, the high acceptance group reported less pain intensity, less interference from pain and higher levels of general activity. As expected, the cluster with low levels of PW and AE, showed the opposite levels of functioning and reported high pain interference in life. Our findings also identified a mixed cluster, similar to that identified by Vowles et al. [59]. The mixed group showed high Activity Engagement but low Pain Willingness, and could be characterized as low in depression, high in anxiety, and higher pain-related fear. The mixed group also report moderate levels of pain and rate the pain as more interfering in their lives than the high acceptance group, even though they also score the highest level of general activity. This could reflect a ‘keep busy to distract from pain’ kind of behavior where they display a pronounced pain anxiety-related distraction in an attention demanding paradigm as a behavioral correlate of hypervigilance towards pain [54]. This group could also be similar to the pattern identified by the avoidance-endurance model of pain (AEM), described as presenting

a pattern of behaviors and thought suppression, anxious mood and task/activity persistence behavior (distress endurance responses) [15]. It is not clear whether these persistent activities are based on committed actions, and that could form the basis of a future investigation. [26]. Committed actions are behavioral patterns linked to values and important goals, in contrast to activities that are intended to suppress anxiety. On the contrary, committed actions are flexibly persistent, in that they can incorporate failure and discomfort while remaining on track towards important personal values and goals. To incorporate such a dimension in the clusters would be of potential value to better understand what influences patient's activity choices [26; 28].

Contrary to Vowles et al (2008), a fourth cluster emerged in this analysis that had a medium level of acceptance. Both the medium and low cluster showed a related profile of poorer functioning, as would be predicted by the ACT model. An interesting suggestion from this finding of a medium cluster is that the benefits of higher acceptance may not be dimensional, but may occur above a certain threshold of activity engagement and pain willingness.

Remarkably, while the middle and mixed groups had no significant difference in their pain severity, fear of movement or level of social support, the mixed cluster reported significantly less pain interference and reported being able to participate to a greater extent in social activities, household chores, outdoor and general activities than the medium cluster, even though this cluster has higher pain willingness (see Table 3a and 3b). Moreover, the mixed group were able to engage in activities to the same extent as the group with high pain acceptance. Although equally as active as the high acceptance group, the mixed group experienced higher anxiety and fear of movement, indicating a potential need of more focus in those areas in their rehabilitation program.

The CPAQ's clusters differentiate levels of function and pain impact, providing further support to the inclusion of acceptance as a functionally useful concept and potential treatment target in pain rehabilitation. The two functional subscales of clustering: Pain Willingness and Activity Engagement describe specific behavioral treatment targets. To relate to pain with an active choice to be open, letting go of unproductive attempts to control or avoid pain is one of the core processes and active components of the psychological flexibility model [32; 35].

There is now significant evidence, across a wide range of disorders that lack of acceptance is associated with a broad range of symptoms and negative outcomes [e.g. 21; 49; 51]. Clustering patients according to acceptance further supports the transdiagnostic value of ACT [22] and its therapeutic processes that focus on functioning rather than targeting symptoms, signs or diagnoses. Developing transdiagnostic models of behavioral change, with closely associated strategies, allows the creation of broadly applicable interventions to treat heterogeneous clinical populations with less focus on their pathologies or co-morbidities and more on their functional/dysfunctional behaviors [19].

Such a transdiagnostic model may also facilitate a pragmatic and predictive assessment approach to patients with chronic pain. Each cluster reflects different levels and expressions of psychological flexibility or inflexibility. Psychological inflexibility has been shown across diverse populations to be linked to various dysfunctional or risk behaviors [20], level of functioning [34] and dysfunction also in adolescents of psychological inflexible parents [61]. It is also possible that developing more tailored rehabilitation programs for these groups of patients, that target their different behavioral styles and psychological flexibility levels, could lead to improvements in treatment. Future research that tests whether these clusters of

patients do respond differently to interventions is needed to further test the predictions that follow from these findings.

Furthermore, to subgroup patients according to pain acceptance supports clearer links between theory, model and the specific intervention. This in turn generates an integrity in the process of subgrouping and predicting outcome for a specific treatment and the outcomes expected [44].

Limitations of the current analyses include the following. First, the measures included in the present study were all limited to self-report and method variance, as well as errors in completion, could have influenced study results. Furthermore, the pattern of findings, while fairly concordant with data collected from an English speaking sample residing in the United Kingdom, may not necessarily be representative of non-Swedish speaking individuals or samples of individuals with chronic pain who differ significantly from the sample analyzed here. More fundamentally, all studies that use self-report measures make the assumption that self-reports do at least in part measure the construct that they are intended to measure. The measures used in this study are valid and reliable by the kinds of standards expected of a self-report questionnaire. Nonetheless, future research that explores the relations between clustering (derived from self report measures such as the CPAQ) and more concrete outcomes such as committed action-based activities, objective physical capacity, return to work, etc. are needed to fully establish the utility of clustering methods.

Second, while there was good concordance overall in the cluster structures between the short and long forms of the CPAQ, there was a degree of disagreement (up to 20% in the group with the least restrictive conditional properties) and it is unclear which classification method is the most appropriate at the present time.

Furthermore, in participants with a low conditional probability (e.g., < 50%), it may be that classification is not appropriate. To our knowledge, there is no empirical guidance with regard to addressing these issues within LCA. Finally, these data were all cross-sectional, which means that relations are likely bi-directional in nature and causality cannot be determined. For example, it is not clear whether low levels of pain acceptance contribute to high distress and disability or vice versa. Longitudinal designs are required to address such issues.

At a principle level, it is not yet clear whether forming categories of patients, based upon their self report of behavioral parameters such as acceptance will lead to strong clinical or research applications. This study is exploratory and assumes for the time being that clustering *could be* a useful tool clinically and is worthy of further exploration. What this study adds is comparing the long and short CPAQ's capacity to generate similar cluster structure with a novel and more robust method of clustering (LCA), differentiating between cluster members on a wide range of other important parameters. In addition, LCA investigates model fit in successive steps and in this sample the best fit was arrived at with four clusters. This means that there is something meaningful about patterns of responding to the CPAQ that is not available if we simply treat the acceptance subscales as continuous variables. Ultimately further research is needed to determine which clustering method is more adapted to generate clinically useful algorithms for grouping patients. In addition, the clinical and research utility of clustering will be determined by future research that investigates other characteristics of the patients in each cluster, such as response to treatment [see for example 47].

In conclusion, the four clusters emerging from the CPAQ appear to be potential indicators for identifying different rehabilitation needs and the same four

clusters could also be identified by the short version of the CPAQ, the CPAQ-8. The current study represents a further step towards a principle-focused clinical model of assessment for pain rehabilitation. This is consistent with the development of a functional contextual behavioral science [see 17] in which “developing interventions are based on theoretical models, tightly linked to basic principles that are themselves constantly upgraded and evaluated” [18, p.181].

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