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ORIGINAL ARTICLE

Predictors of outcomes following interdisciplinary acceptance and commitment therapy for chronic pain: Profiling psychological flexibility

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Abstract

Background: Growing evidence demonstrates the benefit of acceptance and commitment therapy (ACT) for people with chronic pain. However, there remain people with chronic pain who do not benefit from ACT, and predicting treatment response is difficult.

Aims: This aim of this study was to investigate if baseline psychological flexibility (PF) profiles predict responses to an ACT-based pain management programme.

Methods: Data from 415 participants attending an interdisciplinary pain management programme were included. Participants completed measures of PF processes and outcomes pre- and post-treatment. Latent profile analysis was used to identify subgroups of participants based on their baseline PF scores. ANOVAs were conducted to compare subgroups of participants on outcome variables at baseline, and changes from pre- to post-treatment.

Results: Three subgroups of participants were identified: (a) low PF, (b) low openness and (c) high awareness and action. The three subgroups significantly differed on all outcome measures at pre-treatment, supporting the clinical relevance of these PF profiles. However, participants with different baseline PF profiles did not appear to differ in terms of changes in outcome variables.

Conclusions: People with chronic pain demonstrate different PF profiles, but appear to respond to ACT similarly regardless of these profiles. Future studies with a more individualized focus are needed to further understand which components of ACT work for whom on which outcome and how.

Significance: There remain people with chronic pain who do not benefit from acceptance and commitment therapy (ACT), and predicting treatment response is difficult. This is the first study to identify psychological flexibility (PF) profiles along multiple PF processes using latent class analysis, and the first longitudinal study to investigate PF profiles in relation to outcomes in ACT for chronic pain. The findings contribute to the understanding of theoretically consistent predictors of outcomes in ACT, which in turn can inform treatment development.

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1 | INTRODUCTION

Acceptance and commitment therapy (ACT) has been applied to chronic pain, and growing evidence demonstrates its benefit (Hughes et al., 2017; McCracken et al., 2022; Trindade et al., 2021). ACT is a specific form of cognitive behavioural therapy (CBT) based on the psychological flexibility (PF) model. PF is the ability to openly experience unwanted thoughts, feelings and sensations, to consciously and flexibly focus awareness, and to change or persist in behaviours in the service of goals guided by one's values (Hayes et al., 2011). PF includes six interrelated, therapeutic processes: acceptance, cognitive defusion, present-moment-awareness, self-as-context, values and committed action. These are often summarized as behaviour that is "open, aware, and active" (Hayes et al., 2011). Each PF process has an opposing process in psychological *inflexibility*, reflecting unsuccessful efforts to control experiences at the expense of personal values (Bond et al., 2011).

A systematic review of ACT for chronic pain (Hughes et al., 2017), including 11 randomized controlled trials (RCTs) demonstrated small to medium effect sizes for functioning, anxiety and depression, and medium to large effects for psychological flexibility variables at post-treatment and follow-up. A systematic review of online ACT for pain (Trindade et al., 2021) produced similarly supportive results based on five RCTs. However, there remain people with pain who do not benefit from ACT, as for other forms of CBT, and evidence regarding predictors of treatment outcomes remains sparse and inconclusive (Gilpin et al., 2017; Turk, 2005).

There is a need to better understand which components of ACT work for whom, under what circumstances and how (Hofmann & Hayes, 2019). Gilpin et al. (2017) reviewed studies examining predictors of outcomes in contextual cognitive and behavioural therapies including ACT for chronic pain and identified a lack of consistent high-quality evidence for treatment predictors. Furthermore, no studies applied the PF model to investigate predictors. Gilpin et al. (2019) examined PF processes, including pain acceptance, cognitive defusion and committed action, as predictors of ACT-based pain management programme outcomes. They found that higher pain acceptance was associated with larger improvement in mood, and higher cognitive defusion with larger improvement in physical functioning and pain. However, the unique effects of these factors were small, and the association was inconsistent across outcomes. In another study of online ACT for pain, experiential avoidance (the opposite of acceptance) moderated improvements in pain interference (Probst et al., 2019).

Examining PF processes separately may not sufficiently address the individual variance and complexity of behaviour patterns. For instance, two previous studies (Rovner et al., 2015; Vowles et al., 2008) identified three subgroups on the chronic pain acceptance questionnaire (CPAQ), including one with high scores on activity engagement but low scores on pain willingness. Thus, the identification of multidimensional PF profiles could produce a more nuanced understanding of factors associated with treatment outcomes. However, research to date has not explored clustering of PF processes beyond the CPAQ subscales.

This study investigated whether baseline PF profiles predict responses to an ACT-based pain management programme. This included three primary objectives:

1. To identify potential PF profiles along three dimensions, including pain acceptance, self-as-context, and committed action.
2. To compare participants with different baseline PF profiles on baseline outcome variables, including pain intensity, pain-related interference, work and social functioning, and depression, to determine if the profiles are clinically relevant.
3. To examine if participants with different baseline PF profiles have different treatment outcomes.

Secondarily, this study descriptively examined patterns of change in outcomes in each PF profile and the average pattern in the overall sample, to provide additional information on the utility of a more individualized approach to treatment response (objective 4).

2 | METHODS

2.1 | Participants

The initial potential sample consisted of 526 participants consecutively attending an ACT-based interdisciplinary pain management programme at the INPUT Pain Unit at St Thomas' Hospital in London, UK between January 2018 and August 2019. All treatment participants were asked to complete pre- and post-treatment questionnaires, and they provided consent for their data to be used for research purposes. A manuscript describing portions of the current dataset has been published (Yu et al., 2021). The aims of the current analyses are distinct from that publication, which focused on the psychometric validation of a measure of self-as-context (described below under measures).

Among the treatment participants, 46 did not provide consent for their data to be used for research and were

excluded from analysis. Thirty-eight participants did not provide post-treatment data, and 26 participants were missing data on one or more PF processes. All of these were excluded from the analyses, leaving a total sample of 416 participants. One participant was further excluded as the result of outlier identification (outlier for the SEQ, reported in preliminary analyses) leading to a total sample of 415 participants. Table 1 shows the characteristics of the participants. Briefly, the sample consisted mostly of women (80.3%) and white participants (75.6%) with a mean age of 47.56 years (SD = 13.23). Back pain was the most common pain location and participants had a median pain duration of 10 years (range: 1–78 years).

TABLE 1 Characteristics of participants

	Mean (SD) or *N* (%)
Gender	
Women	331(80.3%)
Men	81 (19.7%)
Age (years)	47.56 (13.23)
Ethnicity	
White	306 (75.6%)
Black	49 (12.1%)
Asian	26 (6.4%)
Mixed/Other	24 (5.9%)
Years of education	13.61 (3.52)
Work status	
Unemployed due to pain	213 (51.3%)
Employed part-time due to pain	54 (13.5%)
Retired	50 (12.5%)
Employed full time	41 (10.2%)
Homemaker	10 (2.5%)
Unemployed due to other reasons	9 (2.2%)
Unpaid volunteer	6 (1.5%)
Employed part-time due to other reasons	5 (1.2%)
Student full time	5 (1%)
Student/trainee part-time due to pain	2 (0.5%)
Carer	2 (0.5%)
Pain duration (year)	Median = 10 (range: 1–78)
Primary pain location	
Lower back/spine	162 (42.3%)
Widespread	72 (17.3%)
Lower limbs	42 (10.1%)
Neck region	30 (7.2%)
Upper shoulder/limbs	21 (5.5%)
Head, face or mouth	17 (4.4%)
Abdominal region	16 (4.2%)
Pelvic region	10 (2.6%)
Chest region	4 (1%)

All participants were initially assessed by a psychologist and physiotherapist to determine their eligibility for the ACT-based treatment. Eligibility criteria included pain of a least 3 months' duration that was significantly impacting on the person's daily functioning, mood, and/or overall quality of life. Participants were adults (18 years or older) who were willing to participate in a treatment that was focused on improving functioning and quality of life in the presence of pain, rather than on controlling pain. The ability to participate in a group-based treatment in English was also required, and participants were required to be capable of independent self-care. Exclusion criteria included ongoing medical investigations or interventions that were judged by the assessing clinicians as likely to interfere with treatment engagement. Additionally, potential participants with some types of mental health problems (e.g. severe depression, active suicidality and untreated PTSD), interpersonal difficulties and cognitive impairment were excluded if these conditions were expected to interfere with safe and successfully engagement in group-based treatment.

2.2 | Design

This study used a prospective observational cohort design. All treatment participants were asked to complete a standardized set of self-report questionnaires at the start and end of treatment. On average, it takes about half an hour to complete all questionnaires. Treatment delivery and data collection occurred in the context of routine clinical care. The research database obtained ethical approval from the Health Research Authority South Central—Oxford C Research Ethics Committee (17/SC/0537) and was conducted in accordance with the Declaration of the World Medical Association.

The group treatment was based on principles of ACT for chronic pain (McCracken & Vowles, 2014) and was delivered by a team of psychologists, physiotherapists, occupational therapists and nurses. There was often more than one treatment group running at a time, given the high demand for the service. Therefore, treatment was not delivered by the same clinicians for all patients. However, clinicians from each of the abovelisted disciplines were part of the treatment team for each group. Pain physicians were not involved in the delivery of this treatment. Treatment aimed to increase functioning and quality of life by enhancing psychological flexibility. The treatment did not focus on pain reduction. Instead, it helped participants to explore the workability of pain control efforts

and to develop openness, present-moment awareness and engagement in meaningful life activities in the presence of pain and related challenges such as low mood, pain-related anxiety and fatigue. Education about persistent pain was a component of the programme, but not the primary focus. Metaphors, experiential exercises, exposure, cognitive defusion strategies, mindfulness practice, values clarification and values-based goal setting and activity engagement were used to foster overall psychological flexibility. Physical activity and movement sessions were embedded throughout the programme and linked with the psychological flexibility processes.

The treatment was delivered for 12 days over 3 weeks, with approximately 6 h of treatment per day. There were generally 1–2 treatment sessions per day delivered by each discipline (i.e. psychology, physiotherapy, etc.), although there was flexibility in this depending on clinical need, and there was a focus on enhancing psychological flexibility across the disciplines. The treatment was delivered in a closed group with a median of 10 participants (range: 7–13). There were opportunities for clinicians to work individually with patients, but this was a small proportion of the overall treatment time, and most of treatment was delivered in the group. Treatment participants stayed on site during the week and went home over the weekends. In addition to applying and practicing new skills during treatment sessions, participants were encouraged do this in the evenings and while at home.

2.3 | Self-report measures

2.3.1 | Measures of psychological flexibility

Chronic pain acceptance questionnaire-8 (CPAQ-8)

The CPAQ is a 20-item measure of pain acceptance consisted of two components, activity engagement and pain willingness (McCracken et al., 2004). Examples of the items from this measure include "I am getting on with the business of living no matter what my level of pain is"; "I lead a full life even though I have chronic pain." Each item is rated on a 0–6 scale from "never true" to "always true". Higher total scores indicate greater acceptance of pain. An 8-item version of the measure with the same factor structure was further validated (Fish et al., 2010), and used in this study to assess the "open" dimension of PF. The reliability of the CPAQ-8 in the current study was acceptable, $\alpha = 0.76$.

Self-experiences questionnaire-8 (SEQ-8)

The self-experiences questionnaire is a 15-item self-report measure of self-as-context within the PF model (Yu et al., 2016). Self-as-context refers to a sense of self that is above or that "contains" one's psychological experiences such as thoughts, feelings and sensations. It involves a sense of taking a perspective on one's thoughts, feelings, and sensations, rather than over-identifying with these. Examples of the items from this measure include "Although I can get caught up in my thoughts, emotions and sensations, I can also separate from them"; "I can experience a distinction between my experiences and the 'I' who notices these experiences." Each item is rated on a 0–6 scale, with 0 indicating "never true", and 6 "always true". Higher total scores reflect higher level of self-as-context. The SEQ-15 was validated in a mixed chronic pain sample (Yu et al., 2016) and a fibromyalgia sample (Yu, Norton, Almarzooqi, & McCracken, 2017). An 8-item form was further validated in a mixed chronic pain sample (Yu et al., 2021), and was used in this study to assess the "aware" dimension of PF. The reliability of the SEQ-8 in the current study was excellent, $\alpha = 0.90$.

Committed action questionnaire-8 (CAQ-8)

The 8-item CAQ was used to measure committed action (McCracken et al., 2015), reflecting the "active" dimension of PF. Committed action entails flexible and persistent engagement in personally meaningful actions directed by one's goals and values (McCracken, 2013). Examples of the items from this measure include "I can remain committed to my goals even when there are times that I fail to reach them"; "I prefer to change how I approach a goal rather than quit." Each item is rated on a 0–6 scale, with 0 indicating "never true" and 6 "always true". Higher total scores indicate greater levels of committed action. The CAQ has been validated in mixed chronic pain samples (McCracken, 2013; McCracken et al., 2015). The reliability of the CAQ-8 in the current study was acceptable, $\alpha = 0.79$.

2.4 | Measures of treatment outcomes

2.4.1 | Pain intensity

Participants made numeric ratings of average pain over the last week from 0 to 10, with 0 indicating "no pain" and 10 "pain as bad as you can imagine".

2.4.2 | Brief pain inventory (BPI)

The BPI is a self-report seven-item measure of the impact of pain on daily functioning (Cleeland & Ryan, 1994). Pain-related interference is rated for seven domains of functioning, including general activity, mood, walking ability, normal work, relations with other people, sleep,

and enjoyment of life, with one item for each domain. Each item is rated on a 0–10 scale, from "does not interfere" to "completely interferes". Average scores across the seven items indicate higher level of pain-related interference with daily functioning. The BPI is regarded as a core outcome measure for chronic pain research (Dworkin et al., 2005). The reliability of the BPI in the current study was good, $\alpha = 0.86$.

2.4.3 | Work and social adjustment scale (WSAS)

The WSAS is a five-item self-report measure of impairment in work, home management, social leisure, private leisure, and personal or family relationships. Each item is rated on a 0–8 scale from "no impairment" to "very severe impairment". Higher total scores indicate more severe impairment in functioning. The WSAS is a reliable and well-validated measure for the impact of long-term health conditions on functioning (Cella et al., 2011; Mundt et al., 2002). The reliability of the WSAS in the current study was good, $\alpha = 0.83$.

2.4.4 | Patient health questionnaire-9 (PHQ-9)

The PHQ-9 is a 10-item self-report measure of depressive symptoms. The first nine items represent symptoms and are rated on a 0–3 scale from "not at all" to "nearly every day". The total score of these nine items reflects the severity of depression, with higher scores reflecting higher severity of depression. The final item assessing the extent to which depressive symptoms have affected levels of functioning, and is rated on a scale of difficulty from "not difficult at all" to "extremely difficult". The total scores from the first nine items were used in this study. The PHQ-9 is regarded as a reliable and valid measure of depression severity, and a total score of greater than nine has good diagnostic accuracy as an indicator of depression (Kroenke et al., 2001). The reliability of the PHQ-9 in the current study was good, $\alpha = 0.83$.

2.5 | Statistical analysis

2.5.1 | Preliminary analyses

The skewness and kurtosis for each variable was examined for normality. The scores of all measures were considered normally distributed. The standardized value of each variable was examined for outliers. A score was considered an outlier if it has a z score higher than |3.3| ($p < 0.001$). One outlier was identified for the baseline SEQ scores (this participant was treated as missing data for SEQ and excluded from the sample), three baseline BPI scores, and four baseline WSAS scores. Two outliers were identified for post-treatment WSAS scores. These outliers were excluded from analysis. Three participants were missing data for pain intensity at baseline. At post-treatment, 24 participants were missing data for pain intensity, 26 for the BPI, 23 for the WSAS, and 24 for the PHQ-9, and missing data were deleted list-wise.

2.5.2 | Statistical analyses for objective 1

Following the preliminary data treatment, latent profile analyses (LPA) were conducted using STATA 15.1 to identify sub-groups of participants with different baseline PF profiles. Latent class analysis (LCA) is a statistical technique used to identify different subgroups within populations that share certain outward characteristics (Hagenaars & McCutcheon, 2002). LCA uses participants' responses to categorical indicator variables to detect the latent groups, and when indicators are continuous, LPA is used (Weller et al., 2020). LPA determines the number of clusters and cluster membership based on probability and statistical estimates of model fit. LPA allows the comparison of different cluster structures to help determine the most appropriate cluster structure. LPA also allows for the identification of unobserved subgroups with different behavioural patterns or characteristics based on multiple continuous variables. Specifically in this study, LPA enabled the identification of subgroups of participants with different PF profiles characterized by multiple PF processes.

A series of latent profile models were fitted to examine potential clusters of participants based on their baseline scores of PF processes, including pain acceptance, self-as-context and committed action. These models were then compared on Akaike's information criterion (AIC) (Akaike, 1974) and Schwarz's Bayesian information criterion (BIC) (Schwarz, 1978). AIC and BIC are information criteria that can be used to compare relative fit of models with different numbers of latent classes, and a lower value suggests a more optimal balance between model fit and parsimony. A series of latent profile models with incremental clusters were fitted until a model with the smallest AIC and BIC were identified. For instance, a one-class model, and a two-class model were first fitted. These two models were then compared on the AIC values and BIC values. If the two-class model produced smaller AIC and BIC, indicating that adding one class/cluster improved the model fit, a three-class model was then fitted, and compared with the two-cluster

model. If the two-class model produced larger AIC and BIC than the one-cluster model, indicating that adding one class/cluster worsened the model fit, no additional models were fitted, and the one-class model was determined to be the best model for the data, and so forth. For models with more than one class, starting values were set to be computed using random class assignments, with five random draws taken and the one with the best log likelihood after the expectation maximization (EM) iterations was selected. Twenty EM iterations were used for each random draw. The seed was set for reproducible results (i.e. the seed was set so that the same results will be produced each time the latent class algorithm was run for a given number of classes, unless the input data was changed). Once the best model was identified, participants with different PF profiles were first compared on all demographic variables using ANOVAs for continuous variables and chi square for categorical variables.

2.5.3 | Statistical analyses for objective 2

ANOVAs were then used to compare participants with different PF profiles (in different clusters) on the baseline scores of outcome variables, including pain, pain interference, work and social functioning, and depression, to examine if these PF profiles were clinically relevant.

2.5.4 | Statistical analyses for objective 3

Next, ANOVAs were used to compare participants with different PF profiles (in different clusters) on the changes of the outcome variables after the treatment to examine if participants with different PF profiles responded differently to treatment. Standardized residualized change scores were calculated for each outcome variable to reflect changes in treatment outcomes from pre- to post-treatment. For each variable, baseline scores were used to predict post-treatment scores, and residualized change scores were calculated as the differences between predicted and observed scores. In addition, clinically meaningful changes were also examined for all outcome measures. Participants whose raw change scores were greater than one-half of a standard deviation (SD) from their baseline score for each outcome variable were coded as 'clinically meaningfully improved.' Those whose scores did not improve by half a SD were coded as 'not clinically meaningfully improved,' whereas those who worsened by greater than half of an SD were coded as 'clinically meaningfully worse.' Half of an SD has been recommended as the threshold for meaningful change for health-related self-report measures for chronic diseases (Norman et al., 2003). Participants with different PF profiles were compared on clinically meaningful changes for all outcomes using chi square.

TABLE 2 Information criteria AIC and BIC for each model of baseline PF profiles

Model	Observation	df	AIC	BIC
1-class	415	6	8891.942	8916.112
2-class	415	10	8741.509	8781.792
3-class	**415**	**14**	**8700.119**	**8756.515**
4-class	415	18	8689.426	8761.935
5-class	415	22	8692.205	8780.827

Abbreviations: AIC, Akaike's information criterion; BIC, Schwarz's Bayesian information criterion. The model with the smallest values of AIC and BIC are considered the best.

Results for the final model are highlighted in bold.

2.5.5 | Statistical analyses for objective 4

Finally, changes in treatment outcomes were further examined to explore whether a more-individualized PF profile-based approach to treatment outcomes would provide additional information compared with an overall sample-based approach. *T*-tests were conducted to examine the changes in treatment outcomes in each profile, and across all participants. Within-subject effect sizes were calculated using the equation recommended for repeated measures to avoid inflation of effect sizes associated with non-independent design: $d = t \text{ paired} \sqrt{\frac{2(1-r12)}{n}}$ (Nakagawa & Cuthill, 2007). These effect sizes for each PF profile and the overall sample were calculated.

3 | RESULTS

3.1 | Baseline PF profiles: Results for objective 1

Latent profiles models including one, two, three, four, and five classes/clusters respectively were fitted. Table 2 shows the AIC and BIC for each model. The three-class model clearly produced smaller AIC and BIC compared with the one- and two-class models. Fitting the four-class model led to decreased AIC, but increased BIC. The five-class model produced similar AIC and larger BIC compared with the four-class model. Taken together, the three-class model appeared to be the most suitable model.

Figure 1 illustrates the means of all PF processes for each profile. About 12% of participants were in profile 1, where low levels of all PF processes were observed. This profile was labelled as "low PF". The majority of participants (63%) were

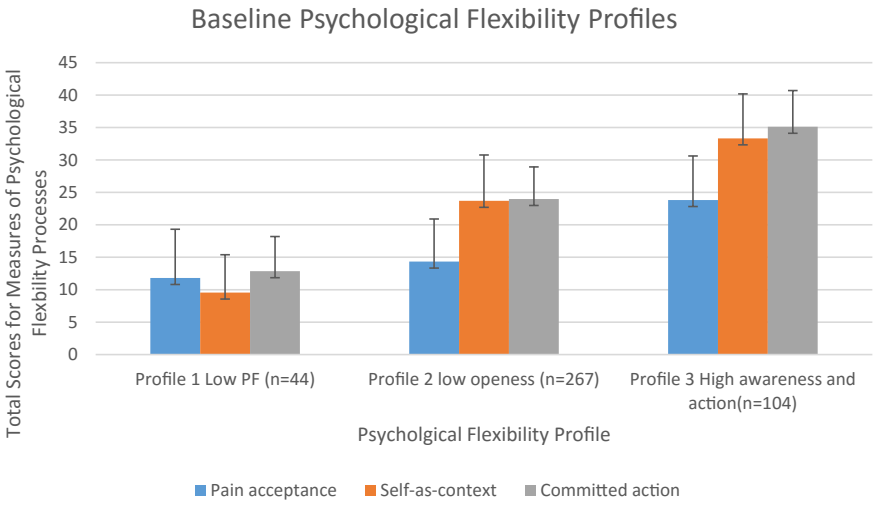

FIGURE 1 Baseline psychological flexibility profiles

TABLE 3 Descriptive statistics of all outcome measures for each profile at baseline

	Pain			Pain interference			Work and social functioning			Depression		
Outcomes	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***	**Mean**	**SD**	***N***
Profile 1	8.18	1.43	44	8.67	1.11	44	36.07	4.30	44	22.42	3.35	44
Profile 2	7.76	1.47	264	7.86	1.50	267	32.85	5.97	267	18.20	5.08	267
Profile 3	7.75	1.47	104	7.25	1.70	104	29.64	7.04	104	15.28	5.86	104

Note: Profile 1, low PF profile, low levels of all PF processes; Profile 2, low openness profile, low pain acceptance and medium self-as-context and committed action; Profile 3, high awareness and action profile, medium pain acceptance and high self-as-context and committed action.

in profile 2, where a similarly low level of pain acceptance, and a medium level of self-as-context and committed action were observed. This profile was labelled as "low openness". A quarter of participants were identified in profile 3, with a medium level of pain acceptance, and relatively high level of self-as-context and committed action. This profile was labelled as "high awareness and action". Participants in the three subgroups were compared on all demographic variables including age, gender, ethnicity, education, pain duration, primary pain location and work status. Participants with different profiles did not differ in any demographic variables, except for work status. 33.7% of the participants with the high awareness and action profile were unemployed due to pain, whereas among participants with low PF profile and low openness profile, 61.4% and 59.4% were unemployed due to pain, respectively.

3.2 | Comparison of participants in different profiles on baseline outcome variables: Results for objective 2

Table 3 shows the means of all outcome measures for each profile. On average, participants with the low PF profile had the highest scores for measures of outcomes, and those with high awareness and action profile the lowest. There was no significant difference between participants with these different profiles in pain intensity, $F(2, 409) = 1.66$, $p = 0.19$.

There was a significant difference between participants with these different profiles in pain interference, $F(2, 412) = 14.10$, $p < 0.001$. Post hoc analyses show that participants with low PF profile demonstrated higher pain interference, compared with those with low openness profile (95% CI [−1.40, −0.23]) and those with the high awareness and action profile (95% CI [−2.07, −0.78]). Participants with the low openness profile demonstrated higher pain interference, compared with those with the high awareness and action profile (95% CI [−1.03, −0.20]).

There was a significant difference between participants with these different profiles in work and social adjustment, $F(2, 412) = 19.32$, $p < 0.001$. Post hoc analyses show that participants with the low PF profile demonstrated higher impairment in work and social functioning, compared with those with the low openness profile (95% CI [−5.56, −0.89]) and high awareness and action profile (95% CI [−9.02, −3.85]). Participants with the low openness profile demonstrated higher impairment in work and social functioning, compared with those with the high awareness and action profile (95% CI [−4.87, −1.55]).

There was a significant difference between participants with these different profiles in depression, $F(2, 412) = 30.89$, $p < 0.001$. Post hoc analyses showed that

TABLE 4 Clinically meaningful changes in outcome variables in each profile and across all participants

Clinically meaningful change	Pain			Pain interference			Work and social adjustment			Depression		
	Improved	Not improved	Worse	Improved	Not improved	Worse	Improved	Not improved	Worse	Improved	Not improved	Worse
Profile 1	57.1	23.8	19	76.2	19	4.8	52.4	35.7	11.9	78.6	19	2.4
Profile 2	49.8	32.8	17.4	65.1	29.3	5.6	42.6	47	10.4	66.5	26.3	7.2
Profile 3	51.5	29.3	19.2	62.2	28.6	9.2	40.4	49.5	10.1	64.3	28.6	7.1
Overall	51	30.9	18	64.5	29.3	6.2	38	53.3	8.7	67.5	25.8	6.6

Note: Profile 1, low PF profile, low levels of all PF processes; Profile 2, low openness profile, low pain acceptance and medium self-as-context and committed action; Profile 3, high awareness and action profile, medium pain acceptance and high self-as-context and committed action. Data are presented as percentages.

participants with the low PF profile demonstrated higher level of depression, compared with those with low openness profile (95% CI [−6.18, −2.25]) and high awareness and action profile (95% CI [−9.31, −4.96]). Participants with low openness profile demonstrated higher levels of depression, compared with those with high awareness and action profile (95% CI [−4.32, −1.52]).

Since the AIC for the 4-class model was smaller than the AIC for the 3-class model, the 4-class model was also tested for potentially clinically relevant PF profiling. Although there was a main effect of profile on all four outcome variables at baseline, post hoc analysis showed participants with profile 1 and profile 2, and participants with profile 3 and profile 4 did not differ in any of the outcome variables. In addition, participants with different profiles generally did not differ in pain. Therefore, the 4-class profiling appeared less relevant clinically, compared with the 3-class profiling. Results of the 4-class model is reported in detail in Appendix S1.

3.3 | Comparison of participants in different profiles on changes in treatment outcome variables: Results for objective 3

There was a significant difference between participants with different PF profiles in the change of work and social functioning, $F\,(2, 389) = 4.16$, $p < 0.05$. Post-hoc analyses showed that participants with the low openness profile showed less improvement in work and social functioning compared with those with the high awareness and action profile (95% CI [−0.60, −0.04]). However, participants with the low PF profile did not different from those with the other two profiles.

There was not a significant difference between participants with different profiles in terms of change in pain intensity, $F\,(2, 385) = 0.01$, $p = 0.99$, change in pain interference a, $F\,(2, 386) = 0.26$, $p = 0.77$, or depression after treatment, $F\,(2, 388) = 1.76$, $p = 0.17$.

Table 4 shows clinically meaningful changes in outcome variables in each profile. Participants with different PF profiles did not significantly differ in any of these outcomes. Pain intensity: $X^2(4, N = 388) = 1.59$, $p = 0.81$; pain interference: $X^2(4, N = 389) = 3.22$, $p = 0.52$; Work and social adjustment: $X^2(4, N = 392) = 3.4$, $p = 0.49$; Depression: $X^2(4, N = 391) = 3.31$, $p = 0.51$.

3.4 | Changes in treatment outcome variables in each profile and across the sample: Results for objective 4

Table 5 shows results from *t*-tests for changes in outcome variables in each profile and across all participants.

TABLE 5 Results from *t*-tests for changes in outcome variables for each profile and across all participants

	Pain				Pain interference				Work and social adjustment				Depression			
	Mean change	SD	*t* (df)	*d*	Mean change	SD	*t* (df)	*d*	Mean change	SD	*t* (df)	*d*	Mean change	SD	*t* (df)	*d*
Profile1	0.90	1.72	3.40 (41)	0.56	2.10	1.98	6.90 (41)	1.12	5.28	8.21	4.17 (41)	0.77	7.21	5.62	8.31(41)	1.33
Profile2	0.74	1.48	7.83 (246)	0.46	1.63	1.87	13.74 (248)	0.91	2.75	6.28	6.94 (250)	0.42	4.85	5.50	13.96 (250)	0.85
Profile3	0.74	1.66	4.46 (98)	0.44	1.50	1.74	8.52 (97)	0.80	3.95	7.31	5.38 (98)	0.50	4.91	5.22	9.28 (97)	0.82
Overall	0.76	1.55	9.62 (387)	0.46	1.65	1.85	17.53 (388)	0.90	3.32	6.81	9.66 (391)	0.46	5.12	5.48	18.45 (390)	0.86

Note: Profile 1, low PF profile, low levels of all PF processes; Profile 2, low openness profile, low pain acceptance and medium self-as-context and committed action; Profile 3, high awareness and action profile, medium pain acceptance and high self-as-context and committed action. $p < 0.001$ for all outcomes for all profiles and the overall, except for pain intensity for profile 1 ($p = 0.001$).

Overall, participants with the low openness profile and high awareness and action profile generally demonstrated a similar pattern of clinically meaningful change across outcomes, compared with the overall sample. Across all outcomes, a larger percentage of participants with the low PF profile showed clinically meaningful improvements, compared with the overall sample.

4 | DISCUSSION

This study investigated whether baseline PF profiles predict response to an ACT-oriented pain management programme. Three PF profiles reflecting different levels of pain acceptance, self-as-context, and committed action at baseline were identified (objective 1). Participants in these profiles scored differently on measures of pain, pain interference and mood at baseline, indicating that the baseline PF profiles appeared to be clinically relevant (objective 2). Although participants with different profiles differed only in change in work and social functioning (objective 3), the response of participants in some PF profiles appeared to deviate from the average response of the overall sample (objective 4). To our knowledge, this is the first study to identify PF profiles along multiple PF processes using latent class analysis. This is also the first longitudinal study to investigate PF profiles in relation to outcomes following ACT for chronic pain.

On the positive side, three theoretically consistent PF profiles were identified, reflecting an overall lower, middle, and higher level of PF across all three PF processes. These profiles appeared clinically relevant and consistent, as people in profiles with higher levels of PF showed lower level of pain-related interference, better work and social functioning, and lower depression symptoms. Notably, participants with all three profiles showed low to medium levels of pain acceptance. This observation perhaps flags up the particular importance of a therapeutic focus on pain acceptance in ACT. Acceptance has also been repeatedly identified to show the strongest association with treatment outcomes, compared with other PF processes (McCracken & Gutiérrez-Martínez, 2011; Scott et al., 2016; Yu, Norton, Almarzooqi, & McCracken, 2017; Yu, Norton, & McCracken, 2017), and to mediate the effect of ACT on a range of outcomes (Cederberg et al., 2016; Lin et al., 2018) in chronic pain. Taken together, therapeutic effort to foster acceptance may be particularly beneficial for people with chronic pain.

The findings regarding the role of PF profiles in relation to treatment outcomes is consistent with previous studies. In one study, PF processes were examined separately as predictors of treatment outcomes in ACT for people with

chronic pain with small effects and inconsistent findings observed (Gilpin et al., 2019). Another study examined PF processes, including pain acceptance, cognitive fusion, value-based action, committed action, and general psychological inflexibility (measured using the Psychological Inflexibility in Pain Scale, consisting of items assessing experiential/pain avoidance and cognitive fusion), as predictors of outcomes in CBT for pain (Åkerblom et al., 2021). Only general psychological inflexibility was a marginally significant predictor of treatment outcomes including pain interference and depression at 12-month follow-up.

Taken together, these findings suggest that baseline PF, examined as separate processes and profiles, does not seem to consistently predict treatment outcomes to a practically significant degree in people with chronic pain in the type of treatment examined here. One possible explanation is that people with different baseline PF benefit from treatments differently in domains other than those assessed in the studies discussed here, such as physical functioning and quality of life. It is also possible that the measures used here are not the most suitable tools to assess PF profiles. Firstly, only three PF processes were examined. Secondly, PF measures necessarily overlap to a degree. More clearly delineated process measures may result in more accurate PF profiles, and their relations to treatment outcomes. Perhaps this prediction is more complex and individual. That is, any one facet of PF works in concert with other facets in highly unique ways across individuals, which means any one process will be confounded in group data. Single case experimental designs are needed to explore this assumption, and potentially produce more refined and individualized understanding of the role of PF in ACT.

PF processes have also been identified in RCTs as mediators of treatment effect on outcomes including pain, pain interference, and depression (Åkerblom et al., 2021; Kemani et al., 2016; Lin et al., 2018; Trompetter et al., 2015). However, this association may still be bi-directional, and change in these outcomes may impact on changes in PF. Nevertheless, here we adopted a theoretically-guided approach and only examined PF processes as predictors of outcomes. Indeed, there is a need for theoretically guided approach to treatment mechanisms, that takes predictors and mediators into account at the same time and allows investigation of these bi-directional relations (Day & Jensen, 2022; Gilpin et al., 2017).

Only 12% of the sample were in profile 1 (with low levels of all PF processes). People with overall low levels of PF processes may have not opted into treatment or not been assessed as suitable, and therefore are not reflected in the sample. It is possible that a greater number of people in this profile in treatment would have influenced outcome prediction. Indeed, the improvement pattern of participants in profile 1 did appear to deviate more from the average pattern of the overall sample, when compared with participants in profile 2 and 3. However, it is also possible that baseline PF processes are simply not associated and therefore not a source of variation in response to treatments in ACT for pain.

The findings regarding PF profiling/subgroups were not completely in line with two previous studies using only the CPAQ (Rovner et al., 2015; Vowles et al., 2008). In these studies several subgroups with concordant scores on the pain willingness and the activity engagement subscales, and one with high activity engagement but low pain willingness, were identified. We identified three subgroups with concordant scores in low, mid, and high ranges on pain acceptance, self-as-context, and committed action, but not any subgroup with discordant scores on different PF processes.

One explanation is that the subgroup with discordant scores on activity engagement and pain willingness in the Vowles et al. study (reflected a seemingly contradictory but functionally consistent profile. That is, people with high scores on activity engagement might be engaging with activities in an inflexible way as a form of avoidance. For instance, a person may get on with work regardless of their pain due to over-identifying themselves with the role of a "good employee". They may approach it with a "just do it" mentality, at the expense of "how" they want to do that work or other important goals, such as spending time with family. This may be a factor to a lesser extent in this study, as the CAQ-8 was used to assess committed action, and it explicitly assesses goal-directed actions. However, goal-directed actions can still be functionally avoidant in other respects. For instance, a person can pursue a goal (e.g. work) because doing so might distract them from pain.

It is also possible that the measures used here are not the most suitable tools to assess PF profiles. The CPAQ is a measure of acceptance that was specifically developed for people with pain, while the SEQ and CAQ are generic measures of PF processes. It is possible that the SEQ and CAQ were not sensitive enough to detect the nuanced difference in these PF processes among people with pain. Again, a more comprehensive assessment of baseline PF profiles with more clearly delineated processes may be useful here. A relatively recent, comprehensive measure of all six psychological flexibility and inflexibility processes, the multidimensional psychological flexibility inventory (Rolffs et al., 2018), may help advance this work.

Although the three subgroups of participants did not significantly differ in changes in most treatment outcomes, the low PF profile did show an improvement pattern that deviated from the average change pattern in the

overall sample. This means that there may be subgroup-level variation in treatment response to some extent that would not be identified when examined based on average performance across the overall sample. Again, this variation may be more complex and individual, and may require more intensive assessment.

There are limitations to acknowledge. First and foremost, this study used a single-group design. Therefore, we cannot draw any conclusions about the moderating role of PF. Future studies that include an experimental design are needed to examine PF processes/profiles as potential moderators of ACT. Secondly, the data were collected from one pain management centre and generalizability may be limited. More studies in different geographical locations, cultures and populations are needed to produce generalizable findings on the role of PF profile in ACT-based treatment. Next, participants were only assessed before and immediately after the treatment, which limited our ability to detect patterns or variance in response to treatment over time. Profiles created from a single assessment of PF based on retrospective recall may not adequately reflect the dynamic and contextual nature of these processes. Studies with more intensive assessments of PF processes (e.g. daily diary or ecological momentary assessment studies) and longer follow-up are required to produce a more nuanced understanding of how ACT works for people with different baseline PF profiles. Finally, the sample of this study included people with mixed chronic pain conditions. Future investigations of specific pain conditions may help further delineate how people with different PF profiles, and different pain conditions, respond to treatments.

5 | CONCLUSION

This study investigated baseline PF profiles as predictors of treatment outcomes in ACT for chronic pain. Three clinically relevant baseline PF profiles were identified. However, people with different baseline PF profile did not appear to respond significantly differently to the treatment. Nevertheless, this study contributes novel knowledge to the understanding of predictors of ACT outcomes. Future studies that include an experimental design, more comprehensive and intensive assessment of PF processes, and longer-term follow-ups, are needed to advance understanding of which component of the treatments work for whom on which outcome and how.

AUTHOR CONTRIBUTIONS

All authors substantially contributed to the conception and design of the study, and interpretation of data. All authors critically revised the drafts, and approved the final version of the manuscript to be submitted. In addition, Dr Lin Yu substantially contributed to data analysis and drafting the article. Dr Whitney Scott substantially contributed to data acquisition and drafting the article.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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