The Pain Ambulatory Monitoring Survey:

Development and validation of an instrument for momentary within-day assessments of pain and cognitive-behavioral factors

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ABSTRACT

Objectives & Methods

The Pain Ambulatory Monitoring Survey (PAMS), a questionnaire measuring outcomes and mechanisms relevant to cognitive-behavioural models of chronic pain, was developed and validated over two studies. PAMS was designed for use over repeated momentary assessments via electronic diaries (PDAs). The first study aimed to support the factor structure and internal validity of multi-item scales in a mixed chronic pain sample completing a once-off questionnaire-based version of the PAMS scales. The second study aimed to validate average scores from one week of PAMS diary monitoring against a battery of standard questionnaires, in a mixed chronic pain sample.

Results

The first study revealed clear factor structure for all multi-item PAMS scales and adequate to excellent internal consistency. In the final study, the PAMS scales demonstrated adequate to excellent convergence with standardised questionnaires.

Discussion

The current set of studies describes a monitoring instrument that assesses pain and certain key functional consequences and cognitive-behavioural mechanisms in a brief yet valid way, making it suitable for use in intensive diary-based studies. The current study sets the stage for further theoretical work exploring the within-person relationships between pain, functioning, and cognitive-behavioural factors.

Recent years have seen an increase in the use of daily diaries, both paper-and-pencil and computerised, for the assessment of pain on a momentary basis within and across days. In these studies based on Experience Sampling Methodologies[1] participants report pain and associated factors from their daily life by carrying a signaling device (such as a pager) and monitoring device (such as a questionnaire booklet). They complete monitoring entries in response to a signal, or 'beep', though in some studies they may also make entries at specified times or in response to designated events. Palm-held computers (PDAs) are used with increasing frequency in these studies because they act as both a signaling and recording device and are able to time- and date- stamp each entry to help ensure compliance[2].

A key feature of daily-diary methods is their capacity to reveal processes that occur within people. Cross-sectional studies are unable to observe intra-individual processes, and are prone to known inaccuracies and biases in recall of pain[3] and judgments about "average" or "usual" pain levels[4]. Furthermore, the reliability of people's insight into the inter-relationships amongst their overt behaviors and internal states is often questionable[5]. Laboratory studies may be able to observe intra-individual processes, but lack the "ecological validity" that characterizes daily diary data and lends it to real world application[6,7].

Daily diary studies have investigated diurnal variations in pain[8-10], the covariation of pain and states such as mood and activity-levels[11], exercise[12], sleep[13], and fatigue[14], and the role of psychosocial factors in daily fluctuations in pain, distress, and disability[15-17]. As useful as this kind of data is, evidence supporting the validity of daily diary scales is often lacking. Some authors appear to assume that daily-diary assessments represent a 'gold-standard' in self-report methods, and that traditional validation is neither applicable nor necessary[18]. This is despite that scales are often

either made up or adapted from existing scales with only a subset of items utilized and wording modified for diary usage.

The purpose of the current study is to develop and validate scales designed specifically for use in electronic daily diary studies involving momentary within-day monitoring of pain. The Pain Ambulatory Monitoring Survey (PAMS) was developed to test cognitive-behavioural (CB) models of chronic pain, measuring momentary pain-intensity as well as other outcomes – psychological distress, activity-levels, and avoidance of daily tasks due to pain or fear of pain.

PAMS scales were also developed to measure coping and appraisal variables of known importance in CB models of pain-related distress and disability[19,20], namely: catastrophising[21,22], perceptions of life-interference due to pain[23], participant's expectations about subsequent pain[24,25], coping[26-28], help seeking and solicitous spousal behaviour[29,30], and pacing of daily activities[31], as well as medication and substance use. The PAMS was developed to facilitate investigations into the reciprocal relationships between these factors and outcomes such as pain, distress, and physical function, on a within-person basis over time. Its items were developed to monitor momentary states, or short term recall of behaviours (up to 3.5 hours). PAMS scales were developed with the aim of using minimal items sets to facilitate repeated and intensive measurements over the course of a study whilst intruding as little as possible on normal daily routines[32].

Two studies were conducted. In the first, the factor structure and internal validity of the multiple-item scales (measuring distress, avoidance, catastrophising, perceived interference, and coping) was established in a larger sample of people with a variety of chronic pain conditions. In this study, a paper-and-pencil version of the scale

(PAMS-P) was used, with participants completing the scales in one sitting at one of eight time-slots between 8:00am and 10:00pm.

In the second study, the Pain Intensity, Distress, Avoidance, Catastrophising, Perceived Interference, and coping scales were validated by comparing the average ratings of 55 mixed chronic pain sufferers, after up to seven days of diary monitoring with up to nine entries per day, to established recall-based measures of the same or similar constructs. This method of supporting convergent validity for diary-based scales has been reported by a number of authors in the pain arena[10,15,33].

The remaining sets of single-item scales, measuring perceived activity-level, pain predictions, pacing, solicitation, and substance and medication use, are reported for descriptive purposes but are not validated explicitly in the current set of studies.

STUDY ONE

Materials and Methods

Participants

One-hundred-and-twenty-four participants (70 female) aged between 14 and 78 years (M=42.17, SD = 15.34) were recruited from a student sample, community sample, and clinical sample. Participants were required to have experienced bodily pain, not due to cancer, for three months or longer. Participants reported a mean pain history of 10.12 years (SD= 11.69).

The student sample consisted of 27 first-year psychology students (19 males), aged between 18 and 52 years (M=25, SD=10.65), seeking course credit for research participation. The community sample consisted of 63 participants (24 males), aged between 14 and 76 years (M= 46.16, SD= 13.27) recruited via advertisements in

community newspapers. In addition, fifteen participants with a whiplash-associated disorder (WAD) in the community sample had participated previously in research through the University of Queensland's Division of Physiotherapy[34] and had indicated their willingness to be involved in further research. They had originally responded to advertisements in community newspapers. The clinical sample was composed of 34 participants (19 males), aged between 26 and 78 (M= 48.60, SD= 11.84) recruited from pain-management classes at the Royal Brisbane Hospital's Multidisciplinary Pain Management Centre.

Using self-reported diagnoses, 98 participants provided information about their pain condition sufficient to designate them to one of five broad categories based on ICD-10 classifications – back pain (n=36), neck pain (n=24), arthropathies (n=19), soft-tissue conditions (n=13), and miscellaneous conditions (n=25). Nineteen participants reported pain conditions across two of these classifications. Neck injuries included fifteen WAD sufferers, arthropathies included thirteen participants reporting osteoarthritis and six reporting rheumatoid arthritis, fibromyalgia constituted the majority of soft-tissue conditions (n=11), and miscellaneous conditions included migraine headaches (n=2), repetitive-strain injury, irritable-bowel syndrome, temporomandibular joint disorder, neuralgia (n=6), and osteopathies (n=7) including reflex-sympathetic dystrophy and Perthes Disease.

All participants were given an information sheet prior to commencing the study, and signed a form indicating informed consent.

Measures

Pain Ambulatory Monitoring Survey – Pilot Version (PAMS-P). The PAMS-P was a paper-and-pencil questionnaire designed to represent questions and question formats

used in the PDA-based questionnaire (PAMS) used in Study Two. It was designed for momentary use: all items ask about what the participant was experiencing at the moment they completed the questionnaire or in the 105 minute period prior to commencing the questionnaire (105 minutes was the average interval between entry occasions in Study Two).

The PAMS-P contained two item formats, devised to resemble as closely as possible the format of questions used when the PAMS was administered via PDAs. The first is what Karoly and Jensen[35] refer to as a Graphic Rating Scale (GRS) - a ten centimetre line labelled "0%" at the left extreme and "100%" at the right extreme, with descriptors anchoring the scale at equal intervals along the line. Participants were asked to indicate their response by placing a single vertical mark anywhere along the line. In the second type of item, check-boxes, a question was followed by up to five options (five being the maximum that could fit on one screen of the PDA). Participants were asked to endorse relevant items with a tick.

All items were worded (a) in the first person to simulate participant's internal dialogue[10], (b) to measure momentary states (eg. "Right now I feel…") or short-latency recall ("In the past 1 hour 45 minutes I have…."), (c) to suit either the GRS or check-box format, and (d) using a minimal word-count to maximize ease of reading and ensure an easy fit on the screen of a PDA.

PAMS-P included sixteen GRS items, one measuring pain-intensity, eight measuring distress (down; depressed; anxious; frustrated; irritable; tense or 'wound up'; cheerful; calm and peaceful. The latter two were reverse scored), one measuring activity-level, three intended to measure catastrophising, and three intended to measure perceived life-interference.

PAMS-P also involved thirty-one check-box items measuring behaviours engaged in during the previous 105 minute period. Four of these measured medication and alcohol use, four measured activity-management ("pacing") behaviours, three measured help-seeking behaviour ("solicitation"), ten measured coping strategy usage, and ten measured tasks that may have been avoided.

Personal-Background Questionnaire. Participants were asked to complete a demographics questionnaire with items regarding age, gender, marital status, education, occupation, and source of income. Pain-related variables were also assessed, including time since onset, bodily locations of pain[36,37], onset circumstances, temporal fluctuations in pain, treatments sought, current medication usage, and involvement in litigation.

Multidimensional Pain Inventory (MPI). The current study used three of the five scales in Part One of the MPI[38] – Pain Severity, Life Interference, and Affective Distress. The scales are completed on a zero to six scale with descriptors anchored at either end. The reliability and validity of the scales have been well documented by Kerns[38]and others[33].

Pain Catastrophising Scale (PCS). The PCS[39] is a 13-item scale in which participants are asked to indicate on a five point scale (0= not at all, 4= all the time) the frequency with which they experienced a range of pain-related catastrophic thoughts in the prior week. Sullivan and colleagues identified three scales from their original principal components analysis, rumination, magnification, and helplessness, which demonstrate internal validity[40]and adequate test-retest reliability[39]. Both the PCS subscale scores and a total score have been used in previous studies[39]. The total score was used for descriptive purposes in Study One and for convergent-validation in Study Two.

Coping Strategy Questionnaire (CSQ). The Coping Strategy Questionnaire (CSQ)[26] is perhaps the most frequently used measure of strategies used to cope with chronic pain[41]. The original scale is composed of 48 items measured on a seven-point scale indicating frequency-of-use (1= never, 3= sometimes, 7= always).

It includes six rationally-devised scales to measure coping strategies usage – Diverting Attention, Reinterpreting Pain Sensations, Coping Self-Statements, Ignoring Pain Sensations, Praying or Hoping, and Increasing Activity Level – and a further scale, Catastrophising, measuring catastrophic pain cognitions (eg. "It is awful and I feel that it overwhelms me"). The CSQ includes two single-item scales assessing participant's beliefs that they are able to control and decrease pain given their repertoire of coping strategies.

The current study employed the original scales (not including "Increasing Pain Behavior"), and two factors of a three-factor version of the CSQ developed by Turner and Clancy[42]. According to their factor structure, the Diverting Attention, Praying or Hoping, and Increasing Behavioural Activities scale combine in the Divert Attention And Praying scale, and the Ignoring Pain Sensations, Re-interpreting Pain Sensations, and Ability to Decrease Pain scale combine in the Denial Of Pain scale. This factor structure was used because all the scales reflecting cognitive and behavioural methods of coping, which are reflective of the content of items used to develop the PAMS scales, were confined to the Denial of Pain and Divert Attention And Praying scales. Those scales were used for validation purposes in Study Two. Their Helplessness scale, which is composed of the appraisal-type scales of the CSQ, was not deemed relevant to assessment of our coping scales. Instead, the Catastrophising scale was used in Study Two for validation of the PAMS Catastrophising scale.

Medical Outcomes Survey Short-Form 36 (SF-36). The SF-36 is a 36 item scale designed to measure of general health-related outcomes in clinical and general populations[43]. In the current study, the Bodily Pain, Physical Functioning, Social Functioning, and Mental Health scales were used for descriptive purposes, and were used in Study Two as indices against which to validate the PAMS Pain Intensity, Avoidance, and Distress scales. The psychometric properties of the SF-36 scales have been well supported in large-scale studies of clinical and general samples[44,45].

Roland and Morris Disability Questionnaire (DQ). The Roland and Morris Disability Questionnaire[46] was constructed as an outcome assessment of functional status amongst low-back pain populations. The scale consists of 24 check-box items in which participants are asked to endorse statements about the functional impact of pain. It demonstrates strong test-retest reliability, internal reliability and convergence with other measures of pain-related disability[47-50].

The version used in the current study was developed and validated for use in general chronic pain populations, rather than low-back pain specifically[51].

Hospital Anxiety and Depression Questionnaire (HADS). The Hospital Anxiety and Depression Scale (HADS)[52] consists of separate Anxiety and Depression scales, each composed of seven items. Respondents are asked to underline one of four statements to indicate how they felt over the previous week. The scale was developed for use with participants in medical settings, with items being selected to avoid measurement of anxious and depressive symptoms that may overlap with symptoms of a medical condition. The authors demonstrated that the scales are internally consistent and display convergent and divergent validity against clinician ratings.

Procedure

Participants were asked to complete a questionnaire package within one day on any day of their choosing. The PAMS-P and personal-background questionnaire were presented first in the package and the order of the remaining questionnaires varied.

To represent responses from across the waking-day, participants were instructed to complete the PAMS-P within a certain 105 minute timeframe. These corresponded with the timeframes during which alarms were scheduled to signal during PDA monitoring in Study Two (8:00 to 9:45; 9:45 to 11:30; 11:30 to 13:15; 13:15 to 15:00; 15:00 to 16:45; 16:45 to 18:30; 18:30 to 20:15; 20:15 to 22:00). Participants were asked to return completed questionnaires to the investigator via an addressed and stamped envelope provided.

In Study One the standard questionnaires are reported only for descriptive purposes.

Results

Participant characteristics

Descriptive statistics for the continuous variables, for the whole sample and broken down according to gender, are reported in Table One. Table Two displays frequencies of categorical variables for the whole sample and broken down according to gender. For continuous variables, t-tests were used to make comparisons between genders and comparisons of each self-reported diagnostic classification to the remainder of the sample. Chi-square analyses were used to make similar comparisons for dichotomous variables. For the purpose of describing the sample, all results below alpha=.05 will be reported as significant.

Insert Table One

Pain clinic attendance was proportionately distributed across the diagnostic and gender groups.

Females were more likely to report using SSRI antidepressants ($\chi^2(1)=6$, p=.014) and NSAID medications ($\chi^2(1)=4.45$, p=.035). They also reported higher anxiety on the HADS than males ($t(119)=-2.2$, p=.03).

Insert Table Two

Back-pain sufferers were less likely than the rest of the sample to use NSAID medications ($\chi^2(1)=3.9$, p=.051), and reported lower scores on MPI Support

(t(110)=2.71, p=.008) and the PCS (t(119)=2.13, p=.035). Those with neck-pain reported a greater propensity to use combination analgesics (χ^2(1)=11.81, p=.001) and demonstrated lower scores on the CSQ Increase Behavioural Activities scale (t(116)=2.43, p=.017). Arthropathy sufferers were more likely to use NSAID medications (χ^2(1)=3.8, p<.001), were older than the rest of the sample (t(121)=-3.86, p<.001), and reported higher levels of control according to the MPI Life Control (t(119)=-2.36, p=.024) and CSQ Control Over Pain (t(118)=-3.44,p=.001) scales. Those reporting soft-tissue conditions were more liable to use opioid (χ^2(1)=5.46, p=.019) and NSAID (χ^2(1)=10.49, p=.001) medications, were likely to be older (t(121)=-2.63, p=.015), and were more likely to cope by diverting attention according to the CSQ (t(116)=-2.02, p=.046). Those in the miscellaneous classification were more likely to use anti-convulsant medications (χ^2(1)=5.98, p=.014), were more likely to cope by ignoring pain according to the CSQ (t(116)=-2.21, p=.029), and experienced better mental health than the rest of the sample according to the SF-36 (t(116)=-2, p=.047). Finally, those whose condition was not classifiable were more distressed, anxious, and reported poorer mental health (MPI Affective distress, t(119)=-2.64, p=.009; HADS Anxiety, t(120)=-2.2, p=.029; SF-36 Mental Health, t(116)=2.9, p=.004), were more prone to catastrophising according to the PCS (t(119)=-3.39, p=.001) and CSQ (t(116)=-2.85, p=.005), and were more likely to cope by praying and hoping according to the CSQ (t(116)=-2.2, p=.029).

Factor Structure

Given the strong relationship demonstrated between predictors such as pain appraisals and coping and outcomes such as distress and task avoidance[21,22] and the acknowledged importance of drawing clear conceptual distinctions between predictor

and criterion constructs[53], it was decided to establish the factor structure of appraisal and coping items separately from items measuring distress and avoidance.

Items measuring distress and task avoidance were subjected to factor analysis via principal axis factoring with Varimax rotation. Two factors were selected for extraction to confirm the independence of the Distress and Avoidance scales (see Table Three). This approach was taken in favor of an exploratory selection of the number-of-factors because when more than two factors were allowed the Avoidance items separated into multiple, often single-item, scales. These appeared to reflect little more than the types of activities that tend to co-occur during the course of the day as opposed to a single scale reflecting over-all activity avoidance.

Insert Table Three

The two factors accounted for 43% of variance. On the Distress factor, all distress items loaded between 0.65 and 0.85 and diverged from loadings on the Avoidance scale by at least 0.48. On the Avoidance scale, loadings between 0.69 and 0.41 were obtained for avoidance items, with at least 0.31 distinguishing them from loadings on the Distress scale. The Distress scale demonstrated an internal consistency of α=0.92, and the Avoidance scale α=0.79. No scale contained items that improved internal consistency when removed. All alpha values were greater than inter-correlations with other PAMS scales (for Distress r=.54 to <.01; for Avoidance r=.49 to -.05), supporting the reliability of scales.

Items measuring coping strategies and pain appraisals were subjected to factor analysis via principal axis factoring with Varimax rotation (see Table Four). This

analysis was intended to explore the structure of the coping items (with the expectation of confirming a two factor structure consistent with Turner and Clancy's[42] two coping factors), and to confirm the two-factor structure of the appraisal items.

Insert Table Four

Four factors with eigenvalues over one were extracted, accounting for 44% of variance.

Items reflecting pain catastrophising loaded between 0.50 and 0.80 on the first factor, with at least 0.33 between loadings on that factor and loadings on any other factor. Perceived life-interference items loaded between 0.73 and 0.88 on factor two, with a difference of at least 0.44 between loadings on that factor and other factors. Five coping items obtained loadings between 0.51 and 0.67 on the third factors and were distinguished from other factors by at least 0.35. This factor appeared to reflect active ways of coping with pain characterized primarily by distraction and cognitive coping. A final factor was characterized by three coping variables reflecting ignoring and denial of pain. Items loaded between 0.42 and 0.68, and were distinguished from loadings on the other factors by at least 0.3.

An internal consistency of α=.66 was obtained for Pain Catastrophising, α=.88 for Perceived Interference, α= .74 for Active Coping, and α=.59 for Ignoring and Denial. In support of the reliability of scales, internal-consistency coefficients were greater than inter-correlations between scales and other PAMS scales, for Catastrophsing (r=.54 to .02), Perceived Interference (r=.49 to .01), Active Coping (r=.15 to <.01), and Ignoring and Denial (r=.35 to -.01).

STUDY TWO

Materials and Methods

Participants

Participants were 55 literate English-speakers (67% females) aged 17 to 74 years (M=39.1, SD=17.7) who lived within two-hours travelling time of the University of Queensland and had experienced bodily pain, not due to cancer, for three months or longer. Twenty-eight of these were recruited from the sample used in the pilot study – five from the student sample, 17 from the community sample, and six from the clinical sample. Seventeen participants from the new cohort were from a student sample, three were from a clinical sample, and five were recruited from the community. Questionnaire booklets were completed by only 48 of the 55 participants.

Forty participants provided self-reported diagnoses that allowed their condition to be classified according to four broad categories based on ICD-10 classification. Although numerous participants reported multiple conditions, in each case the conditions fell under the same classification category. Fifteen individuals reported back pain, seven arthropathies (five osteoarthritis and two rheumatoid), eight soft-tissue conditions (including six with fibromyalgia), and ten with miscellaneous conditions, including migraine headaches (n=3), irritable bowel-syndrome, reflex-sympathetic dystrophy, and osteomyelitis.

All participants were given an information sheet prior to commencing the study, and signed a form indicating informed consent.

Measures

On the day after their last electronic-diary monitoring day, participants completed a feedback questionnaire and the standard measures completed in Study One. The results of the feedback questionnaire will not be reported in the current paper.

Electronic PAMS Diary. One item was presented per diary screen. Participants were unable to return to previous items and were unable to commence the next item unless they had responded to the current item.

Four screen-types were used for diary assessments. Firstly, occasional message screens were presented, analogous to instructions between sets of questions on a paper-an-pencil questionnaire. For example, participants were reminded to answer questions according to their state at the time of the alarms, or to answer questions regarding the period between alarms.

Secondly, corresponding with paper-and-pencil GRS scales for continuous items, respondents used a stylus-pen to slide a bar along a 'sliding-scale' corresponding to 0-100 ratings. Descriptors presented at the bottom of the screen were anchored to ranges on the rating scale. For example, when asked "How calm and peaceful were you feeling?" a rating between 0 and 20 returned a descriptor of "Not at all". This types of screen was used for the Pain Intensity, Distress, Pain Predictions, Activity-Level, Perceived Interference, and Catastrophising items.

Thirdly, for one item relating to the nature of any medication use participants were given a forced-choice of only one of three options (on an 'as required' basis, as part of a regular schedule, or both).

Finally, for the remainder of dichotomous items participants simply used the stylus-pen to endorse a check-box next to each item. One, none, or any combination of check-boxes could be selected.

Procedure

Data collection was conducted via Casio E-11 PDAs, which use stylus-based navigation, operate on the Windows CE platform, weigh 6.6oz, and have a 3.1 by 2.4 inch grey-scale screen.

The experimenter delivered the PDA to participant's homes, at which time he explained the use of the PDA and helped the participant complete one example entry. Participants were given "trouble-shooting" information, a spare set of batteries, an instruction booklet for use of the PDA, and a power-cord and recharging "cradle".

Participants were asked to monitor for only 7 days, but were able to conduct monitoring on up to nine days. They were asked to begin the project on the day after the PDA was delivered, however they were free to commence monitoring immediately as the PDA's alarms had begun sounding. Similarly, participants were free to continue responding to alarms on the eighth day until the experimenter was able to collect the PDA.

Data was collected in subjects' natural environment at a frequency of up to nine times per day. Waking hours, between 8 am and 10 pm, were broken into eight 105 minute blocks. Alarm signals were programmed to occur at a random time once during each block with the one stipulation that no two signals would occur within 30 minutes. Feedback indicated that on occasions alarms were cancelled by the device, and this may have been due to battery levels or because alarm-times intruded on the timing of

alarms in adjacent blocks. An alarm was also sounded at midnight each night when the device "woke itself up" to set alarms for the next day. Participants were told to ignore this alarm, but were encouraged to respond to it only if they wished to do so.

Alarms were programmed to sound repeatedly for one minute, and then once per minute for 10 minutes. A visual display indicated how much time had elapsed since the alarm began to ring. After 10 minutes the PDA automatically switched itself off.

When participants responded they were given the option to "Open", "Postpone", or "Dismiss" the alarm. They were asked to dismiss as few alarms as possible, and only when their circumstances were such that opening the alarm would be unsafe for the participant or the PDA, or if it would be impossible for them to complete the PDA within the maximum postponement period (such as if they were driving). If the postpone option was selected, participants were given the options to postpone the alarm for one, five, ten or fifteen minutes, but were not offered postponement periods that would put their entry more than 20 minutes after the initial onset of the alarm.

When a participant selected the "Open" option the PDA commenced the PAMS monitoring program. If the PDA was unattended for one minute during an entry it emitted a beep each minute to attract the participant's attention, switching itself off after four minutes to preserve batteries.

No other functions on the PDA were operable during entries, and PDAs were rendered inoperable between alarms so participants could not use its other functions or make an unsolicited entry.

Participants were asked to complete the questionnaire booklet on the eighth day.

Results

Participant characteristics

Descriptive statistics for continuous variables are presented in Table Five, for the whole sample and broken down according to gender. Genders comparisons were made via t-tests and differences between diagnostic categories were assessed via one-way ANOVAs with bonferroni adjustments.

Insert Table Five

Frequencies of dichotomous variables are presented in Table Six, for the whole sample and broken down according to gender. Gender comparisons and between group-comparisons of diagnostic categories were made via chi-square tests, with group differences between diagnostic categories assessed via inspection of standardized residuals.

Insert Table Six

Genders did not differ on any measure. Those with arthropathies were older than ($F(4,45)=4.082$, $p=.007$) and suffered from more sites of regular pain ($F(4,45)=4.18$, $p<.006$) than those in the back-pain, miscellaneous-pains, and no classification groups. They were also more likely than those with a soft-tissue or miscellaneous conditions to take NSAID medications ($\chi^2(4)=19.77$, $p=.001$).

Compliance

Entries were made over 369 monitoring days, producing a total-possible response of 3321 entries. A total of 2065 alarms were opened, but only 2019 valid responses were obtained from these (in some cases entries were left incomplete and in others responses were made down the mid-line or at one extreme of the rating scales). Entries were dismissed on 175 occasions and no response was made to alarms on 861 occasions, producing a 66.6% compliance rate across the 3101 alarms. The discrepancy between the alarm rate and total-possible rate appears to have been attributable to battery problems or cancellation of alarms by the device because of conflicting overlaps with adjacent alarms.

Examining compliance on a within-person basis as a proportion of opened alarms to total alarms, only 18% of the sample demonstrated a compliance rate of 50% or below. Half of the sample opened at least two-thirds of alarms.

Half of the diary entries were completed in under 4.35 minutes (M=5.04, SD=2.76). Only 8.8% of entries were completed over nine minutes or more.

Scale properties

Descriptive statistics for all continuous variables and frequencies of dichotomous variables are reported in Table Seven. Statistics are provided for both the entire dataset (across individuals) and for individual-means.

Distributional properties of the two coping scales were considered problematic – the Active Coping scale varied over only six levels and the Ignore/Deny scale over only four. Over the whole data-set both scales were highly skewed and kurtotic, with standardized skew and kurtosis of 15.89 and -2.9 for Active Coping, and 13.33 and -

4.58 for Ignore/Deny, respectively. Individual mean values were also skewed but not kurtotic, with standardized values of 2.14 and -1.0 for Active Coping and 2.28 and -0.09 for Ignore/Deny, respectively. Both scales were dichotomized to reflect no coping attempt versus any coping attempt. After transformation both variables were relatively evenly distributed over the whole data set, with coping indicated on 61.6% of entries for Active Coping, and 56.4% for Ignore/Deny. They were also evenly distributed within individuals (reporting Active Coping on 63.4% of entries and Ignore/Deny on 51.6% of entries, on average), and average values were relatively evenly distributed across the sample (standardized skew and kurtosis of -1.18 and -1.9 for Active Coping, and -0.51 and -1.92 for Ignore/Deny).

The avoidance scale was square-root transformed to improve its distributional properties (see Table Nine).

Insert Table Seven

Convergent validity

The averaged PAMS Pain Intensity scale correlated r=-.58 (p<.001) with the SF-36 Bodily Pain scale and r=.56 (p<.001) with the MPI Pain Intensity scale. The averaged Avoidance scale correlated strongly with the DQ (r=.72, p<.001) and adequately with the SF-36 Physical Functioning (r=-.46, p<.01) and Social Functioning (r=-.51, p<.001) scales. The averaged PAMS Distress scale demonstrated strong to moderate correlations with established measures of distress and mental-health, including the MPI Affective Distress scale (r=.85, p<.001), the SF-36 Mental Health scale (r=-.7, p<.001), and the HADS Depression (r=.62, p<.001) and Anxiety (r=.69, p<.001)

scales. The average of the PAMS Catastrophising scale demonstrated adequate convergent relationships with the PCS ($r=.63$, $p<.001$) and CSQ ($r=.56$, $p<.001$) catastrophising scales, and Perceived Interference was correlated $r=.72$ ($p<.001$) with its associated MPI scale. The PAMS Active Coping and Ignore/Deny scales demonstrated modest convergent relationships with the CSQ Divert Attention And Praying ($r=.48$, $p<.01$) and Denial Of Pain factors ($r=.48$, $p<.001$), respectively. Active Coping was also related to the CSQ Divert Attention subscale ($r=.57$, $p<.001$), and demonstrated relationships with the CSQ Reinterpret Pain Sensations ($r=.36$, $p<.05$) and Increased Behavioural Activities subscales ($r=.35$, $p<.05$). The PAMS Ignore/Deny scale demonstrated a relationship with the CSQ Ignore Sensations subscale ($r=.56$, $p<.001$). In support of divergent validity, the PAMS Ignore/Deny scale was not significantly related to the CSQ Divert Attention And Praying factor ($r=-.14$ns) or the Divert Attention, Reinterpret Pain Sensations, or Increase Behavioral Activities subscales ($r= -.09$ns; $.17$ns; $-.14$ns respectively), and the PAMS Active Coping scale was not significantly related to the Denial Of Pain factor ($r=.2$ns) or the Ignore Sensations subscale ($r=.05$ns).

DISCUSSION

The current study described the development and validation of a set of scales intended to measure pain, emotional functioning and physical avoidance, and factors relevant to cognitive-behavioural models of chronic pain, using a momentary format with scales composed of a minimal set of items. These scales constituted part of the Pain Ambulatory Monitoring Survey (PAMS), an inventory intended for use in momentary, within-day diary studies of adaptation to chronic pain.

Study One was conducted to establish the factor structure of the items in a chronic pain sample completing a paper-and-pencil version of PAMS in one sitting. In confirmatory factor analyses, distress and activity avoidance items loaded on two distinct scales. Appraisal and coping scales also emerged as predicted – catastrophising, perceived life-interference, coping via denial and ignoring, and active-coping all loaded on separate and distinct factors. All multiple-item scales demonstrated adequate to strong internal validity.

Study Two was conducted to explore the convergent correlations between summary scores of PAMS scales, after one week of monitoring by a chronic pain sample, and established measures of related constructs. All convergent correlations were significant, with the highest of these for each scale ranged from moderate (r=.58 for Pain Intensity) to strong (r=.85 for Distress). These relationships were comparable to and often of greater magnitude than similar relationships reported in the literature between averaged momentary scales and established questionnaires. A correlation of r=.58 was found between PAMS Pain Intensity and SF=36 Bodily Pain. Prior studies have found correlations between momentary and standard versions of the MPI Pain Intensity scale of both lesser (r=.4)[10] and greater (r=.65 to 0.75)[54,33] magnitudes.

The correlation of r=.63 between the average PAMS Catastrophising score and the PCS Total score was comparable to correlations of r=.66[10] and r=.65[15] between recalled and momentary versions of catastrophising scales found in the literature. For Perceived Interference, the r=.72 correlation between the MPI scale and the mean PAMS scale was of greater magnitude than relationships reported by Peters and colleagues (r=.34)[10] and Lousberg and colleagues (r=.6)[33] with standard and momentary versions of that MPI scale.

The PAMS coping scales demonstrated convergent and divergent validity. The Active Coping scale correlated significantly with the Divert Attention And Praying factor of the CSQ, but not with the Denial Of Pain factor. The opposite set of relationships was observed for the PAMS Ignore/Deny scale. Correlations with the CSQ subscales suggests that the Active Coping scale is specifically related to diverting attention, but also reinterpreting pain sensations and increasing behavioural activities. The Ignore/Deny scale appeared to be related to strategies involving ignoring pain. Peters and colleagues[10] reported correlations of r=0.41 between momentary and standard versions of both the CSQ Divert Attention and Ignore Pain Sensations scales, both of which are of lesser magnitude than the r=.57 and r=.58 demonstrated in the current study between the PAMS Active Coping and Ignore/Deny scales and these CSQ scales, respectively.

In the current study the mean PAMS Distress scale correlated r=.85 with the MPI Affective Distress scale – a relationship of superior magnitude compared to previously reported correlations of r=.42[10] and r=.2[33] between recalled and momentary versions of that MPI scale.

The PAMS Avoidance scale was associated with measures of disability and, inversely, measures of both social and physical functioning. The scale was related r=.74 with the Disability Questionnaire. This was comparable to the correlation of r=.73 found between recalled- and momentary versions of the MPI Physical Functioning scale by Peters and colleagues[10], and was of greater magnitude than the r=.4 relationship reported by Lousberg and colleagues[33] between momentary and recalled "household chores" scales derived from the MPI and the non-significant relationship between the two versions of an MPI "general activity" scale.

The current study was not intended to explore possible sources of error that may have influenced the convergent relationships reported, though such questions are open to empirical examination and may be explored in future studies to develop more sophisticated methods of diary-validation. For example, a number of studies demonstrate that whilst standard recall-based questionnaires and summaries of momentary reports may be highly related, recall is usually associated with overestimation of pain[10,55]. The task of establishing convergent relationships between diary-based measures and standard questionnaires would appear to be more complex than between two standard questionnaires, with possible extraneous 'noise' attributable to such factors as: recall and judgement biases in the recall-based scales; sampling variability in the summary scores of momentary measures (ie. summaries based on a greater number of diary entries are likely to be more stable); and effects of divergent completion times and contexts (analogous to test-retest variability).

The PAMS scales were worded for momentary assessment applications, and are composed of minimal item sets. In some cases, such as the coping scales, this may have come at the expense of content validity. There are aspects of coping, represented by the various scales of the CSQ and other coping scales such as the Chronic Pain Coping Inventory[56], not covered by the PAMS scales. However, the PAMS scales were intended to sample from the wider domain of coping in a minimal way, and their small size is intended to facilitate repeated measurements of a diverse range of indices within and across days. Those indices measured by PAMS certainly do not represent all constructs considered relevant to models of psychosocial adaptation to pain, but it does target some of the key factors suggested by prior empirical work.

The current research paves the way for subsequent investigations into how these constructs vary over time and how they interact, within people, to influence

adaptation in a dynamic way. It is hoped that such studies will help illuminate the mechanisms of maladjustment in those who suffer chronic pain, supporting psychosocial models, and guiding the clinical interventions that stem from them.

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Table 1. Study One descriptive statistics for total sample and by gender: M(SD)

		Total	Gender Males	Female
Age		42.2 (15.3)	43.3 (15.6)	41.3 (15.2)
MPI	Pain Severity	3.8 (1.1)	3.6 (1.2)	4 (1.1)
	Affective Distress	3.2 (1.2)	3 (1.3)	3.4 (1.1)
	Interfere	3.9 (1.3)	3.9 (1.4)	3.9 (1.3)
	Support	4.2 (1.5)	4.3 (1.6)	4.1 (1.4)
	Life-Control	3.2 (1.2)	3.3 (1.2)	3.1 (1.2)
PCS		7.3 (3.9)	7.4 (4.3)	7.2 (3.6)
CSQ	Catastrophising	12.4 (8.7)	11 (9)	13.4 (8.4)
	Control over Pain	2.7 (1.4)	2.8 (1.4)	2.6 (1.5)
	Ability to Decrease Pain	2.3 (1.3)	2.5 (1.2)	2.2 (1.4)
	Divert Attention	14.9 (9.9)	13.9 (9.7)	15.7 (10.1)
	Reinterpret Pain Sensation	7.9 (6.8)	7.7 (6.5)	8.3 (7.1)
	Ignoring Sensations	13.9 (7.6)	15.1 (6.8)	13.2 (8)
	Praying or Hoping	11.9 (8.8)	10.8 (8.6)	12.7 (9)
	Coping Self Statements	21.1 (7.2)	20.9 (7.6)	21.5 (6.7)
	Increased Behavioural Activities	16 (6.9)	15.5 (7.1)	16.5 (6.8)
HADS	Anxiety	9.5 (4.4)	8.5 (4.5)	10.2 (4.2)
	Depression	7.2 (4.3)	7 (4.5)	7.4 (4.3)
SF-36	Physical Functioning	20.5 (5.5)	21.4 (5.7)	19.9 (5.2)
	Bodily Pain	5.1 (1.8)	5.2 (1.9)	5.1 (1.7)
	Social Functioning	16 (4.4)	15.7 (5.1)	16.2 (3.8)
	Men Health	19.8 (5.1)	20.6 (5.5)	19.2 (4.8)
DQ		10.7 (5.9)	9.9 (5.8)	11.1 (5.9)

Table 2. Study One frequencies: total and by gender (%)

		Total	Gender Males	Female
N		124	54	70
Neck Pain		18.55	20.75	17.14
Back Pain		29.03	26.42	31.43
Athropathy		15.32	13.21	17.14
Soft-Tissue		10.48	5.66	14.29
Other Condition		20.16	24.53	17.14
No Condition Reported		20.97	22.64	18.57
Pain Clinic		47.58	51	44
Sedatives, hypnotics		10.57	9	11
Antianxiety		8.13	13	4
Antidepressants	Tricyclic	15.45	15	16
	SSRI	14.63	6	21
	Other	9.76	15	6
Anticonvulsants		10.57	11	10
Narcotics		46.34	38	53
Simple analgesics		37.4	40	36
Combination analgesics		10.57	11	10
NSAIDS		15.45	8	21

Table 3. Rotated factor matrix for outcome variables

	Factor 1.00	2.00
Calm	**-0.67**	0.05
Down	**0.65**	-0.13
Depressed	**0.77**	-0.23
Anxious	**0.78**	-0.19
Frustrated	**0.73**	-0.25
Irritable	**0.82**	-0.14
Tense	**0.85**	-0.16
Cheerful	**-0.71**	0.12
Chores	-0.15	**0.52**
Yardwork	0.04	**0.68**
Work	-0.14	**0.56**
Shopping	-0.06	**0.69**
Sport	-0.17	**0.57**
Cooking	-0.10	**0.42**
Visiting	-0.18	**0.49**
Self-care	-0.09	**0.41**
Hobby	-0.12	**0.43**
Driving	-0.02	**0.44**

Table 4. Rotated factor matrix for appraisal and coping variables

		Factor 1.00	2.00	3.00	4.00
Catastrophising	Suffering from pain	0.20	0.08	**0.53**	0.02
	Pain as terrible	0.17	-0.02	**0.80**	0.15
	Injury expectations	0.14	0.00	**0.50**	0.06
Perceived Interference	Achieve less	**0.73**	0.19	0.29	0.06
	Difficulty performing	**0.76**	0.08	0.31	0.06
	Limited in activities	**0.88**	0.14	0.17	-0.04
Coping	Do something enjoyable	0.12	**0.59**	-0.07	0.03
	Talk sense	0.07	**0.58**	-0.07	0.23
	Think pleasant thoughts	0.05	**0.67**	0.10	0.04
	Positive thinking	0.12	**0.66**	0.02	0.06
	Relax/deep-breathing	-0.03	**0.51**	0.09	-0.07
	Pretend it isn't there	-0.05	0.02	0.11	**0.68**
	Tell myself it doesn't hurt	0.09	0.12	0.11	**0.42**
	Ignore pain	-0.05	0.00	-0.03	**0.60**
	Hope/wish it'd go away	0.15	0.17	0.25	0.31
	Distract myself	0.19	0.37	0.07	0.15

Table 5. Study Two descriptive statistics for total sample and by gender: M (SD)

		Total	Gender Males	Female
Age		39.78 (17.83)	38.73 (17.6)	40.23 (18.16)
MPI	Pain Severity	3.75 (1.01)	3.4 (1.3)	3.9 (0.83)
	Affective Distress	2.93 (1.31)	3.11 (1.41)	2.86 (1.28)
	Interfere	3.61 (1.42)	3.18 (2.02)	3.79 (1.06)
	Support	3.97 (1.6)	4.07 (1.77)	3.93 (1.54)
	Life-Control	3.48 (1.21)	3.27 (1.24)	3.56 (1.21)
PCS		18.04 (11.19)	17.73 (9.23)	18.17 (12.06)
CSQ	Catastrophising	9.29 (8.12)	7 (7.23)	10.33 (8.39)
	Control over Pain	3.09 (1.64)	3.5 (1.55)	2.91 (1.68)
	Ability to Decrease Pain	2.12 (1.29)	2.4 (1.51)	2 (1.18)
	Divert Attention	14.14 (9.56)	12.13 (9.09)	15.05 (9.76)
	Reinterpret Pain Sensation	7.23 (8)	8 (7.68)	6.88 (8.23)
	Ignoring Sensations	19.06 (8.56)	21.27 (10.02)	18.06 (7.77)
	Praying or Hoping	10.52 (7.55)	8.87 (5.72)	11.27 (8.22)
	Coping Self Statements	22.89 (7.28)	23.63 (7.67)	22.55 (7.2)
	Increased Behavioural Activities	16.54 (7.29)	13.8 (7.05)	17.79 (7.15)
HADS	Anxiety	8.24 (4.34)	8.07 (4.08)	8.32 (4.51)
	Depression	5.71 (4.28)	6.07 (5.24)	5.56 (3.85)
SF-36	Physical Functioning	21.43 (5.74)	22.47 (6.01)	20.98 (5.66)
	Bodily Pain	5.82 (1.77)	6.37 (2.47)	5.59 (1.35)
	Social Functioning	16.6 (4.38)	16.53 (5.63)	16.63 (3.81)
	Men Health	20.46 (5.1)	19.67 (5.94)	20.8 (4.75)
DQ		9.48 (5.12)	8.8 (5.86)	9.77 (4.83)

Table 6. Study Two frequencies: Total and by gender (%)

		Total	Gender Males	Fem.
N		55	18	37
Back Pain		12.5	25	28.21
Arthropathy		14.29	6.25	15.38
Soft-Tissue		17.86	12.5	15.38
Other Condition		26.79	25	15.38
No Condition Reported		42	31.25	25.64
Female		70.91		
Pain Clinic		10	6.67	2.86
Sedatives, hypnotics		4	13.33	11.43
Antianxiety		12	0	14.29
Antidepressants	Tricyclic	10	6.67	2.86
	SSRI	4	6.67	2.86
	Other	4	20	45.71
Anticonvulsants		38	46.67	37.14
Narcotics		40	6.67	8.57
Simple analgesics		8	6.67	20
Combination analgesics		16	25	28.21
NSAIDS		70.91	6.25	15.38

Table 7. Descriptive statistics for PAMS scales across all data and for person-level averages

		Person-level averages				All data pooled across people			
		M	SD	Std. Skew (SE 0.322)	Std. Kurtosis (SE 0.634)	M/Freq	SD	Std. Skew (SE 0.055)	Std. Kurtosis (SE 0.109)
Pain Intensity		45.23	15.34	-0.64	-0.34	45.5	22.38	-4.3	-4.79
Avoidance		0.19	0.21	5.07	2.88	0.19	0.21	27.64	12.03
Avoidance (sq-root)		0.29	0.24	3.11	0.26	0.29	0.323	11.47	-8.37
Activity-Level		34.98	11.62	0.11	-1.15	34.63	22.02	4.05	-4.35
Distress		37.64	15.15	0	0.23	37	20.39	2.07	-5.27
Pain Prediction		44.4	13.94	-0.55	-1.18	44.25	19.65	-8.67	-1.6
Catastrophising		29.38	15	1.2	-0.98	28.68	19.94	8.51	-5.51
Perceived Interference		48.6	20.81	-1.11	-0.38	49.68	26.98	-5.56	-5.99
Active Coping		0.63	0.31	-1.18	-1.9	61.61%			
Ignore/Deny		0.52	0.31	-0.51	-1.92	56.41%			
Pain medications	Regular	0.2	0.28	3.94	0.88	21.05%			
	As required	0.12	0.16	3.95	0.66	11.69%			
Sedatives		0.03	0.09	14	33.77	1.89%			
Alcohol		0.02	0.05	8.11	12.71	1.89%			
Resting/sleeping		0.36	0.27	1.68	-0.4	36.4%			
Pacing	Give up	0.10	0.17	7.32	9.81	11.98%			
	Persisted	0.39	0.29	1.26	-1.44	42.17%			
	Took breaks	0.27	0.25	1.97	-1.6	27%			
	Switched between	0.19	0.22	4.48	2.83	20.49%			
Solicitation	Refused help	0.09	0.2	9.31	15.52	10.24%			
	Sought help	0.14	0.22	7.2	8.57	16.36%			
	Accepted help	0.23	0.3	3.98	0.73	22.43%			