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ORIGINAL ARTICLE

Distortions to the passage of time during chronic pain: A mixed method study

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Abstract

Background: A core aspect of the clinical assessment of pain is establishing how long pain has been present for. The reported length of pain can therefore influence diagnosis and treatment. Despite this, little is known about how chronic pain affects the passage of time.

Methods: A mixed-methods cross-sectional study examined experiences of the passage of time in people identifying as living with chronic pain ($n = 398$).

Results: Experiencing chronic pain slows the passage of time for most people. Greater pain intensity, rumination about pain, helplessness and identifying as disabled were associated with a greater slowing of the passage of time. Thematic analysis of responses to open-ended questions suggested that a slowing of time during pain was associated with (1) pain intrusion preventing activities which would otherwise enable time to pass quickly, (2) increased attention to time and (3) as sense that in retrospect, time throughout life was 'lost' to chronic pain.

Conclusion: Chronic pain causes widespread distortion to the passage of time. The slowing of time during pain means that periods of pain feel subjectively longer than periods without, exacerbating patient distress.

Significance: This study examined how chronic pain impacts on the experience of time. Chronic pain substantially slowed the passage of time for most people, subjectively lengthening the period of time that pain lasted for, exacerbating distress. Given the importance of time processing in clinical assessments of pain, medication adherence and therapeutic interventions, these findings underscore the importance of raising awareness about altered temporal processing in patients and clinicians.

1 | INTRODUCTION

Pain has an adaptive function to interrupt current concerns and warn of potential danger, which facilitates survival (Eccleston & Crombez, 1999). This interruptive

function can however become disabling and many chronic pain patients experience attentional and memory problems (Bell et al., 2018; Berryman et al., 2013; Davis et al., 2004; Katz et al., 2004; Moore et al., 2019) which can contribute to the negative effects of pain on

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well-being and quality of life. There is however a lack of research exploring the effect of chronic pain on other cognitive processes which may be important to the diagnosis and treatment of pain.

Estimates of time form a core element of clinical assessment of pain (Somov, 2000). How long pain is reported to last for can significantly influence diagnosis and treatment (Somov, 2000). Despite this, little is understood about how the perception of time is affected by chronic pain and how pain-induced changes in temporal processing may influence patient reports of pain and well-being.

Emergent evidence suggests that pain alters temporal processing. Clinical pain (Bilting et al., 1983; Somov, 2000) and experimental pain (Fayolle et al., 2015; Hellström & Carlsson, 1997; Ogden et al., 2014; Piovesan et al., 2019; Rey et al., 2017; Thorn & Hansell, 1993) appear to distort temporal processing resulting in pain being experienced and remembered as subjectively longer than its actual duration. Time slowing during periods of pain is associated with greater inactivity and boredom due to pain, and increased anxiety about future deteriorations in the patients' condition (Carr et al., 2014).

Pain-induced changes in temporal processing, resulting in pain being experienced as subjectively long and slow, likely exacerbate distress and suffering, as observed in people experiencing depression (Gallagher, 2012) or stress (Wittmann et al., 2006). They may also have significant consequences for treatment by impairing individuals' abilities to adhere to time-sensitive medication schedules, potentially reducing medication efficacy. They also have the potential to reduce the effectiveness of physical therapies because pain-induced time distortions may lengthen/shorten the duration of self-guided exercises. Such effects may be particularly acute in people experiencing chronic pain due to the frequency of pain experienced and the chronic nature of the condition. Understanding the factors which contribute to pain-induced distortions to time is therefore important for improving patient safety and outcomes.

The current study used mixed methods to explore the passage of time in people living with chronic pain and establish how pain-related individual differences related to temporal experience. We chose a mixed-methods design because, in combining both types of data, the qualitative could elaborate on the quantitative data and provide context and enhance our understanding of the passage of time in people living with chronic pain. Data were collected using an online questionnaire which collected quantitative and qualitative data on participants' experiences of pain and experiences of time during daily life. It was expected that both pain intensity and negative pain processing styles would be related greater alterations in perceptions of the passage of time.

2 | METHOD

Data were collected using an online questionnaire which incorporated a range of quantitative measures of pain experience and time experience, as well as open-ended questions for qualitative analysis. The quantitative measures included a modified version of the passage of time questionnaire (Ogden, 2020) to explore time experience, the Brief Pain Inventory (BPI) (Cleeland et al., 1988), the Pain Catastrophizing Scale (Sullivan et al., 1995) to explore pain experience, and the Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983). Finally, two open-ended questions asked participants to describe their experiences of time during pain.

2.1 | Participants

Four hundred and fifty-one people opened the link to the online questionnaire. Of these, 51 did not complete all questions. The final sample therefore consisted of 398 participants. Participants were recruited from local GP practices, Prolific.ac and from online chronic pain support groups. Participants were eligible to participate if they had experienced chronic pain for the preceding 6 months. All participants reported experiencing pain in the 24 h prior to questionnaire completion. An official diagnosis of chronic pain was not a requirement for participation. Table 1 shows further demographic information. The study was approved by Liverpool John Moores University Ethics Committee (21/PSY/038) and was conducted in accordance with the Declaration of Helsinki. All participants provided informed consent before participation.

TABLE 1 Demographic information for the sample.

Variable	Mean/%	SD
Mean age in years	44.14	(15.05)
Mean length of chronic pain in years	13.71	(12.73)
Current level of pain	4.78	(2.43)
Gender		
Male	23%	–
Female	75%	–
Other response	2%	–
Diagnosis of chronic pain		
Yes	68%	–
No	32%	–
Identified as disabled		
Yes	39%	–
No	61%	–

2.2 | Measures

Participants completed an online questionnaire distributed through [Qualtrics.com](https://qualtrics.com). The questionnaire included bespoke closed questions to record demographic information and experiences of the passage of time, as well as two open-ended questions to allow participants to describe their experiences of time during pain. Also included were standard measures of pain experience (BPI, Cleeland et al., 1988) and the Pain Catastrophising Scale (PCS) (Sullivan et al., 1995). The questionnaire took 10 min to complete.

2.2.1 | Demographic questions

Participants stated their age, gender, employment status, whether considered themselves to be disabled and whether they had a formal diagnosis of chronic pain.

2.2.2 | Passage of time judgements

At present, there is no validated measure of the subjective passage of time. Therefore, to assess experiences of the passage of time during chronic pain, the following two Likert scale questions were devised by modifying existing passage of time questions posed in recent studies exploring the effects of age (Droit-Volet, 2019), emotion (Droit-Volet & Wearden, 2015), drug use (Ogden & Faulkner, 2022) and COVID-19 (Ogden, 2020, 2021) on the passage of time.

1. Thinking about today, how quickly time has felt like it is passing in comparison with when you have no pain?
2. Thinking about when your pain is at its worst, how quickly does time felt like it is passing in comparison to when you have no pain?

As in previous research, participants responded using the following 7-point Likert scale: 1. extremely slow, 2. somewhat slower, 3. a little slower, 4. as normal, 5. a little faster, 6. somewhat faster, 7. extremely fast. A higher score therefore indicated a faster passage of time. The structure and response scales used to measure the passage of time during chronic pain are therefore consistent with other studies on the topic.

2.2.3 | Pain Catastrophising scale

The PCS (Sullivan et al., 1995) is a 13-item questionnaire investigating thoughts and feelings usually associated with the pain experience (e.g. I worry all the time about

whether the pain will end). A 5-point rating scale (0: Not at all; 4: All the time) was used by participants to rate how much they have those thoughts and feelings whilst experiencing pain. The PCS includes total scores (score range: 0–52) and three subscales: Rumination (score range: 0–16), Magnification (score range: 0–12) and Helplessness (score range: 0–24). Higher scores indicated higher pain catastrophising, rumination, magnification and helplessness, respectively.

2.2.4 | Brief Pain Inventory–short form

The BPI (Cleeland et al., 1988) assesses the type of pain, its body location, its severity and its impact on daily functions in the past 24 h. The questionnaire consists of 12 items. 5 Yes/No questions asking whether (I) participants' pain could be defined as chronic; (II) they have an official chronic pain diagnosis; (III) their condition has a specific name (and to specify it if so); (IV) they take medications; (V) they usually take the medications on time. Two open questions asked to indicate for how long they have been experiencing pain and the injured body part. Four questions asked to indicate the pain intensity in different moments (e.g. at its worst) using an 11-point Likert scale (0: No pain; 10: Pain as bad as you can image). Finally, the last question asks how pain interfered in 7 aspects of daily life (e.g. walking ability) using an 11-point Likert scale (0: Does not interfere; 10: Completely interferes). Final scores are divided into Pain Severity Score (score range: 0–10) and Pain Interference Score (score range: 0–10). Higher scores indicate higher pain severity and interference, respectively.

2.2.5 | Hospital anxiety and depression scale

The HADS (Zigmond & Snaith, 1983) is a 14-item questionnaire investigating thoughts and feelings related to anxiety and depression (e.g. I feel tense or 'wound up'). A 4-point rating scale (e.g. 0: Not at all; 4: Very often) was used by participants to rate how much or how frequent they had those thoughts and feelings in the past week. The HADS includes two subscales: Anxiety (score range: 0–21) and Depression (score range: 0–21). Higher scores indicated higher pain anxiety and depression, respectively.

2.2.6 | Open-ended questions

At the end of the questionnaire, participants were given the opportunity to expand on their experiences of time during chronic pain by answering two open-ended questions:

1. Please describe how time passes for you when you experience pain.
2. Please describe how your experience of chronic pain affects the passage of time during day-to-day life.

2.2.7 | Data analysis

Quantitative data

Fifty-three people did not complete the online questionnaire until the end or failed to provide answers to all questions posed. Quantitative analyses were therefore conducted on the 398 people who completed the questionnaire in full. Spearman's correlations were used to explore the relationships between the passage of time, age, length of pain, BPI, PCS and HADS scores. Ordinal regression examined whether these factors predicted experiences of time.

Qualitative data

Of the 398 participants who completed the quantitative elements of the questionnaire, 324 participants provided responses to open-ended question 1 and 319 participants provided responses to open-ended question 2. Responses to these open-ended questions ranged from one to 6 sentences. Due to significant overlap in the responses provided by participants for the two questions, data from the open-ended questions were combined. These data were then analysed using Reflexive Thematic Analysis (RTA) (Braun & Clarke, 2006, Braun et al., 2021). This approach was selected as it enables the researcher to consider patterns and commonalities across data from different participants. Consistent with the RTA approach, a critical realist theoretical framework was employed whereby the data were considered to reflect participants' own lived realities which were interpreted through the researchers' own knowledge and experiences. The research team included individuals with lived experience of chronic pain, three cognitive psychologists and a Health Psychologist. All were white Europeans and experienced researchers with a shared interest in chronic pain and time. Analysis was inductive and, in so far as possible, driven by the data and not by preconceived ideas. Following Braun and Clarke (2006) six steps of RTA, led by RO, the authors became familiar with the data by reading and re-reading the responses provided by participants and noted ideas and potential codes. To maintain the quality and robustness of the analysis, the codes and subsequent tentative themes were continuously reviewed, deliberated upon and improved throughout this process via email discussions and a series of analysis meetings between all authors. Throughout, the authors upheld reflexivity by

engaging in introspection and mutual discussions about their individual coding processes and decisions. This collaborative effort aimed to enhance the credibility of the analysis and its interpretations (Yardley, 2000). Excerpts from the data were consistently incorporated to illustrate and reinforce the analysis, ensuring that the results are firmly rooted in and aligned with the data. Participant quotes from across dataset are presented in support of the four themes described and discussed below.

3 | RESULTS

3.1 | Quantitative analysis

Figure 1 shows the distribution of responses for the passage of time judgements related to the passage of time today in comparison with when participant has no pain (upper panel) and how time passes when pain is at its worst in comparison to when participant has no pain (lower panel). Examination of Figure 1 suggests that distortions to the passage of time are widely experienced by people with chronic pain and that there is a tendency to experience a slowing of time during pain. When comparing the current passage of time to periods with no pain, 42.90% of participants reported that the current day was passing more slowly than days without pain, compared with 25.80% who believed time was passing more quickly and 31.30% who believed that time was passing as normal. When thinking about the passage of time when pain was at its worst, 85.90% reported that time passed more slowly than when in no pain, whereas only 6.30% reported that time passed more quickly and 7.80% experienced it as passing as normal (Table 2).

3.2 | Correlates and predictors of the passage of time during chronic pain

Table 3 shows correlation coefficients for the relationship between the passage of time today in comparison with when experiencing no pain, the passage of time when pain is at its worst, age, current level of pain, length of pain condition, BPI impact on function, PCS rumination, magnification and helplessness, and HADS anxiety and depression. Examination of Table 3 suggests that the passage of time today in comparison with when experiencing no pain was negatively associated with current pain levels, BPI score, PCS rumination and PCS helplessness. A slower passage of time today in comparison with no pain was therefore associated with higher scores on each of these measures. The passage of time when pain was at its worst was negatively associated with age, current pain,

FIGURE 1 Distribution for the passage of time judgements today and when pain is at its worst.

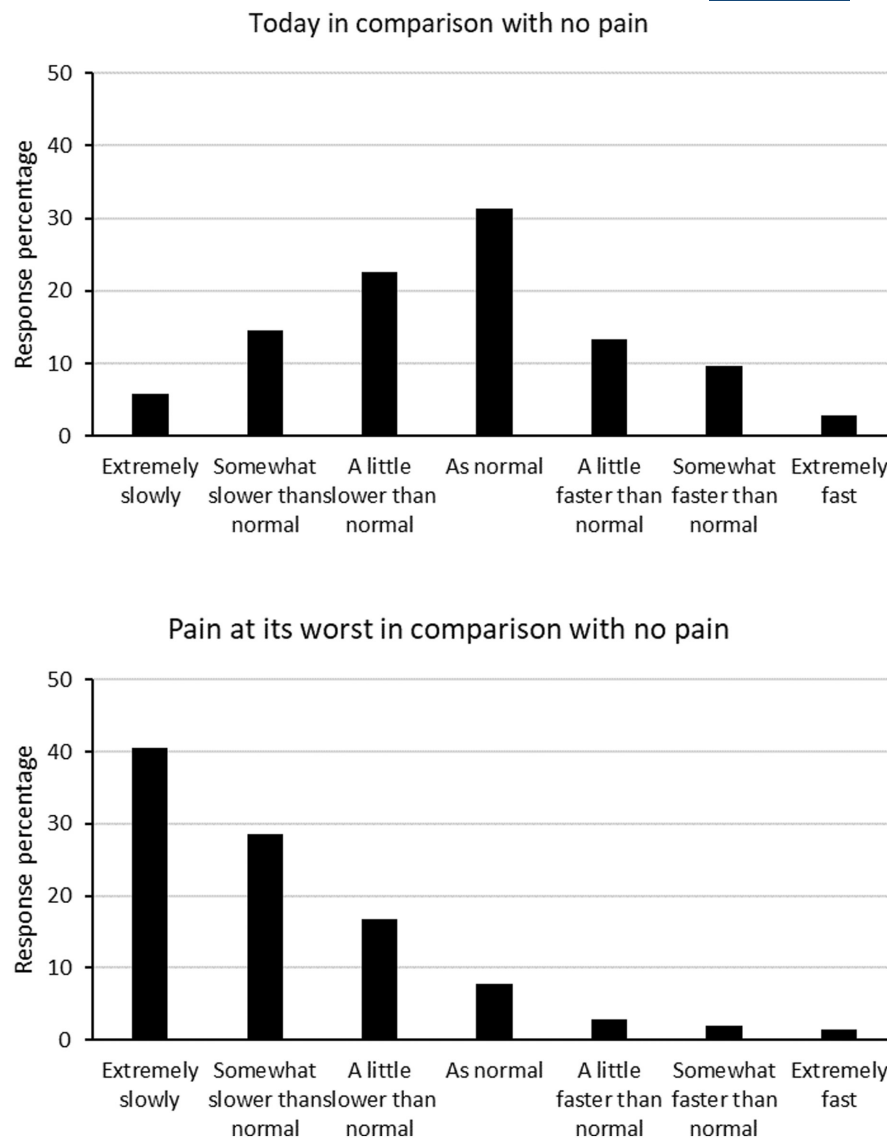


TABLE 2 Means and standard deviations for the questionnaire measures.

Measure	Mean	Standard deviation
BPI intensity	5.16	1.96
BPI interference	5.84	2.60
PCS rumination	11.63	4.16
PCS magnification	7.56	2.90
PCS helplessness	15.79	5.75
HADS anxiety	17.19	2.25
HADS depression	16.81	1.79

BPI score, PCS rumination and PCS helplessness. Higher scores on each of these measures were therefore associated with a slower passage of time.

Ordinal regression with proportional odds was conducted to establish the effect of demographic factors,

anxiety, depression and the measures of pain on the passage of time. Table 4 shows the odds ratios for each variable with 95% confidence intervals.

3.3 | Time experience now in comparison with no pain

The model was a statistically significant, $\chi^2(14)=61.32$, $p<0.001$ fit for the data, with pseudo R^2 values of 0.05–0.16. There were three significant predictors of the passage of time today in comparison with when there was no pain; current level of pain, BPI interference score and PCS rumination. Greater current pain, BPI interference and levels of rumination were all associated with a slower experience of the passage of time now in comparison with when there was no pain. Gender, diagnosis and disability status, HADS anxiety and depression, PCS magnification and helpfulness, length of condition and BPI intensity

TABLE 3 Spearman's correlations between POTJs, measures of anxiety and depression, pain experience and pain catastrophising.

Variables	POTJ-no pain	POTJ worst pain	Age	Current pain	Length of pain	BPI intensity	BPI interference	PCS rumination	PCS magnification	PCS helplessness
Age	-0.03	0.15*	-	-	-	-	-	-	-	-
Current pain	-0.32**	-0.10*	0.19*	-	-	-	-	-	-	-
Length of pain	-0.08	-0.06	0.33**	0.20**	-	-	-	-	-	-
BPI intensity	0.31**	0.16**	0.19**	0.89**	0.22**	-	-	-	-	-
BPI interference	0.33**	0.23**	0.11*	0.64**	0.18**	0.76**	-	-	-	-
PCS rumination	-0.16**	-0.35**	-0.06	0.30**	0.02	0.32**	0.42**	-	-	-
PCS magnification	-0.09	-0.25**	0.11+	0.26**	-0.001	0.28**	0.40**	0.68**	-	-
PCS helplessness	-0.18**	-0.38**	0.12+	0.37**	0.04	0.40**	0.54**	0.79**	0.70**	-
HADS Anxiety	-0.05	-0.02	0.31**	0.13+	0.07	0.19**	0.03	0.21**	-0.27**	-0.22**
HADS depression	-0.02	-0.09	-0.03	-0.04	0.001	-0.06	-0.03	-0.13**	-0.14*	-0.11*

Abbreviations: BPI, Brief Pain Inventory; HADS, Hospital Anxiety and Depression Scale; PCS, Pain Catastrophising Scale; POT-J, passage of time judgements.

* $p < 0.05$; ** $p < 0.001$.

were not predictive of the speed of time today in comparison with when there was no pain.

3.4 | Time experience when pain was at its worst

The model was a statistically significant, $\chi^2(14) = 73.61$, $p < 0.001$ fit for the data, with pseudo R^2 values of 0.07–0.19. There were four significant predictors of the passage of time when pain was at its worst; age, PCS rumination, PCS helplessness, and whether the participant considered themselves to be disabled. Greater levels of rumination, helpless, older age and considering oneself to be disabled were all associated with a slower experience of the passage of time when pain was at its worst. Gender, current levels of pain, HADS anxiety and depression, BPI scores, PCS magnification, being formally diagnosed and the length of condition were not predictive of the speed of time at pains worst.

3.5 | Quantitative questionnaire summary

The results of the quantitative questionnaire data suggest that participants associated chronic pain with the sensation that time was passing more slowly than normal. This was particularly true when participants considered their experience of time when their pain was at its worst. Participants' experience of the passage of time now, in comparison with when they had no pain, was predicted by current pain levels, BPI score and pain rumination. Experiences of the passage of time when pain was at its worst were predicted by pain rumination, pain magnification, age and disability status.

To further understand participants' experiences of time, responses to the two open-ended questions were analysed using thematic analysis. Due to the similarity of answers provided to both open-ended questions, responses were combined.

3.6 | Thematic analysis

Thematic analysis of responses to the open-ended questions suggests that participants experience regular and substantial distortions to the passage of time during periods of chronic pain. Participants overwhelmingly associated chronic pain with a slowing of the passage of time (theme 1). The causes and consequences of temporal distortion during chronic pain were subsumed under three further themes; (2) The intrusive nature of pain; (3) Increased attention to time; and (4) Lost time.

TABLE 4 Ordinal logistic regressions with odds ratio and 95% of confidence intervals with the two passage of time judgements as outcomes.

Variable	Time now in comparison with no pain				Time when pain is at its worst			
	Wald	Odds ratio	95% CI		Wald	Odds ratio	95% CI	
Age	2.05	0.99	0.98	1.00	9.49**	0.98	0.96	0.99
Illness length	0.08	1.00	0.99	1.02	2.44	1.01	1.00	1.03
Current level of pain	6.90**	1.26	1.06	1.50	2.67	0.85	0.70	1.03
HADS anxiety	0.16	1.02	0.90	1.11	2.87	1.09	0.99	1.21
HADS depression	0.01	1.00	1.01	1.12	1.03	0.95	0.85	1.05
PCS rumination	4.69*	1.09	1.01	1.18	4.46*	1.09	1.01	1.19
PCS magnification	2.80	0.92	0.83	1.02	0.75	0.85	0.86	1.06
PCS helplessness	1.01	0.97	0.91	1.03	6.83**	1.09	1.02	1.17
BPI intensity	0.63	0.90	0.71	1.16	0.62	1.12	0.85	1.47
BPI interference	5.02*	1.16	1.02	1.31	0.13	1.03	0.90	1.17
Disabled								
Yes	0.85	0.82	0.52	1.27	4.33*	0.61	0.38	0.97
No	–	–	–	–	–	–	–	–
Formal diagnosis								
Yes	1.02	1.25	0.81	1.93	0.09	1.07	0.68	1.69
No	–	–	–	–	–	–	–	–
Gender								
Male	1.92	0.39	0.10	1.49	0.19	0.70	0.14	3.39
Female	2.90	0.32	0.09	1.19	0.19	0.71	0.15	3.30
Other	–	–	–	–	–	–	–	–

Abbreviations: BPI, Brief Pain Inventory; HADS, Hospital Anxiety and Depression Scale; PCS, Pain Catastrophising Scale.

* $p < 0.05$; ** $p < 0.001$.

3.6.1 | Theme 1: Time passes slowly during periods of pain

Consistent with the quantitative analysis, the majority of participants' experience was that the passage of time during periods of chronic pain was slower than during periods without pain. Participants generally associated increased pain with a greater degree of temporal slowing.

It just drags, as if I'm swimming through treacle, everything seems so slow. Even waiting a few seconds for the microwave to ping or the kettle to boil feels like forever at times.

Agonisingly slowly. Like being in wet concrete not being able to move or stand up.

Participants noted that the slowing of time during pain elongated the sensation of pain, worsening its effects on well-being and quality of life. These effects were

overwhelmingly associated with negative emotions and a sense of helplessness and lack of control. Not only did participants have no control over their pain but they also had no control over its effects on time.

It feels everything is eternal, nothing is more long-lived than a minute in my most hurtful of times, and when I feel like it is finished, another second goes by, and it's the same all over.

Participants often associated the slowing of time with the concurrent sensation that they themselves were slowed by their chronic pain. They reported their thoughts and in particular their physical movements were slowed in comparison to pain-free others and that this contributed to the sensation that time passed more slowly for them because other people were on 'fast forward'.

When the pain is at its worst everything seems to take so much more effort that time seems to slow down.

Whilst this theme was reported by almost all participants, it is noteworthy that a very small number of participants reported the sensation that time passed quickly during periods of pain. These instances appeared to be when pain was so great that participants were unaware of time during pain, resulting in the sensation that time passed by more quickly than normal.

Time passes in odd bursts, if the pain is fairly mild it slows down, when the pain is really bad it speeds up.

In addition, a very small minority of participants reported that they had experienced chronic pain for such a long time that they could no longer distinguish the passage of time during pain from the passage of time before chronic pain. Pain time has therefore become normal time.

I've gotten used to it so I'd say normal?

Time passes normally for me, but similarly I can't recall not being in any pain at all. That is not my normal.

3.6.2 | Theme 2: The intrusive nature of pain

This theme examines the ways in which participants described the role of pain intrusion in their experience of time. Participants believed that the intrusive nature of pain was causal in the slowing of the passage of time that they experienced during chronic pain. This intrusion was characterized as having three primary effects: on cognition, on physical activity and on social engagement.

Participants noted that when they were in intense periods of chronic pain, cognitive pain intrusion prevented them from thinking about or focusing on anything other than their pain. Their inability to distract themselves from the pain or to fill time thinking about anything other than their pain, therefore caused time to pass by more slowly than normal.

Time goes a lot slower, because I am unable to lose myself in a task that would distract me. Pain keeps my focus on exactly that and that alone. You're just waiting for the pain to calm to more manageable levels.

Pain intrusion had a particularly paralysing effect on the passage of time during the night. Here, participants consistently reported that time felt like it was passing particularly slowly when they were unable to sleep because of

their pain. The lack of distractions to fill time when waiting to sleep therefore acutely slowed time.

'Sometimes during the night when the pain has woken me, I feel as if morning will never come'. And 'More slowly, particularly during the night, when I have no other distractions'.

The lack of distractions to 'fill' painful periods of time was also associated with the physical implications of pain intrusion. Participants reported that their pain created an inability to engage in physical activities which would otherwise help them to pass the time more quickly. Participants noted that it was not just the absence of particularly enjoyable or exhilarating activities which slowed time, but also the absence of more mundane day-to-day tasks.

It means I can't do many activities I would do at home, such as housework or extensive cooking, which makes it difficult to pass the time.

Participants also noted that their inability to engage in desired activities due to pain intrusion increased feelings of loneliness and isolation and that this exacerbated the sense of time dragging by.

I'm also less likely to see other people when I feel like this because I can't get out so time moves a bit slower because of that too.

Whilst participants associated pain intrusion with a slowing of the passage of time, they also associated the absence of pain intrusion with a normal, or indeed faster passage of time.

I take painkillers to do the gardening but only manage for small bouts at a time and have to sit down...time does pass very quick when I'm in the garden.

Theme 3: Increased attention to time.

This theme examines participants' descriptions of increased attention to time during periods of chronic pain. Participants described two broad forms of increased attention to time: (1) a general sense of increased clock-watching and temporal awareness during pain and (2) increased monitoring of time whilst waiting for the occurrence of a specific event (most frequently when medication could be taken).

Many participants reported that they paid more attention to time during periods of pain than during pain-free

periods. Increased attention to time was sometimes characterized as simply being more aware of the passing of time; however, it was also described as a greater amount of physical clock-watching to monitor the passing of time.

I'm just more conscious of time, I think usually when people are living normally, time just passes unless they're bored and clock-watching. It's like being permanently clock-watching and being aware of every second and literally having to live through every second rather than it going by unnoticed and it makes time feel like it passes much more slowly.

Participants explained their increased tendency to monitor time in a number of ways. For some, the desire for the day to be over quickly so that they could get relief from pain during sleep resulted in an increased awareness of the passing of time.

I just pay attention to how much time I have until I can sleep next.

For others, increased attention to time was a consequence of a desire to know how long pain symptoms were lasting for. Most commonly however, participants reported that increased clock watching occurred because participants needed to monitor the passage of time to determine when they could take their medication. However, increased clock-watching continued after medication administration because of participants' desire to monitor whether it was nearly time for the medication to take effect, and then, when it was likely that the medication would wear off.

'Time passes very slowly and I cannot wait until I am due to take my next lot of tablets in order to take the edge of the pain' and 'then I wait for it to work. I keep thinking about how long it has been since I took the triptan. If it doesn't work then it is awful, the migraine will go on for days, It is utterly disabling. If it does work, I think about time again and I wonder how long it will work for. Will it come back'.

3.6.3 | Theme 4: Lost time

The final theme explores participants' reports of their retrospective recollections of their experience of time since having chronic pain. Unlike previous themes which explored reports of the experience of the passage of time

'during pain', this theme explores participants' accounts of time when 'looking back' over their lives since developing chronic pain.

When reflecting on the passage of time since developing chronic pain, a number of participants expressed the belief that chronic pain 'stole time' from them, resulting in the sensation that life was flying by quickly. The sensation of past times flying by quickly was seen, in part, as a consequence of the mundanity of life with chronic pain and everyday being the same because it was defined by pain and a lack of activity.

Chronic pain can make every day seem as if it drags on, however, as many days appear to be the same due to the pain, it can make retrospectives on previous days/months seem compressed, as if they passed quickly.

Although when focusing on a particular pain flare, it makes time feel slow ..., when I look at my day to day life overall, time goes really fast. I feel this is because I rarely have events occur or social interaction, by which, I could mark time and it's distance between such events. So every day just blends into one, and therefore it all feels the same.

Life flying by was also associated with a sense of missed opportunities and a lack of achievements during periods of chronic pain as a result of an inability to do things.

Sometimes if I have a bad migraine for days, the days just merge into one another. I can't do much because I'm in pain, so I have nothing to distract. Everything merges into a big, frustrating lump of time that feels like it'll never end. Then when the pain does ease up, it feels like I've lost a chunk of my life. I feel terrible for having not done anything for days, but I wasn't physically capable of it.

The sensations of life flying by without them and time being lost were overwhelmingly associated with negative affect. It was not therefore that participants appreciated the relative 'shortening' of memories of life since chronic pain, instead the rapidity of the progress of time and life with chronic pain created a further aspect of the negative impact and reduced quality of life resulting from their conditions.

Then when the pain does ease up, it feels like I've lost a chunk of my life.

Together with theme 1, this theme illustrates the doubly damned nature of distortions to time during chronic pain. On the one hand, pain is lived as being slow and long. As a result, experiences of pain and distress drag out for participants and remove or reduce pleasurable sensations. On the other hand, in retrospect day to daytime flies by resulting in the sensation that time and indeed life are lost to chronic pain.

3.7 | Integration of quantitative and qualitative findings

Integration of the quantitative and qualitative analysis reveals five core themes which describe participants' lived experience of time whilst living with chronic pain; (1) time slows during pain, (2) this slowing increases as pain worsens, (3) the slowing of time is associated with greater pain intrusion, (4) attention to time is increased during chronic pain, (5) time is seen as lost to chronic pain across

the lifespan. Table 5 shows mapping of data sources for each theme.

Examination of Table 5 suggests that both forms of data illustrate participants' beliefs that the passage of time slowed during chronic pain, that this slowing was more profound with greater pain intensity, and that intrusion from pain intensity was perceived as a determinant factor of time experience. Critically however, the integration of the qualitative and quantitative data enables identification of the mechanisms through which increased pain intrusion may contribute to distortions to the passage of time. These mechanisms are depicted in Figure 2.

The integrated qualitative and quantitative findings depicted in Figure 2 suggest that pain intrusion rendered participants unable to think about anything other than their pain. This, and the pain itself, restricted or limited their physical capabilities, and these factors also impaired their ability to socialize with others and to engage in cognitive tasks (alone or in groups) which would otherwise

TABLE 5 Integration of quantitative and qualitative data.

	Quantitative evidence	Qualitative evidence
Time slows during pain	85.90% reported that time passed more slowly when pain was at its worst in comparison to periods of no pain	Theme 1: the majority of participants' experience was that the passage of time during periods of chronic pain was slower than during periods without pain
Greater pain is associated with greater slowing of time	Current levels of pain and BPI interference score were significant predictors of the passage of time 'now' in comparison with a period of no pain	Theme 1: participants reported that time passed more slowly as pain intensity increased
Intrusion from pain alters time experience	BPS interference, PCS Helplessness and Rumination were significant predictors of the passage of time	Theme 2: Participants associated the negative effects of pain intrusion on cognition, physical abilities and social activities with a slowing of time
Attention to time increases during chronic pain		Theme 3: participants described a sense of increased clock-watching and temporal awareness during pain and increased monitoring of time whilst waiting for specific events or actions such as medication
Time across the lifespan is lost during chronic pain		Theme 4: participants reported that the limitations imposed on them by chronic pain, and the resultant missed opportunities, left a sense that in retrospect, time was lost to chronic pain

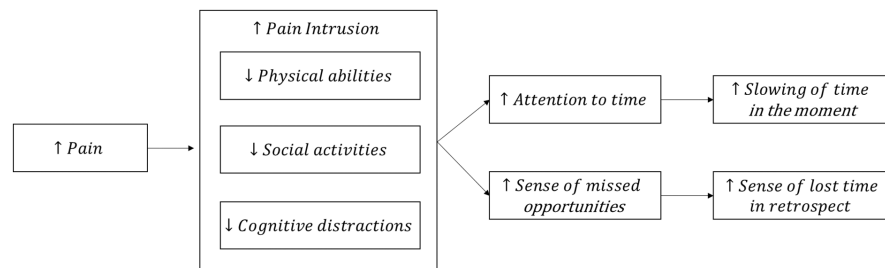


FIGURE 2 Pathways to time slowing during chronic pain.

occupy them. Pain intrusion therefore prevented participants from being able to fill their time with activities which would normally distract them from their pain. Pain-induced restrictions on physical activity, socialization and cognition also prevented participants from filling their time. As a result, participants paid greater attention to the passage of time and this contributed to the slowing of time in day-to-day life reported.

The same mechanisms can also explain why participants reported a sense that, in retrospective, time appeared to pass quickly across the lifetime, because it was lost to chronic pain. In this instance, pain-induced reductions in physical abilities and opportunities for socialization meant that people living with chronic pain missed out on opportunities that people were available to many people living without chronic pain. As a result, time and opportunity were lost to pain because of its intrusion.

Figure 2 therefore demonstrates how qualitative data illuminate the potential mechanisms through which the quantitatively observed relationship between increasing pain and increased pain intrusion slows the passage of time (see Figure 2).

4 | DISCUSSION

This study aimed to explore experiences of the passage of time in people with chronic pain. The results suggest a near-universal trend for time to subjectively slow during periods of chronic pain in comparison to periods without. Chronic pain therefore appears to systematically slow the passage of time, subjectively elongating painful periods relative to pain-free periods.

Integration of the quantitative and qualitative data enabled identification of the potential mechanisms through which pain slows the passage of time. Specifically, increased cognitive, physical and social intrusion from pain prevented participants from engaging in activities which would distract them from pain, or which would help to pass the time during pain. The resultant boredom, isolation and confinement therefore appeared to be one pathway through which the passage of time slowed. This is consistent with other studies conducted in the general population which demonstrate that isolation, boredom and confinement slow the passage of time (Ogden, 2020, 2021).

The effects of pain intrusion on cognition, socialization and activity also slowed the passage of time by increasing general awareness of time and increased explicit monitoring of time (i.e. clock watching). Heightened levels of explicit attention to time may reflect participants' desires to gain a sense of control over their pain. Knowing when pain started, when medication can be administered and

when it is likely to take effect may provide people with chronic pain an enhanced sense of control over pain. However, paradoxically, this heightened attention to time itself contributes to the subjective slowing and lengthening of time during periods of chronic pain. This is because the prioritization of time processing over other forms of cognition slows time by altering the fidelity of the transfer of the raw neural processing of time into working memory (Brown, 2008; Tse et al., 2004; Zakay & Block, 1996). Importantly, non-clinical research suggests that reducing attention to time is an effective way to speed up the passage of time (Brown, 2008). This is mirrored by comments from participants in the current study who noted that the only way to make painful moments pass quickly was by distracting themselves (e.g. by watching the TV). Future research should therefore evaluate whether reducing attention to time is effective in 'shortening' the subjective length of periods of chronic pain without reducing participants' sense of control over their pain.

Pain intrusion also affected participants' retrospective experiences of time. When looking back on their lives with chronic pain, pain stole time from them resulting in the sensation that life was flying by. Participant quotes for this theme are consistent with models of timing which suggest that judgements about the length of previous events are based on the number of memories recallable from the period in question (Block & Zakay, 2001; Ornstein, 1969). In general, the greater the number of memories form in a period of time, the longer the period is thought to be. Conversely, periods from which we can recall few events are remembered as being 'short'. For people with chronic pain, the often mundane and boring nature of life with chronic, coupled with the sense of missed opportunities due to pain intrusion, likely reduced the number of memories formed across their life. This then contributed to the sensation that retrospectively life was passing quickly and that time was being lost.

Although the quantitative findings failed to observe a relationship between depression and anxiety and the passage of time, responses to the open-ended questions revealed that participants associated distortions to the passage of time with an increase in negative affect and the impairment caused by pain. However, this appeared to be situation-specific, that is participants perceived the slowing of time negatively but did not associate this with an increase in general feelings of depression and anxiety. This highlights the importance of taking a mixed methodological approach when exploring the complex effects of chronic pain on cognition.

The findings from this study demonstrate that pain affects a broad range of cognitive functions beyond memory and attention. There may therefore be scope for changes in the perception of time to be incorporated into existing

models of pain (e.g. Fear Avoidance Model, Crombez et al., 2012). Indeed, observations that time slowing was associated with greater rumination related to pain perhaps suggest that that altered time experience may be a driver of ruminative processes.

Distortions to time during chronic pain may also contribute to varying effectiveness of therapeutic models for chronic pain management. Acceptance and Commitment Therapy, and mindfulness-based approaches are based on the idea of centring people within the present (McCracken et al., 2007) and using a non-judgemental approach to evaluate current experiences. However, heightened attention to time may be a barrier to 'present-moment' focused therapeutic models. Furthermore, the pain-time distortions reported also highlight additional difficulties that people may face when completing time-dependant acts such as physical therapies or adhering to time-sensitive medication regimes.

Together, the findings of this study show that there are intrinsic links between the experience of pain and time which require consideration in interventions for chronic pain. The combination of feelings of time lost to pain, coupled with the negative affect associated with the slowing of time during pain, highlights the importance of time in the quality of life of people with chronic pain. We therefore tentatively suggest the need for paradigm shift in the way in which 'time' is viewed in pain treatment. That is, rather than it being viewed as an objective measure of the duration of a condition, therapy or exercise, which passes independently of experience, it should *also* be viewed as a malleable and changeable variable which can act as a vector for the negative consequences of chronic pain. Time should therefore be explicitly considered in therapeutic interventions as a parameter *to* change and as barometer for patient well-being. Interventions which include strategies to structure and fill time may have the dual benefit of reducing the perceived length of periods of pain, via a reduction in attention to time, whilst also attenuating the sense of time lost to pain via an increase in 'filled time'.

Examining changes in the perception of time in chronic pain patients may also present interesting proxy for understanding the effect of pain on cognition. At present, the primary domains that have been researched are attention and memory (Berryman et al., 2013; Moore et al., 2012). However, tasks within these domains are effortful and potentially sensitive to underlying/existing skills and effort mobilization (Moore et al., 2012). By comparison, measures of the passage of time are simple and might therefore be less vulnerable to these effects than existing tasks. Future research should therefore explore time experience as a measure of the impact of pain.

These findings illustrate the myriad of ways in which chronic pain distorts time, and how this distortion then

impacts on well-being. Distortions to time are not limited to periods of pain themselves, but instead encompass reflections on the experience of time across the lifespan. The dual effect of time slowing in the moment of pain and therefore elongating the subjective length that pain is experienced, whilst also being 'lost' in retrospect, illustrates the doubly-damned nature of the temporal distortions during chronic pain. These findings add to existing evidence that distortions to time are a common feature of clinical conditions such as depression (Blewett, 1992), ADHD (Nielsen, 2017) and autism (Poole et al., 2021).

5 | LIMITATIONS

Our sampling technique did not allow us to verify any of the reported symptoms and diagnoses. It is therefore possible that some participants do not meet the criteria for a chronic pain diagnosis. Whilst it is unlikely participants would be motivated to fabricate a diagnosis, the findings should be validated within a clinical setting.

The absence of data on participant ethnicity prevented analysis of the generalizability of these findings across ethnicities. Ethnicity is a significant factor in pain inequality (Morais et al., 2022) and future work should seek to analyse its effects on time experience on chronic pain groups.

Finally, although the quantitative measures of time experience were based on those used in a wide range of existing studies, the measures are not validated. It is therefore possible that the quantitative data generated in this study does not validly reflect participants' experiences of the passage of time. However, the consistency between the quantitative and qualitative findings indicates face validity for the quantitative passage of time measures. Furthermore, the cross-section design prohibits conclusions about whether chronic pain is a causal factor in the time distortions reported.

6 | CONCLUSION

People with chronic pain experience substantial distortions to the passage of time. Pain appears to slow the passage of time, elongating periods of pain, with greater slowing occurring with greater pain intensity. Time slowing was associated with pain intrusion limiting opportunities for distraction and increasing time monitoring. Distortions to time appear to exacerbate discomfort and distress and likely contribute to reduced well-being and quality of life for people with chronic pain. Clinicians should therefore be mindful of pain-induced distortions to time when treating patients.

AUTHOR CONTRIBUTIONS

Ruth Ogden conceived the original idea. Ruth Ogden, Helen Poole, Andrea Piovesan and David Moore planned the study. Ruth Ogden, Helen Poole, Andrea Piovesan and David Moore collected and analysed the data. Ruth Ogden and David Moore took the lead in writing the manuscript. Helen Poole and Andrea Piovesan provided critical feedback.

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CONFLICT OF INTEREST STATEMENT

All authors declare that they have no conflicts of interest.

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