

1 **Title:** “It’s a weight off your shoulders... knowing how your brain works and stuff like that is
2 huge:” a qualitative study of reconceptualisation after Pain Neurophysiology Education for
3 adults with chronic low back pain.

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26 **Abstract**

27 Pain neurophysiology education (PNE) is an educational intervention for patients with
28 chronic pain. PNE purports to assist patients to reconceptualise their pain away from the
29 biomedical model towards a more biopsychosocial understanding by explaining pain biology.
30 This study aimed to explore the extent, and nature, of patients' reconceptualisation of their
31 chronic low back pain (CLBP) following PNE. Eleven adults with CLBP underwent semi-
32 structured interviews before and three weeks after receiving PNE. Interviews were
33 transcribed verbatim and thematically analysed in a framework approach using four *a priori*
34 themes identified from our previous research: 1) Degrees of reconceptualisation, 2) Personal
35 relevance, 3) Importance of prior beliefs, and 4) Perceived benefit of PNE. We observed
36 varying degrees of reconceptualisation from zero to almost complete, with most participants
37 showing partial reconceptualisation. Personal relevance of the information to participants and
38 their prior beliefs were associated with the degree of benefit they perceived from PNE.
39 Where benefits were found, they manifested as improved understanding, coping and function.
40 Findings map closely to our previous studies in more disparate chronic pain groups. The
41 phenomenon of reconceptualisation is applicable to CLBP and the sufficiency of the themes
42 from our previous studies increases confidence in the certainty of the findings.

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49 **Introduction**

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51 Pain neurophysiology education (PNE), has become a commonly used educational
52 intervention for patients with chronic pain. PNE is a cognitive-behavioural-based intervention
53 in that it aims to reduce inappropriate beliefs and maladaptive behaviours, in order to
54 decrease pain and disability, by explaining the biology of pain to the patient (1). A growing
55 body of literature supports its effectiveness (2-10).

56

57 Patients with chronic pain, fuelled by health care professionals, often hold strong biomedical
58 model beliefs that their pain is due to tissue damage (11-14). A number of conceptual models
59 have proposed that such inappropriate beliefs can lead to the development/maintenance of
60 chronic pain. Within the fear-avoidance model, when pain is perceived as threatening,
61 catastrophic thinking can result in pain-related fear and anxiety, leading to avoidance
62 behaviour, disability and a vicious cycle of chronic pain (15). Additionally, as proposed
63 within the model of misdirected problem solving, inappropriate beliefs about tissue damage
64 housed within a medical model framework can lead patients with chronic pain to repetitively
65 seek solutions to remove their pain, moving from one treatment to the next, stuck within a
66 *perseverance loop*. Each unsuccessful solution amplifies the condition and can prevent the
67 patient from reframing their efforts away from an arguably unachievable goal of pain
68 cessation to one of pursuing a *valued life in the presence of pain* (16).

69

70 A primary mechanism by which PNE purports to work is by helping patients better
71 understand their pain and issues around its causes, correcting inappropriate beliefs –
72 reconceptualising their pain (17). Reconceptualisation can be defined by four key concepts:
73 (i) *pain does not provide a measure of the state of the tissues*; (ii) *pain is modulated by many*

74 *factors across somatic, psychological and social domains; (iii) the relationship between pain*
75 *and tissue becomes less predictable as pain persists; and (iv) pain can be conceptualised as a*
76 *conscious correlate of the implicit perception that tissue is in danger* (17). In theory, pain
77 reconceptualisation should reduce the commonly perceived fear that pain is a clear signal of
78 tissue damage by dispelling the notion that pain is an accurate indication of the state of tissue.
79 Reduction of this fear may lead to reduced pain-related fear, distress and disability, improved
80 physical and mental health (15, 18), an escape from the perseverance loop identified within
81 the misdirected problem solving model (16), and potentially reduced levels of pain (8).

82

83 Only a few studies have been carried out exploring the phenomenon of reconceptualisation as
84 a key mechanism of PNE. Evidence that PNE improves participants' knowledge of pain
85 neurophysiology and reduces fear avoidance and pain catastrophising has been used to imply
86 that reconceptualisation is a key factor (3, 4, 19, 20). However, the narrow scope of the
87 outcome measures (using structured questionnaires) in these studies provide limited insight
88 into the complex phenomenon of pain reconceptualisation and a validated questionnaire for
89 the measurement of reconceptualisation has not been developed. At this stage of the
90 development of evidence, qualitative methodology is better suited to studying pain
91 reconceptualisation as it allows for an in-depth exploration of multifaceted phenomenon (21)
92 such as reconceptualisation. Our previous studies have found that patients with chronic pain
93 often hold conflicting views about the cause/nature of their pain. Qualitative methods can
94 help to reveal and explore these conflicting complex beliefs to an extent that quantitative
95 methods cannot (22).

96

97 Two recent qualitative studies completed by our group identified the level of pain
98 reconceptualisation following a single 2-hour session of PNE in patients with chronic pain as

99 “partial and patchy” (23, 24). However, where degrees of reconceptualisation were evident
100 we also saw clinical improvements, supporting the idea that reconceptualisation is a central
101 mechanism of PNE’s effect. A notable finding was the importance of relevance of PNE to
102 the individual’s specific experience as opposed to being relevant to a more general
103 experience of living with pain (23, 24). The participants included in these two studies were
104 from a range of pain conditions including; multisite pain, lower back pain (with and without
105 leg pain), thoracic pain, throat pain, complex regional pain syndrome, neck pain, and upper
106 limb pain. A key factor which may impact upon relevance to the patient is their pain
107 condition and how they perceive PNE fits with their symptoms. Poor perceived fit between
108 symptoms and PNE may reduce perceived relevance for the patient. *“For me personally I*
109 *didn’t think it was any good for the symptoms that I have... it was for more for people with*
110 *different parts of the body pain and not the one I have”* (24). Thus, looking at the experience
111 of PNE for specific pain populations may be important.

112

113 In Robinson et al. (2016) (23) four participants out of a total of 10 demonstrated some
114 evidence of reconceptualisation following PNE. All four had multisite pain. In contrast, two
115 of the four participants with chronic low back pain (CLBP) reported that PNE was not
116 relevant to them, they perceived no benefit, and showed no signs of reconceptualisation.
117 Within educational theory, conceptual change requires a dissatisfaction with one’s current
118 understanding of a concept (25). For many, perhaps most people, there is a strong belief that
119 back pain can be readily aligned with the medical/tissue injury model (26). This gives rise to
120 the possibility that they may be more accepting of a biomedical explanation and thus less
121 open to reconceptualisation than people with multi-site pain or painful conditions that defy
122 the logical of a medical model explanation. It may also be that they are less likely to have
123 encountered an alternative explanation for their pain beyond the medical model. This

124 corresponds with observations we made from previous work (24) where a participant with
125 CRPS, a condition that fits poorly with the medical model, demonstrated pain
126 reconceptualisation following PNE and showed clear signs of an awareness and
127 understanding of pain hypersensitivity before receiving PNE.

128

129 Chronic low back pain (CLBP) is a particularly important pain subgroup to focus upon as it is
130 one of the most common pain conditions globally and it is the largest single cause of
131 disability adjusted life years (2,313 per 100,000 population) in the UK (27). The National
132 Institute for Health and Care Excellence (NICE) estimate that back pain costs the UK
133 economy over 2.1 billion annually (28). Considering the potential importance of the person's
134 pain condition with respect to perceived relevance, reconceptualisation and ultimately the
135 effectiveness of PNE there is a need to explore pain reconceptualisation in people with CLBP
136 following PNE. In doing so, new approaches to tailoring and enhancing this education
137 specifically for patients with CLBP may be identified. Thus, the aim of this study was to
138 investigate the extent, and nature, of people's reconceptualisation of their CLBP following
139 PNE.

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141 **Materials and Methods**

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143 **Design**

144 We used the approach of theoretical thematic analysis (29) with a focus towards deductive
145 analysis to explore the applicability of the themes we had found in our previous work on
146 people with chronic pain in general (23, 24), to a group with CLBP only. Due to the
147 heterogeneity of this studies sample we felt that it was important to be open to exploring the

148 data for any additional/new themes that may emerge. To reflect this we also used inductive
149 analysis.

150

151 **Recruitment and sample**

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153 Participants were recruited from a single site – an NHS pain clinic in the North East of
154 England. We aimed to recruit a convenience sample of 10-12 participants. While no formal
155 guidelines exist with respect to sample size estimation for qualitative studies it has been
156 proposed that in studies where the aim is to understand common perceptions and experiences
157 twelve interviews should be sufficient (30). Patients were eligible for inclusion if they had
158 been referred to PNE as part of their usual care; were ≥ 18 years of age; and if their primary
159 complaint was chronic (>6months duration) lower back pain (+/- leg symptoms) of a
160 neuro/musculoskeletal origin. All referrals were made by Consultants in Pain Management
161 following assessment. None of the participants required spinal or orthopaedic surgery.

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163 Patients were excluded from the study if their level of English was not judged suitable
164 enough to take part in an interview or if their pain was not primarily associated with the
165 musculoskeletal system such as neurological conditions. To limit any feeling of coercion,
166 patients of the interviewer (RK) were also excluded from taking part in the study. Patients
167 with the primary complaint of LBP who had been referred to PNE as part of their usual care
168 were sent a brief information sheet regarding the study. Following this the patient was
169 contacted by a research assistant and asked if they would like to receive more information
170 regarding the study. If they did this information was sent to them and they were contacted to
171 see if they would like to participate. Data was collected between September and November
172 2014. This study was approved by NRES Committee Yorkshire & The Humber – Sheffield

173 (REC Reference number: 14/YH/0153). Written informed consent was obtained from all
174 participants before they entered the study. On completion of data collection all data was fully
175 anonymised.

176

177 Intervention

178 All participants in this study received PNE as part of their routine usual NHS care. The PNE
179 session was heavily based upon the manual *Explain pain* (1). The PNE session was delivered
180 in a group setting of 10-12 patients with chronic pain. The patients within the groups were
181 heterogeneous with respect to their clinical condition, however only people with CLBP were
182 recruited into this study. Thus the PNE delivered was not back pain specific. The intervention
183 was delivered by two experienced, pain specialist physiotherapists who have worked within
184 the pain setting for > 5 years each, had undertaken postgraduate training in pain and attended
185 *Explain Pain* courses delivered by the Neuro Orthopaedic Institute. Published service
186 evaluation data has shown that patients with chronic pain who receive PNE at this clinic
187 demonstrate average increases in pain knowledge in keeping with increases reported in the
188 literature (31, 32).

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190 **Data collection**

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192 Participants underwent a semi-structured interview one week prior to PNE. The interview
193 script is provided in supplementary material 1. The pre-PNE interview focused on beliefs
194 about the nature, cause and experiences of their pain. Three weeks after PNE, participants
195 were re-interviewed by the same researcher using the same semi-structured approach.

196 Participants were asked the same questions as in the first interview but were also asked to
197 reflect on any change in their understanding of their pain. All interviews took place in the

198 hospital in a private room lasting approximately one hour, with only the interviewer and
199 participant present. They were audio recorded and transcribed verbatim for thematic
200 analysis.

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202 **Analysis**

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204 The primary analysis of the data was conducted by RK using NVivo software (version 10),
205 following the guidelines for theoretical thematic analysis outlined by Braun and Clarke
206 (2006) (29). Each transcript was read multiple times and statements were coded according to
207 their meaning. Coded statements were grouped together into four *a priori* themes that we
208 found in our previous work (23, 24) - degrees of reconceptualisation; personal relevance;
209 importance of prior beliefs; and perceived benefit of PNE.

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211 We also provided for the emergence of themes that did not fit with the above.

212 To ensure dependability, all views were treated equally. Three weeks following the second
213 interview, RK telephoned all participants to verify that he had an accurate interpretation of
214 the participants account. Only 8 participants could be contacted. During the telephone
215 conversation extracts from the interview were described to the participant to assess/verify if
216 the researcher had made an appropriate interpretation of the interview comments. In all cases
217 the participants agreed with the interpretation of the account. Therefore, no amendments were
218 made. The average duration of the telephone conversation was 12 minutes. Following this
219 process, a second researcher (HE) read all the transcripts to ensure the themes were logical
220 and rooted in the data. To increase credibility, the results were circulated throughout the rest
221 of the research team for further refinement and to be collected into a coherent account.

222

223 Evidence for or against the *a priori* themes was sought from participants' subjective accounts
224 and changes were explored by comparing participants' pre and post PNE interviews.

225

226 **Reflexivity**

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228 Reflexivity relates to the amount of influence the researcher – consciously or unconsciously –
229 has on the outcome of the study and can be defined as; “*a continuous process of reflection by*
230 *the researcher on their values, preconceptions, behaviour or presence and those of the*
231 *participant which can affect interpretation of responses*” (33). Therefore, disclosure of the
232 researchers' standpoints allows the reader to consider how this might have impacted on the
233 findings. To this end four of the researchers (RK, VR, JW and CR) have experience of
234 delivering PNE. RK and VR have extensive experience in pain management (6 and 11 years'
235 full time physiotherapists in pain management respectively), regularly deliver PNE as part of
236 their clinical practice and have undertaken professional training to do so. It is their (RK, VR,
237 JW and CR) belief that PNE is a clinically useful intervention; however, they have no vested
238 interest in the outcome of this study. DM and HE do not have experience of delivering PNE
239 clinically. Their involvement is from a research methods perspective. They support the
240 potential underlying theory of reconceptualisation and remain open to the theories being
241 shaped by evidence.

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248 **Results**

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250 Out of 12 participants initially recruited only 11 provided a pre and post interview. One
251 participant did not provide a post interview (participant 6). This individual didn't supply a
252 reason for this and we did not have ethical approval to approach her to find out why she did
253 not attend (table 1). Of the 12 participants 7 were female and 5 were male. All participants
254 were diagnosed with low back pain of greater than 6 months duration. The average (range)
255 duration of pain was 10 years 4 months (8 months – 26 years). The average (range) age of
256 participants was 48 years of age (25-72 years). Of the 12 participants 3 were unemployed, 6
257 were employed and 3 were retired. Participants ranged from having no qualifications to
258 holding a BSc (Hons) degree. A summary of how each participant was analysed against the *a*
259 *priori* themes is shown in table 1. Additional themes, beyond those identified *a priori*, did not
260 emerge from the data.

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273 **Table 1. Participant demographics and thematic analysis for each of the four *a priori* themes**

ID					Pre		Post			
	Age (yrs)	Sex	Duration of pain (yrs)	Work status	Belief that pain may not be due to tissue damage	Awareness of an Emotion-pain relationship	Tissue damage reconceptualization	Role of emotion reconceptualization	Personal relevance	Perceived benefit
P1	42	F	22.0	Unemployed	No	No	Partial	Yes	Yes	Yes
P2	51	M	26.0	Unemployed	No	Partial	Partial	No	Yes	Yes
P3	44	F	6.0	Employed	No	Yes	Partial	Partial	Yes	Yes
P4	29	M	3.0	Employed	Yes	Yes	Yes	Yes	Yes	Yes
P6	25	F	4.5	Employed						
P7	46	F	10.0	Unemployed	Yes	Yes	Partial	Yes	Yes	Yes
P8	55	M	8.0	Retired	No	Partial	Partial	No	No	No
P9	72	F	5.0	Retired	No	Yes	No	No	Unclear	No
P10	40	F	22.0	Employed	No	No	Partial	No	Unclear	-
P11	62	F	0.7	Retired	No	Partial	No	No	No	No
P12	56	M	7.0	Employed	No	No	No	No	No	-
P14	58	M	3.0	Employed	Yes	Partial	Yes	-	Yes	Yes

274 *Legend: Table showing participant's prior beliefs, degree of reconceptualization, perceived relevance of PNE, and perceptions of benefit. The tissue damage*
 275 *reconceptualisation and role of emotion reconceptualisation categories looked at change from pre PNE. Blank (-) spaces indicate that the issue was not*
 276 *discussed. Yes and No are used when there was clear evidence related to the theme and partial when there was tentative evidence. Unclear is used when the*
 277 *issue was discussed but it could not be determined whether the evidence supported or refuted the issue. P6 didn't provide a second interview. F = females, M*
 278 *= male.*

279 **Theme 1: Degrees of reconceptualisation**

280 No evidence for reconceptualisation was found in the accounts of Participants 9, 11 & 12.

281 Following PNE, their explanations of the current cause of their pain were expressed

282 exclusively in biomedical language, as was the case before PNE.

283 “*When they done the MRI, when they done that, they discovered I had this impingement in my*

284 *spine.*” P9 pre

285 “*The reason why I’m in pain? Because of my impingement...*” P9 post

286 We observed evidence of reconceptualisation in the accounts of P1,2,3,4,7,8 & 10. This

287 evidence took various forms: language that no longer discussed pain in purely biomedical

288 terms; the use of neurophysiological terms in a way that was not evident in the interviews

289 before PNE; new language about the links between pain and emotions.

290 P10’s shift from an entirely biomedical view of her pain to becoming open to the idea that

291 such an explanation may not be sufficient is illustrative.

292 “*...I won’t have that made as an excuse for this because there’s something real happening in*

293 *my back. I think there’s something wrong with my discs.*” P10 pre

294 “*...there might not be [a structural] explanation for it...as it was explained in the session*

295 *last week, it might not be structural.*” P10 post

296 For P1,2,3,7 & 8 we considered the evidence for reconceptualisation as *partial and patchy*

297 because the language consistent with reconceptualisation was accompanied by language that

298 was consistent with a biomedical understanding of pain. For example, in her interview before

299 PNE, P1’s response to being asked about the cause of her back pain was

300 “*Sclerosis...I know I’ve got disc degeneration.*” P1 pre

301 After PNE, she introduced neurophysiological language using the phrase “new nerve” in
302 relation to neuroplasticity

303 “...it is the new nerve in sending the messages up...” P1 post

304 while still describing the current cause of her pain in structural terms as before PNE.

305 “I know I’ve got sclerosis of my lower back...whether the arthritis is starting to affect it more
306 I don’t know.” P1 post

307 Participant 4, however, showed strong signs of reconceptualisation that exceeded partial
308 reconceptualisation. He demonstrated the clearest change from pre to post PNE with respect
309 to his explanation of his pain and his appreciation of the role of psychosocial factors on his
310 pain. Both showed a clear shift away from the medical model. Prior to PNE the participant
311 believed that the most likely cause of his back pain was a fracture that had shown up in an
312 MRI scan based on consultations with two different health care professionals

313 “He showed me on the thing (MRI scan) with his finger, that looks like a stress fracture to
314 your back” P4 pre

315 “He (the health care professional) said, and he believed that I’ve probably like fractured a
316 couple of bones in my body” P4 pre

317 After PNE P4’s explanation of his current pain was uniformly expressed in
318 neurophysiological language with an absence of the biomedical language that had dominated
319 the interview before PNE. “...any slight jarring, or anything like that, and it sends my back
320 into spasm, which is like just basically creating a protective shell and it’s so used to doing it
321 it’s on hypersensitive and I think that’s generally why my pain is, and it’s just not switching
322 off...(Interviewer: What causes that hypersensitivity?) ...I think that’s all those too much
323 chemicals in my body.” P4 post

324 Also, he showed a clear change in understanding of the link between pain and mood from
325 tenuous

326 “...I won’t completely reject it...” P4 pre

327 to a full acceptance of the links.

328 “...the psychology...and stuff like that is massive and knowing how your brain works and
329 stuff like that is huge...” P4 post

330 Participant 14 was a unique case. With a university-level educational background in biology,
331 P14 had developed a clear understanding of pain mechanisms consistent with
332 reconceptualisation as seen in his interview before PNE.

333 “...I’ve had possibly a few back problems...and my back has picked up on this, if you like the
334 nerve has picked up on this, it’s sent the signals to the brain, the brain’s sent it back down
335 and it probably happens over two or three months.” P14 pre

336 That understanding did not change after PNE but was reinforced.

337

338 **Theme 2: Personal relevance**

339 Even though he already had a clear understanding of pain mechanisms, P14 did find the
340 session relevant to his own condition.

341 “it all it did was to completely reaffirm the way that I was actually going or the way I’d
342 actually thought before I came but you did it did help to if you like allay any I was going to
343 say fears but it’s not so much fears it’s more concerns that I had in many ways, I’m going
344 round the twist.” P14 post

345 Of the 7 participants in whose accounts we observed evidence of reconceptualisation, we
346 counted 5 as having applied that reconceptualisation to their own particular circumstances -
347 P1,2,3,4, & 7. In other words, their new understanding had personal relevance. Typically, this
348 was noted by clear use of the first person singular such as

349 *"...basically the cause of my pain, my pain is sort of constant..."* P4 post

350 and by clear statements discussing the relevance of the session

351 *"...at the time things that she was explaining did make sense and how, you know, things just*
352 *triggered and how it all moves around your body and your mind and everything...I could*
353 *relate to it, I could relate to it."* P7 post

354 In contrast P8's account of reconceptualisation was more theoretical and related to a more
355 general experience of living with pain, and when he described his own condition the language
356 was explicitly biomedical. Participants 9, 11 and 12 showed no clear evidence of relevance
357 and indeed Participant 11 made it clear that she saw PNE as just another of the many things
358 she was open to trying to help with her pain.

359 *"If you offered another session to me I'd still go, whether it was 100% relevant to me or not,*
360 *I'll take anything that's going, I won't knock anything."* P11 post

361 Participant 12 also reported a lack of relevance. His problems were pain and numbness in his
362 legs following back surgery that had reduced pain in his back and he lamented the lack of a
363 particular focus on his personal circumstances in the session.

364 *"...I didn't get the chance to explain what my problems were...it was about pain in general*
365 *but it wasn't targeted at myself or anybody specific, it was just like everybody."* P12 post

366

367 **Theme 3: Importance of prior beliefs**

368 Before PNE, all three participants in whom we found no reconceptualisation (P9, 11 & 12)
369 believed that their current pain was caused by biomechanical factors and did not show any
370 signs of dissatisfaction with this belief. The beliefs of Participants 9 and 12 were passive in
371 that they hadn't really given other potential causative factors consideration while Participant
372 11 was actively opposed to any alternative explanation – indeed she had walked out of a
373 previous consultation when the clinician enquired about social issues.

374 *“...all she wanted to know about was my personal life and I walked out because I said I'm*
375 *not here about anything other than a crash...” P11 pre*

376 Participant 8, whose reconceptualisation was general rather than personal, had a steadfast
377 belief that his current pain was caused by damage to his facet joints. For the other six
378 participants in whom we did find some reconceptualisation and relevance (P1, 2, 3, 4, 7 &
379 10), all apart from Participant 1 stated prior beliefs which demonstrated either a
380 dissatisfaction with their existing biomedical explanation of the current pain

381 *“...the only thing I've been told as well it's probably mechanical...I'm not convinced that it*
382 *is mechanical, it's not the same kind of pain as on the left side...” P3 pre*

383 and/or an openness to a more biopsychosocial/neurophysiological sensitisation explanation
384 consistent with PNE.

385 *“I think I've got a lot of nerve, I know I've got a lot nerve damage...I think it's just those*
386 *nerve endings suddenly coming alive again...I presume it's just that message going to my*
387 *brain saying you're in pain, that's all I'm thinking you know, I don't know if that's correct.”*
388 P7 pre

389

390 **Theme 4: Perceived benefit of PNE**

391 Neither Participant 8 nor Participant 10 described any clinical benefit from their PNE session.

392 In the case of P8, rather than showing a clinical benefit after PNE, he discussed scenarios that

393 were at odds with the aims of PNE. Most marked were statements about restricting

394 movement and activity because of the potential damage to structures in his back.

395 While he offered an explanation for back pain linked to neurophysiology following PNE,

396 *“... a build-up of the gateways being open permanently...allowing sensation to override...”*

397 he clearly continued to link his pain with tissue damage.

398 *“I think it’s telling me be careful...because you don’t want to aggravate an injury or a*

399 *potential injury or something’s going to happen if you continue with that activity.”* P8 post

400 The context of this was that he was comfortable with the facet joint diagnosis that he had

401 received and its plausibility was enhanced because he had experienced benefit from a

402 stretching regime that he could rationalise in terms of that diagnosis. That ties in with his

403 general rather than personal reconceptualisation.

404 P14 reported clinical benefit mainly in terms of reinforcement of his current understanding

405 *“...all it did was to completely reaffirm the way that I was actually going or the way that I’d*

406 *actually thought before I came to you...”* P14 post

407 and clarification of some concerns that were causing him confusion.

408 *“...it did help to, if you like, allay any, I was going to say fears, but it’s not so much fears,*

409 *it’s more concerns that I had in many ways, I’m going round the twist.”* P14 post

410 The remaining participants who we considered to have showed various degrees of partial
411 reconceptualisation (P1, 2, 3, 4 & 7) all spoke about benefits from PNE. These described
412 improved understanding about their pain and its management;

413 *“It made a lot of sense as to why even though especially over the last three or four years and*
414 *all they’ve been doing is upping the painkillers why I’m not getting the relief that I thought I*
415 *would be getting off them.”* P3 post

416 an increased ability to cope with pain;

417 *“...I suppose it’s the acceptance what I’ve got out from this session is like to trying to accept*
418 *the fact that you’ve got the pain for life and it’s how that pain is managed is what makes life*
419 *more manageable in itself.”* P2 post

420 and functional improvements.

421 *“...when I was walking quite briskly I just slowed down. I thought, oh calm down you’ve got*
422 *plenty of time to get there...where before I would have just carried on...”* P7 post

423 Here, P7 describes how her new understanding of her pain influenced her walking in a form
424 of activity pacing to carry on functioning while still experiencing pain.

425 Those who did not show signs of reconceptualisation under our criteria (participants 9, 11, &
426 12), showed neither personal relevance nor clinical benefit.

427 *“It was more interesting than useful”* P11 post

428 Participant 2 provided the first example in the literature of evidence of an adverse effect from
429 PNE in that she found the session to be upsetting. She explained how the PNE instructor had
430 given an example of someone who injured his back falling off a ladder and then found his
431 pain triggered when he saw a ladder. From that example Participant 2 recognised how she

432 associated her back pain with childbirth and that now the presence of her child was acting as
433 a trigger for her pain.

434 *“They made a reference to a person who had chronic back pain after having fallen off a*
435 *ladder and every time they saw a ladder or had to go anywhere near a ladder it triggered the*
436 *pain, made it worse, and although that’s nothing like my situation it made me worry because*
437 *my back pain is related to childbirth that the effects my pain was having on my family... I was*
438 *upset to think that my pain was sometimes worse when my daughter was being more*
439 *demanding and although that scenario that was given that person could spend a good quality*
440 *of their life avoiding the situation, avoiding using a ladder, avoiding going near a ladder, I*
441 *don’t want to and couldn’t even if I did want to avoid the situation of being a parent...I mean*
442 *it was just that the pain could be associated to the cause and knowing the cause of my pain*
443 *was my daughter initially though it wasn’t her fault.” P2 post*

444

445 **Discussion**

446 This study aimed to explore the extent, and nature, of patients’ reconceptualisation of their
447 CLBP following PNE. The study investigated if the findings from our previous studies on
448 reconceptualisation with PNE for people with chronic pain were sufficient to describe the
449 experience of people specifically with CLBP. We found that the *a priori* themes – degrees of
450 reconceptualisation, personal relevance, importance of prior beliefs and perceived benefit of
451 PNE – were all clearly identifiable within the data and did indeed provide a good description
452 of participants’ accounts.

453 Our finding of partial and patchy reconceptualisation, whereby participants showed a range
454 of degrees of reconceptualisation including none, is similar to what we found previously (23,

455 24). Our earlier observation of the importance of prior beliefs applies here as well. This time,
456 however, we found strong signs of reconceptualisation in one participant, P4. What was
457 interesting was that his prior beliefs were not notably dissimilar to that of others.

458 The role of prior beliefs of participants within our study were in keeping with the four steps
459 to accommodate a new scientific concept outlined by Posner et al. (1982) (25): 1)
460 dissatisfaction with current beliefs; 2) the new concept making sense to the person; 3)
461 plausibility of the new concept; 4) a belief that the new concept will be of practical help to
462 the person. Broadly those who showed no signs of reconceptualisation showed no signs of
463 dissatisfaction with their existing biomedical explanation for their pain while the majority of
464 those who did show signs of reconceptualisation were open to the neural sensitisation
465 explanation of pain within PNE as plausible/relevant/potentially helpful.

466 P4 shows that it is possible to achieve advanced reconceptualisation after one session.
467 However, for most it seems that more sessions would be required. P14's report of clinical
468 benefit further highlights the importance of the availability of follow up education. This was
469 someone who had already acquired a high level of reconceptualisation and was functioning at
470 a high level but was suitably troubled to seek help from a pain clinic. His expressed need was
471 clarification of some issues that were causing him problems.

472 Another finding in this study that we had not come across before was the distress experienced
473 by P2. She reported the distress as happening during the session and it was evident at the time
474 of the interview three weeks after. We do not have any insight into how long if at all the
475 distress continued into the longer term. This is the first reporting of an adverse event
476 associated with PNE in the literature. The participant was offered the opportunity to discuss
477 their feelings with a clinical psychologist, however, they didn't think this was necessary and
478 therefore declined the offer.

479 The lack of long term follow up is a limitation of this study. Pain management is an ongoing
480 process and this is an important gap in knowledge. As highlighted by the needs expressed by
481 P14 for education despite having a long history of managing his pain successfully, it would
482 be foolish to think that people would never need further education and advice. The lack of
483 data saturation could also be viewed as a limitation of this study (34). However, this study did
484 not attempt to achieve data saturation. The need for data saturation in all qualitative studies
485 has not been established and it has been proposed that using saturation as a generic marker of
486 qualitative research quality is misplaced (35). The sample size employed in this study is in
487 keeping with previous recommendations for studies which aim to *understand common*
488 *perceptions and experiences* within a homogenous group (30).

489 As we have previously demonstrated (23, 24), relevance was once again seen as catalytic in
490 the clinical impact of PNE. Interestingly, in Participant 8, we found an example of a
491 participant who had misinterpreted the information to reinforce their maladaptive beliefs and
492 behaviour having come across this in one of our previous studies (24). This may reflect a
493 form of confirmation bias that has been noted in the learning of scientific concepts (36).
494 Again, this reinforces the need for follow up education and support.

495 A strength of the study was the use of interviews before and after the PNE session, which
496 allows greater insight into changes in beliefs than would be obtained by only interviewing
497 people after PNE. The coherence of the themes between our previous work and the current
498 findings lends confidence to the certainty of this evidence (37). That said, at this stage the
499 findings are still subject to the limitations of qualitative research as outlined in our last study
500 (24) with the findings being illustrative rather than representative with limitations determined
501 by the delivery of PNE by way of a single session; the close proximity between the post PNE
502 interviews and the delivery of the session; and the restriction of the sample to people whose
503 first language is English.

504 Recommendations for future research

505 Important further work is needed to develop a method, probably using a questionnaire, to
506 allow quantification of reconceptualisation so that a statistical approach can be used to
507 produce more representative findings. This would require careful preliminary work to
508 develop such a questionnaire with appropriate validity and reliability of a potentially
509 mercurial construct. A useful starting point could be the pain neurophysiology quiz which has
510 been developed and revised as a method of assessing change in knowledge of pain
511 physiology information (38). Also, further work is required to extend the qualitative approach
512 used here to explore the delivery issues stated above.

513 Given the importance of the personal relevance of the information provided to the patient in
514 PNE identified in this study and our previous work (23, 24), PNE may be most effective
515 when the information is tailored to the individual. This would be in keeping with Moseley
516 (2003) who found that PNE was clinically more effective, though less cost-effective, when
517 delivered in a one-to-one compared to a group setting (19). Future work should explore if
518 PNE delivered in a homogenous patient group setting (e.g. a group of patients with CLBP)
519 facilitating a more tailored group approach would maximise both clinical and cost-
520 effectiveness. Patient group specific PNE curricula are already available for a range of
521 specific pain groups including people with CLBP (39). Another clinical approach to facilitate
522 tailoring of the material, to enhance relevance, could be to have the educating therapist
523 undertake a thorough examination of the patient prior to delivering PNE. The examination
524 could be used as a way of identifying individual patient issues (e.g. anxieties, fears,
525 misconceptions) that could be specifically targeted during the education session. Again,
526 future work should explore if this would enhance the effectiveness of PNE.

527 PNE may be most effective when delivered in combination with other interventions, such as
528 exercise, compared to when it is delivered in isolation (8, 10) as in this study. It would be
529 interesting to explore qualitatively the extent and nature of patients' pain reconceptualisation
530 following PNE delivered as part of a comprehensive multimodal package of care. Finally,
531 Health care professional's beliefs about pain can influence their clinical management of their
532 patients. PNE has been shown to enhance healthcare students understanding of pain and
533 increase their likelihood of making appropriate recommendations for patients in practice. (40,
534 41). However, that work has been quantitative nature and there is a need to further explore
535 health care professional student's experience of PNE and the extent and nature of their pain
536 reconceptualisation qualitatively.

537 **Conclusion**

538 This study aimed to explore the extent, and nature, of patients' reconceptualisation of their
539 CLBP following PNE using a set of *a priori* themes developed from previous research with
540 heterogeneous samples of pain patients. We found that patients with CLBP who received
541 PNE underwent varying levels of reconceptualisation, that the degree of reconceptualisation
542 was influenced by previous beliefs and how relevant the information was deemed by the
543 patient. Furthermore, the degree of reconceptualisation appeared to be related to the
544 perceived benefit reported by the patient. No new themes beyond the *a priori* themes
545 emerged. The findings were in keeping with our previous work, which included chronic pain
546 participants from a range of clinical groups including multisite pain, back pain and complex
547 regional pain syndrome. The applicability of the four *a priori* themes, developed in previous
548 heterogeneous pain samples, indicate that the key experiences of PNE for those with back
549 pain are similar to those identified within samples of patients consisting of heterogeneous
550 pain groups.

551 **Data Availability**

552 Anonymised extracts of the interviews are available from the following authors CR and RK.
553 As part of the research ethics and governance approval process participants were assured that
554 interviews would not be shared outwith the research team to ensure anonymity and
555 confidentiality. Permission from participants was obtained to publish/share extracts from the
556 interviews but permission was not obtained to publish/share full interviews.

557

558 **Conflicts of Interest**

559 CR and DM have a patent in submission for a medical device that could be used for the
560 treatment of chronic pain conditions. We believe the device is unrelated to the material
561 presented in this study but in the interests of full disclosure wish to acknowledge this
562 information. The other authors have no conflicts of interest to declare.

563

564 **Funding Statement**

565 The study was funded by a Scheme B grant from the UK Chartered Society of Physiotherapy.

566

567 **Acknowledgements**

568 The authors would like to thank all staff and participants who facilitated this study.

569

570

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690 **Supplementary material 1**

691

692 Interview Schedule.

693 Introduction.

694 Warm up questions.

695 1. Can you tell me about your pain?

696 2. How long have you had CP?

697 3. How did it start?

698 A. Current pain conception (Does pain represent tissue damage in the participants' belief
699 system?)

700 1. What is the cause of your pain?

701 a. If you were to tell a friend what causes your pain what you say?

702 b. Why does that cause pain?

703 2. What does your pain tell you about the state of your tissues?

704 a. Because you are in pain are your tissues injured.

705 3. How do you know that is the cause of your pain?

706 a. Without mentioning names, who told you/diagnosed your problem? (was it a
707 Doctor/physiotherapist/other?)

708 b. Have you had other opinions?

709 c. Have you done your own research?

710 4. What evidence do you have for your understanding for the causes i.e. scans, test doctors.

711 B. Other contributing factors (pain can be modulated by many factors)

712 1. What affects your CP?

713 Prompts. Is your pain always the same level on a VAS or does it alter? If so, what alters it?

714 2. What makes it better?

715 3. What makes it worse?

716 Prompts. Physical/Emotional /Social factors

717 C. Length of time you have been in pain. (The longer pain persists the less predictable and
718 weaker the correlation between pain and tissue damage become)

719 1. What does the length of time you have been in pain say about your pain?

720 Prompt. Has the problem heeled/not healed? Does it mean the problem has got worse or
721 getting worse?

722 2. Does your pain behave the same way as it has always behaved?

723 3. Can you predict what will cause your pain?

724 4. Can you predict the way your pain will behave?

725 a. and have you always/ever been able to predict this?

726 Prompt. Activity/the weather hot cold/stress/depression/fatigue

727 D. Does worrying about the cause of pain correlate to pain levels

728 1. Do you associate your pain with danger to the tissues?

729 2. Are you worried about the cause of your pain?

730 3. Has the state of worry, (ether not worried or worried) changed over time?

731 4. In that time has your pain changed?

732 Prompt. Does the amount you worry about your pain effect the level of pain you are in?

733 **E. Second interview: Questions.**

734 Introduction

735 1. What did you think of the education session?

736 2. Was it relevant to you?

737 3. Was there any information that you had not heard before?

738 4. Did you understand the session?

739 5. Has it changed the way you understand your pain

740 Prompt.

741 6. Were you able to identify with any new contributing factors, for example, thing that might
742 make your pain worse or better?

743 7. What are the cause of your pain? Are they the same now as before the session?

744 a. You said that your pain was due to your.... for example Back/neck/FMA

745 8. Has the session change any worries you might have had about your pain?

746 a. For example you said.... for example, you were worried about the stat of your
747 back/future/wheelchair etc

748 9. If you have adopted a new belief about the cause or influences of/on your pain how
749 relevant are they

750 a. How must is due to sensitisation how much is due to MSK origin?

751 10. Were there parts of the talk that you found more useful/relevant?

752 a. If so which part and why?

753 11. Rounding off

754 Is there any ways I which it could be improved?

755 Is there anything you would like to ask?

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