Exploration of changes in understanding and coping strategies among individuals with low back pain following a short multidisciplinary rehabilitation program with a pain neuroscience education component: a qualitative study alongside a randomised controlled trial

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ABSTRACT

Context: A clinical trial was recently conducted to compare the efficacy of pain neuroscience education (PNE) with spinal physiology and ergonomics education as part of a short multidisciplinary rehabilitation program (MRP) in individuals with persistent low back pain (LBP). A qualitative study could provide additional context for these results. OBJECTIVE: To explore change in understanding and coping strategies in individuals with persistent LBP who received PNE as part of a one-week MRP. **Methods**: Four medical residents conducted semi-structured interviews of 12 individuals with LBP who had participated in a one-week MRP including a PNE component. Audio recordings were analysed thematically by three physiotherapists. **Results**: The prespecified themes of understanding and coping were present in the data and analysed with regard to change. Other themes – other forms of learning, other barriers to change, satisfaction and criticisms – also emerged. Pain reconceptualisation was frequently associated with new adaptive coping strategies. However conceptual change was found in only half of the participants and does not always appear to be sufficient to lead to changes in coping strategies for pain. Other forms of learning (e.g. experiential learning) and non-educational factors (e.g. motivation) also seem to influence conceptual and coping change. Satisfactions (e.g. innovative nature of the approach) and criticisms (e.g. lack of interaction and insufficient connection to everyday life) were reported by some participants. **Conclusion**: Strategies that promote conceptual change, safety perception, and behavioural change are likely to improve the outcomes of PNE within a MRP.

KEYWORDS: patient education, low back pain, chronic pain, rehabilitation

Introduction

Low back pain is a complex and painful condition, the persistence of which appears to be associated with the sensitivity of vertebral structures and the combined influence of various biological, psychological and social factors [1]. Along with therapeutic exercises and physical activity, patient education has been included in management guidelines for individuals suffering from low back pain [2, 3]. Among these educational programs, Spinal Physiology and Ergonomics Education (SPEE) is the most conventional one [4, 5]. In this context, pain neuroscience education (PNE) is an educational approach consisting of explaining pain using images and metaphorical explanations of the neurophysiological mechanisms of pain [6, 7, 8]. Many clinical trials have compared the efficacy of PNE and SPEE [9, 10, 11, 12]. When combined with a multimodal exercise program, PNE was associated with significantly lower levels of disability in the medium and long term (relative to a biomedical education and

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exercise program) [12]. Moseley suggested that this effectiveness was due to the phenomenon of pain reconceptualisation [13]. Shifting the understanding of pain from a neurophysiological perspective may promote more appropriate cognitive and behavioural coping strategies. However, in a recent randomised study, we were not able to detect any meaningful difference in functional improvement between PNE and SPEE when nested within a one-week multidisciplinary rehabilitation program in individuals with persistent low back pain [14]. Qualitative research methods provide a means of interpreting the results of quantitative studies [15]. A few qualitative studies of PNE have already been reported, but none have focused on understanding the differences in outcomes between PNE and SPEE [16]. As a result, the objective of the present study was to assess changes in understanding and coping following PNE sessions within a multidisciplinary rehabilitation program (MRP).

Methods

Study design

This qualitative study consisted of semi-structured interviews and a deductive thematic content analysis of prespecified themes derived from previous research on PNE [17, 18, 19] and the common sense model of chronic low back pain [20]. The study also included an inductive analysis, so that new (non-prespecified) themes could emerge. The study took place in the Department of Physical Medicine and Rehabilitation at Pierre Swynghedauw Hospital (Lille, France). Participants were recruited from the EVAL-PNE trial [14]. Participants from the clinical trial's PNE group were consecutively enrolled from March 2021 until September 2022.

The study population

The chosen sample size (n=12) was based on that of a qualitative study with a similar patient population, a similar intervention, and similar objectives [19]. Participants were included initially if they were aged between 18 and 65 and experienced persistent (lasting more than one year), disabling low back pain (a score of 8 or more on the *Echelle d'Incapacité Fonctionnelle pour l'Evaluation des Lombalgies*, a French-language version of the Roland-Morris Disability Questionnaire) [21] with a moderate-to-high risk of chronicity (a Start Back score of 4 or more). The study's exclusion criteria and intervention allocation procedure are detailed in the initial protocol [22].

Protocol and registration

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by an independent ethics committee (CPP Île-de-France III, Paris, France) on March 9th, 2021. The study results were reported in compliance with the Standard for Reporting Qualitative Research [23]. The initial protocol has been published elsewhere [22]. The study was registered at clinicaltrials.gov (identifier: NCT04179708).

Intervention

Individuals participated in a multidisciplinary back school program, which included assessments, therapy (physiotherapy, physical activity, occupational therapy, etc.), and PNE sessions spread over a week. The educational intervention included a 30-minute initial assessment (on the first day) and a final assessment (on the last day), allowing the content to be tailored to each individual's situation. The educational content (4 hours in 8 half-hour sessions over 4 days) focused on debunking erroneous anatomic and biomechanical beliefs, explaining what low back pain is, and how it can be managed from a neurophysiological standpoint. The educational material included short written texts, pictures, and metaphors. This material was delivered in a lecture-style format, while the teacher sought to maintain a compassionate attitude and address the participants' questions.

Data collection

Data were collected during semi-structured interviews three months after the end of the program (after a follow-up consultation). The interviewing investigators (CL, PP, MG, and MN), who were medical residents, used a digital tablet as an audio recorder and followed an interview guide designed to identify potential changes in participants' understanding of their situation and their coping strategies. The interview guide is provided as **supplementary material**. The investigators had not met the participants prior to the interviews. The interviews took place in a designated consultation room and were expected to last about 45 minutes. Only the investigator and the participant were present. Participants were encouraged to provide detailed responses and to give illustrative examples. The investigator sought to combine compassion with neutrality and (to make participants comfortable) adopted a slightly angled posture. To encourage more elaborate responses, the investigator used probing and rephrasing techniques.

Analysis

The digital audio recordings were manually transcribed into verbatim text in a Word document (Microsoft Corporation, Redmond, WA, USA). Content was analysed thematically using Nvivo 10 software (Lumivero, Burlington, MA, USA). Once all the verbatims had been transcribed, the statements were coded according to their meaning. The meanings were grouped into prespecified themes based on common sense and fear-avoidance models. The themes on diagnosis (identity and cause), prognosis (consequence and duration), and treatment themes (controllability) reflect (*i*) how the patient conceptualizes his/her problems and their management, and (*ii*) whether the educational intervention has altered this understanding. The coping themes respectively encompass the participant's cognitive-emotional and behavioural coping strategies, and reflect whether these strategies changed following the educational interventions. For clarity, the prespecified themes *diagnosis*, *prognosis*, and *treatment* were consolidated into the overarching theme *understanding*. The themes *emotion* (cognitive-emotional coping) and *behaviour* (behavioural coping) themes were combined to give the *coping* theme. The verbatims were transcribed by MD. The primary analysis was conducted by two investigators (NA and FH). In the event of disagreement, a third investigator (MD) was consulted. Analysts had prior experience with qualitative methodologies throughout their academic training.

Reflexivity

Knowledge of the investigators' beliefs allows the reader to consider how these may have influenced the study results. NA was responsible for content analysis and regularly conducts PNE sessions. He believes that PNE is more clinically effective than conventional education. He also delivered the PNE content in the present study. The interviewers PP, CL, MG and MN have no experience in delivering PNE sessions. They have no prior beliefs regarding the superiority of one educational approach over the other. However, they had access to the educational content presented during the PNE sessions prior to conducting the semi-structured interviews. They had not interacted with participants before meeting them in the interview. MD believes that PNE is a useful, more effective intervention than biomechanics-based conventional education if delivered metaphorically and in line with the patient-caregiver relationship. She has experience in delivering PNE sessions and has co-authored an implementation guide [24]. FH regularly uses PNE with individual patients and in groups. She believes that understanding pain enhances coping and that the effectiveness of PNE does not depend greatly on the cumulative duration of the sessions. MD and FH had no contact with the study participants at any point.

Table 1 Patient characteristics

Participant Nº	Age	Sex	PD	EIFEL (Change from baseline to D90)	NRS (Change from baseline to D90)	FABQ-PA (Change from baseline to D90)	FABQ-W (Change from baseline to D90)	PCS (Change from baseline to D90)	TSK (Change from baseline to D90)	HAD-A (Change from baseline to D90)	HAD-D (Change from baseline to D90)
1	45	M	10	-5 (-56%)	0	-7 (-37%)	+1 (+3%)	+2 (+11%)	-6 (-11%)	0	+1 (+25%)
2	42	F	7	-1 (-33%)	-3 (-38%)	+2 (+15%)	-4 (-14%)	-14 (-50%)	-5 (-12%)	-1 (-10%)	-3 (-38%)
3	49	F	3	-4 (-31%)	-3 (-38%)	+12 (+133%)	+7 (+23%)	-1 (-4%)	+10 (+26%)	0	+1 (+14%)
4	37	F	3	+13 (+217%)	0	-1 (-6%)	0	-4 (-31%)	+2 (+6%)	+6 (+200%)	10 (+1000%)
5	46	M	14	-3 (-43%)	-2 (-33%)	+3 (+27%)	7 (+25%)	-5 (-16%)	+5 (+13%)	0	+3 (+50%)
6	30	F	2	-3 (-21%)	-3 (-43%)	-14 (-74%)	-12 (-48%)	0	-16 (-38%)	-2 (-18%)	-1 (-7%)
7	65	M	30	+1 (+14%)	0	+1 (+9%)	-5 (-45%)	-1 (-25%)	-5 (-16%)	-3 (-38%)	0
8	42	F	15	-1 (-6%)	0	-3 (-25%)	Not applicable	0	+1 (+2%)	-2 (-14%)	-6 (-46%)
9	32	F	3	-7 (-70%)	-1 (-33%)	-6 (-33%)	-16 (-80%)	-12 (-75%)	-20 (-42%)	-4 (-50%)	-2 (33%)
10	40	M	15	-3 (-23%)	+3 (+60%)	-20 (-69%)	-17 (-71%)	-15 (-83%)	-22 (-44%)	-1 (-7%)	+2 (+22%)
11	43	F	10	0	+2 (+40%)	-2 (-11%)	-2 (-8%)	+3 (+6%)	-1 (-2%)	-2 (-13%)	-6 (-33%)
12	36	M	3	-4 (-36%)	-2 (-33%)	-1 (-33%)	0	-22 (-76%)	-5 (-13%)	-1 (-13%)	-1 (-20%)

PD: Pain duration; EIFEL: *Echelle d'Incapacité Fonctionnelle pour l'Evaluation des Lombalgies* scale; NRS: numerical rating scale; FABQ-PA: Fear Avoidance and Belief Questionnaire — Physical Activity subscale; FABQ-W: Fear Avoidance and Belief Questionnaire — Work subscale; PCS: Pain Catastrophism Scale; TSK: Tampa Scale of Kinesiophobia; HADS-A: Hospital Anxiety Depression Scale — Anxiety subscale; HADS-D: Hospital Anxiety Depression Scale — Depression subscale.

Table 2 First prespecified theme: understanding

Sub-themes	Change	Lack of change
Diagnosis[1]	After the PNE sessions, participants 2, 5, 6, 7, 9, 10, 12 appeared to have changed their biomedical beliefs. *No, I reckon it's not at all the same thing. I was always focused on, um, well… my slipped disc, […]. It would seem that it's not … exactly that comes into play, in fact. [P10, 7:23]* Participants 2, 5, 6, 9, 10 and 12 had now new conceptions for identity and cause of their pain. *[…] we have a pain threshold even though it's lower than the others… [P5, 2:49]* Participants 2, 3, and 6 now understood the influences of the brain and perceptions on pain. *So, in fact, the brain has, like, a big influence, and that part there […] that stayed with me in fact! [P6, 36:42]*	Participants 4 and 8 did not consider that their understanding of the identity and causes of their lower back pain had changed after the PNE sessions. *Um… So, compared with before you attended the back school, do you understand or perceive your lower back pain differently? [Interviewer CL] - No. It's the same as it was. [P4, 3:39]* Participants 1, 2, 3, 7, 10, and 11 appeared not to have changed their understanding regarding certain aspects of the identity and cause of their low back pain. *Because there are times when I'll say, well, everything is fine, I don't have back pain anymore. It's great. And after that, it comes back… […] You don't understand. You wonder why it is so. [P1, 18 :35]*
Prognosis[2]	Before the PNE sessions, participants 2, 6, 9, and 12 believed that their situation could either not change or only worsen. *[…] before, I thought I had had pain because something was degenerating, that I had no control over it, that I was …. that it didn't depend on me. [P9, 10:11]* After the PNE sessions, participants 1, 2, 5, 6, 7, 9, 10 and 12 had a more positive perception of their prognosis. *I became conscious that it might not necessarily stay like that and that I can - as he explained in the class - increase the warning threshold. [P6, 9:05]* Participants 2, 9, and 10 now realised that the recovery process would be long and nonlinear. *I understood that it was a long journey. […] there would be improvement and then maybe a relapse and that we needed to… kind of keep on course with that. [P10, 8:06]* Participants 2, 5, 6, 7, and 9 now believed that their pain level might fall but remained sceptical about complete resolution. *Interviewer MN: […] do you think more than before that your lower back pain could decrease or disappear, more than before? - Participant: Yes. More than before. Even if… let's be honest, I tell myself, "arthritis, it won't come back to normal" […] It might stabilize but it won't go back to how it was before. [P6, 9:29]*	Participants 4 and 8 stated that the PNE sessions did not influence their expectations of recovery. *Interviewer MN: […] your way of, well, perceiving the progression of your low back pain hasn't changed for you…? [Patient: No!] Okay. Why? - Patient: Well, because I already knew that! Actually, that's it. I know that low back pain will be there, we manage it daily, and that's it… [P8, 7:27]* Participant 3 appeared not to have changed the way she conceptualised the potential for change. *Well, I don't see how it can be cured, well, once a part… of the body is damaged, I can't see how it can… Well, no, I can't see how. [P3, 15:02]*
Treatment[3]	Participants 1, 9, and 10 stated that they would depend less on medications and would tend towards an approach based on physical activity. *I think I'm more into the treatment… How should I put it? Uh, physical treatment. But not… the other way around. Not medications. [P1, 26:46]* Participants 9, 10 and 12 perceived physical exercise differently. *I already knew that with back pain, you have to keep moving, and that was something I understood. But I didn't know how far I could go, so… it gave me information […] knowing that I could push further, that it wouldn't be harmful […] and it broadened the limits of doing movements, of activity [P9, 23:29]* Participants 2 and 10 no longer considered that certain tissue-focused interventions were necessary. *I thought that… for me, it would be… an operation or something like that, that would solve the…the problem. That there was nothing else to do, you know. In fact, that … yeah, it seemed different to me in the end, you know. [P10, 10:58]* The participants 2 and 11 now have expectations for treatment targeting psychological factors. *It's about working on, um… The mind. And then also working on the body in parallel, actually. […] that's why I started relaxation classes. [P11, 14:09].*	Participants 3, 4, 6, and 8 said that the PNE sessions did not change their understanding of how to manage their lower back pain. *Well, I had already understood, actually, well, because there are a lot of, um, exercises for muscle strengthening as well… Exercises that we do at the physiotherapist's, so, um. Well, I had already understood its importance […]. [P3, 21:36].* Participant 1 still thinks that he might undergo surgery if he's not careful. *Because I don't want to have surgery,. […] I'm not scared. But it's in my head [P1, 19:59].*

[1] Diagnosis refers to the participants' representations of the identity of their LBP (e.g., a discopathy) and the cause (e.g., aging), analysed in terms of change. [2] Prognosis refers to the participants' representations of the potential consequences (e.g., worsening disability) and duration (e.g., lifelong) of their LBP, in terms of change. [3] Treatment: refers to the participants' representations of their ability to control their LBP (e.g. a reduction in pain through a tailored physical exercise program), in terms of change.

Table 3 Second prespecified theme: coping

Sub-themes	Change	Lack of change
Cognitivo-emotional coping[1]	Participants 1, 2, 6, 9, and 10 reported being more confident in their ability to do certain painful, feared, or avoided activities than before the PNE sessions. *I told myself, when I get out of this, this stay, that I'm, I'm going to implement this, I know I can do it, I know I can perform certain movements, it's not… There you go, it reassured me that there was nothing… broken… So I could go further, and it was good to go further. Well, within the pain… threshold. [P9, 12:07]* After the PNE sessions, participants 2, 4, 5, 6, 9, 10, and 12 had fewer catastrophic thoughts and more helpful cognitive strategies. *[…] before the sessions, I used to think, "Well, as soon as I'm in pain, I should stop and all that, and then it's going to get worse and all that!" Whereas now I think, "Well, I'm in pain… I'm nearing the limit, so I should slow down a bit but it's not dangerous. [P12, 12:17]* Participants 2, 5, 9, and 10 said that they generally felt better after the PNE sessions. *Hmm, no, well, it's, it's what I had also said at the end - it kind of adds, it boosts the morale a bit, uh, really. Uh… Because we're in a phase where… it's always the pain, the pain… There we are, and having a different perspective, and also having solutions other than taking medications, taking medications… Yes, personally, at least for me, it gave me, uh… well, quite a boost, clearly! [P10, 20:49]*	Participants 3, 5, 7, 8 and 11 were still apprehensive when performing certain daily physical activities or carrying loads. Participants 5, 7, and 11 were still scared to carry heavy loads. Well, when it comes to carrying loads, *I'm always limited because, you know, I don't have a lot of muscle. So, I'm always limited in terms of carrying loads. [P5, 14:05]* Participants 3 and 4 were still apprehensive about engaging in certain physical or everyday activities, due to the intensity of their pain. *But really, there are things in daily life that I can't do like I used to. And it's not just because I hold back by saying "I'm scared of having more pain!" […] It's because, in reality, if I make certain movements, it's going to be extremely painful. And so, of course, well, naturally, we still want to protect ourselves from certain pain levels. [P3, 6:34]* Participant 1 related remaining vigilant to avoid having surgery. *And I think one needs to be careful about certain things. Now I know that I won't do what I used to do when I was 20, or if I hadn't had this work accident issue […] So I pay attention, why do I tell you I pay attention. Because I don't want to have surgery, I don't want to… […] I'm not scared. But it's in my head. I tell myself, I'll do everything not to be hospitalized. [P1, 19:59]*
Behavioral coping[2]	Participants 1, 2, 3, 6, 9, 10, and 12 had increased their levels of physical activity. *I'm doing it all over again on my own, exercising. And I'm not just doing back exercises. […] I have other parts of my body to take care of too, after all, so sometimes I even go a bit hard; I do weights, I do pull-ups. [P2, 31:14]* Participants 1, 2, 3, 6, 9, and 10 stated that they had gradually started to do physical and sports activities they had previously avoided, at their own pace. *I danced before but I stopped between [Laughs] Too much pain. So I do it, but we do it for three, four minutes, like as long as a song lasts, and then that's it. But well, that's already not bad. [P6, 11:33]* Participants 1, 9, 11, and 12 pace their activities and/or exercises to prevent pain flares. I know that I need to set more limits… on … working hours, positions, and stress. *I know that I need to… uh, pay more attention to myself, even if I already knew before [laughs] […] So I try as much as possible to… to pace things. [P9, 18:24]* Participants 1, 2, and 9 handled their medication use differently. *I was taking some anti-inflammatories… Doliprane, [ie non opioid analgesic] as soon as the pain, even after a physiotherapy session, to anticipate… […] Well, before and after… […] So that also helped me a lot, and the few times when I really thought, well, I would be tempted… to take something. I told myself "no, come on". I wait and… Well, then, generally, I'm satisfied with not having taken… [P2, 37:08]* Participants 1, 2, 5, 10 and 12 were better at managing their pain than before because they had implemented the exercises they had learned. *So, if I'm really in pain, I do some… […] small stretches for my back, just to relieve it a little. But… I think, yes, it has taught me quite a few things. [P1, 17:42]* Since the PNE sessions, participants 1, 6, 11, and 12 mention adapting their positions to prevent or manage pain. *I try to… have postures that will help me feel less pain. [P12, 8:28]*	Participants 3, 4, 5, 7, 8, and 11 considered that the PNE sessions did not have an influence on their behaviour towards pain. Regarding heavy lifting, participants 3, 6, 7, and 8 did not change their habits. *Interviewer MN: …Alright. And what about carrying heavy loads, for example? There hasn't been any change relative to before? […] Participant: It's not that I avoid it, I do it but I pay a high price for it, but I still do it. [P8, 11:30]* Participants 4, 7, 8, and 11 did not alter their pain alleviation strategies after the PNE sessions. *So, when I'm in pain, uh, it's either the pills, or I wait for it to pass. I lie down and wait for it to pass. […] Before already, you know, the stay didn't do anything for me. Nothing on how to manage my pain. [P4, 8 :53]*

[1] Cognitive-emotional coping refers to participants' adaptation strategies in response to pain that was not visible to a third party (e.g., being afraid of carry a heavy load), in terms of change. [2] Behavioural coping: refers to observable adaptation strategies (e.g., taking painkillers) used by participants in response to pain, interpreted with regard to change.

Table 4 Additional themes

Themes	Thematic analysis
Other form of learning[1]	For participants 2, 5, 10, and 12, changes in their perceptions and/or coping strategies occurred partly as a result of their positive experience with exercise or physical activity. *Interviewer PP: […] did the course itself and the presentation that was given there already prime… trigger your boost in confidence? Participant: Well, not so much. No, for me it was the practice [laughs]. There you go… The course was more the pathway [P2, 25:49]*
	Participant 12 stated that the PNE sessions, combined with reduced symptoms, changed their view of pain irreversibility. *[…] here it was caring and they explained that it's not inevitable […] And seeing that… well, there's an improvement there too, […] it still allows you to think about it and tell yourself that it's not like you're heading straight into a wall in 10 years… I'm not doomed, you know. [P12, 16:26]*
	Conversely, participant 4 did not change their outlook on the prognosis, as their pain remained unchanged. *Interviewer CL: […] Are you more or less confident that your lower back pain will diminish after these sessions? - Participant: No, given that my pain is still there, it hasn't, it was just a course, it's still just a course after all. Given that it didn't suit me, and I didn't get any advice that I'll be using. [P4, 4:52]*
	Participants 1 and 4 reported having learned just as much by sharing experiences with the other participants. *[…] we learned by sharing. I mean that we knew more about the pain, the pain felt by people, by individuals. […] We listened, you see. But it's not advice, for example, that I took from someone and then used. How she lives with her pain. [P4, 11:29]*
Other barriers to change[2]	Participants 5 and 7 considered that external motivational factors unrelated to understanding had hindered the implementation of behavioural changes. *Well… Yes, it helped me understand things well […] but the impact, um… it was up to me, up to me to get um, an improvement. It's not going to get better on its own, so there you go! That's why I say that it hasn't changed. It's me who hasn't changed. [P7, 17:32]*
	Participants 4, 6, and 7 considered that their family situation or life events were obstacles to implementing behaviours that could facilitate progress. *I do less of it, that's because… because I have family issues, my mother is ill, so I take care of her. So as a result, I'm very… And also the fact that I stopped physical therapy, stopped aqua gym, stopped doing sport, […] my pain is more present compared to that […]. [P4, 7:40]*
	Participants 2, 3, 5, 8, and 12 felt that work hindered behaviours that could improve their situation. *I see in my job there are certain things where we can't really apply, you know… […] Yes, we understand, we understand things about pain, but yeah, really it's not easy to implement… [P3, 4:47]*
	Participants 1, 2, 9 and 12 considered that work was an obstacle to changing their activities and/or implementing exercises that promote recovery. *[…] today I haven't had zero pain because… Well, [laughs] I haven't stopped working, I still do the same type of work, so [sighs] I try to do my best, to go to the gym, to be more active. It doesn't happen… It's sometimes, so the pain comes back; so I know why it is, it comes back, why it's not zero - that's it. If I had a different type of life or lifestyle, maybe it would be zero… [P9, 10:02]*
Satisfactions[3]	Participants 2, 9, 10 and 12 pleasantly surprised by the innovative nature of the approach. *Well, this presentation, you see, I wasn't expecting that at all. I thought it was going to be more focused on the physical aspect. Like 100% pure rehabilitation, you know […]. So, I really liked that, and it was also beneficial for me. It was a 50-50 thing, and the balance was good because… the physical advice and the presentation helped me, both. It was really… welcome and it really helped me. [P2, 45:24]*
	Participant 9 mentioned appreciating having scientific explanations rather than just stating without explaining. *I had been told a lot, "Oh, it's not because you have an MRI like that, that you must have pain." And there wasn't any more explanation. So, I didn't understand why I… with an MRI that shouldn't have pain, I had pain, so, um… I finally got the scientific explanation. [P9, 3:59]*
	Participants 1, 6, 7 and 9 appreciated the educator's teaching approach. […] if we didn't understand, we would take a break and… we'd go back to it, actually. *[…] if we hadn't understood it, well, he would explain again, he gives examples, […]. But yeah, it helped me a lot. [P6, 25:53]*
	Participants 2, 5, 7, and 11 appreciated the contact with experienced, attentive, and caring professionals. *Yes, I have much more confidence because the people are… very professional. They pay a lot of attention to the patients at the end of the day, they listen to each patient, […] they are very caring actually, so they are there for you to help you ultimately get better and to advise you on things you thought you couldn't even do anymore. [P5, 10:35]*

Table 4 Additional themes (*Continued*)

Themes	Thematic analysis
Criticisms[4]	Participants 4 and 8 did not feel committed to the PNE sessions and did not consider them to be relevant to their situation. *So, what was in his PowerPoint? It was very interesting, but I couldn't manage to… for me, what does that mean, that? […] It didn't really fit with me [P4, 3:01] […] I told him, "I can't identify with your course, in fact." [P4, 10:09]*
	Participants 1, 4, 5 and 12 found the MPR a bit short and participants 2, 6, and 11 found the educational format somewhat dense. *So yeah, a lot of information, it's very dense, you know, it was very well… taught, but still. [P2, 5:54]*
	Participants 3, 8, 9, and 11 expressed criticism about the teaching style (cognitive conflict, overly simplistic visuals and explanations, lack of interaction). *The Powerpoint? It was long. Very long. […] Well, afterward, um, we often dozed off, and he noticed that we often dozed off. Uh… We learned a lot of things, you know! […] It was still quite monotonous, actually. He should make his stuff, yeah, a bit livelier! [P11, 22:16]*
	Participants 3 and 11 would have liked more job-specific occupational therapy sessions to make their daily lives easier. *Disappointed that the occupational therapist, we didn't see her long enough […] she hadn't planned to talk to us about it, but then we talked to her about bedding! So, um… Mattresses, pillows, um… All of that is for good sleep too […] But yeaf, she didn't have enough time […]. [P11, 18:00]*
	Participant 12 noticed inconsistencies between the educator's and the coach's statements. *[…] there are things that are a bit contradictory because the sports coaches wanted to push us a bit, whereas the educator told that we should… go within our limits and not exceed them… [P12, 17:38]*
	Given what she learned during the PNE sessions, participant 2 would have preferred personalized psychological support. *I expected a few sessions - not psychotherapy but something approaching it… [P2, 46;17] […] it unblocked something, the course set something in motion and… made me really aware of certain things. Then, when it comes to applying it… Yes. Afterwards, for practical implementation, I was waiting a little, you know, for some quick tips, simple things, and advice. [P2, 48:17]*

[1] Other forms of learning refer to changes in understanding and/or coping strategies through modalities other than the cognitive learning of educational content. [2] Other barriers to change: refers to factors other than understanding that prevented them from making the necessary behavioural changes that could facilitate their recovery. [3] Satisfactions relate to the satisfactions of PNE sessions as recounted by participants in terms of content, pedagogical elements, and therapeutic alliance. [4] Criticisms relates to the participants' criticism of the PNE sessions with regard to the learning methods and organization.

Table 5 Detailed summary of pre-specified themes.

	Understanding			Coping	
	Diagnosis	Prognosis	Treatment	Cognitive	Behavioural
1	*Doesn't make sense of his pain.*	**Improvement is possible if changes are implemented.**	**Increase in adherence to a physical and active management approach (including paced activity); running is possible, still cautious about avoiding surgery.**	*Hypervigilant about his posture.*	**Paced physical exercise, paced activity; graded physical activity; do exercise more frequently; adapting positions, adjusting medication; pain relieving stretching or movement.**
2	**Strength of the back; low impact of physical factors; pain doesn't equal tissue damage; pain is influenced by the brain; unable to attribute a cause to their pain; doesn't understand nighttime flares-up.**	**Stop thinking that pain can only get worse; improvement is possible; improvement takes time and is nonlinearly; zero pain scepticism.**	**Disengagement from exclusively structural or biomedical interventions; increase adherence to interventions that target psychological factors.**	**More pain self-efficacy; new helpful cognitive pain coping strategies; better mood; more physical activity self-efficacy****	**More active lifestyle; paced physical activity; adapt medication; pain relieving stretching or movement.**
3	**Psychological factors can influence pain; no change in the conception of pain's identify;**	**Stop thinking that pain can only get worse; symptom stabilization is possible but improvement is not possible.**	*Already understood the importance of muscle strengthening and physical activity for becoming stronger.*	**More physical activity autoefficacy**, still apprehensive of pain exacerbation; occasionally resigned.**	**Graded physical activity; certain daily activity avoidance.**
4	*No change.*	*Not impossible that pain could improve; it will be very long.*	*No change.*	**Less catastrophism; still apprehensive of pain exacerbation.**	*Continued use passive coping strategies.*
5	**Pain does not mean danger; pain does not equal tissue damage; the pain threshold is lowered when pain persists.**	**Improvement is possible if changes are implemented; zero pain scepticism.**	**Increase in adherence to a physical and active management approach**	**New helpful cognitive pain coping strategies, better mood, more physical activity self-efficacy**, no change in self-efficacy regarding heavy weightlifting; perceived weakness.**	**Pain relieving stretches or movement, avoidance of heavy weightlifting; don't do exercise***
6	**Pain does not mean danger; pain is influenced by the brain; the pain threshold is lowered when pain persists.**	**Stop thinking that pain can only get worse; improvement is possible if changes are implemented; zero pain scepticism.**	**Understand physiotherapy better.**	**More pain self-efficacy; new helpful cognitive; pain coping strategies; no change in self-efficacy regarding heavy weightlifting.**	**Graded physical activity; more activity; adapt position.**
7	**Imagery abnormalities are not dangerous; doesn't know factors that explain his LBP and why his pain persists.**	**Improvement is possible if changes are implemented; zero pain scepticism.**	**Learn keys to improve his situation.**	**Reassurance; pain acceptance; no change in self-efficacy in heavy weightlifting.**	*Don't do exercise*, avoidance of certain daily activity.*
8	*Had already a good understanding of their condition.*	*No cure, must leave with pain.*	**Paced activity; rehabilitation is good for low back pain.**	*Still no fear of painful activity or carrying heavy loads.*	*Still demonstrates perseverance behaviour and use active pain coping strategies.*
9	**Strength of the back; low impact of physical factors pain doesn't equal tissue damage; pain is influenced by biopsychosocial factors.**	**Stop thinking that pain can only get worse; improvement is possible if changes are implemented; improvement takes time and is nonlinearly; no pain scepticism**	**Increase in adherence to a physical and active management approach; change in representation of physical exercise.**	**More pain self-efficacy, new helpful cognitive pain coping strategies, less catastrophism, better mood.**	**More active lifestyle; graded physical activity; do exercise more frequently; adapt medication.**
10	**Pain does not mean tissue damage; pain is influenced by biopsychosocial factors; doesn't know factors that explains his LBP.**	**Improvement is possible if changes are implemented; improvement takes time and is nonlinearly.**	**Disengagement from exclusively structural or biomedical interventions; increase in adherence to a physical and active management approach; change in perception of physical exercise**	**Less catastrophism, better mood; no change in self-efficacy in heavy weightlifting.**	**More active lifestyle; graded physical activity.**
11	Does not fully understand the origin of their pain; understands that certain factors exacerbate it.	Lack of data.	**Increase in adherence to interventions that target psychological factors.**	*No change in self-efficacy in heavy weightlifting.*	**Paced physical exercise, adapt position; avoidance of heavy weightlifting.**
12	**Imagery abnormalities are not dangerous; pain does not mean danger; pain does not mean tissue damage.**	**Stop thinking that pain can only get worse; improvement is possible if changes are implemented.**	**Change in representation and perception of physical exercise.**	**New helpful cognitive pain coping strategies; less catastrophism.**	**Paced physical exercise; paced activity; graded physical activity; adapt position; pain relieving stretching or movement.**

In bold: change. *In italic*: no change. *link to other barrier to change. **thanks to other forms of learning

Results

The interviews took place between May 2021 and August 2022. Of the 12 participants, 7 were female and 5 were male. The mean (range) time since the onset of pain was 9.58 years (2-30 years). The mean (range) age of the participants was 42.25 (30-65). Table 1 summarises the participant characteristics. In addition to the prespecified themes of *understanding* (sub-themes: diagnosis, prognosis, and treatment options) (Table 2) and **coping** (sub-themes: cognitive-emotional coping and behavioural coping) (Table 3), the additional themes identified were *other form of learning*, *other barriers to change*, *satisfactions*, and *criticisms* (Table 4). Table 5 and 6 summarise the presence or absence of changes in understanding, coping strategies and additional themes for all participants. Data from this analysis is available elsewhere [25].

Discussion

The objective of the present study was to evaluate changes in understanding and coping strategies of participants having received PNE sessions as part of a multimodal care approach. The prespecified themes of understanding and coping were indeed found in the transcribed data. Additional themes (other forms of learning, other barriers to change, satisfactions and criticisms) also emerged.

According to the crossover of learning framework adapted to pain science learning [26], half of the participants (participants 2, 5, 6, 9, 10 and 12) appeared to have reconceptualised their low back pain in a neurophysiological manner. This included ideas such as the notion that pain does not necessarily indicate danger or tissue damage, that persistent pain may reflect a lowered pain threshold rather than ongoing injury, that pain is influenced by the brain, and that improvement is possible through active coping strategies. As participant 5 explained, this shift in perspective was reflected in his understanding of sensitisation.

> "*We have a pain threshold even though it's lower than the others…*" [P5, 2:49] (Table 2).

The proportion of people with a reconceptualisation of pain was slightly higher in our study than in the other qualitative studies [17, 18, 19]. It is also interesting to note that even for these individuals, language elements reflecting the structural pain model persisted. For instance, participant 6 no longer believes that pain equates to tissue damage and now believes that improvement is possible. However, this participant remains sceptical about complete pain resolution due to a lumbar osteoarthritis. This illustrates what has been described in the conceptual prevalence model, whereby erroneous conceptions — even among experts — do not disappear but rather coexist with the new, more influential conceptions [27]. As she explained:

> "*More than before [about thinking that pain can decrease or disappear]. Even if… Let's be honest, I tell myself, 'arthritis, it won't come back to normal'* " [P6, 9:29] (Table 2).

Our analysis also revealed that some participants had learned through means different from those exhibited in the PNE sessions, notably through physical exercise sessions. According to some experts, PNE enables cognitive learning and the generation of new hypotheses, while physical phenomena (such as the experience of movement or symptomatic changes) can be used to confirm and thus strengthen these hypotheses [28, 29]. The combination of PNE with multimodal exercise sessions (which serve as a type of behavioural experimentation) might account for the substantial proportion of people in this sample who significantly reconceptualised their pain. As participant 12 expressed, the reassurance and explanation provided during sessions helped shift their mindset:

> "*It was caring and they explained that it's not inevitable […] And seeing that… well, there's an improvement there too, […] it still allows you to think about it and tell yourself that it's not like you're heading straight into a wall in 10 years… I'm not doomed, you know.*" [P12, 16:26] (Table 4).

Conversely, participant 4 stated that she has not changed her view about her prognosis because her pain has not improved. This highlights the bidirectional relationship between representations and symptomatic changes, and the importance of modifying symptoms to consolidate conceptual change [30]. As she put it bluntly:

> "*Given that my pain is still there, it hasn't… it was just a course, it's still just a course after all*" [P4, 4:52] (Table 4).

Moreover, participant 12 acknowledged inconsistencies between the principles taught by the educator and the instructions from the exercise physiologist. In our study, the professionals (e.g. physical therapist, exercise physiologist) supervising the movement and physical activity-based sessions had not been instructed to adapt the exercise therapy to be consistent with PNE sessions (e.g. time contingent and cognition targeted exercise), which may have impaired conceptual learning in some way [28, 29].

> "*There are things that are a bit contradictory because the sports coaches wanted to push us a bit, whereas the educator told us to go within our limits and not exceed them…*" [P12, 17:38] (Table 4).

Representations of low back pain did not change for some participants (participants 3, 4 and 8). Among them, participant 3 did not see how their pain could improve given that a part of their back was damaged. The importance of prior beliefs (strength, coherence, commitment) can represent an obstacle to conceptual change [18, 19, 26]. Others (participants 4 and 8) did not feel concerned by the educational content. King et al. (2018) had already highlighted that a lack of personal relevance could be associated with an absence of conceptual change [19]. This lack of resonance was clearly expressed by participant 4, who stated:

> "*It didn't really fit with me.*" [P4, 3:01] (Table 4).

Some participants experienced what could be described as gap filling, with a minimal understanding of the concepts discussed. For example, Participant 1 now believes that progress is possible provided that active coping strategies are adopted; however, they still do not make sense of their pain. Even for individuals who have experienced a significant change of their pain conceptualization, certain aspects regarding identity and causal factors remain unexplained (participants 2 and 10). As an example, participant 2 explained:

> "*I… I just can't understand why, […]. At night, for example, at five in the morning, it often wakes me up. Even though I don't think I'm feeling any emotions. I'm asleep, just sleeping… So, uh, no particular worries or stress, I'm really feeling fine. […] So there's still an element of the unknown.*" [P2, 22:59] (Table 2).

It is likely that these participants do not have the same depth of understanding of pain concepts [26]. We therefore note that PNE sessions do not automatically lead to a deep understanding of their pain. In parallel with these observations, several participants expressed criticisms of PNE sessions, such as program density, session timing, or certain pedagogical aspects (e.g., lack of interaction, inappropriate content, etc.), depending on participants. In our study, the educational material was delivered using a lecture-based approach, with little room for consideration of pre-existing beliefs, interaction and personalization, which is known to limit conceptual learning [31, 32]. As participant 11 described:

> "*The PowerPoint? It was long. Very long. […] We often dozed off, and he noticed that we often dozed off. It was still quite monotonous, actually. He should make his stuff, yeah, a bit livelier!*" [P11, 22:16] (Table 4).

Table 6 Summary of thematic analysis

Participants	Understanding			Coping		Other forms of learning	Other barriers to change	Satisfaction	Criticisms
	Diagnosis	Prognosis	Treatment	Cognitive	Behavioural				
1	No change	Conceptual change	Partial change	Partial change	Conceptual change	Evidence of positive social learning	Work factors	Educator teaching skills;	Program too short
2	Partial change	Conceptual change	Conceptual change	Conceptual change	Conceptual change	Evidence of positive experiential learning	Work factors	Innovative nature of the approach; Therapeutic alliance and perceived skills	Dense educational format; lack of psychological session
3	Partial change	Partial change	No change	No change	Partial change	Evidence of positive experiential learning	Work factors	No data	More occupational therapy session;
4	No change	No change	No change	Partial change	No change	Evidence of positive social learning and negative experiential learning	Socio-familial factors	No data	Not feel committed; too short program
5	Conceptual change	Conceptual change	Conceptual change	Partial change	Partial change	Evidence of positive experiential learning	Motivational factors	Therapeutic alliance and perceived skills	Too short program
6	Conceptual change	Conceptual change	Conceptual change	Coping change	Coping change	No data	Socio-familial factors	Educator teaching skills	Dense educational format
7	Partial change	Conceptual change	Conceptual change	Coping change	No change	No data	Motivational and socio-familial factors	Educator teaching skills; Therapeutic alliance and perceived skills	No data
8	No change	No change	No change	No change	No change	No data	No data	No data	Do not feel committed
9	Conceptual change	Conceptual change	Conceptual change	Coping change	Coping change	Evidence of positive experiential learning	Work factors	Innovative nature of the approach; scientific explanation; educator teaching skills	Nearly give because of cognitive conflict
10	Partial change	Conceptual change	Conceptual change	Partial change	Coping change	Evidence of positive experiential learning	No data	Innovative nature of the approach	No data
11	Partial change	Lack of data	Conceptual change	No change	Partial change	No data	No data	Therapeutic alliance and perceived skills	Dense educational format; more occupational therapy session; more interaction
12	Conceptual change	Conceptual change	Conceptual change	Coping change	Coping change	Evidence of positive experiential learning	Work as a barrier	Innovative nature of the approach	Inconsistencies between educator and other professionals

We observed differences among participants' attitudes, which ranging from absence to varying degrees of change in their coping strategies. A majority of participants adopted new, more adaptive cognitive-emotional coping strategies (e.g., fewer catastrophic thoughts, alternative self-explanations, pain self-efficacy and/or acceptance, better mood, etc.) [33]. This type of cognitive-emotional shift was clearly illustrated by participant 9, who stated:

> "*I told myself, when I get out of this, this stay, that I'm, I'm going to implement this, I know I can do it, I know I can perform certain movements, it's not… There you go, it reassured me that there was nothing… broken… So I could go further, and it was good to go further. Well, within the pain… threshold.*" [P9, 12:07] (Table 3).

Some of these changes may have occurred through experiential learning (e.g. participants 2, 5, 10 and 12). For participant 2, it was the practice of exercising that allowed her to regain confidence in their ability to engage in physical activity, while education served more as a guide. As she explained:

> "*Well, not so much. No, for me it was the practice [laughs]. There you go… The course was more the pathway.*" [P2, 25:49] (Table 4).

However, several of these participants still had apprehensions (e.g., fear of pain flares, lifting heavy loads, having surgery). Even some participants who had reconceptualised their pain (e.g. participants 5, 6 and 10) still had apprehensions related to lifting heavy loads. Their level of pain understanding did not allow them to feel safe with heavy lifting. This observation may be related to the lack of experiential and behavioural learning regarding heavy lifting [28], as workshops on this topic were excluded from the PNE sessions (as they were considered part of the educational component of the SPEE) [14]. Some participants also expressed regrets about not spending more time on practical application in daily and professional activities through the occupational therapy workshops (e.g. participants 3 and 11). As participant 11 stated:

> "*We didn't see [the occupational therapist] long enough… She hadn't planned to talk to us about it, but then we asked her about bedding! So, um… mattresses, pillows… All of that is for good sleep too. But yeah, she didn't have enough time.*" [P11, 18:00] (Table 4).

Various degrees of adaptive behavioural changes [33] were also observed in a majority of participants (e.g., more active lifestyle; graded exercise; activity pacing; adapting analgesics use; pain-relieving positions, stretches, or exercises). However, some participants had little to no changes in their behavioural coping strategies (e.g., perseverance behaviour, avoiding heavy lifting or certain activities; managing pain through passive coping strategies). In most cases, pain reconceptualization was associated with adaptive changes in coping strategies and vice versa. However, this observation was not consistent among all participants. For example, participant 5 who appeared to have undergone important changes in their pain understanding experienced partial changes in their coping strategy (e.g. still apprehensive to carry heavy loads, don't do exercise). Pain reconceptualisation could be an important factor, but not sufficient to change pain coping strategies.

"*When it comes to carrying loads, I'm always limited because, you know, I don't have a lot of muscle. So, I'm always limited in terms of carrying loads.*" [P5, 14:05] (Table 3).

Our analysis also revealed an "other barriers to change" theme, which highlighted the existence (among certain participants) of ambivalence fuelled by lifestyle habits, family or work-related constraints, and/or life events. These factors can act as barriers to change, even when the individual has a good understanding of their situation [34], and could be addressed through a motivational and occupational support. For instance, participant 7 acknowledged not taking the time to practice his exercises, not because he didn't understand their importance, but because he hadn't prioritised his health. He explained:

"*Well… yes, it helped me understand things well […] but the impact, um… it was up to me, up to me to get, um, an improvement. It's not going to get better on its own, so there you go! That's why I say that it hasn't changed. It's me who hasn't changed.*" [P7, 17:32] (Table 4).

It is worth noting that participant 2 also expressed strong regret about not attending individual psychology sessions regarding the importance of the brain in educational sessions. The ultimate goal of PNE is to increase patient adherence to rehabilitation program that includes cognitive-behavioural reactivation [7]. Just as it would be frustrating if PNE sessions were not accompanied by a graded exercise program given the educational content, it is understandable that this participant was frustrated for not having learned cognitive behavioural strategies to manage her pain, as can be found in other pain neuroscience approaches [35].

Clinical practice perspectives

These results suggest that pain reconceptualisation could be an important factor in promoting the adoption of adaptive cognitive and behavioural coping strategies. However, in our RCT no significant difference was found at 3 months on the primary outcome between PNE and SPEE integrated within a one-week multidisciplinary rehabilitation program [14]. One possible explanation is that only half of the participants received pain reconceptualisation, and not all of them may have the same depth of understanding of pain concepts. A less didactic approach to pain neuroscience education sessions, with more interaction, consideration of prior beliefs, personalisation, and integrated during the physical sessions could increase the proportion of conceptual change [26]. Moreover, fear-avoidance patterns, particularly regarding lifting heavy loads, persisted in half of the participants, even among those who had reconceptualised their pain. The absence of workshops explicitly designed to encourage experimentation with load lifting may have hindered the experiential learning necessary to build confidence in performing these activities, despite the cognitive learning achieved [28]. Some unchanged behaviours seemed to be related to factors beyond pain understanding. Integrating PNE within a personalised approach that takes into account motivational and/or social factors is likely to optimise behavioural changes and better outcomes [32, 36].

Strengths and limitations

The main strength of this study is that it helps make sense of the quantitative data from our RCT, where self-questionnaires can only partially capture the cognitive, emotional, behavioural, and motivational factors targeted by educational interventions. Our study also has several limitations. First, we did not assess the participants' pain representations, coping strategies and other learner-related factors that may influence conceptual learning (e.g., level of health literacy) before the PNE sessions. Therefore, we cannot rule out any influence of memory bias and learner-related factors that may have affected participants' responses. Second, we did not establish objective criteria *a priori* in our method to determine what fell under gap filling or various degrees of reconceptualisation or learning. This shortcoming leads to a hindsight bias, which limits the internal validity of our study. Third, the five interviewers (residents) lacked experience in conducting semi-structured interviews. Engagement with professional interviewers might have allowed some participants to clarify or better expose some of their thoughts and feelings. We attempted to mitigate this bias by providing the investigators with a brief (1-hour) training course on conducting semi-structured interviews. Fourth, although the investigators' questions targeted the participants' understanding of and feelings about the PNE sessions, it is likely that their responses were influenced by information and experiences gained from the "non-educational" parts of the program (physiotherapy, adapted physical activity, etc.). Finally, since the interviews were conducted three months after the PNE sessions, we cannot rule out other factors (change in symptoms, experiences, or subsequent interactions) on the participants' responses.

Conclusion

The objective of the present study was to evaluate changes in understanding and coping strategies among participants who received PNE sessions as part of a one-week multidisciplinary rehabilitation program, with the aim of interpreting the clinical trial results from which the interviews were derived. Two prespecified themes (understanding and coping) were derived from the hypothesis whereby reconceptualising pain from a neurophysiological perspective would lead to more appropriate cognitive and behavioural responses. Each of these themes was analysed in terms of change or lack of change. Four additional themes – other forms of learning, other barriers to change, strengths, and criticisms - emerged from the analysis. We observed varying degrees of change in understanding and coping strategies. For most participants, a change in understanding was followed by a change in coping strategies (and vice versa). Pain reconceptualisation is considered an important factor influencing cognitive and behavioural pain-coping strategies. However, within a MRP, PNE led to pain reconceptualisation in only half of the participants, and with varying depths of understanding of pain concepts. Other forms of learning (e.g. experiential learning) also seem to influence conceptual and coping change. Nonetheless, pain reconceptualisation does not appear to be necessary or sufficient for the promotion of behavioural change: this relationship might also be affected by other factors (e.g. social and/or motivational barriers). Several participants appreciated the innovative nature of the approach, the educator's expertise, and the attentiveness of the healthcare team. However, some participants reported feeling disengaged from the educational content, citing the short and intensive lecture format, and the lack of practical applications for daily life. Clinical perspectives are discussed to optimise the effectiveness of PNE sessions.

Statement and declaration

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Competing Interests

The authors report there are no competing interests to declare.

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References

[1] Jan Hartvigsen, Mark J Hancock, Alice Kongsted, Quinette Louw, Manuela L Ferreira, Stéphane Genevay, Damian Hoy, Jaro Karppinen, Glenn Pransky, Joachim Sieper, et al. What low back pain is and

why we need to pay attention. *The Lancet*, 391(10137):2356–2367, 2018.

[2] Haute Autorité de Santé. Prise en charge du patient présentant une lombalgie commune, 2025. URL https://www.has-sante.fr/jcms/c_2961499/fr/prise-en-charge-du-patient-presentant-une-lombalgie-commune.

[3] National Guideline Centre (UK). *Low Back Pain and Sciatica in Over 16s: Assessment and Management*. National Institute for Health and Care Excellence: Guidelines. National Institute for Health and Care Excellence (NICE), London, 2016. URL http://www.ncbi.nlm.nih.gov/books/NBK401577/.

[4] Arnaud Dupeyron, Philippe Ribinik, Alexandre Gélis, Marc Genty, Didier Claus, Christian Hérisson, and Émilie Coudeyre. Education in the management of low back pain. literature review and recall of key recommendations for practice. *Annals of physical and rehabilitation medicine*, 54(5):319–335, 2011.

[5] Sebastian Straube, Markus Harden, Heiko Schroeder, Barbora Arendacka, Xiangning Fan, R Andrew Moore, and Tim Friede. Back schools for the treatment of chronic low back pain: possibility of benefit but no convincing evidence after 47 years of research—systematic review and meta-analysis. *Pain*, 157(10):2160–2172, 2016.

[6] Arno J Engers, Petra Jellema, Michel Wensing, Daniëlle AWM van der Windt, Richard Grol, and Maurits W van Tulder. Individual patient education for low back pain. *Cochrane database of systematic reviews*, 1, 2008.

[7] Lorimer Moseley and David S Butler. Fifteen years of explaining pain: the past, present, and future. *The Journal of Pain*, 16(9):807–813, 2015.

[8] Adriaan Louw, Kory Zimney, Emilio J Puentedura, and Ina Diener. The efficacy of pain neuroscience education on musculoskeletal pain: a systematic review of the literature. *Physiotherapy theory and practice*, 32(5):332–355, 2016.

[9] Lorimer Moseley, Michael K Nicholas, and Paul W Hodges. A randomized controlled trial of intensive neurophysiology education in chronic low back pain. *The Clinical journal of pain*, 20(5):324–330, 2004.

[10] Anneleen Malfliet, Jeroen Kregel, Mira Meeus, Nathalie Roussel, Lieven Danneels, Barbara Cagnie, Mieke Dolphens, and Jo Nijs. Blended-learning pain neuroscience education for people with chronic spinal pain: randomized controlled multicenter trial. *Physical therapy*, 98(5):357–368, 2018.

[11] Laura Gallagher, James McAuley, and G Lorimer Moseley. A randomized-controlled trial of using a book of metaphors to reconceptualize pain and decrease catastrophizing in people with chronic pain. *The Clinical journal of pain*, 29(1):20–25, 2013.

[12] Anneleen Malfliet, Jeroen Kregel, Iris Coppieters, Robby De Pauw, Mira Meeus, Nathalie Roussel, Barbara Cagnie, Lieven Danneels, and Jo Nijs. Effect of pain neuroscience education combined with cognition-targeted motor control training on chronic spinal pain: a randomized clinical trial. *JAMA neurology*, 75(7):808–817, 2018.

[13] Lorimer Moseley. Combined physiotherapy and education is efficacious for chronic low back pain. *Australian journal of physiotherapy*, 48(4):297–302, 2002.

[14] Nicolas Adenis, Valérie Wieczorek, Sophie Corbinau, Léa Mortain, and André Thevenon. Pain neuroscience education is not superior to spinal physiology and ergonomics education within a short multidisciplinary rehabilitation program: A randomized controlled trial. *Musculoskeletal Science and Practice*, 74:1–8, 2024.

[15] Laurence Kohn and Wendy Christiaens. Les méthodes de recherches qualitatives dans la recherche en soins de santé: apports et croyances. *Reflets et perspectives de la vie économique*, 4(67):67–82, 2014.

[16] James A Watson, Cormac G Ryan, Lesley Cooper, Dominic Ellington, Robbie Whittle, Michael Lavender, John Dixon, Greg Atkinson, Kay Cooper, and Denis J Martin. Pain neuroscience education for adults with chronic musculoskeletal pain: a mixed-methods systematic review and meta-analysis. *The journal of pain*, 20(10):1140–e1, 2019.

[17] Victoria Robinson, Richard King, Cormac G Ryan, and Denis J Martin. A qualitative exploration of people's experiences of pain neurophysiological education for chronic pain: the importance of relevance for the individual. *Manual Therapy*, 22:56–61, 2016.

[18] Rick King, Victoria Robinson, Cormac G Ryan, and Denis J Martin. An exploration of the extent and nature of reconceptualisation of pain following pain neurophysiology education: A qualitative study of experiences of people with chronic musculoskeletal pain. *Patient Education and Counseling*, 99(8):1389–1393, 2016.

[19] Richard King, Victoria Robinson, Helene L Elliott-Button, James A Watson, Cormac G Ryan, and Denis J Martin. Pain reconceptualisation after pain neurophysiology education in adults with chronic low back pain: A qualitative study. *Pain Research and Management*, 2018(1):3745651, 2018.

[20] Samantha Bunzli, Anne Smith, Robert Schütze, Ivan Lin, and Peter O'Sullivan. Making sense of low back pain and pain-related fear. *journal of orthopaedic & sports physical therapy*, 47(9):628–636, 2017.

[21] Joël Coste, Jean-Marie Le Parc, Élisabeth Berge, Gérard Delecoeuillerie, and Jean-Baptiste Paolaggi. French validation of a disability rating scale for the evaluation of low back pain (eifel questionnaire). *Revue du rhumatisme (Ed. francaise: 1993)*, 60(5):335–341, 1993.

[22] Nicolas Adenis, Valérie Wieczorek, Paul Potel, Ingrid Soust, Quentin Hanot, Fabien Moretto, and André Thevenon. Évaluation de la compréhension et du ressenti de personnes atteintes de lombalgies persistantes concernant la composante éducative de leur programme de réadaptation multidisciplinaire: protocole pour une étude qualitative. *Kinésithérapie, la Revue*, 23(256):13–18, 2023.

[23] Bridget C O'Brien, Ilene B Harris, Thomas J Beckman, Darcy A Reed, and David A Cook. Standards for reporting qualitative research: a synthesis of recommendations. *Academic medicine*, 89(9):1245–1251, 2014.

[24] KineFact. Guide edudouleur, 2025. URL https://www.kinefact.com/guide-edudouleur/.

[25] Nicolas Adenis. Data from the manuscript "Understanding and perceptions of pain science education sessions as part of a multidisciplinary rehabilitation program: a qualitative study"', 2025. URL https://entrepot.recherche.data.gouv.fr/dataset.xhtml?persistentId=doi:10.57745/XDMFBI.

[26] Lorimer Moseley, Hayley B Leake, Anneke J Beetsma, James A Watson, David S Butler, Annika van der Mee, Jennifer N Stinson, Daniel Harvie, Tonya M Palermo, and Mira Meeus. Teaching patients about

pain: the emergence of pain science education, its learning frameworks and delivery strategies. *The Journal of Pain*, 25(5):104425, 2024.

[27] Patrice Potvin. Proposition for improving the classical models of conceptual change based on neuroeducational evidence: Conceptual prevalence. *Neuroeducation*, 2(1):16–43, 2013.

[28] Cory Blickenstaff and Neil Pearson. Reconciling movement and exercise with pain neuroscience education: A case for consistent education. *Physiotherapy theory and practice*, 32(5):396–407, 2016.

[29] Jo Nijs, Enrique Lluch Girbés, Mari Lundberg, Anneleen Malfliet, and Michele Sterling. Exercise therapy for chronic musculoskeletal pain: innovation by altering pain memories. *Manual therapy*, 20(1): 216–220, 2015.

[30] João Pedro Caneiro, Samantha Bunzli, and Peter O'Sullivan. Beliefs about the body and pain: the critical role in musculoskeletal pain management. *Brazilian journal of physical therapy*, 25(1):17–29, 2021.

[31] Adriaan Louw, Kory Zimney, Christine O'Hotto, and Sandra Hilton. The clinical application of teaching people about pain. *Physiotherapy theory and practice*, 32(5):385–395, 2016.

[32] Jo Nijs, Amarins J Wijma, Ward Willaert, Eva Huysmans, Paul Mintken, Rob Smeets, Mariëlle Goossens, C Paul van Wilgen, Wouter Van Bogaert, Adriaan Louw, et al. Integrating motivational interviewing in pain neuroscience education for people with chronic pain: a practical guide for clinicians. *Physical therapy*, 100(5):846–859, 2020.

[33] Arndt Büssing, Thomas Ostermann, Edmund AM Neugebauer, and Peter Heusser. Adaptive coping strategies in patients with chronic pain conditions and their interpretation of disease. *BMC public health*, 10(1):507, 2010.

[34] William R Miller and Stephen Rollnick. *Motivational Interviewing: Helping People Change, (Applications of Motivational Interviewing Series)*. The Guilford Press, New York, NY, 3 edition, 2012.

[35] Yoni K Ashar, Alan Gordon, Howard Schubiner, Christie Uipi, Karen Knight, Zachary Anderson, Judith Carlisle, Laurie Polisky, Stephan Geuter, Thomas F Flood, et al. Effect of pain reprocessing therapy vs placebo and usual care for patients with chronic back pain: a randomized clinical trial. *JAMA psychiatry*, 79(1):13–23, 2022.

[36] Eva Roose, Jo Nijs, and G Lorimer Moseley. Striving for better outcomes of treating chronic pain: integrating behavioural change strategies before, during, and after modern pain science education. *Brazilian Journal of Physical Therapy*, 27(6):1–4, 2023.

[37] Patrice Potvin. The coexistence claim and its possible implications for success in teaching for conceptual " change"". *European Journal of Science and Mathematics Education*, 5(1):55–66, 2017.