Understanding Discrepancies in a Person's Fear of Movement and Avoidance Behavior: A Guide for Musculoskeletal Rehabilitation Clinicians Who Support People With Chronic Musculoskeletal Pain

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Understanding discrepancies in a person's fear of movement and avoidance behaviour: a guide for musculoskeletal rehabilitation clinicians who support people with chronic musculoskeletal pain.

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Abstract

Background: Generic self-report measures do not reflect the complexity of a person's pain-related behaviour. Since variations in a person's fear of movement and avoidance behaviour may arise from contextual and motivational factors, a person-centred evaluation is required—addressing the cognitions, emotions, motivation and actual behaviour of the person.

Clinical Question: Most musculoskeletal rehabilitation clinicians will recognise that different people with chronic pain have very different patterns of fear and avoidance behaviour. However, an important remaining question for clinicians is "how can I identify and reconcile discrepancies in fear of movement and avoidance behaviour observed in the same person, and adapt my management accordingly?".

Key Results: We frame a clinical case of a patient with persistent low back pain to illustrate the key pieces of information that clinicians may consider in a person-centred evaluation (i.e., patient interview, self-report measures and behavioural assessment) when working with patients to manage fear of movement and avoidance behaviour.

Clinical Application: Understanding the discrepancies in a person's fear of movement and avoidance behaviour is essential for musculoskeletal rehabilitation clinicians, as they work in partnership with patients to guide tailored approaches to changing behaviours.

Key Words: behavioural assessment; safety behaviour; pain-related fear; pain avoidance; pain management; chronic pain

1. Introduction

Among the many drivers of pain and disability in chronic musculoskeletal pain conditions[26, 41, 42], fear of movement and avoidance behaviour have consistently been linked with poor treatment response[19, 21, 37, 44, 57]. Early theories suggested fear as the sole motivator for avoidance[51]; contemporary evidence indicates that contextual and motivational factors play a major role in the relationship between pain, fear and avoidance[32, 47, 50, 59, 61].

Different people make sense of their pain in different ways—based on their own experiences and personal context—which may explain differences in fear of movement and avoidance behaviour between different people (e.g., some patients may avoid painful activities, others may persist with them)[7, 9, 10]. Insights into inter-individual differences are highly valuable, yet, they do not fully explain discrepancies that are apparent *within* the same person—arising from contextual and motivational factors. For example, a patient may disclose to you that she avoids certain painful activities, while persisting with other activities even though the activities are painful. Another patient may avoid specific behaviours during a behavioural assessment, despite a low score on the Tampa Scale for Kinesiophobia (TSK))[14, 35, 46] that you might reasonably interpret as indicating low fear of movement.

Based on previous recommendations[65], clinicians might strongly rely on total scores of generic self-report measures to guide treatments targeting fear of movement and avoidance behaviour, while these measures alone might not be the most appropriate selection criteria. Therefore, a substantial proportion of patients with low scores on general self-report measures but who display clear avoidance behaviour that interferes with their daily functioning might not be offered appropriate treatment.

It is essential that clinicians understand the process of a person-centred approach to evaluating fear of movement and avoidance behaviour, and how to identify and manage within-person discrepancies in the assessment. Therefore, we build on and extend previous work[8, 13, 65] by focusing on (1) understanding within-person discrepancies in fear and avoidance behaviour; (2) how to interpret individual items (rather than total scores) of self-report measures of fear of movement to better understand a person's problem and guide adequate treatment selection; (3) how to complete an in-depth behavioural assessment to identify safety behaviours and discuss safety behaviours from different viewpoints; and (4) designing behavioural treatment that is informed by a person-centred assessment of fear of movement and avoidance behaviour. We illustrate our approach with a clinical case.

2. Clinical Question

Most musculoskeletal rehabilitation clinicians will recognise that different people with chronic pain have very different patterns of fear and avoidance behaviour. However, an important remaining question for clinicians is "how can I identify and reconcile the variable pattern of fear of movement and avoidance behaviour in my patient, and design a behavioural treatment based on a person-centred assessment of fear of movement and avoidance behaviour for this patient?".

3. A person-centred approach to evaluating fear of movement and avoidance behaviour

When assessing fear of movement and avoidance behaviour, a person-centred evaluation is required that addresses the cognitions, emotions, motivation and actual behaviour of the individual person in the relevant context[47]. A person-centred evaluation includes (1) an in-depth interview, to understand the person's narrative and specific context regarding their fear of movement and avoidance behaviour[7, 9, 11, 13], (2) an individual item-based analysis of the self-report measures to delve into specific items and reveal additionally relevant information, and (3) a behavioural assessment that evaluates the feared activities, to elicit beliefs and emotional responses to specific movements and identify safety behaviours[31] (**FIGURE 1**).

The approach enables clinicians to identify within-person discrepancies that may exist, and manage them appropriately. We present detailed information from the interview, common self-report measures and the behavioural assessment from one of our patients, and highlight the value of each of these components (see **TABLE 1** and **FIGURE 2**).

3.1. Interview

Eva reported that she initially avoided flexion to control her low back pain. Currently she avoids flexion because she is afraid to cause more damage (**TABLE 2** - Quote 1). Eva's fear and protective behaviour was influenced by an unhelpful explanation of her imaging results, and by her own beliefs about back pain that were very much aligned with current societal beliefs (**TABLE 2** - Quote 2)[15]. Although Eva believed that exercising and being physically active would help keep her back healthy, she was convinced that only controlled exercises or activities performed with caution, where she could avoid lumbar flexion, were appropriate for her (**TABLE 2** - Quote 3).

Quote 3 (**TABLE 2**) exemplifies how Eva's avoidance behaviour spanned from subtle safety behaviours (e.g., putting her steer in a high position to avoid lumbar flexion during cycling) to complete avoidance (e.g., not dancing with her daughter anymore) depending on the type of activity and context. Quote 4 (**TABLE 2**) highlights Eva's competing goals, as she indicated that the social relevance of continuing cycling with her husband outweighed the goal of avoiding pain and potential harm. In contrast, cleaning the house is a painful activity she did not enjoy, and thus avoided.

Another example of the importance of motivation and goal competition is the fact that Eva had not been absent from work since her complaints, although she attributed the origin of her back pain to her sedentary and stressful job. Because she valued her job and felt highly responsible for the organization and her team, Eva persisted despite her pain while at work (**TABLE 2** - Quote 5).

3.2 Item-based analysis of self-reported measures

Various systematic reviews have shown only marginal to weak associations between general self-report measures assessing fear of movement and the actual behaviour[14, 35, 46]. In Eva's case, there was a discrepancy between the *total scores* on the generic self-report measures, indicating a low level of fear of movement (see **TABLE 1**), and the information gathered during the interview and behavioural assessment, indicating the presence of harm beliefs and avoidance behaviour (see **TABLE 1**, **FIGURE 2** and 3.1. patient interview). Although the total scores from self-report measures assessing fear of movement may be informative, we also recommend analyzing how individual items are scored, as this may reveal additional information.

When analysis of individual item-responses may indicate the presence of fear of movement, or when discrepancies are present (between item-responses on the self-report measure, or with information from the interview or behavioural assessment), further in-depth discussion of individual items with the patient is useful. However, an extensive item-based discussion may not have to be prioritised when there are no indications of fear of movement and avoidance behaviour based on the patient interview, behavioural assessment, and item-analysis of self-report measures. Therefore, therapists should decide when, to what extent and which individual items to discuss. In **SUPPLEMENTARY MATERIAL 1** we provide an overview of Eva's scores on the isolated items of the TSK, FABQ and PHODA-SeV, and explain how discrepancies in Eva's answers to the individual TSK items led to new insights on item-interpretation.

Here, we discuss the individual item-based analysis of the PHODA-SeV, and how it helped our understanding on the context-dependency of Eva's perceived harmfulness. Eva's total score of 31.8/100 on the PHODA-SeV indicated a low level of perceived harmfulness. The item-based analysis revealed that Eva generally scored flexion-related activities higher (mean score= 64.8/100) than non-flexion-related activities (mean score= 23.8/100), indicating that she particularly perceived *flexion-*

related movements as harmful. However, even between the various flexion-related tasks, there was a large variability in perceived harmfulness. By discussing the different items with Eva, it became clear that her harm beliefs were dependent on specific activity characteristics (See **TABLE 3** for details). Discussing the patient's answers to specific items of self-report measures is thus an important source of additional information to the patient interview and it helps guide an individualised behavioural assessment.

3.3 Behavioural assessment

We focused on flexion-related activities in Eva's behavioural assessment. Eva had an upright habitual sitting position with over-activity of the lumbar extensor muscles (**FIGURE 2** A). When asked to slouch, she was unable to relax these muscles and flex her lumbar spine (**FIGURE 2** B). When asked how this slouched position felt, Eva reported she felt something was out of place in her lower back, and that she experienced a grinding feeling.

Flexion in standing (**FIGURE 2** C) and lifting a 5 kg crate in her habitual way were predominantly performed via hip flexion, with very limited lumbar movement and with strong co-activation of the lumbar extensor and abdominal muscles. When she was asked what she thought would happen if she had to flex her lumbar spine to lift the crate, Eva indicated that her back would not be strong enough and it would buckle. Correspondingly, she said she would not be able to get back up again. When asked how performing the task in her habitual way made her feel, Eva indicated that although she was afraid, she felt somewhat reassured and safe with the physical therapist by her side. However, she mentioned that she would be more fearful and likely avoid the lifting manoeuvre with a heavier crate, especially if the physical therapist would not be present.

Thorough behavioural assessment is imperative, even for patients who do not self-report high levels of fear of movement as it may highlight within-person discrepancies. An emotional response may only be triggered when one is confronted with the feared activity, or when one believes the task needs to be performed, while simply viewing pictures of feared activities may not suffice for these emotions to surface[12, 31]. The standard inclusion of the behavioural assessment is thus of low cost but high benefit.

4. Theory informing practice to help Eva manage her back pain

In this section, the outcomes on the different components of the person-centred evaluation are interpreted and discussed considering relevant theoretical models. Details on these theoretical models are provided in **SUPPLEMENTARY MATERIAL 2**.

It has been suggested that total scores on questionnaires might offer a quick and robust method for the initial screening of potentially suitable patients for further assessment and behavioural treatment targeting fear and avoidance[65]. Clinical studies investigating exposure therapy in vivo for musculoskeletal pain have used cut-off scores on the TSK as an inclusion criterion[3, 30, 38, 73]. We recommend that clinicians avoid using total scores when selecting treatments, given the clear discrepancy between the total scores on the self-report measures (TSK, FABQ, PHODA-SeV), and the information gathered from the interview and behavioural assessment.

Preliminary evidence indicates that the scores on behavioural avoidance tests, in contrast to the total TSK score, predict reduction in global disability after exposure treatment for chronic low back pain[34]. Interpreting total scores in isolation may therefore lead to misleading conclusions and inadequate treatment choices. For example, one might inappropriately classify Eva as a person without fear of movement (and avoidance behaviour), and deem further testing or treatment of fear of movement as unnecessary. In **TABLE 4**, more information is provided on the limitations of self-report measures assessing fear of movement and avoidance behaviour.

Eva initially avoided flexion-related and sudden, uncontrolled movements because they were painful. Unhelpful messages from a health care professional and her social environment were central drivers of her damage beliefs (**SUPPLEMENTARY MATERIAL 2** – fear acquisition).

A person might completely avoid activities or show subtle behavioural adaptations, the so-called safety behaviours, which are specific adaptations that aim to prevent the feared outcome (**SUPPLEMENTARY MATERIAL 2** – avoidance behaviour and safety behaviour)[47, 48]. Fear of movement and avoidance behaviour can spread excessively to safe activities, which are conceptually or perceptually similar to originally-feared or avoided movements or activities (**SUPPLEMENTARY MATERIAL 2** – (over)generalisation)[29]. From a motivational perspective, safety behaviours may be considered as an attempt to continue to participate in activities a person values from a social perspective (e.g., Eva cycling with her husband) or a health perspective (e.g., Eva exercising to keep her back healthy) (**SUPPLEMENTARY MATERIAL 2** – goal persistence)[16, 19, 59, 60].

Eva showed complete avoidance as well as safety behaviour. For example, although Eva loved to play with her children (e.g., dancing and playing football), she completely avoided these activities as she feared the sudden and uncontrolled movements would damage her back. This complete avoidance clearly interfered with valued activities and participation (**SUPPLEMENTARY MATERIAL 2** - goal interference), and negatively affected her mood[48]. A key example of Eva's safety behaviour is the bracing of her spine to avoid flexion, which enables her to participate in her hobbies and continue working, despite the pain she feels during these activities.

Eva wanted to continue cycling as she values the time she can spend with her husband and because she can do this activity in a controlled manner by using her safety behaviour. She continues to work as she feels responsible for the company (**SUPPLEMENTARY MATERIAL 2** – inter-goal relations). However, she hired someone to clean the house, as cleaning was not an activity she enjoyed.

While safety behaviours may initially result in reduction of pain, fear and its related disability, it is hypothesized that they may have negative consequences in the long term[13, 23] . In Eva's case, her stereotypical spinal bracing with continuous overactivation of spinal muscles can become a source of ongoing peripheral nociceptive input by loading spinal structures in an unhelpful manner, which in turn can contribute to the persistence of pain[25, 33, 52] (See **TABLE 5** for more information). Although causal inference cannot be made, this is indirectly supported by clinical evidence showing that decreased safety behaviour during activities (e.g. greater spinal range of motion, faster movement, more relaxed postures and less back muscle activity) is associated with less pain and experienced disability during those particular activities[70-72].

Using stereotypical (i.e., invariable) motor strategies is related to higher levels of pain during repetitive or prolonged movement tasks[1, 25, 55]. Performing activities with safety behaviours may also paradoxically increase the fear of performing these activities via so called *ex-consequentia* reasoning: "I'm avoiding, so it must be painful or harmful, and/or I must be afraid"[64, 66]. While safety behaviours might have negative consequences in the long term, safety behaviours may also ensure engagement in valued activities. Identifying safety behaviours during the behavioural assessment to decide to what extent they need to be addressed is therefore of great importance.

5. Implications for behavioural management

Eva had low total scores on self-reported measures. However, we recommended in vivo exposure therapy as she was very frightened of performing key tasks in her life that she believed were harmful for her back. Eva avoided valued activities, rendering her disabled[23]. We suggest that adequately exposing Eva to her feared and valued activities is central to her recovery.

During exposure therapy, patients are exposed to the feared activities in order to challenge and disconfirm their unhelpful beliefs. For example, Eva could be asked to lift an object by flexing her lumbar spine. By experiencing that the feared outcome (i.e., buckling of the lower back) did not occur, her expectations are challenged and new associations (i.e., lifting with a bent back is safe) learned. Repeated exposures strengthen new associations so that they will be more easily retrieved and guide behaviour when Eva is confronted with the feared situation. This is essential for extinction of the avoidance behaviour and re-engagement in activities. Earlier theoretical models of exposure therapy suggested that extinction of an avoidance behaviour depended on reducing fear during exposure.[36] However, within and between session fear reduction is not a good indicator of learning and it does not predict treatment outcomes.[4, 36] The inhibitory learning theory has been proposed as an alternative explanation.[18] A central tenet of inhibitory learning theory is that maximising the expectancy violation during exposure is essential to enhance extinction learning.[18, 68] In **TABLE 6**, we demonstrate how this goal can be achieved.

Although exposure therapy is an effective treatment for patients with fear of movement and avoidance behaviour,[30, 40] many of its principles described to improve exposure therapy have not yet been investigated in clinical musculoskeletal pain populations. Consequently, there is an urgent need for properly designed studies investigating these theoretical models, especially in (musculoskeletal) pain populations.

There are strong theoretical arguments for disallowing safety behaviours during exposure. [14, 18] However, there is inconclusive empirical evidence for either allowing or removing safety behaviours during exposure[49]. Moreover, some argue for judicious use of safety behaviours, as they may be a strategy for pursuing valued life goals[49, 56]. For example, Eva puts the steer of her stationary bike in the highest position, so she does not have to bend her back too much, which allows her to participate in a highly-valued social activity with her husband (**TABLE 2** – Quote 3). In this case, the potential benefit (i.e., achieving a valued life goal) should be weighed against the potential cost (i.e., preservation of Eva's fear that bending will damage her back) of making a slight postural adjustment during a very specific activity.

Excessive spinal co-activation is a more generalised safety behaviour that Eva uses during various activities. Besides the negative impact on extinction learning, this behaviour comes with a high cost as it may be an important reason for her persistent pain, and consequently, it is clear that it should be discouraged during Eva's exposure treatment.

An important clinical goal is to guide patients to understand the principles underpinning treatment (i.e., why safety behaviour is discouraged) so they can apply the new strategies at home and at work, and during other valued activities. An important caveat here, is that the role of safety behaviours in the context of (musculoskeletal) pain has mostly been investigated in a small number of experimental studies[43, 63, 66, 67]. Although these studies show that allowing safety behaviours during exposure does protect from extinction of pain-related fear, these findings need to be validated in clinical samples with musculoskeletal pain. Indeed, since the experience of increased pain during behavioural experiments by disallowing safety behaviours can cause severe emotional distress, integrated behavioral approaches such as exposure with pain control have already been advocated for patients with chronic musculoskeletal pain[53].

6. Key points

Findings: Total scores on generic self-report measures fail to capture all the relevant information regarding fear of movement and avoidance behaviour, and thus inaccurately reflect the complexity of pain-related behaviour. A person-centred evaluation addresses the cognitions, emotions, motivation and actual behaviour of the individual person in the relevant context – identifying the variable pattern of fear of movement and avoidance behaviour in one person. Specific attention during behavioural assessment and treatment should be directed to a person's safety behaviours as these may become potential sources of local peripheral nociception and reinforce harm beliefs, contributing to the persistence of pain. Combining knowledge from various theoretical frameworks can explain discrepancies in a person's fear of movement and avoidance behaviour.

Implications: Although clinicians might find it challenging to perform, interpret and implement a person-centred evaluation of fear of movement and avoidance behaviour, it is necessary to gain all relevant information to understand the problem and to guide appropriate treatment choices.

Caution: Part of the reasoning that justifies the clinical approach is based on assumptions and treatment principles from theoretical models. While there is emerging evidence from (mostly) experimental studies supporting these theoretical models, properly designed studies in clinical populations are necessary to validate the assumptions.

Study details:

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Patient and public involvement: we present the case of a real patient who provided consent for sharing the content that is outlined in this manuscript. We used an alias for anonymity purposes.

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Figures

FIGURE 1. Person-centred approach to evaluating fear of movement and avoidance behaviour

Legend: Person-centred approach to the evaluation of fear of movement and avoidance behaviour, including the patient interview, the behavioural assessment, and the item-based analysis of self-report measures. Interview prompts elicit individual beliefs regarding specific movements, related emotional responses, together with individual contextual and motivational aspects related to fear of movement and avoidance behaviour. By assessing the patient in this all-encompassing way, discrepancies between and within the outcomes of the interview, self-report measures and behavioural assessment can be identified and interpreted. The question marks refer to the potential discrepant outcomes between the evaluation's components. Icons by Juicy Fish, Justine Blake, Kylie Hana, Cuputi, Gan Khoon Lay from the Noun Project.

FIGURE 2. Observing lumbar flexion during habitual sitting posture (A), maximally slouched sitting posture (B), and maximal forward flexion in standing (C) during the behavioural assessment.

Legend: Eva shows an upright habitual sitting position (A). In maximally slouched sitting, her lumbar posture remains unchanged and only increased thoracic flexion is observed (B). The same pattern is observed during forward bending where Eva does not flex her lumbar spine and only bends at the hips and thoracic spine. Kinematic assessment revealed that Eva's lumbar range of motion during maximal spinal flexion and lifting a crate (not shown) was 10.3° and 7.0°, respectively. Reference values of lumbar flexion range of motion during these tasks are 37.4° (maximal flexion) and 27.5° (lifting a crate) for persons with chronic nonspecific low back pain, and 46.4° (maximal flexion) and 37.7° (lifting a crate) for pain-free persons[45]. Both in the habitual sitting position and the maximally slouched position, over-activity of the lumbar extensor muscles is observed by palpation (A, B). A strong co-activation of the lumbar extensor muscles and abdominal muscles is identified on palpation during maximal flexion in standing and while lifting (C).

TABLE 1. Clinical case: Eva's story
Eva is a 42-year old woman, with a senior management position in an international company. Eva's job is highly demanding and stressful. Eva's low back pain started four years ago. She cannot recall a specific event that triggered this episode of low back pain, but she believes that it is related to her sedentary job. A few weeks after the onset of her low back pain, Eva had an MRI, which showed a herniated disc at L4/L5 without nerve root compression. Since the onset of her back problems, Eva has received physical therapy on multiple occasions, which consisted of manual therapy and motor control exercises. Currently, Eva has pain across the lower back region, without leg symptoms. The pain is constant, moderate to severe (mean pain score= 6/10), and aggravated mainly by flexion-related activities, such as lifting shopping bags and working in her garden. Eva experiences high levels of pain-related disability, impacting her leisure time activities and playtime with her kids. This is evident from her high score on the Roland Morris Disability Questionnaire (17/24). Eva's low scores on self-reported measures of fear of movement and avoidance behaviour indicate low levels of fear of movement (31.8/100 on the Photograph Series of Daily Activities (PHODA) – Short electronic Version (PHODA-SeV), 27/68 on the Tampa Scale for Kinesiophobia (TSK) and 29/96 on the Fear Avoidance Beliefs Questionnaire (FABQ)). Eva is concerned that some of her symptoms during bending reflect damage in her back, and she avoids lumbar flexion (**FIGURE 2**). Taken together, the low levels of fear based on the self-report measures do not correspond with the information she provided during the in-depth interview and behavioural assessment.

TABLE 2. Quotes from Eva that help clinicians understand Eva's narrative and specific context regarding her fear of movement and avoidance behaviour	
Quote 1	*"….pain definitely plays a role, but then also, sometimes it just doesn't feel right… I have the feeling that, when I bend, there is some friction in my back, a grinding feeling… Like some things are rubbing against each other."; "I feel that something in my back is out of place… that's why I think that there is some damage and why I try to avoid bending my back. Pain tells you something's wrong… that something bad can happen".*
Quote 2	*"… after I had my MRI and I discussed it with the specialist, he told me to be careful because I had this disc bulge … He said to be careful not to make it worse"; "It is generally known that a hernia is a very serious problem. I mean, once you've got a hernia, that's for life. You hear a lot of stories about it from friends."*
Quote 3	*"I know that exercising is necessary for my back. I sit for many hours a day, even in weekends, that's really not good for my back"; "I have been doing Pilates for 2 years. I like it because I can control the exercises very well, so they do not cause pain and nothing bad can happen. I continuously check the position of my back, you know, to keep it in a good position without bending my back"… "I cycle indoors in the gym, on a stationary bike. I like that as I know nothing unexpectedly will happen…I make sure I put my steer in a really high position, so I don't have to bend my back... that's better for me and for my back."; "I can't play football with my son or do some dancing with my daughter because… it is a lot of unexpected and fast movements... that is too dangerous and would give me a lot of pain."*
Quote 4	*"Cycling… I am doing this together with my husband, and it is the only activity that we actually do together, without the kids … And we go for a drink afterwards. That's why I don't like to give up on this... I think it's more important for us that we just continue this, even though I know I'm going to have pain afterwards."*

	“Cleaning the house, I really don’t like it… It also hurts my back. I’m so glad we found someone to clean our house.“
Quote 5	*“I sit too much at work and I don’t move around enough …that’s not good for my back”; “I need to be there to manage everything, and if I’m not there, who will do it then?”; “I also do not want to stop working, I feel so involved in the organization. I don’t want people to wait for me. I feel responsible if things don’t move forward.”.*

TABLE 3. The influence of activity characteristics on Eva's harm-expectancies on different Photograph Series of Daily Activities – Short electronic Version (PHODA-SeV) items

The activities 'picking up shoes with a bent back' (score 45/100) and 'unloading a dishwasher' (score 44/100) are scored lower than 'mopping the floor' (score 62/100). Although none of these tasks involve heavy weights, Eva associates the latter activity with a *longer* and *more continuous spinal flexion* position, which is the reason she perceives it as more harmful.

In contrast, 'lifting a pot with a bent back' is scored very harmful (score 88/100) because of the load *in a flexed position*. Eva says she would not be able to lift the pot as she believes her back would buckle. Related to this, the activity 'taking a heavy box from a shelf above head' (score 61/100) is perceived as more harmful than the activity 'drilling a hole above head' (score 28/100), although these activities are both performed in a spinal extension position. For Eva, the *weight* of the box, which she perceives as much heavier than that of the drilling machine, is the reason to score this activity as harmful. This shows that back posture, load and duration of an activity are characteristics that influence the perceived threat for Eva.

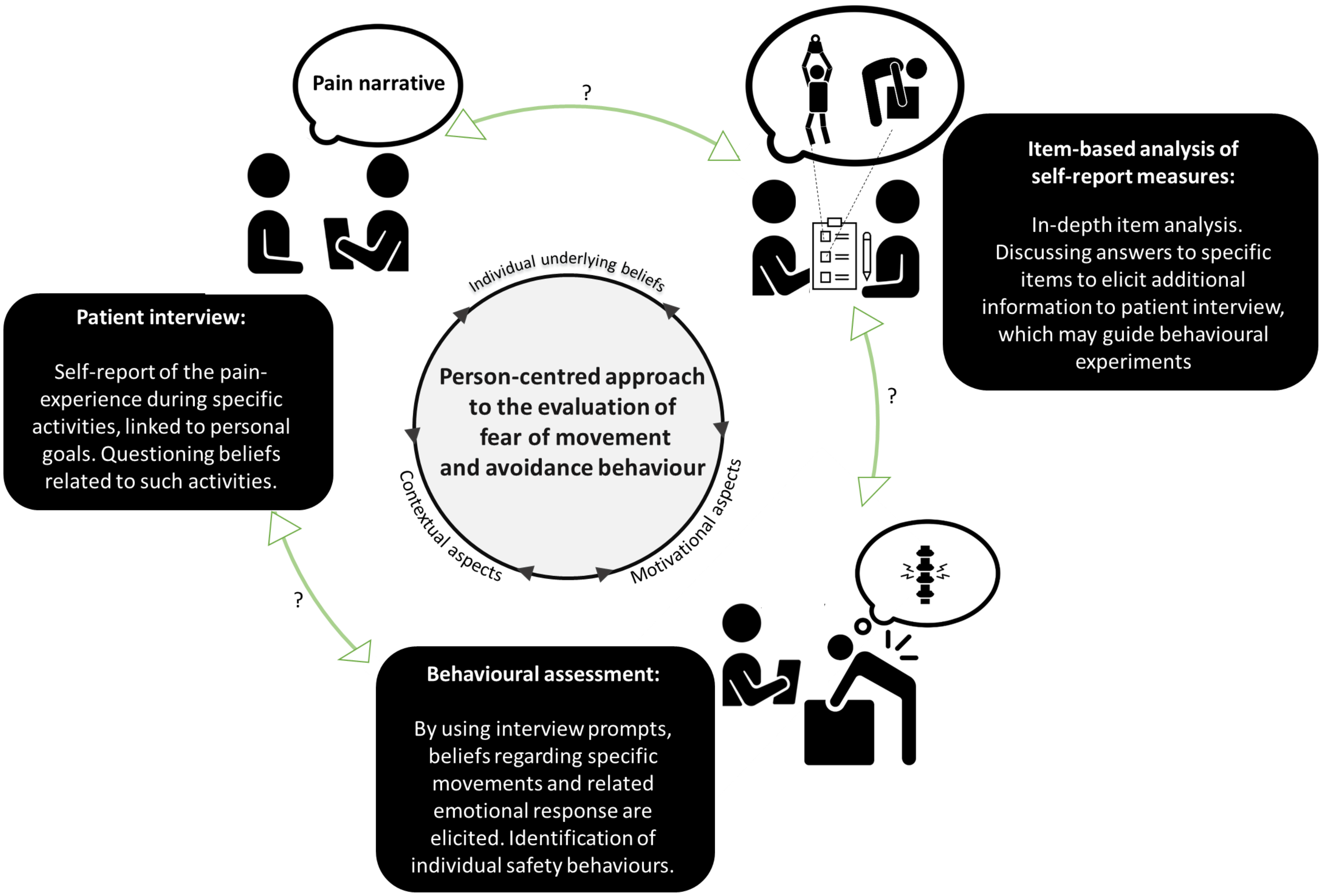
TABLE 4. Limitations of self-report measures assessing fear of movement and avoidance behaviour
General self-report measures, such as the Tampa Scale for Kinesiophobia (TSK) or the Fear-Avoidance Beliefs Questionnaire (FABQ)[58] have important limitations for assessing fear of movement and avoidance behaviour [5, 17]. First, they only provide a generic perspective on a person's fear of movement as they do not evaluate fear related to specific movements or activities[45], thereby discounting potentially important contextual and motivational factors[60]. Some self-report measures do evaluate the perceived harmfulness of specific activities (e.g., the PHODA-SeV or the Avoidance of Daily Activities Photo Shoulder Scale)[2, 39], yet, they only tap into a person's cognitions superficially, not considering motivational and contextual factors[59]. Second, general self-report measures do not assess the person's actual avoidance behaviour, and recent systematic reviews indicate that self-report measures are only weakly associated with the actual behaviour[14, 22, 35, 45]. Finally, the currently used self-report measures make no distinction between expectations about harm, pain, or functional limitations[9-11], while this distinction significantly affects treatment choices.

TABLE 5. Safety behaviour as source of ongoing peripheral nociceptive input
While safety behaviour might initially be adaptive by temporarily unloading painful or damaged tissues, they might have negative consequences in the long-term as they can lead to sensorimotor adaptations in the musculoskeletal system[62]. These sensorimotor adaptations may induce (continuous) nociceptive input, by inappropriately loading the musculoskeletal system[25, 28, 54]. Examples of sensorimotor adaptations are sustained muscle co-activation, increased movement rigidity and decreased variability in the within and between muscle activation distribution[25, 69, 71, 72]. These stereotypical movement and muscle activation patterns may cause greater net local muscle activity[24, 25] and increased compressive loads on the spine, resulting in peripheral nociceptive input. This way, pain can persist even though the original source of nociception may no longer be present in persons with chronic nonspecific musculoskeletal pain. In turn, pain reinforces the notion that the body part needs to be protected which leads to further tension and loading, initiating a vicious cycle of fear, protection, pain and disability.

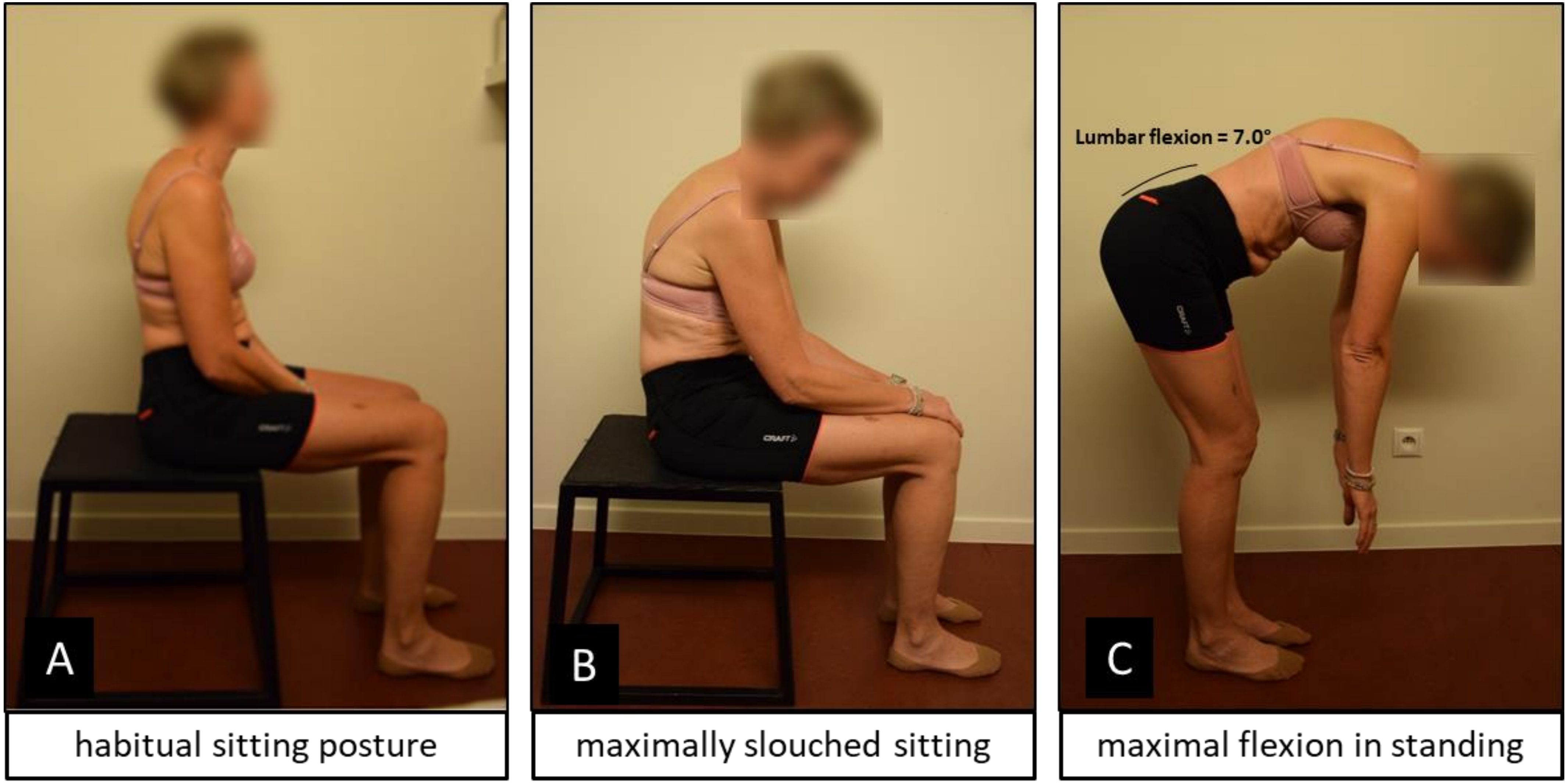
TABLE 6. Eva's case demonstrates that maximising expectancy violation during exposure is essential to enhance extinction learning[18, 20, 27]
Instead of exposing Eva to gradually increasing feared activities to achieve habituation (i.e., fear reduction), we immediately expose Eva to highly fearful activities. We expected that the catastrophe is more likely to occur during a highly fearful task; the expectancy violation will be stronger and extinction learning will be enhanced. Instead of asking Eva to lift a light object with a bent back and to gradually increase the weight, we asked her to lift a heavy object. Eva fears and avoids different types of activities (e.g., spinal flexion and sudden movements): we can initially expose Eva to these feared activities separately, after which these can be combined (e.g., sudden spinal flexion)[27]. By combining both types of activities, it hypothesised that the expected outcome is much worse as for the activities separately. If no catastrophic event happens when performing the compound activity, expectancy violation will be substantial.[20] From the item-based analysis of the PHODA-SeV, it became clear that the duration of the task and the load of an object played a role in Eva's perception of harmfulness. As such, Eva should also be exposed to continued flexion positions and heavy load handling, that latter also during non-flexion positions or movements of the spine. Consider duration and load characteristics when exposing Eva to compound activities. Eva also indicated that the presence of the therapist made her feel safe. Therefore, exposure should not be confined to this safe context, but Eva should also be confronted with the feared activities in different contexts (e.g., via home assignments). Using various contexts can also enhance generalisation of extinction, which is an important treatment aim. This generalisation may also be increased by using variations of the same activity during exposure, to stimulate variable movement patterns. For lifting, Eva can use real life objects of different shapes and sizes, perform lifting activities with one or both hands, introduce rotational movements, or lift objects that are positioned close by or far away. From an inhibitory learning perspective, safety

behaviours should not be allowed during exposure, since the non-occurrence of the catastrophic event during exposure will be attributed to these safety behaviours. Consequently, no expectancy violation and extinction learning will occur.

Eva's unhelpful safety behaviours are to keep her back straight and to continuously co-activate her abdominal and back muscles. Specific focus during exposure on spinal flexion and the conscious relaxation of these muscles might help disconfirm her harm-expectancies[6]. Specifically addressing these sensorimotor adaptations may also reduce the peripheral nociceptive input that may partially be responsible for her persistent pain[25, 28, 54](see Table 3).



Pain narrative
?
Item-based analysis of self-report measures:
In-depth item analysis. Discussing answers to specific items to elicit additional information to patient interview, which may guide behavioural experiments
?
Patient interview:
Self-report of the pain-experience during specific activities, linked to personal goals. Questioning beliefs related to such activities.
Individual underlying beliefs
Person-centred approach to the evaluation of fear of movement and avoidance behaviour
Contextual aspects
Motivational aspects
?
Behavioural assessment:
By using interview prompts, beliefs regarding specific movements and related emotional response are elicited. Identification of individual safety behaviours.


Lumbar flexion = 7.0°
A
habitual sitting posture
B
maximally slouched sitting
C
maximal flexion in standing

Supplementary material 1.

General information on the self-report measures and Eva's individual items scores on the self-report measures, with additional remarks on the individual item analysis when relevant.

Photograph Series of Daily Activities—Short Electronic Version

The Photograph Series of Daily Activities—Short Electronic Version (PHODA-SeV) is a measure of perceived harmfulness of specific physical activities[3]. Forty consecutive pictures of daily life activities are shown on a computer screen. Participants are asked to imagine themselves performing the activities and to indicate to which extent they think the activities are harmful to their back on a 0 to 100 scale (0 = not harmful at all, 100 = extremely harmful). A total score (0–100) is calculated by averaging the scores of the 40 pictures.

Eva's total score on the PHODA-SeV is 31.8/100, indicating a low level of perceived harmfulness. When assessing more task-specific, and calculating her score only based on flexion-related activities, Eva scores 64.8/100, indicating a high level of perceived harmfulness. In contrast, calculating her score for non-flexion-related activities, she has a score of 23.6/100.

Item scores in order of perceived harmfulness

Short photograph label (photo number)	score	order	flexion?
Falling backwards (38)	91	1	
Lifting pot, bent back (3)	88	2	x
Shovelling soil (1)	81	3	x
Lifting toddler from cot (31)	72	4	x
Lifting beer crate, bent back (10)	67	5	x
Mopping floor (17)	62	6	x
Taking heavy box from shelf above head (21)	61	7	
Lifting basket, walking up stairs (9)	60	8	
Carrying child on hip (32)	59	9	
Vacuum cleaning (16)	59	10	x
Mowing lawn (39)	57	11	
Picking up shoes, bent back (4)	45	12	x
Clearing out dishwasher (14)	44	13	x
Carrying rubbish bag, one hand (13)	36	14	
Carrying shopping bag, one hand (11)	34	15	
Carrying two shopping bags, both hands (12)	32	16	
Doing dishes (33)	32	17	
Getting out of bed (26)	30	18	
Drilling hole above head (40)	28	19	
Lifting pot, squatting (2)	26	20	
Trampoline jumping (22)	23	21	
Making bed (25)	23	22	
Leg stretching (18)	22	23	

Cleaning windows above head (29)	20	24
Taking box from cupboard (15)	18	25
Back twisting (19)	15	26
Cycling from kerb (36)	15	27
Rope skipping (23)	12	28
Abdominal exercises (24)	11	29
Back bending (20)	10	30
Picking up shoes, squatting (5)	8	31
Ironing while standing (7)	8	32
Cycling, looking aside (37)	7	33
Taking book, twisted back (6)	6	34
Running through forest (34)	4	35
Riding bike bumpy street (30)	3	36
Ironing while sitting (8)	2	37
Walking up stairs (27)	2	38
Walking down stairs (28)	0	39
Walking through forest (35)	0	40
Mean score	**31.8**	

Item scores flexion-related activities in order of perceived harmfulness

Short photograph label (photo number)	score	order	flexion?
Lifting pot, bent back (3)	88	2	x
Shovelling soil (1)	81	3	x
Lifting toddler from cot (31)	72	4	x
Lifting beer crate, bent back (10)	67	5	x
Mopping floor (17)	62	6	x
Vacuum cleaning (16)	59	10	x
Picking up shoes, bent back (4)	45	12	x
Clearing out dishwasher (14)	44	13	x
Mean score Flexion	**64.8**		

PHODA-SeV item scores non-flexion-related activities in order of perceived harmfulness

Short photograph label (photo number)	score	order	flexion?
Falling backwards (38)	91	1	
Taking heavy box from shelf above head (21)	61	7	
Lifting basket, walking up stairs (9)	60	8	
Carrying child on hip (32)	59	9	
Mowing lawn (39)	57	11	
Carrying rubbish bag, one hand (13)	36	14	
Carrying shopping bag, one hand (11)	34	15	
Carrying two shopping bags, both hands (12)	32	16	
Doing dishes (33)	32	17	
Getting out of bed (26)	30	18	
Drilling hole above head (40)	28	19	

Lifting pot, squatting (2)	26	20
Trampoline jumping (22)	23	21
Making bed (25)	23	22
Leg stretching (18)	22	23
Cleaning windows above head (29)	20	24
Taking box from cupboard (15)	18	25
Back twisting (19)	15	26
Cycling from kerb (36)	15	27
Rope skipping (23)	12	28
Abdominal exercises (24)	11	29
Back bending (20)	10	30
Picking up shoes, squatting (5)	8	31
Ironing while standing (7)	8	32
Cycling, looking aside (37)	7	33
Taking book, twisted back (6)	6	34
Running through forest (34)	4	35
Riding bike bumpy street (30)	3	36
Ironing while sitting (8)	2	37
Walking up stairs (27)	2	38
Walking down stairs (28)	0	39
Walking through forest (35)	0	40
Mean Score	**23.6**	

Tampa Scale for Kinesiophobia

The Tampa Scale for Kinesiophobia (TSK) is a questionnaire containing 17 items to assess fear of movement/re-injury due to physical activity[6]. The total score ranges between 17 and 68, where 17 means no fear of movement, 68 means severe no fear of movement, and score ± 37 indicates there is no fear of movement. For patients with CLBP, two subscales can be discerned in the TSK. The activity avoidance subscale (TSK-AA, items 1, 2, 10, 13, 15, and 17) specifically measures activity avoidance and fear of re-injury, whereas the Somatic Focus subscale (TSK-SF, items 3, 11, 6, 7, 5) assesses to which extent patients believe that their pain can be attributed to a serious underlying medical problem[2].

Eva's total score on the TSK is 27/68, indicating a low level of fear of movement. She scores 11/32 on the TSK-AA and 9/20 on the TSK-SF.

		Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1	I'm afraid that I might injury myself if I exercise	**1**	2	3	4
2	If I were to try to overcome it, my pain would increase	**1**	2	3	4
3	My body is telling me I have something dangerously wrong	1	**2**	3	4
4*	My pain would probably be relieved if I were to exercise	1	2	3	**4**
5	People aren't taking my medical condition seriously enough	1	**2**	3	4
6	My accident has put my body at risk for the rest of my life	**1**	2	3	4
7	Pain always means I have injured my body	1	2	**3**	4
8*	Just because something aggravates my pain does not mean it is dangerous	1	2	3	**4**
9	I am afraid that I might injure myself accidentally	1	2	**3**	4
10	Simply being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my pain from worsening	**1**	2	3	4
11	I wouldn't have this much pain if there weren't something potentially dangerous going on in my body	**1**	2	3	4
12*	Although my condition is painful, I would be better off if I were physically active	1	2	3	**4**
13	Pain lets me know when to stop exercising so that I don't injure	1	**2**	3	4
14	It's really not safe for a person with a condition like mine to be physically active	**1**	2	3	4
15	I can't do all the things normal people do because it's too easy for me to get injured	**1**	2	3	4
16*	Even though something is causing me a lot of pain, I don't think it's actually dangerous	**1**	2	3	4
17	No one should have to exercise when he/she is in pain	**1**	2	3	4

*Scores are reversed when total score is calculated

Additional remarks regarding Eva's TSK's total and relevant items' scores:

Eva's low TSK-total score corresponds to Eva's story, in which she indicates that she 'knows' that activity and exercise are good for a healthy back. This is also evident from her low scores on the TSK items assessing her attitude regarding bodily exercises, indicating no fear to exercise and that she beliefs exercising is good for her back (See Appendix 1, e.g. items 1, 4, 12, 13, 14, 17).

There seems to be some inconsistency in Eva's answers on the items 9 ('I am afraid that I might injure myself accidentally', score 3: agree) and 10 ('simply being careful that I do not make any unnecessary movements is the safest thing I can do to prevent my pain from worsening', score 1: strongly disagree). When asking how she perceives the difference between both items, she associates 'injuring oneself accidentally' (item 9) with sudden, uncontrollable movements which, in her perception, might cause harm. However, Eva explains that she does not associate 'unnecessary movements' (item 10) with these sudden, uncontrollable movements.

Apart from the motivational perspective which is not questioned in the TSK[1, 4], an important reason for the discrepancy between Eva's (avoidant) behaviour and her score on the TSK, is that the TSK items refer to 'exercises' or 'activity', rather than to specific activities. However, Eva considers exercising or being active in general as beneficial, although she is fearful of particular activities.

Fear-avoidance Beliefs Questionnaire

The Fear-avoidance Beliefs Questionnaire (FABQ) is a 16-item scale investigating fear-avoidance beliefs. Two subscales are defined: the FABQ-physical activity subscale (4 items, item 2, 3, 4, 5) and FABQ-Work subscale (7 items, item 6, 7, 9, 10, 11, 12, 15).[5] Each item is scored on a 7-point Likert scale with a score ranging from zero ("completely disagree") to six ("completely agree"). Higher scores indicate higher levels of fear avoidance beliefs.

Eva's total FABQ score is 29/96, her subscores on the FABQ-physical activity and work subscale are 10/24 and 18/42, respectively.

		Completely disagree			Unsure			Completely agree
1	My pain was caused by physical activity	0	**1**	2	3	4	5	6
2	Physical activity makes my pain worse	0	1	2	3	4	**5**	6
3	Physical activity might harm my back	0	1	**2**	3	4	5	6
4	I should not do physical activities which (might) make my pain worse	0	1	**2**	3	4	5	6
5	I cannot do physical activities which (might) make my pain worse	0	**1**	2	3	4	5	6

The following statements are about how your normal work affects or would affect your back pain.

6	My pain was caused by my work or by an accident at work	0	1	2	**3**	4	5	6
7	My work aggravated my pain	0	1	2	3	4	**5**	6
8	I have a claim for compensation for my pain	**0**	1	2	3	4	5	6
9	My work is too heavy for me	0	1	**2**	3	4	5	6
10	My work makes or would make my pain worse	0	1	2	3	4	**5**	6
11	My work might harm my back	0	1	2	**3**	4	5	6
12	I should not do my normal work with my present pain	**0**	1	2	3	4	5	6
13	I cannot do my normal work with my present pain	**0**	1	2	3	4	5	6

14	I cannot do my normal work until my pain is treated	**0**	1	2	3	4	5	6
15	I do not think that I will be back to my normal work within 3 months	**0**	1	2	3	4	5	6
16	I do not think that I will ever be able to go back to that work	**0**	1	2	3	4	5	6

Additional remarks:

From the FABQ-work score, it is clear that Eva thinks that her pain is caused and increased in intensity by her job (items 6, 7, 10, 11). In contrast, scores on the items 13 to 16 indicate that she feels very able to perform her job. She furthermore indicates that she strongly disagrees that she should discontinue her tasks at work due to her pain. These scores are in line with Eva's story regarding her work-activities and her idea on the origin of her pain.

Apart from the motivational perspective which is not questioned in the TSK[1, 4], an important reason for the discrepancy between Eva's (avoidant) behaviour and her score on the FABQ-PA, is that the FABQ-PA items refer to 'physical activity', rather than to specific activities. However, Eva considers being active in general as beneficial, although she is fearful of particular activities.

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<table>
<tr><td colspan="2">SUPPLEMENTARY MATERIAL 2.
TABLE 1. Theoretical frameworks that underpin the person-centred approach to the evaluation of fear of movement and avoidance behaviour</td></tr>
<tr><td colspan="2">FEAR ACQUISITION[3, 4]
Fear of movement can be acquired via direct experience, instructional learning, observational learning or a combination of the previous. These forms of fear acquisition are examples of Pavlovian conditioning.</td></tr>
<tr><td>Direct experience</td><td>Pain is an alarm signal of bodily harm and it elicits defensive responses, such as fear and avoidance behaviour. When a person experiences pain (unconditioned stimulus; US) during an initially neutral movement (e.g., lifting with a bent back; conditioned stimulus; CS), this person will start to associate the movement with pain. As a consequence, confrontation with the initially neutral movement will also elicit fear and avoidance (conditioned responses; CR).</td></tr>
<tr><td>Instructional learning</td><td>Fear can be acquired via (verbal or written) instructions or information received from various sources, such as significant others, the media or health care providers. For example, when a health care provider instructs a patient to keep a straight back while lifting because lifting with a bent back may damage the spine, this patient may develop a fear for lifting with a bent back and start avoiding this activity.</td></tr>
<tr><td>Observational learning</td><td>We can learn by observing other people’s behaviour when they are confronted with pain. For example, when we see someone experiencing pain during a particular movement, we may learn that this movement is dangerous and should be avoided.</td></tr>
<tr><td colspan="2">AVOIDANCE BEHAVIOUR[3, 4]
Avoidance behaviour can range from very subtle behavioural adaptations to complete avoidance. Depending on the situation, avoidance behaviour can be considered adaptive or overprotective. Furthermore, avoidance behaviour might generalise to other activities.
Behavioural adaptations are shaped by the consequences of the shown behaviour. For example, based on operant conditioning, behavioural adaptations may be reinforced or maintained due to the reduction of fear/pain (negative reinforcement) and/or increase in activity participation (positive reinforcement) that result from the adapted behaviour. Therefore, behavioural adaptations might be considered functional. However, behavioural adaptations might also have negative consequences, for example, by overloading musculoskeletal structures or by misattributing safety to the adapted behaviour. This is the case for safety behaviours.</td></tr>
<tr><td>Complete avoidance behaviour</td><td>A person may completely avoid a certain activity. For example: never lifting heavy objects because it may damage the spine or never running in a forest because the fear of an ankle sprain.</td></tr>
<tr><td>Subtle behavioural adaptations – safety behaviours</td><td>A person may not completely avoid an activity, but only perform it with behavioural adaptations. Regarding fear of movement, these behavioural adaptations often pertain to movement-related behaviour. Examples of such adaptations are: no or less movement at the painful area (e.g., keeping the back straight), compensatory movement in non-painful body regions (e.g., bending the knees, rotating at the hips), increased co-contraction, reduced movement variability, slower movements or taking a larger base of support. People may consciously adapt their behaviour, but it is also possible that persons are not aware of these adaptations (e.g., a person might not be aware of exaggerated co-contraction).
Safety behaviours are (subtle) behavioural adaptations that intend to prevent the expected negative outcome from occurring (prevention of</td></tr>
</table>

	harm/damage). For example, if a person is convinced that lifting with a bent back will cause the intervertebral disc to pop out, this person may only lift with a straight back to prevent the feared outcome. Paradoxically, safety will be (mis)attributed to this behaviour. Therefore, they are considered a barrier for genuine fear extinction during exposure in vivo, since harm beliefs are not disconfirmed[1]. Furthermore, safety behaviours may load spinal structures in a suboptimal manner, so these structures become sensitised and a source of ongoing peripheral nociceptive input.
Adaptive avoidance behaviour	The temporary avoidance of certain activities can be indicated in the presence of tissue damage (e.g., relative rest after an ankle sprain). When recovery of function and the participation in valued activities is prioritized (also see motivational account), a person will gradually explore whether it is possible to perform the painful movement or to load the painful tissue (e.g., gradually take support after an ankle sprain). When the load on the tissues is adequately increased based on the stages of tissue healing, this will improve recovery. A second reason why avoidance behaviour may be adaptive, is when a person lacks the physical capacity to safely perform certain activities. For example, it has been well-documented that the re-injury rates after an anterior cruciate ligament reconstruction dramatically increase when patients return to sport too early, without achieving certain physical criteria. In this case, avoiding full return to sport until the physical criteria are fulfilled seems adequate.
Overprotective avoidance behaviour	When avoidance behaviour is excessive relative to the context (overprotective avoidance behaviour), it becomes unhelpful. This is the case when avoidance behaviour persists after tissues have healed and do not need to be protected anymore. Another example is when avoidance behaviour spreads to safe activities in case of (acute) tissue damage (e.g., avoidance of walking in case of (acute) flexion-related low back pain). This latter is also an example of overgeneralisation.
(Over)generalisation	Generalisation is the spreading of fear of movement and avoidance behaviour to movements, situations or activities which are conceptually or perceptually similar to original harm-signalling stimuli. Overgeneralisation refers to generalisation to safe activities which should not be avoided or protected from a tissue healing point of view. For example, in case of an acute injury, the generalisation of avoidance behaviour towards movements that are best avoided from a tissue healing perspective is highly adaptive. It becomes unhelpful when there is overgeneralisation, indicating that safe activities or movements are avoided as well. In this context, category-based or conceptual overgeneralisation refers to fear and avoidance of safe movements or activities which are physically dissimilar but semantically related to the initial threat-inducing movements/activities. For example, when one gets injured due to tackle of an opponent, every uncontrollable, unexpected situation might elicit fear and avoidance behaviour. Learned fear can also overgeneralise to safe events due their perceptual (physical or proprioceptive) similarity with threat-relevant stimuli. For example, when lifting with a bent back in a person with chronic nonspecific low back pain is already associated with fear and is avoided, every flexion-related movement can elicit fear.
CONSIDERING BEHAVIOURAL ADAPTATIONS IN A MOTIVATIONAL PERSPECTIVE[2, 5, 6]	

Pain-related fear of movement and behavioural adaptations never occur in isolation of context and ongoing goal pursuit. The transition from acute to chronic pain is not only explained by fear- or pain-induced avoidance behaviour, but also by task or *goal persistence* in the presence of pain and fear.	
Goal persistence	A person may prioritize either a pain-related goal (e.g., avoidance of pain) or a non-pain-related goal (e.g., participation in valued life goals, despite the pain). When a person persists in performing activities despite pain or fear, this is referred to as goal persistence. In the context of goal persistence, subtle behavioural adaptations might be used to cope with the fear or pain, and can therefore be considered functional as they help to maintain goal pursuit. For example, one's goal might be to take care of the grandchildren, despite being in severe pain when lifting them with a bent back. Therefore, this person might decide to only pick the children up by bending the knees and a straight back. Of course, the presence of the behavioural adaptations may have negative consequences on the long term (see safety behaviours). Prioritization of either pain control/avoidance or persistence in activity participation depends on different factors. First, dispositional factors (e.g., individual personality traits, temperament, and genetics) influence personal behaviour and actions. For example, if someone feels responsible for a company or an organisation, or the household, this person might persist in these activities despite being in severe pain. Second, situational/contextual factors, such as the goal underlying an activity, are equally important. In different situations, different goals can be activated, and the perceived characteristics of these goals (e.g., importance/value, how congruent with one's values, feasibility, self-efficacy, required effort) will additionally determine the motivation to perform the activity. For example, a person might avoid bending activities with the back at work because bending is painful, but might endure in these activities to be able to take care of the children, or to engage in leisure activities.
Goal interferences	A person might dislike the fact that they avoid activities due to pain or fear, as it interferes with successful goal pursuit. This can result in negative affect. For example, a cyclist may stop cycling after a fall in a race, because the fear of falling is greater that the cyclist's wish to participate in races again. However, this can cause depressive symptoms in this person because this person identified as a cyclist.
Inter-goal relations	In context of inter-goal relations, inter-goal interference (i.e., pursuing one goal hinders attaining another goal – see goal interference) and inter-goal facilitation are described. This latter refers to the fact that pursuing one goal (e.g., cycling for good health) helps attaining another goal (e.g., spending time with friends).

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