

Supplementary Online Content

Traeger AC, Lee H, Hübscher M, et al. Effect of intensive patient education vs placebo patient education on outcomes in patients with acute low back pain: a randomized clinical trial. *JAMA Neurol*. Published online November 5, 2018. doi:10.1001/jamaneurol.2018.3376

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This supplementary material has been provided by the authors to give readers additional information about their work.

eMethods 1. Screening With PICKUP Tool

Excluding patients at low risk of pain chronicity using PICKUP Tool

To identify those at low-risk of poor outcome, we screened all potential participants using a validated 5-question prognostic screening tool, PICKUP.⁽¹⁾ The questions included: 1. “How much low back pain have you had during the past week?” 1 = none, 2 = very mild, 3 = mild, 4 = moderate, 5 = severe, 6 = very severe; 2. “Do you have leg pain?” 0 = no, 1 = yes; 3. “Is your back pain compensable, e.g., through worker’s compensation or third party insurance?” 0 = no, 1 = yes; 4. “How much have you been bothered by feeling depressed in the past week (0–10 scale)?” 0 = not at all, 10 = extremely; 5. “In your view, how large is the risk that your current pain may become persistent (0–10 scale)?” 0 = none, 10 = extreme. Scores on these 5 questions were converted into an absolute risk for developing chronic low back pain. Risk for developing chronic LBP in acute low back pain trials from a similar geographic area of Sydney was 20%.^(2, 3) By using PICKUP and applying a cutoff of $\leq 30\%$ predicted risk in our validation sample we estimated that we would exclude from the PREVENT Trial approximately 60% of the patients with acute low back pain who were less likely to develop chronic LBP. That is, we aimed to include double the number of ‘high-risk’ participants in our sample compared to an unscreened trial population. Data on PICKUP questions were collected prior to obtaining informed consent.

References

1. Traeger AC, Henschke N, Hubscher M, et al. Estimating the risk of chronic pain: development and validation of a prognostic model (PICKUP) for patients with acute low back pain. *PLOS Med*. 2016;13(5):e1002019.
2. Williams CM, Maher CG, Latimer J, et al. Efficacy of paracetamol for acute low-back pain: a double-blind, randomised controlled trial. *Lancet*. 2014;384(9954):1586-96.
3. Hancock MJ, Maher CG, Latimer J, et al. Assessment of diclofenac or spinal manipulative therapy, or both, in addition to recommended first-line treatment for acute low back pain: a randomised controlled trial. *Lancet*. 2007;370(9599):1638-43.

eMethods 2. Standard History and Physical Examination Form

PREVENT

Patient Name: _____ Recording 1st Session
Date: _____

PT/ GP _____ 2nd Session
Date: _____

Work _____ Date of injury/ pain onset _____ Days since
injury _____

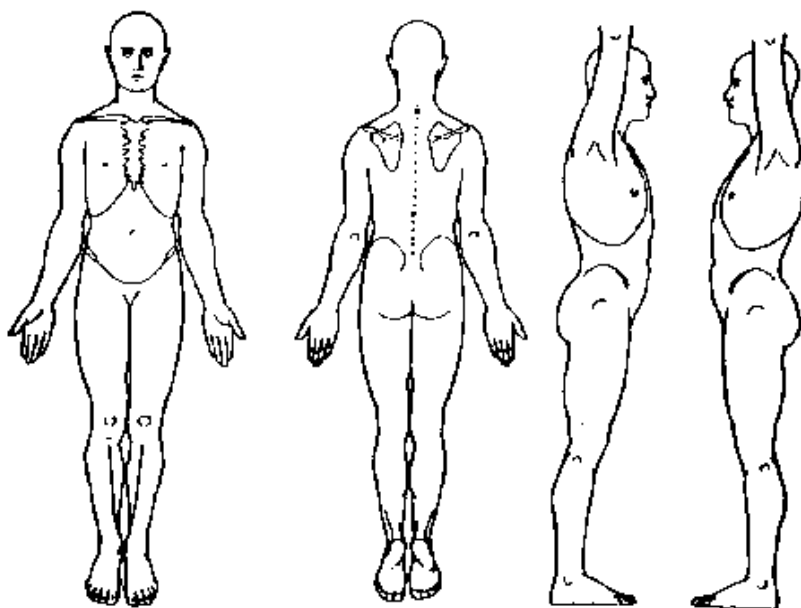
Brief overview:

What the physio/ GP has told you:

Patients Understanding of why painful?

Treatment to date:

Pain location/ description: Leg Pain Yes No



Active Movements:

	Range/ Pain/ Comments
Flex	
Ext:	
R Rot:	
L Rot:	
R Sflex	
L Sflex	

Neuro Examination

Level	Movement	R	L	Reflexes	
L2	Hip Flex				
L3	Knee Ext				
L4	Ankle DF/ INV			Knee Jerk	
L5	1 st Toe Ext				
S1	Ankle PF			Ankle Jerk	

Pain A:

Constant	Yes	No	If yes does it vary?	Yes	No
Intensity:	Worst (/10)			Best (/10)	
Quality					
Depth					

Pain B:

Constant	Yes	No	If yes does it vary?	Yes	No
Intensity:	Worst (/10)			Best (/10)	
Quality					
Depth					

Aggravating Factors

Activity 1

Analyse	
How long to come on?	
What action?	
Have to stop?	
How long to ease?	

Activity 2

Analyse	
How long to come on?	
What action?	
Have to stop?	
How long to ease?	

Activity 3:

Analyse	
How long to come on?	
What action?	
Have to stop?	
How long to ease?	

Other known aggravating factors:

- Bending
- Lifting
- Sitting
- Standing
- Stairs Up/ Down
- Gardening

Easing Factors

Activity 1

Analyse	
How long to ease?	
Relationships?	
Therapeutic V Non Provocative?	

Activity 2

Analyse	
How long to ease?	
Relationships?	
Therapeutic V Non Provocative?	

Activity 3

Analyse	
How long to ease?	
Relationships?	
Therapeutic V Non Provocative?	

Other known easing strategies:

Heat- Hot pack/ shower/ Cold/ Lying/ Sitting

Irritability

Severity	
Intensity	
Time to settle	

24 Hour Behaviour

First thing AM	
During the Day	
Evening	
Sleep	

Stage of Condition

Better	
Worse	
Same	

General Health

State of General Health	
Under doctors care for anything else	

Medications (ask for steroids/ anticoagulants/ previously used for long period of time)

Medication Name	For?	Dose

Tests/ Investigations

eMethods 3. PREVENT Trial Patient Education Manual

Introduction

- Spiel
- Mechanism of injury
- Neuro examination
- Conversation about worries

Explaining the diagnosis

Structural Diagnosis

- Spinal alarm system & non-specific diagnosis
- Disc
- Joint
- SIJ
- Nerve-root
- Muscle

Biomedical diagnosis

- Arthritis/ degeneration
- Spondylolisthesis
- Instability

Other diagnoses

- My back is out
- My pelvis is twisted
- Weak and insecure

Explaining therapy so far

Mechanism of physiotherapy treatments

- Manual therapy
- Motor control/stability
- Mackenzie
- Exercise
- Explaining pain

Mechanism of medical treatments

- Tablets
- Injections
- Surgery

Mechanism of alternative treatments

Explaining pain biology

What is pain all about?

- What is pain?
- Pain is protective
- Pain is not a measure of tissue damage
- Pain tries to get us out of danger
- Visual metaphors
- Complex output
- Thirst metaphor

How is it processed and what can change it?

- Nociception vs. pain
- Danger to the tissues doesn't = pain
- Pain doesn't always = danger
- Pain processing diagram
- Inflammation
- Tissue healing
- Peripheral modulation – inflammatory soup
- Spinal modulation – gain on the amplifier
- Descending modulation – credible evidence
- The pain neurotag
- Systems to get you out of trouble
- How dangerous is this really?
- Importance of context

Sensitive alarm system

- The spine is hyperprotective
- If the brain perceives vulnerability, protection will increase
- Alarm system metaphor
- Timing of pain – speed of change
- Twin peaks
- Short term and long term sensitization examples

Take home messages

- Pain is protective, not a symptom of damage
- Pain is overestimating what is going on in the tissues
- Understanding this will help you recover

Explaining what to expect from here

- Recurrence
- Prognosis
- Pacing
- Tools
- Return to work

Tricky questions

- Are you saying it's in my head?
 - Does that mean my pain isn't real?
 - Could they have missed something?
 - So you aren't going to do any massage or anything?
 - Shouldn't I get an MRI?
-

Introduction

Spiel

- Firstly I'd like to thank you for being part of our study.
- My background is in clinical physiotherapy and I have specialist training in pain science and acute low back pain.
- We are doing this project because we have learnt so much about low back pain in the last 20 years, that the way we are treating chronic low back pain now is a real focus on you understanding what you need to do and why you need to do it to get better.
- The Commonwealth Government is excited about this and has asked us to try it with people early on, so that is what we are doing.
- So I know you have already been assessed, but we want to double check we have ruled out all the nasty things because we have to protect our own backs here.
- Once we have ruled it out, I want to know about everything that we now know affects pain. And tell you about what we now know about those things in a way you will understand.
- What I have been finding recently with my patients is that it can be really helpful to understand the biology of pain, particularly in low back pain because it can give some explanation for why it is so painful, when often a specific cause cannot be identified. I have also found that the more people know about their pain, and why they need to do certain exercises, the more reassuring this can be. This has also been shown in recent scientific studies. More knowledge about pain tends to help with these problems.
- I'm going to ask you a lot of questions and I'm going to do a lot of talking, but at the end of this, I really hope that you have a clear understanding of what is going on with your back, and a clear direction to plan your recovery.
- I hope you will also have a clear understanding about what to expect from here, and no worries.
- I have been selected as one of the experts because I have been involved in this area for some time, and I am studying a PhD on this topic.
- The aim of this is to give you a level of knowledge and understanding that you need to make the fastest recovery possible.
- So its going to be important that at the end, that I can get an idea of how much you have understood. I also want to know at the end if you still have any things that you don't understand or that you are worried about.
- My job is to teach you this stuff, so its really important that you let me know if you don't understand anything
- Gone are the days when we can give you a pill or an injection – it never works. We now know it doesn't work.
- You have been referred over by, can you please tell me in your own words what you think is going on with your back? How do you think its going so far? Ok, I have to do my own set of questions because we are really good at spotting the nasty things, but I just need to double check nothing has been missed (because it'll be on my back). Something can be missed but there no way two people will miss the same thing.
- The best evidence we've got, is that the things that determine recovery are the way you make sense of your pain, and not the things that are in your back. Even now, I can tell that you are really worried about this, and almost convinced that this is never going to get better. One of the big challenges for me is to explain to you why that doesn't have to be the case. Because even expecting that will increase your chances of not recovering quickly. There are no risks at all to thinking about this stuff.

Mechanism of injury

- Clearly you have done something. Otherwise it wouldn't hurt so much... I understand that it started hurting when you lifted that thing....
- Nil MOI: It's very possible that you haven't damaged any tissue; but because there are so many alarm systems...and the brain is always on the look out...that it could be anything! If it hurts that badly then it could be all sorts of stuff. Maybe it was just that things weren't operating as well as they could in there. And this is the way it's letting you know.
- (If someone has an idea of the multifactorial nature of pain): The system is so hyperprotective that you are probably getting close (to an injury). This is where the physio will be great – you just need to be sure to slowly return to function. “what if it just goes back to how it was with a dull ache every now and then??” Maybe that would be a good time for you to see a good physio to help you with a physical upgrading...to help you get a bit fitter and stronger.

Conversation about worries

- Can you tell what concerns you the most about this back pain?
- Have you had any thoughts about what your back might need in terms of medicine or therapy?
- This sort of stuff is important for me to know because it affects your brain evaluation of danger. We know that pain is very much related to your brain's evaluation of danger. There are lots of body systems that can modify this evaluative process.
- (When discussing concepts, remove the observables (emotion, fear, mood) and rather talk about the systems that control these things): It's all about your brain's evaluation of danger. And your immune system can modify that. And your endocrine system can modify that. And your sympathetic nervous system can modify that. And when you worry, that will also change your pain because you are worried about damage.
- Are there any other worries that you have which we haven't covered?
- So how was it the next day...were you worried about that at all? We are going to come back to that because I think I might be able to make sense of that for you.
- My job is to teach you this stuff, and I hope that by the end of our time together, you will have a clear understanding of your back pain, what to expect from here, and no worries.
- Example questions
 - o Can you tell me what you think is causing your pain?
 - o Have you had any other thoughts about what your back might need in terms of medicine or therapy?
 - o What is it that concerns you the most about your back pain?
 - o Are you worried at all that will cause damage in your back or slow your recovery?
 - o How do you see yourself recovering?
 - o How has your family reacted to you having this back pain?
 - o What about work? Is work being supportive? How do you feel about going back?
 - o What have you been doing to cope with the pain so far?
 - o Are there any other worries that you have which we haven't covered?

Diagnosis

Structural Diagnoses

Spinal alarm system

- Lets say you want to protect your most vital thing, like precious jewelry.
- Where would you put it?...in a safe.
- That's exactly how we are constructed!
- Our brain is our most important thing – no brain, no you!
- Our second most precious thing is our spinal cord – that is what keeps the body talking to the brain.
- Picture of how well encased the spinal cord is: thick bone, disc, ligament, muscle
- So let say you wanted to be extra sure no-one went near that precious thing – what would you install?...an alarm system.
- Absolutely. That is exactly the way we are constructed
- Picture of vertebra – that's the bony bit. But you need movement → sideways view: there are these things in here that are just full of ligaments.
- So if you do anything there that's a little bit dangerous, which you have done because it hurts, it rings the alarm bell.
- The alarm bells converge with maybe 150 of them going into one nerve, which goes toward the brain. That message says “danger”.
- In fact, we don't know which alarm bell went off and we are never going to know that. And it doesn't really matter because we'll treat it the same way.
- One of the reasons that backs really hurt when you hurt them is because we have so many alarm bells
- We could even do an MRI or CT and we'll see all different shapes and stuff but we have no way of knowing where the alarm bell that rung is. So there is no gain at all in having a scan.
- The reason we know the alarm has rung is that your back really hurts (Your pain is completely legit)
- Clearly when you picked up that thing you did something that rang some alarm bells. But it is so well protected, that you would be ringing alarm bell even with a tiny injury
- In fact, sometimes you don't have any injury at all, you just came a bit close.
- Pain is about protection. It's about stopping you doing things. Which is fantastic if the pain is accurate. One problem we have with the back is that it's overprotective. And if you don't know that and don't realize that that is how we are setup, then you are going to overprotect. When we overprotect and we don't move enough then the problem becomes worse.

Disc

- Disc diagram as strong ligament tissue. A couple of small ligaments in the knee hold the whole thing together. It's just like the ligaments in the ankle – they get injured and heal up. You gradually get back to running, but if you do it too quickly, you could make it worse. Conversely if you don't do enough, you can end up with a really stiff ankle and things take much longer.
- The disc is a really strong ligamentous thing, just like the ligaments in your ankle. Same stuff. Absolutely covered in alarm bells that are looking for anything dangerous. They are all over the bones and joints and ligaments and muscles.
- Picture of vertebra – that's the bony bit. But you need movement → sideways view: there are these things in here that are just full of ligaments.
- Cross hatched ligament diagram
- There is actually no better part of your body to injure, because this part is so solid and well protected. Even when you do injure it, it fixes itself.
- You know how strong ligaments are? A ligament the size of your little finger holds the knee together, every disc has at least as much ligament in it as that or more. As you get older, they don't move as much, but they stay strong.
- Discs are amazing! Cup model: When you bend forward, it put a bit of strain on this ligament (posterior), when you bend back on this ligament, when you twist its over here etc..the ligaments control movement, just like in your ankle. Have you ever sprained your ankle? How is it now?
- Emphasis on similarity between ankle and back lig
- If we took an image of this with an MRI, we'd see that a few of your discs are curved out a bit. That's completely normal. In fact, there are some people that you can't even see their discs. But they don't have any pain because the alarms haven't rung. Because there is no danger there. 1 in 2 50 year olds will get an MRI that shows changes in the disc. Even if we see a ligament tear here, there are so many alarms that we have no idea whether that is actually what set it off or when that ligament tear occurred. But that isn't an issue anyway because ligaments heal.

Facet Joint

- How do you know its your joint?
- Well that's great. Joints are great!
- Joints love movement and regular compression which are essential for their health.
- Movement distributes the fluid and is really important for the health of joints
- Motion is lotion
- Injuries to these joint are too small to see on xrays or scans but we know that they heal reliably
- We know that it will heal and get working properly again if we slowly upgrade your activity.

Nerve-root/ "Pinched nerve"

- When the ligament is torn, the disc is still strong and working well, but the ligament has torn a bit and now the chemicals of inflammation have come the area to heal it.
- And if they get near the nerve they will stimulate the nerve so that your brain gets messages about your leg.
- That will go away, but it can take a while because the blood supply isn't so good.
- We have nerves that are pressing on tissue all over our bodies.
- They are very slippery, and they've got a bit of padding around them.
- Sometimes we get these images and it looks as if we are almost pinching a nerve in the spine. Have you ever heard that term? It feels like that as well!
- Pinched nerves don't really exist. If you are going to pinch a nerve, what you will feel is not pain, but numbness.
- The only way we know if a nerve is truly being compressed is if there is a loss of sensation rather than an increase in sensation – that is a sign of irritation not pinching.
- Don't forget that there are many of these alarm bells, and it's a bit inflamed, and the inflammation makes those alarm bells ready to fire, so all you need to do is move the tissue and those alarm bells will ring as a protective strategy.
- Isn't that great? It's a protective strategy – you aren't even close to injuring.

Muscle strain or spasm

- Muscles are great things to injure because they have an awesome blood supply and they heal really well.
- The other great thing about muscles is you can train them, and they are really adaptable.
- At the moment the muscles in your back are being very protective – there are a few things we can do to modify that like muscle exercises, stretches, pilates.
- The other way we can deal with tight muscles is looking at the nervous system and the brain.
- We are going to talk more about the protectiveness of the system and how we change this in other ways

Biomedical diagnosis

Arthritis/ degeneration /old age

- Timing
 - “So tell me when the pain started.” (They probably won’t say that they have had slowly building pain for the last 20 years.)
 - “so your pain doesn’t match the starting of the changes there...and that makes complete sense because the **danger receptors respond to sudden changes not gradual changes**”
 - e.g. if you put a 42 degree thermode on your finger, you can tolerate it for an hour or more because it doesn’t activate danger receptors, but you will get a third degree burn. Whereas if you put a 60 degree thing there, the temp changes so quickly that you take it away so quickly that you don’t burn the skin – that is, the protective function works!”
 - If it is really slow, it doesn’t work so well. That’s why cancers kill you.
 - Its about speed of change. Quick change will set off the danger receptors.
 - If the changes are slow, the brain probably concludes that there is no real danger.
 - If there is no pain, it means that these changes in the tissues are not perceived by your brain to be a threat
 - Most people will notice that their pain started at some stage or another.
 - The degeneration didn’t start then...it would have started a long time ago.
 - Xray findings don’t necessarily match pain. In fact, your xray would have looked that way for a long time, and you haven’t had a big problem until now.
 - Most people with worn joints never know about it.
 - The over 60s have less back pain than the under 60s. This provides a bit more evidence that pain is not necessarily related to the amount of degeneration in the tissues
- Hip replacement success
 - These are your vertebrae all the way up, pelvis and hips. When hips start to wear out, every time you take a step, the entire body weight is on the hip, on one joint surface.
 - So that is quite a sudden increase in danger in there. So I can understand that it would cause some inflammation.
 - There are 3 joint surfaces here – so it is impossible to put the same load through your back every time you walk.
 - When we talk about arthritis in the hip, there is a whole lot of people who have nasty wear and tear and are pain free, and others with no wear and tear and heaps of pain.
 - It can look good on x-ray and still be painful.
 - Why do hip replacements work so well? I don’t know. Because when you do a hip replacement you do so much injury: you dislocate the hip, saw through a bone, cut all the muscles and ligaments. And it doesn’t hurt!
 - No-one understands why that is. The best explanation that we have is that it is your brain is satisfied that you have done what is required.
- Knee arthroscopy
 - Degenerative knees underwent scope or Placebo. Surgeon went in and fixed it up, or went in and did nothing. And the results were the same. Half of the people that received the Placebo surgery couldn’t believe they were in the control group because the results were so good.
 - (However, you need to be very careful not to imply the “its not real” implication)
 - Even when there is severe degeneration, we do the same things.
 - Motion is lotion.

Spondylolisthesis

- Andre Agassi won Wimbledon with one.
- It can look unstable but you can’t see all the tough cartilage and ligament in that area – its solid and strong.
- Spondy can be a cause for concern , so can I just check again that you don’t have any of these signs?
- OK great – we are clear to go.

Instability

- It really does feel like its unstable doesn't. But it is not unstable.
- Use drawing to show how reinforced the area is.
- If you were to design something to protect the spinal cord, would you design something that was unstable?
- Backs don't collapse.
- There are some signs that will tell us if we need to look further. Do you lose control of your bladder or bowel, stocking numbness etc?
- Anatomy textbook: this is so tightly held together, there is no way it can collapse or slip out or anything.
- But I'd really like to explore that feeling, because that might give us some important information about what your brain is trying to protect you from.
- Sometimes when people don't know when the pain is going to come on, it feels unstable because that is what the pain means to you, that you have damaged something.
- But actually that's not how pain works....spiel. A bit more work required...

Other diagnoses

My back is out

- It's amazing how much it feels like something is out isn't it?
- It's not "out" but that is exactly what it feels like
- The back is really good at giving that feeling
- Anatomy textbook: this is so tightly held together, there is no way it can collapse or slip out or anything.
- But I'd really like to explore that feeling, because that might give us some important information about what your brain is trying to protect you from.
- Sometimes when people don't know when the pain is going to come on, it feels unstable because that is what the pain means to you, that you have damaged something.

My pelvis is twisted

- When muscles in the back go into protective spasm, they can pull you into strange position
- This will resolve itself
- Rather than being a *cause* of pain it is more likely a symptom of the fact that the back is in protection mode
- We can treat the symptoms and it can give you relief, but it is always important to treat the problem as well as the symptoms
- What I want to do is talk about all the things that have caused your back muscles to respond the way they have

Insecure

- The back is really good at giving that feeling of insecurity
- I can tell you that backs don't collapse.
- There are some signs that will tell us if we need to look further. Do you lose control of your bladder or bowel, stocking numbness etc?
- Anatomy textbook: this is so tightly held together, there is no way it can collapse or slip out or anything.
- But I'd really like to explore that feeling, because that might give us some important information about what your brain is trying to protect you from.
- Sometimes when people don't know when the pain is going to come on, it feels unstable because that is what the pain means to you, that you have damaged something.

Therapy so far

Mechanism of physiotherapy treatments

Manual therapy

- When you push on a joint the whole thing moves.
- If you were to push on my back now you would see my whole body move up and down, not just one joint, so it isn't very diagnostic.
- What we do know is that you can't fix tissue by pushing on a joint.
- You haven't solved any problems as such – but the pain goes away.
- Which is so interesting, it tells us quite clearly that we can change your pain even if we aren't fixing the problem.
- Look how modifiable pain is! When we do this (manual therapy), we don't do anything to the problem, but we change the pain. Clearly the problem is not in the tissue, it's in how your brain is interpreting stuff.
- It'll take a bit longer to get the tissues to heal.
- An injection can relieve pain by stopping the alarm bells ringing, but it isn't fixing the problem.
- ...that's really helpful because its given your back all the right signals that indicate – ok, its safe to back on track with things now

Manipulation/"adjustment"

- It's amazing how much it feels like something is out isn't it?
- It's not "out" but that is exactly what it feels like
- The back is really good at giving that feeling
- When you go to the chiro, he doesn't put anything back in, he just removes the feeling that it's out by doing things at the joints
- There are some really good chiros, and really bad chiros, just like there are really good physios and bad ones
- There is pretty good evidence that the best of these professions do things that can be helpful
- It has given your back all the right signals that indicate – ok, its safe to back on track with things now
- With chiro, the very best evidence tells us that it has nothing to do with the click, or the joint, and that it is something else. So it might work, but its almost certainly not working how we used to think it worked.
- How might it work? There is a whole bunch of things that physios and chiros can do that will bombard the brain with sensory input. This releases a whole lot of chemicals, and you get a nice, short term pain relief.
- How long does it last?
- This does nothing for the problem, but it can help the pain.
- Your other option there would be to take some serious panadol. It will more than likely do the same thing i.e. give you some relief.
- My job is the help you fix the problem. You need pain relief but that shouldn't be your only treatment.

Motor control/stability

- TA exercises can be really helpful because they get the brain re-connected with the body part.
- We are moving away from calling them "stability" exercises, because the problem with the back is not that it is unstable.
- The spine is incredibly strong, and held together with really strong ligaments and muscles.
- Motor control exercises help get the brain re-connected with that part of your body, and can help reduce un-wanted muscle patterns like guarding.

Mackenzie

- ...that's really helpful because its given your back all the right signals that indicate – ok, its safe to back on track with things now
- The exercises can be great because they can reduce pain and gradually get the back moving normally again.
- We used to think they might be pushing the disc "back in" but we know now that isn't the case.
- Discs can bulge and sometimes get injuries around the outside of them, but they never go "out" and need to be pushed back in.
- The exercises probably work because they are gradually getting the back moving again.

Exercise

- Movement not only increases the health of joints, soft tissues, circulatory and respiratory systems, it as another very important function. Educated movement is brain nourishing, because it establishes and re-establishes fine functional sensory and motor representations in the brain, using pathways laid low by fear and ignorance.
- Gradual exercise is a great way of exposing the back to threat in a safe way. This will reduce overprotectiveness which we know is a bit of a problem with back pain.

Explaining pain

- Learning about pain physiology reduces the threat value of pain. Reduced threat will reduce the activation of all our protective systems: sympathetic, endocrine and motor. This in turn helps restore normal immune function.
- Combining pain physiology education with movement approaches reduces pain and improving physical capacity and well-being.
- We want you to understand as much as possible about what is causing pain, not just what you should do about it.
- The best evidence we've got, is that the things that determine recovery are the way you make sense of your pain, and not the things that are in your back.

Mechanism of medical treatments

Tablets

- Tablets can be really useful in the early stages of low back pain
- They can look after some of the chemicals of inflammation, which is great because it helps you get moving
- Just taking the tablets won't be effective though – there is this other stuff we need to consider

Injections

- Injections for the back are really interesting
- You hear stories of people having great success, but a lot of the time it doesn't work.
- The thing is that you anaesthetize the danger messenger nerves as well as sensory nerves, so there is no way of knowing if it was danger messages or just normal sensory messages coming from that area. Remember the diagram....?
- If it can give you relief, then I'm all for it. But it's quite invasive and certainly not a guaranteed outcome.

Surgery

- Surgery should always be the very last resort
- Unfortunately the success rates of surgery for back pain are not good at all
- It also provides some more evidence for the stuff we are going to be talking about. That pain is about much more than just what is going on the tissues...remember the diagram?
- They've been trying the "find it and fix it" approach in back pain for years, and most of the time it doesn't work. This is because back pain is caused by a bunch of complex processes. It's not just about a signal coming from the back...

Mechanism of alternative treatments

- There is a whole bunch of things that these health practitioners can do that will bombard the brain with sensory input. This releases a whole lot of chemicals, and you get a nice, short-term pain relief.
- This does nothing for the problem, but it can help the pain.
- Your other option there would be to take some serious panadol. It will more than likely do the same thing i.e. give you some relief.
- My job is the help you fix the problem. You need pain relief but that shouldn't be your only treatment.

Pain biology

What is pain all about?

What is pain?

- Pain is a normal protective response to something the brain has assessed as threatening.
- It is designed to get you out of trouble by making you change your behavior
- It involves *all* of your body systems and all of the responses that occur are aimed at protection and healing
- It's about stopping you doing things. Which is fantastic if the pain is accurate. One problem we have with the back is that it's overprotective. And if you don't know that and don't realize that that is how we are setup, then you are going to overprotect. When we overprotect and we don't move enough then the problem becomes worse.
- It's a system that has been perfected throughout the evolutionary process.
- There are many myths, misunderstandings and unnecessary fears about pain
- We've found that understanding how and why we experience pain can be really useful for something like back pain, because it can give some explanation why it is such a painful and disabling thing, even if there has been little or no tissue damage.

Pain is protective

- Pain protects you, it alerts you to danger, often before you are injured or injured badly
- But, the pain system can behave oddly and even fail sometimes
- As a rule, back pain is overprotective. Anything around your spinal cord i.e. spinal pain will be particularly overprotective. That wasn't a problem when we were cavemen and were always forced to "test it out". If we were cavemen, I'm sure if we hurt our back, we would try it the next day, just like you would with an ankle. If you twist your ankle, next morning you get up and you test it out and see how it goes. We should do the same thing with backs. But we tend not to because we get really frightened of it because it means all this stuff. Anything that is unpredictable like back pain can be quite frightening.
- The really interesting thing about pain is that the amount of pain you experience does not necessarily reflect the amount of damage that has taken place.
- Sometimes we can have major injuries and no pain, and other times we can have tiny injuries and a huge amount of pain. Pain is definitely not a good damage meter.
- So we know from the biology of pain that it is not a symptom of damage, it is more of a protective device.
- Even if there is no tissue damage at all, if the brain has assessed a situation as threatening you can experience pain. The more threatening the situation the worse the pain will be.

Pain is not a measure of tissue damage

- Most commonly, pain occurs when your body alarm system alerts the brain to actual or potential tissue damage. But this is only one part of a big story
- Nociception (danger reception/sensation) is not sufficient for pain
- stories: shark attack, hammer in the neck etc etc
- if the brain has decided that the situation is not dangerous or threatening, then pain will not be produced
- If the brain thinks that experiencing pain is not the best thing for survival (imagine a wounded soldier hiding from the enemy) you may not experience pain at the time of a very severe injury
- Many changes in tissues are just a normal part of being alive and don't have to hurt
- you can also have pain with no danger messages coming from the tissues
- stories: phantom limb etc etc
- Scientists did a really sneaky experiment on volunteers who put their head inside a Placebo stimulator and were told that a current would be run through their head. Pain increased in line with the instructed intensity of stimulation even though no stimulation was given. That showed us that there is more to experiencing pain than tissue damage.
- pain is dependent on complex neural processing and adaptation rather than being a robust informer of spinal pathology.

Pain tries to get us out of danger

- As unpleasant as it is, pain serves a very useful purpose. It makes us change our behavior to get us out of danger. That's why ignoring it is not useful. Where it gets tricky is in situations like back pain, where people can often be confused about what is the best approach particularly if our body is telling us one thing, like lie down, and our physio is telling us to get moving.
- Pains from poor posture and sprains are simple 'everyday' pains that can be easily related to changes in tissues. The brain concludes that tissues are under threat and action is required.
- Its about stopping you doing things. Which is fantastic if the pain is accurate. One problem we have with the back is that its overprotective. And if you don't know that and don't realize that that is how we are setup, then you are going to overprotect. When we overprotect and we don't move enough then the problem becomes worse.
- Pain can be so effective that you can't think, feel or focus on anything else.
- This is where it can be useful to think back to pain being an overestimation of what is going in the tissues. You have been checked out for all the real nasties that can cause back pain, and you know now that the pain you are feeling, although its really terrible right now, is not a good indicator of damage.
- In fact, right now, those tissues are better protected than ever!
- Judge whether what you are doing is safe by how vigorous the activity you are doing is, rather than how much pain you are feeling. The brain is probably overestimating things.
- We have really good evidence now that tells us that staying active is very important for recovery from back pain.
- We know biologically why this can be painful to begin with but not damaging.
- If you work with the physio to gradually get back into things, you tissues will be very safe, and you also reassure your brain that it is good to move.

Visual metaphors

- vision is like this as well
- what we see is not simply a reflection of light onto the retina
- that signal goes through very complex, split second processing to give us an image that is biologically useful
- its wrong (the colours are the same), but its biologically useful
- Pain is like this, it's a conscious experience based on complex neural processing, not simply signals coming from the body
- Descartes diagram? More accurate diagram.
- In a split second, and outside of your consciousness, your brain processes a great deal of information and calls on a great deal of previous knowledge. You don't know this is happening. The first thing you are aware of is that you see a sensible and meaningful image/you feel pain. This is conscious representation of what is really there. It is not accurate, but it is meaningful and sensible
- Pain, like vision, is a conscious experience that is based on many complex processes, not just the sensory information coming from your body

Complex output

- It's a hard thing to get your head around but pain is not an incoming thing. I'm going to attempt to explain why.
- Because of this, pain is not always an accurate assessment of danger to the tissues
- Descartes diagram
- Thirst story, vision story
- Anything we *experience* involves many thoughts and emotional contributions
- We need to talk about the brain in order to really understand pain – especially pain that persists, spreads or seems unpredictable
- The brain evaluates the sensory input from the tissues of the body and draws on complex evaluative processes. Pain then, can be considered conscious experience based on the brain's evaluation of how much danger the tissues are in.
- The evaluation of how much danger the tissues are actually in happens really quickly and happens outside your awareness and control. Pain then, depends on the unconscious evaluation of threat to body tissue.
- Pain is the conscious correlate of perceived threat to tissues that motivates us to get our tissues out of danger.

Thirst

- Thirst is not a great measure of dehydration.
- Similar to pain, thirst is something that makes us change our behavior.
- However there are many times where we can be dehydrated and not be thirsty, because the brain has decided there is no need.
- The same goes for pain – its not a good measure of what is going on in the tissues because it is the product of many complex processes in the nervous system

How is it processed and what can change it?

Nociception vs. pain

- This is the area in your back that we are talking about in which the alarm bells are ringing.
- There are particular nerves that detect danger – and because its your back, and its protecting something important (your spinal cord) there are heaps of them.
- What is interesting here is that these fibers don't transmit "pain" messages, they transmit "danger" messages.
- There are danger receptors in there that respond to chemicals, temperature and mechanical stuff like pressure.
- These are the alarm bells. And there are heaps of them.
- That sends a danger message to the spinal cord which then goes up to the brain.
- But the brain has to think of everything (write things in, what is particular to them??) e.g. worries, beliefs about what has happened (for example, your immediate conclusion is that you have completely ruined something in your back – which is a fair conclusion because it hurts so much, but that causes brain activation)
- It's the sum total of all this that *causes your back pain*.
- So the danger message itself is not enough to cause pain. In fact, you don't even need a danger receptor to be activated to feel pain.
- If they are coping with this: "If the brains evaluation is different to this (tissue) then the brain changes this (spinal cord). It can turn it up or down.

Danger to the tissues doesn't = pain – pain experiments & amazing pain stories

- The ringing of alarm bells in the tissues is not enough for you to feel pain
- E.g. shark attack, impaling of objects, wartime stories, NRL player finishing a game with a broken neck
- In these situations there a heaps of danger messages flooding the system, but no pain is felt
- Many and varied cues may relate to the pain experience, but it is the brain that decides whether something hurts or not. 100% of the time, with no exceptions.
- This tells us that there is much more to the story of pain
- What is happening in the tissues is only one part of the amazing pain experience

Pain doesn't always = tissue damage – pain experiments & amazing pain stories

- In fact you don't even need an alarm bell to ring in the tissue to experience pain
- E.g. phantom limb, Courvade syndrome (well documented)
- All you need is the brain to decide a part of your body is in danger
- There are heaps of things that might contribute to the brain deciding this

Pain processing diagram

- this is the area in your back that we are talking about in which the alarm bells are ringing.
- That sends a danger message to the spinal cord which then goes up to the brain.
- But the brain has to think of everything (write things in, what is particular to them??) e.g. worries, beliefs about what has happened (for example, your immediate conclusion is that you have completely ruined something in your back – which is a fair conclusion because it hurts so much, but that causes brain activation)
- It's the sum total of all this that causes your back pain.
- Its up to the brain to construct as sensible a story as possible, based on all the information that is arriving.
- So this shows how pain is not an incoming thing, it's a very complex output, just like something like vision

The Pain Neurotag

- There isn't just one pain centre – there are heaps of areas that pain borrows or hijacks to express itself.
- E.g. the parts that:
 - o Organize and prepare movements (pre-motor and motor cortex)
 - o Concentration ?introversion (cingulate)
 - o Problem solving and memory (prefrontal cortex)
 - o Fear and addiction (Amygdala)
 - o Sensory discrimination (Sensory cortex)
 - o Stress responses and motivation (hypothalamus/thalamus)
 - o Movement co-ordination (cerebellum)
 - o Memory, special cognitions (hippocampus)
- The brain acts as a “meaning attributor” to the incoming signals
- Lots of different things will change the meaning the brain attaches to the incoming danger message.
- For example:
 - Beliefs
 - Previous events
 - Worries
 - Knowledge
 - Other sensory stuff
 - Social context
 - Anticipated consequences
 - Family
 - Media
 - Culture
 - What the physio said
 - Scan results
- All these things will change the meaning of that incoming danger message. Once the brain takes this into account, it will decide whether what is going on down there is *really* dangerous or not.
- If its assessed as not really that dangerous → no pain
- If its assessed as really dangerous → pain+++
- All this happens in a split second, and it's outside of your awareness!

Systems to get you out of trouble

Inflammation

- If there is a little bit of inflammation, the whole system is sensitive.
- This makes the danger messenger nerves much more likely to fire.
- The sensitivity will make you pay more attention to the body part and make you protect it and help it heal. Really helpful.
- That sensitivity takes a while to get rid of, so you need to stick at this for a little while.
- Your pain is not to do with damage, its telling you to gradually get moving to flush irritating chemicals out of the area.
- This will be quite painful in the beginning to do this.
- But this is where the physio can be great, they will get you moving in a way that you are completely safe.
- (In acute pain, the inflammation is a nice way of explaining things so that they don't have to face their demons just yet)

Tissue healing

- Even when there is a lot of healing to do, it is a strong and dependable process...unless we don't let it do what it needs to do
- In your situation, the tissues need movement to heal – this gives the area a great blood supply and prevents in stiffening up and getting weak
- Like other injuries, a period of relative rest is appropriate but to heal optimally we need to gradually get that area moving.
- Think about what you would do if you injured your ankle...
- The main thing to know is that whatever you have done in there will definitely heal.
- Tissues with a poorer blood supply like ligaments take a bit longer to heal that blood rich tissues like muscles. This is an even better reason to stay active because it promotes circulation.
- Tissues always heal but they can remain deconditioned and a bit unhealthy
- This is where the physio is great...

Peripheral modulation – inflammatory soup

- Inflammation is designed to hurt, and it does!
- It is essential to the repair process, and is a sign that the repair system is doing a really good job
- It'll go away, but its one of the reasons it's painful to get moving sometimes with a back problem
- The area gets flooded with a bunch of chemicals like immune cells, histamines, clotting factors and enzymes for mopping stuff up. This makes the area swell up sometimes – which is likely to make movement painful.
- The reason it is more painful to move when an area is inflamed is because the danger messenger nerves get sensitized by the chemicals – they get primed to fire.
- That is why even the slightest movement can be really painful.
- The inflammatory soup that is bathing the nerves in the area makes them much more likely to fire → which sends a lot of messages to the spinal cord and up to the brain.
- The brain will be very interested in these signals. But remember that humans are able to draw on a wide variety of cues in order to make the danger message meaningful.
- “issues in the tissues” helps explain a lot of aspects of pain – particularly why only a little bit of damage can result in a lot of pain (if you think about all those sensitive nerves).
- Medications can be useful to clear out a few of these chemicals, and so is movement.
- But the story doesn't end here...

Spinal modulation – gain on the amplifier

- To fully understand pain, we need to head into the spinal cord and up to the brain, which is the command centre of the alarm system
- When the spinal cord gets an influx of danger messages, it adapts really quickly to cope with the demand
- Changes occur in the neurons in the spinal cord as well as the nerves coming down which normally keep the relay quiet
- When this happens its like turning up the gain on an amplifier – the same signal gets amplified as it heads up to the brain
- So now you have another area where the nerves are ready to fire
- This all happens within seconds of getting all the message from the tissues

- The net effect of this is that things that used to hurt, now hurt more and things that didn't hurt before now hurt.
- The danger messenger neurons are much more sensitive and looking out for you.
- Now even just touching the skin or having a slight temperature change might cause a danger message to be sent to the brain
- In a way, your brain is being tricked
- It is operating on faulty information about the condition of your tissues
- All these changes in the spinal cord, which can start happening very early in an injury, give us good evidence why the pain we feel is not a good measure of exactly what is going on in the tissues
- In back pain it is often an overestimation
- This is why we can think of the cord as being a magnifier or amplifier of what is actually going on in the tissues
- The brain gets a distorted image
- When this happens, the brain is being fed info which no longer reflects the true health and abilities of the tissues at the end of the neurons
- This happens to everyone when they are injured
- Metaphors for sensitization
 - o Amplifier
 - o Super alarm system
 - o Computer P malfunction

Descending modulation – credible evidence

- Lets move up to the brain
- The brain is responsible for making the final decision whether something is dangerous for the tissue and needs protecting
- We now know that brain will very likely be getting an overestimate of what's going on in the tissues due to sensitization
- So the brain gets all these danger messages but has to “weigh the world” before it decides if something is actually dangerous enough to need protection from
- The brain acts as a meaning attributor to all these signals
- If the brains evaluation is different to this (tissue) then the brain changes this (spinal cord). It can turn it up or down.
- Many things can affect what these signals mean to a person
- The brain looks for any piece of credible evidence that protection is required
 - o This doctor thinks I'm putting it on
 - o The CT couldn't find it so it must be really bad and deep
 - o Aunt Doris had back pain all her life and now she is in a wheelchair
- Even these thoughts are nerve impulses that are threatening to a brain that is concerned with survival
- If the brain perceives something as threatening, protection (and thus pain) will increase.
- That doesn't mean that you *think* the pain is worse, the pain *is* worse.
- So we have a direct pathway by which pain can be changed just by thinking or worrying about something

How dangerous is this really?

- My colleague has a great story that helps understand this idea that the brain ultimately decides if protection via pain is required, by asking “how dangerous is this really?”
- Snake story
- So the point of the story is that pain is a protective response to something the brain has perceived as threatening.
- That story really resonates with me because I see similar things in my patients at the clinic with back pain. Often with recurrent episodes, the pain is severe, similar to the first episode, and results from doing something quite minor like sitting or picking up a pen.
- Think about your situation now and when you first had a back problem. Your body has installed a really sensitive alarm system that may not be giving a great indication of the state of your back.
- All of these things we have talked about can give you a biological explanation as to why the pain comes back so easily. A sensitive alarm system.
- It remembers that you have been here before, and you are in trouble.
- What has happened in your back could be relatively minor, but the nervous system has decided that you need protecting – and now you are hurting. A lot. More sensitivity = more protection = more pain
- So unfortunately it’s not as simple as just thinking the pain away. The decision that your back needs protecting was based on a lot of factors outside of your awareness
- Where we think it is important to start is having you learn about this stuff, and hopefully give you a fuller understanding on what your pain means.
- In particular, you now know that pain is always a protective thing and not a symptom of damage

Importance of context

- The context of the pain experience is critical
- Exactly the same minor finger injury will cause more pain in a professional violinist than a professional dancer, because finger damage poses a greater threat to the violinist. The event plays a greater role in the violinist’s livelihood and identity
- If you step on a piece of glass down at Bondi, this may or may not hurt immediately. It could really hurt straight away because the danger receptors in the toe have been activated which goes into your spinal cord and up to the brain, and with everything else going on, your brain says: protect the toe, so it makes your toe hurt. Lets say we have that same scenario (walk them through), but some idiot flies around the corner and nearly hits you, this time you get across the road and realize that your toe hurts. In that scenario, you still had all of this happening, but your brain said: actually, that’s not the issue, the issue is the auditory input of I’m about to get killed, and the rush of emotion from that. Its not until later that your brain decides to make it hurt.
- Pain is dependent on perceived cause e.g. post mastectomy patients who attribute pain to returning cancer, have more intense an unpleasant pain than those who attribute it to another cause, regardless of what is actually happening in the tissues

Sensitive alarm system

The spine is hyperprotective

- In general, pain is overprotective – it’s a survival thing.
- In the lower back, because it is housing our second most important structure, it is particularly overprotective.
- ?? Alarm system metaphor
- If this is not your first episode, it will be even more protective
- Add some inflammation into the mix and the brain is even more interested.
- ??Twin Peaks
- Now we have a system that is so well protected by pain that you can even move!
- So here is how we get the system to calm down and get you back on track
- The pain you are feeling is not likely to be because something is badly damaged

OR

- pain is about protection. Its about stopping you doing things. Which is fantastic if the pain is accurate. One problem we have with the back is that its overprotective. And if you don’t know that and don’t realize that that is how we are setup, then you are going to overprotect. When we overprotect and we don’t move enough then the problem becomes worse.

OR

- As a rule, pain is overprotective. The response of the brain is nearly always to turn down the spinal cord, I'll take care of it. Anything around your spinal cord i.e. spinal pain will be particularly overprotective. That wasn't a problem when we were cavemen and were always forced to "test it out". If we were cavemen, I'm sure if we hurt our back, we would try it the next day, just like you would with an ankle. If you twist your ankle, next morning you get up and you test it out and see how it goes. We should do the same thing with backs. But we tend not to because we get really frightened of it because it means all this stuff.

If the brain perceives vulnerability, protection will increase

- when you are stressed or depressed (using diagram), one thing that changes is your mood – which you feel, but another thing that changes are the chemicals floating around the body.
- And those chemicals we know will activate alarm bells if the body is sensitized.
- So if you are depressed, the pain is going to be worse.
- If you are stressed, your pain is going to be worse.
- They are just the cold hard facts of human biology.
- So its worth us trying to reduce your stress and depression because that will help your pain. (We need avoid implying any illegitimacy. Attributing things to biological mechanisms helps you get away with it)
- Whatever causes your depression/stress/anxiety the same things causes chemical to be released in your body. And we can't help that. We are one machine.
- The chemicals in the body will find receptors anywhere they can. If you have a sensitized nervous system, they are the receptors they will bind to.
- Sticking to the biology can be very useful.

OR

- Someone steals all the power tools out of your shed. You install a fancy alarm system. Cat can walk in front of it any trigger it. The tools are really safe but it give you the shits because its always going off, and you are always having to go and see what the problem is, and often there isn't a problem.

Alarm system & safe metaphor

- you want to protect your most vital thing
- precious jewelry
- where would you put it – in a safe.
- That’s exactly how we are constructed!
- Our brain is our most important thing – no brain, no you!
- Our second most precious thing is our spinal cord – that is what keeps the body talking to the brain
- Picture of how well encased the spinal cord is: thick bone, disc, ligament, muscle
- So let say you wanted to be extra sure no-one went near that precious thing – what would you install?
An alarm system
- Absolutely. That is exactly the way we are constructed
- Picture of vertebra – that’s the bony bit. But you need movement → sideways view: there are these things in here that are just full of ligaments.
- The disc is a really strong ligamentous thing, just like the ligaments in your ankle. Same stuff. Absolutely covered in alarm bells that are looking for anything dangerous. They are all over the bones and joints and ligaments and muscles.
- So if you do anything there that’s a little bit dangerous (which you have done because it hurts) it rings the alarm bell.
- The alarm bells converge with maybe 150 of them going into one nerve, which goes toward the brain. That message says “danger”.
- In fact, we don’t know which alarm bell went off and we are never going to know that. And it doesn’t really matter because we’ll treat it the same way.
- One of the reasons that backs really hurt when you hurt them is because we have so many alarm bells
- We could even do an MRI or CT and we’ll see all different shapes and stuff but we have no way of knowing where the alarm bell that rung is. So there is no gain at all in having a scan.
- The reason we know the alarm has rung is that your back really hurts
- Your pain is completely legit. Clearly when you picked up that thing you did something that rang some alarm bells. But it is so well protected, that you would be ringing alarm bell even with a tiny injury
- In fact, sometimes you don’t have any injury at all, you just came a bit close.
- There is actually no better part of your body to injure, because this part is so solid and well protected. Even when you do injure it, it fixes itself. If you go outside, half of those people have injured their back and now its completely functional. Here is Gary Ablett taking a screamer 3 months after he tore the ligament in his disc.

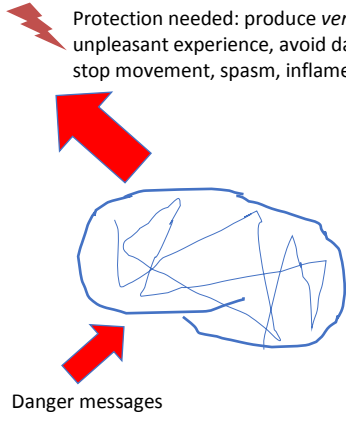
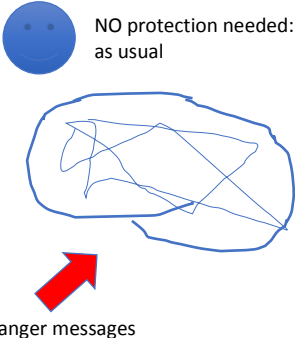
Timing of pain – speed of change

- Part of the healing process is to release inflammatory chemicals.
- They might take a while to get to where you have danger receptors
- When they get there, they will ring alarm bells
- What is really good is that it took two days
- It hurts like anything now, that’s a sign of that chemical irritation from a little injury somewhere
- That’s good because it tells us it is a little injury
- When you get sudden pain, straight away, it might be more likely that an injury might be ringing the alarm bells
- If you are doing something that is not that sudden, and you get really sudden pain. E.g. if you are walking and talking to your friends, and then BANG you get sudden severe back pain, that’s probably a really good sign that you were slowly approaching this zone here (protection line), you might have been distracted by the conversation, the alarm bells are ringing and then there is a lull in conversation and BANG.
- But because you were slowly building up, your alarm bells were going STOP!
- And did you stop? Yeah I couldn’t move. There you go! It’s a fantastic system.
- When you recover, tissue tolerance probably doesn’t change.
- You can increase the height of the mountain by training.
- You return the buffer to normal by gradually increasing what you are doing, and it will creep its way back up to where it was.

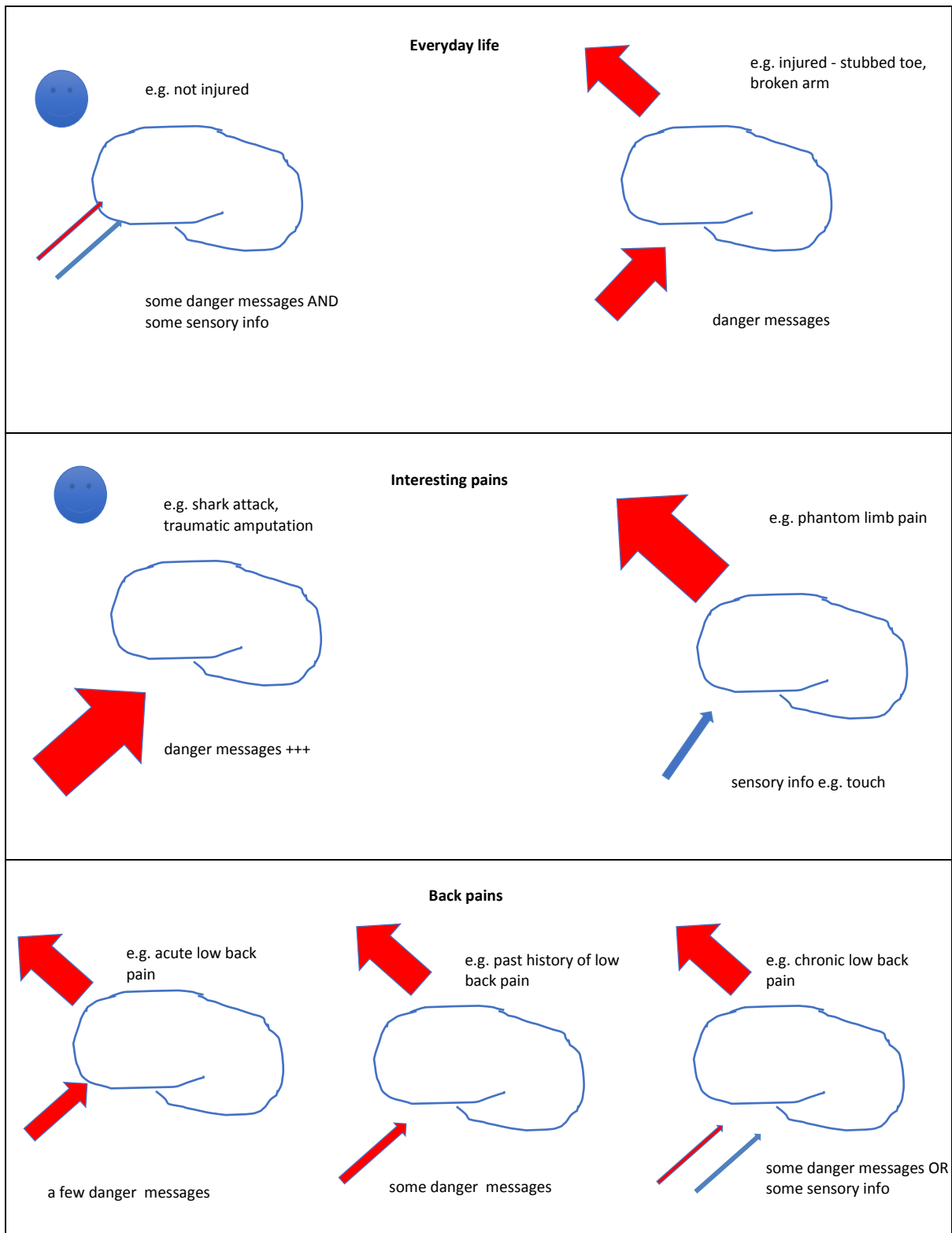
Twin peaks

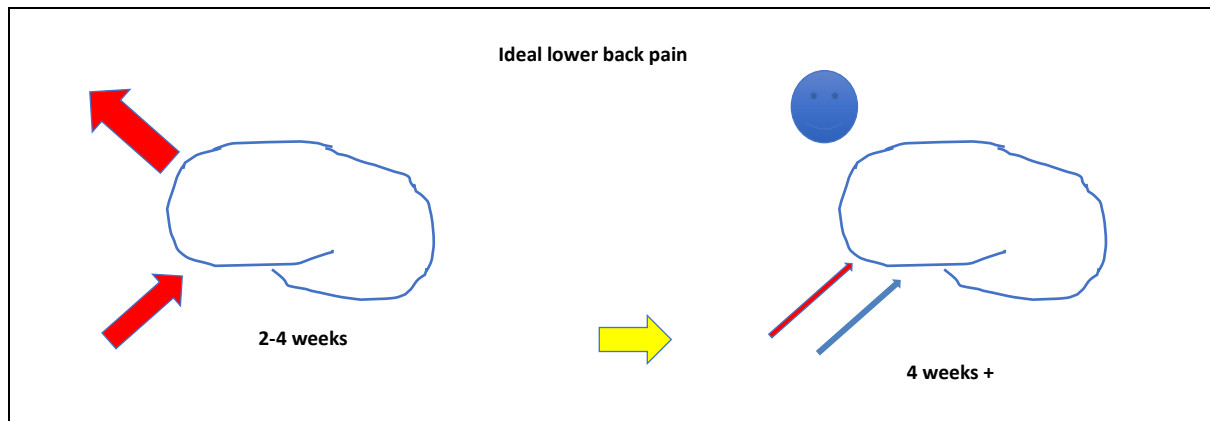
- If there was an incident e.g. bending over, before you bent over on that day, you could probably bend over and lift this much weight.
- But if you had slowly built up the weight you were lifting, you would probably get to here and your back would start hurting, and stop you lifting a heavier load.
- But that's not the way we lift things, we tend to just get in there and lift.
- So you went screaming through this "protect by pain" line.
- And pain is a really effective protector, so it gives us this buffer to protect the tissue.
- And that is because of danger receptors in the tissues. We've talked about that stuff.
- It's a really reliable system that has been perfected throughout the evolutionary process. Its been perfected over generations and generations.
- All animals have this and it's a beautiful system, but it looks like this time it didn't work to protect you in this scenario. Maybe that's just because you did a bit too much a bit quickly.
- And that's nearly always the way that it happens – too much too quickly.
- Insidious onset: this is why we think you haven't actually done anything to the tissues, but you might have come close.
- That's why we think the pain is a sign of other things going on, or you got a bit close. You hit the line. And normally what that makes you do is not pick it up.
- The body will contract muscle and get your immune system going to get you to not pick up the box or push your luck. This response is terrific.
- So you were at this line. And now you have activated this protection thing, particularly if you have injured something.
- Lets say you've torn a little bit of that ligament on the outside of your disc. The disc is really strong, it can cope, but you have exceeded this line(tissue damage line).
- This puts in place a very effective protective mechanism.
- It makes your alarm bells that we talked about a bit more sensitive.
- Then, in a matter of days, this messenger nerve inside your spinal cord becomes more sensitive, so it wants to fire, which means that the danger message gets bigger.
- So this is you now: the disc is only slightly weaker very difficult to tell, but not much. It's a torn ligament that will heal.
- But this: (protect by pain line), because of what's happening in the spinal cord, is probably down here somewhere (lower protect by pain line), because of the sensitivity.
- So now your protect by pain line, when you are a long way short of damaging something, pain will come on because of the sensitivity, not because the tissues are getting damaged.
- The leg pain that is giving you grief at the moment is probably a sign that the nerves are irritated by the chemicals of inflammation, which is going to push the protect line lower again because of that.
- Freaking out that you think something is about to go out and you'll be left with this pain forever – this will take the line down even further.
- Your pain starts at this point – but you are a long way from damaging the tissue. There's no way you are going to get through that.
- Your brain will stop you. You'll hurt, and if that doesn't work it'll make you vomit, faint, fall over, legs wont work.
- The brain will do everything it has to, to stop you getting to that point. So unless you drug yourself up to point of numbness or you are a complete idiot, the tissues are safe.
- Because of the unpleasant experience your brain is producing.

Short term and long term changes in sensitivity – examples

	Short term	Long term
<p>Increases sensitivity/pain</p>  <p>Protection needed: produce very unpleasant experience, avoid danger, stop movement, spasm, inflame</p> <p>Danger messages</p>	<p>Inflammation Muscle spasm Distress Being very worried/anxious Adrenalin (stress hormone) Fear of damage</p>	<p>Depression Trauma (past or present) Unhappiness Social factors (work/family/friends) General difficulties in life Concern about the future e.g. aging, work ability</p>
<p>Decreases sensitivity/pain</p>  <p>NO protection needed: continue as usual</p> <p>Danger messages</p>	<p>Movement Walking Distraction Medicine Placebo Oxytocin (love hormone) Relaxation</p>	<p>Knowledge about pain Exercise/pacing Happiness Exposure No fear of damage</p>

How pain might be produced in different contexts. Sharks, nails and peanuts.





Take home messages

- ***Pain is protective, not a symptom of damage***
- ***Pain is overestimating what is going on in the tissues***
- ***Understanding this will help you recover***
- When we first talked, you were concerned about this
- How do you feel about that now?
- **Do you feel like you have an answer to that now?**
- Can you tell me now what you think is causing your pain?
- If you do a little bit more today than you did yesterday, but not much more, you will recover

What to expect from here

Recurrence

- Most people that hurt their back will have another episode.
- That is a normal thing that happens because things are hyperprotective.
- You can probably reduce the number of episodes by not just recovering to pain free but then getting fitter and stronger.
- But its also useful that you now know that if you do get a twinge, its not a sign that you have damaged something, it is a sign of protection.
- And you know now that there a many things (in addition to any alarm bells ringing in your back) can could contribute to having this protective response.

Prognosis

- The best evidence we've got, is that the things that determine recovery are the way you make sense of your pain, and not the things that are in your back.
- Even now, I can tell that you are really worried about this, and almost convinced that this is never going to get better.
- One of the big challenges for me, is to explain to you why that doesn't have to be the case.
- Because even expecting that will increase your chances of not recovering quickly. There are no risks at all to thinking about this stuff.

Pacing

- The nature of the system is that if you only progress slowly, and you keep progressing, the system just wont let you damage anything.
- But if you progress suddenly, you might flare-up.
- As long as you apply that principle of gradually increasing what you are doing, like you would with an ankle.
- If you twist your ankle, next morning you get up and you test it out and see how it goes. We should do the same thing with backs. But we tend not to because we get really frightened of it because it means all this stuff.
- If you sprained your ankle, on day 3 it would be feeling a bit better, but you wouldn't run on it yet would you?
- So you don't do that with back either.
- What you would do is check if you could take a few little steps, which could really hurt, so you back and try again tomorrow.
- Use the ankle scenario. It an acute injury of tissue that identical to what is in your back. The commonly targeted culprit of back pain which is the disc. Its identical tissue!

Tools

- Understanding your back pain is crucial
 - o Recovery needs understanding of what is going on in your back, as well as these other things we know affect pain
 - o Why perform painful activities if you don't understand why they hurt? That just further provokes protective mechanisms.
 - o Education, knowledge and understanding reduce the threat associated with pain. Reduced threat has a positive effect on all the input and response systems.
- When I am hurting, it doesn't necessarily mean I am hurting myself
 - o Respect pain but don't be afraid of it
- Pacing and graded exposure
 - o Every day do a little bit more than you did yesterday. If you stick to these things then this will resolve.
 - o If you feel like you are going crazy and you need some temporary pain relief or you need a coach to help you plan these things, then I reckon you should go and see a good physio.

Return to work

- The brain will take into consideration where you are – the baker story.
- Baker would get phantom hand pain whenever he smelt bread because he injured his hand at the bakery.
- Or cyclist who got back and leg pain if we tilted the tv screen to make it look like she was riding up hills.
- This is really sensible!
- Pain is the only system that does this.
- If you get bitten by a snake down in the back shed, you will avoid the back shed – what a clever adaptation!
- This is the same: if you hurt your back lifting an odd shaped box, you are probably not going to want to lift that box again.
- Therefore to be able to recover, we have to train getting back to work, otherwise your brain wont let you do it.
- The way your brain stops you is by making it hurt.
- You might notice that your pain gets worse when you are at work.
- Your back isn't in any more danger at work or more damaged, but it hurts more doesn't it?

Tricky questions

Are you saying it's in my head?

- This is the question asked most often by people learning the physiology of pain
- We have to honest and say, yes - absolutely all pain bee-sting/paper cut/skiing accident is produced by the brain – no brain no pain!"
- This doesn't mean for a second that it isn't real – much to the contrary – all pain is real.
- In fact, anyone that tells you "it" is all in your head, implying that therefore "it" is not real – does not understand physiology
- Really understanding this is quite empowering.
- Understanding the spinal cord and the brain processes behind the pain experience can provide you with enormous control.

OR

- Every single pain we feel, bee –sting, paper cut its up to your brain whether it hurts or not.
- If we removed your brain the pain would go away but that doesn't mean its not real.
- The pain is an attempt by your brain make you protect your body.
- You don't have any choice when it hurts, its what you do. It works beautifully well.
- ?Give example of the brain making split second decisions about things

Does that mean my pain isn't real?

- This doesn't mean for a second that it isn't real – much to the contrary – all pain is real.
- In fact, anyone that tells you “it” is all in your head, implying that therefore “it” is not real – does not understand physiology
- Really understanding this is quite empowering.
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OR

- If we removed your brain the pain would go away but that doesn't mean its not real.
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Could they have missed something?

- If you are the first person who's got some major thing that medicine has missed, then I am really sorry. But if you are like every other human that has ever been investigated, then the risk is minute.

So you aren't going to do any massage or anything??

- The thing about massage is that it can relieve the symptoms, but is unlikely to do anything for the cause.
- We know now why it only has a very small effect in scientific research – because what is going on in the actual muscle has almost nothing to do with the problem of back pain.
- All these other things as a whole, cause back pain. And muscle tightness. And if we don't treat these, then we are missing the point.

Shouldn't I get an MRI?

- An MRI can show a lot of things because they are really sensitive
- Unfortunately even if the MRI shows something like discs that are curving out or a bit of wear and tear, there is absolutely no way we will know if that is what triggered your back pain
- There are so many alarm bells in there. Any one of them could have rung to give you this pain. And truth is, it doesn't matter where the alarm bell went off, because it will fix itself. The reason we know alarm bells have rung is that you are hurting.
- Sometimes even getting a scan can make people feel worse because it shows a few nasty things, and even though they have nothing to do with the pain, and may have been there for years, people worry that their back has worn out and that's why it's not getting better.
- Many changes in tissues are just a normal part of being alive and don't have to hurt
- We know now that is absolutely not true. I've had patients with perfect scan and in a lot of pain, and others with really nasty scans that haven't got any pain at all.
- We have ruled out all the nasties, everything else that's going on in the back will get better.
- What is really important is that you understand how to best move forward from here, because whatever has happened in your back will heal if you have an MRI or not.

I'm scared that it's not getting better yet.

- The best evidence we've got, is that the things that determine recovery are the way you make sense of your pain, and not the things that are in your back. Even now, I can tell that you are really worried about this, and almost convinced that this is never going to get better. One of the big challenges for me, is to explain to you why that doesn't have to be the case. Because even expecting that will increase your chances of not recovering quickly. There are no risks at all to thinking about this stuff.

eMethods 4. PREVENT Trial Placebo Patient Education Manual

Key principles

- patient to discuss any topic they wanted to
- no advice provided
- no pain management techniques will be taught
- no reading material provided
- no encouragement or discouragement of ideas presented by the patient
- no information on back pain treatments
- therapist will use techniques such as active listening, along with reflective and reframing statements
- direct questions will be referred to treating practitioner to answer
- a standard response to direct questions will be “As this is a study, I’m not allowed to give you any direct advice. We don’t know what the best advice to give people is at the moment anyway. Part of the purpose of this study is to work that out. Who would you normally go to, to get an answer for things like that?”

Example topics

1. History of their low back pain
2. Treatments they have received
3. Family
4. Work and lifestyle

Example responses

“I can see you are really concerned – the doctor didn’t seem too concerned when he sent you over but you still are?”

“I guess there are different ways of looking at things aren’t there?”

“So what are the options we’ve got here?”

“It sounds as though you have a lot of confidence in your doctor. What are the options? What do you think about that?”

“I’m glad we had this chat/ I think you have lots of good ideas/ I can see you have thought a lot about this/ We are keen to follow up and see how things progress”

Additional prompting questions

- What have you done during the last week?
- What do you think will help?
- Is there anything else you are expecting to help?
- How is work?
- How is your family?
- How do you feel about your behaviour as a result of the back pain?
- Have you ever had to assist any one else in pain?
- How is your life in general?
- How do you cope with things that stress you?
- What would you say to someone else in your situation?
- What have other people told you about your back pain and back pain in general? Anyone else given you advice? (people at work, pharmacist, yoga/ pilates instructor, friends)
- What are your thoughts on medication for back pain?
- What are your thoughts on acupuncture?
- What do you think about surgery for back pain?
- Do you prefer hands on treatment, or exercise treatment?
- Who do you generally turn to for support and help?
- Do you ever use the internet for diagnosing problems or for advice for injuries/ sickness? What websites?
- Who do you consider the best profession to deal with back pain? GP/ Physio/ Chiropractor
- Who would you go to first for a new episode of back pain and why?
- What is the role of imaging (X-ray, MRI, CT scan in the treatment of low back pain?
- What do you think is more important, what the PT/ GP does to you/ prescribes to you, or what they PT/ GP tells you?
- Do you think personality affects recovery of back pain?
- Do you think men and women respond differently to pain in general and back pain?

eMethods 5. Statistical Analysis of Secondary Outcomes

Secondary outcomes and process measures

Secondary outcomes were disability (Roland Morris Disability Questionnaire)¹, the proportion of participants who developed chronic low back pain (at 3 months, reporting an average of 2 or more on a 11-point pain intensity NRS over the past week and no periods of recovery during that time), depressive symptomatology (depression severity scale of Depression Anxiety and Stress Scale)², healthcare utilisation, global change (Global Back Recovery Scale)³, recurrence (answering ‘yes’ to both of the following: i) “In the last 6 months /12 months has your lower back pain gone away completely for a period of more than 30 days, only to return later on?” and ii) “If yes, did the return of LBP last at least 24hrs with a pain intensity of more than 2/10?”)⁴, pain attitudes and beliefs (Survey of Pain Attitudes⁵ and reassurance (assessed using two questions: “How reassured do you feel that there is no serious condition causing your back pain? 0 = not reassured at all, 10 = completely reassured”; “Do you think that your symptoms should be investigated more extensively (laboratory tests, X-rays etc.)”)^{6,7}.

We collected data on potential mechanisms: catastrophizing (Pain Catastrophizing Scale)⁸, back beliefs (Back Beliefs Questionnaire)⁹ self-efficacy (Pain Self-Efficacy Questionnaire)¹⁰ and neurophysiology knowledge (Neurophysiology of Pain Questionnaire)¹¹. These will be reported separately in a planned mediation analysis.¹²

Statistical analysis of secondary outcomes

We also investigated persistence of effects on outcomes at 6 and 12 months by examining the relevant *group x time* interactions in the mixed models. To compare the incidence of chronic low back pain in both groups, we categorised the status of all participants at the 3 month follow-up time-point as either ‘chronic low back pain’ or ‘recovered’. We defined ‘chronic low back pain’ as reporting 2 or more on an 11-point NRS for pain over the past week,¹³ as well as reporting no periods of recovery (defined as a pain-free period of more than 30 days) during that time.¹⁴ We used a Generalized Mixed Effects Model with a logit link to determine the effect of the intervention on development of chronic low back pain.

We used a similar model as for the primary outcome to estimate intervention effects on continuous secondary outcomes (disability, depression, pain, global change, pain attitudes and healthcare visits). We analysed outcomes at one week. This analysis was not specified in the published statistical analysis plan¹⁵ but was clearly stated in the study protocol.¹⁶ We estimated intervention effects on categorical secondary outcomes (recurrence, further investigations) using logistic regression analyses. For binary outcomes, we used logistic regression models.

We planned a sensitivity analysis to examine the effect of out-of-trial therapy on our primary outcome. That is, we planned a mediation analysis to estimate the direct effect of the intervention on the primary outcome that controls for the effect of out-of-trial therapy.

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eResults 1. Process Evaluation/Mediation Analysis

Process evaluation – causal mediation analysis

We followed a published analysis plan for the causal mediation analysis.¹ The main objective of this secondary analysis was to estimate the extent to which catastrophization, beliefs (proximal treatment targets) and self-efficacy (distal target) measured at 1 week post intervention would mediate the effect of pain education on pain at 3 months. Details of the statistical analysis plan and technique are available in the published protocol.¹⁹

The analysis showed that all indirect effects through the targeted mediators were small and non-significant (eTable 1 and left panel of eFigure 1). These effects were robust to moderate levels of residual confounding (middle and right panels of eFigure 1). Although pain education was superior to placebo pain education in reducing the primary targets (catastrophization and maladaptive beliefs - eFigure 2), these hypothesised psychological mediators were not associated with pain at 3 months (eFigure 3). Pain education did not improve self-efficacy at week 1, a more distal mechanism which was associated with pain at 3 months.

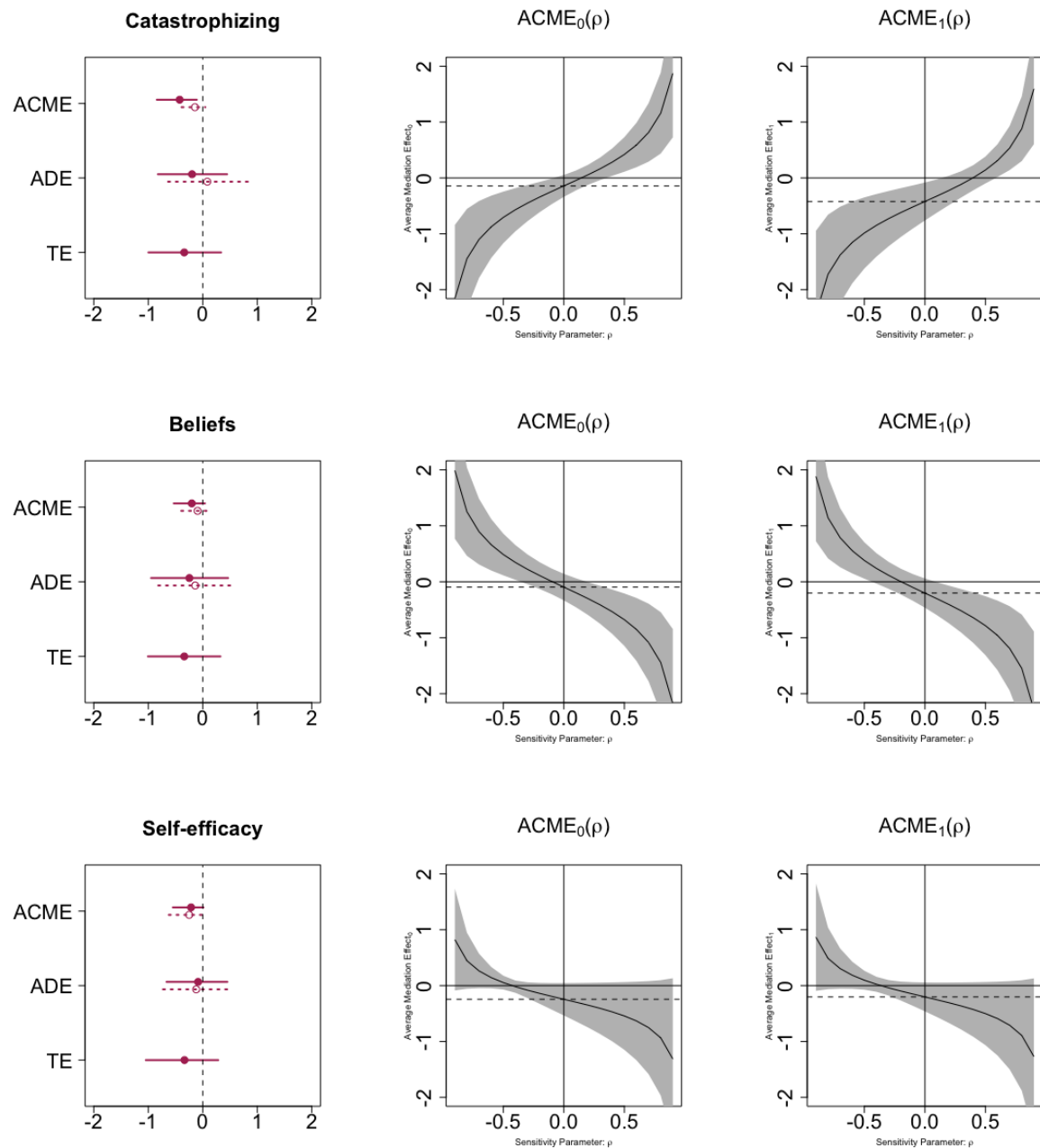
This process evaluation indicates that the intervention produced an effect on the key targeted mediators, but these mediators did not cause changes in the primary outcome. This suggests that psychological constructs (primarily catastrophization and beliefs) may not be worthwhile treatment targets for patients with acute low back pain.

eTable 1. Results of Causal Mediation Analysis for Primary Outcome (Pain at 3 Months)

	Intervention-mediator effect	Mediator-outcome effect	Natural indirect effect (ACME)	Natural direct effect (ADE)	Total effect
Proximal mechanisms					
Catastrophization	-4.62 (-7.39 to -1.86)	0.03 (-0.25 to 3.41)	-0.28 (-0.56 to -0.08)	-0.06 (-0.71 to 0.62)	-0.34 (-0.99 to 0.34)
Beliefs	3.36 (1.35 to 5.36)	-0.03 (-0.09 to 0.03)	-0.15 (-0.38 to 0.02)	-0.19 (-0.85 to 0.48)	-0.34 (-1.01 to 0.33)
Distal mechanism					
Self-efficacy	2.97 (-0.28 to 6.21)	-0.08 (-0.12 to -0.05)	-0.23 (-0.55 to 0.02)	-0.10 (-0.68 to 0.44)	-0.34 (-1.05 to 0.28)

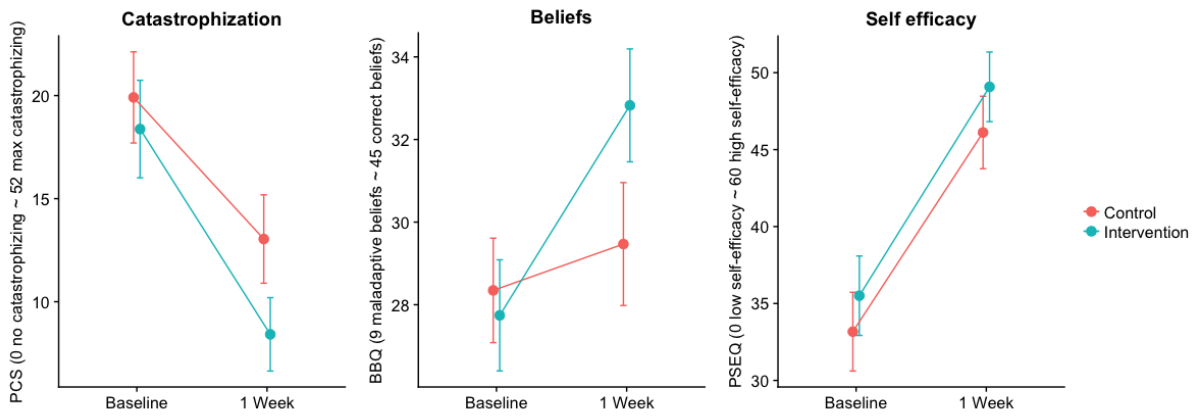
Effects are unadjusted coefficients with their 95% confidence intervals; ACME = average causal mediation effect; ADE = average direct effect

eFigure 1. Sensitivity Analysis of Mediation Effects in the PREVENT Trial



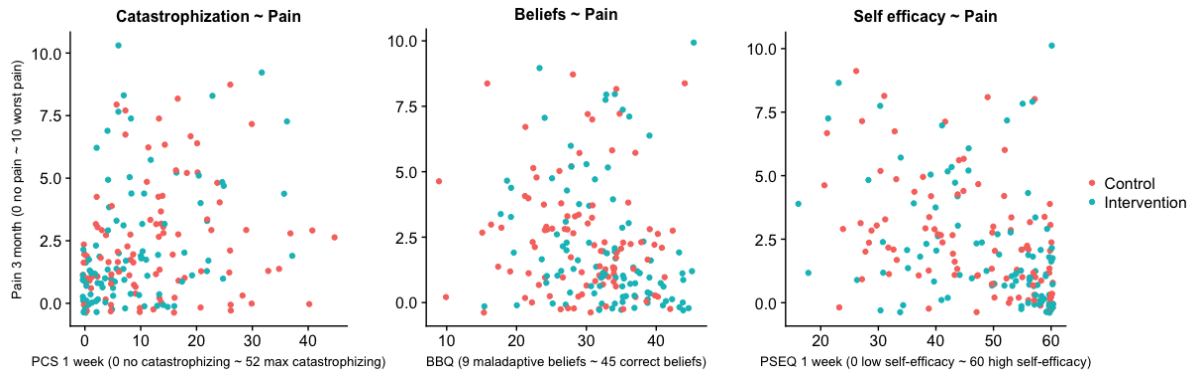
The effect decomposition (left panel) shows how the average effect of the treatment on the outcome - total effect (TE) is decomposed into the average causal mediation effect (ACME), and the average direct effect (ADE). These effects are presented as unstandardized effects with their 95% confidence intervals. The sensitivity plots (middle and right panel) show how much the estimated ACME would change if there was residual confounding of the mediator-outcome effect. The curved solid lines represent the estimated ACME for the control (middle panel) and pain education (right panel) groups at varied levels of residual confounding. The sensitivity parameter (horizontal axis) represents hypothesised levels of residual confounding: 0 indicates no residual confounding, and -1.0 and 1.0 are the maximum levels of residual confounding. The dashed horizontal line represents the estimated ACME when there is no residual confounding (ie. sensitivity parameter = 0).

eFigure 2. Effects on targeted mediators in the PREVENT Trial



Mean (circles) and 95% confidence intervals (error bars) for primary treatment targets (catastrophization and beliefs) and secondary target (self-efficacy) at week 1 in Pain Education group (blue line) and Placebo Pain Education group (red line).

eFigure 3. Scatter Plot of Targeted Mediators in the PREVENT Trial



Scatter plot of targeted mediators at week 1 (x-axis) and pain at 3 months (y-axis) stratified by treatment allocation [Pain Education group (blue) and Placebo Pain Education group (red)].

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eResults 2. Out-of-Trial Therapy–Sensitivity Analysis

Out-of-trial therapy – sensitivity analysis

Out-of-trial therapy did not influence the effect of randomisation on primary outcome (pain). Out-of-trial therapy was measured by 'no healthcare visits' vs '1 or more healthcare visits' at 3-month follow-up. The natural direct effect from the mediation analysis (which represents the treatment effect that was not mediated through out-of-trial therapy over 3mo) was equivalent to the total effect of treatment. See eTable 2 below:

eTable 2. Results of Sensitivity Analysis Evaluating Influence of Out-of-Trial Therapy on Primary Outcome Pain at 3 Months

	Mean difference (95% CI)	P Value
Average Direct Effect on pain (effect not mediated by out-of-trial therapy)	-0.2 (-0.9 to 0.5)	0.61
Total Effect on pain in sensitivity analysis	-0.3 (-0.9 to 0.4)	0.48
Total Effect on pain in primary analysis	-0.3 (-1.0 to 0.3)	0.31