Brazilian Journal of Physical Therapy 27 (2023) 100554

Brazilian Journal of Physical Therapy

https://www.journals.elsevier.com/brazilian-journal-of-physical-therapy

MASTERCLASS

Affordance-based practice: An ecological-enactive approach to chronic musculoskeletal pain management

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Received 5 October 2022; received in revised form 16 August 2023; accepted 4 October 2023
Available online 16 October 2023

KEYWORDS
Affordance;
Biopsychosocial;
Chronic pain;
Ecological;
Enactive

Abstract
Background: The biomedical understanding of chronic musculoskeletal pain endorses a linear relationship between noxious stimuli and pain, and is often dualist or reductionist. Although the biopsychosocial approach is an important advancement, it has a limited theoretical foundation. As such, it tends to be misinterpreted in manners that lead to artificial boundaries between the biological, psychological, and social, with fragmented and polarized clinical applications.
Objective: We present an ecological-enactive approach to complement the biopsychosocial model. In this approach, the disabling aspect of chronic pain is characterized as an embodied, embedded, and enactive process of experiencing a closed-off field of affordances (i.e., shutting down of action possibilities). Pain is considered as a multi-dimensional, multicausal, and dynamic process, not locatable in any of the biopsychosocial component domains. Based on a person-centered reasoning approach and a dispositional view of causation, we present tools to reason about complex clinical problems in face of uncertainty and the absence of 'root causes' for pain. Interventions to open up the field of affordances include building ability and confi-

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https://doi.org/10.1016/j.bjpt.2023.100554

dence, encouraging movement variability, carefully controlling contextual factors, and changing perceptions through action according to each patient's self-identified goals. A clinical case illustrates how reasoning based on an ecological-enactive approach leads to an expanded, multipronged, affordance-based intervention.

Conclusions: The ecological-enactive perspective can provide an overarching conceptual and practical framework for clinical practice, guiding and constraining clinicians to choose, combine, and integrate tools that are consistent with each other and with a true biopsychosocial approach.

Background

Despite scientific advancements revealing the complexities of pain, it is still commonly interpreted within an overly simplistic biomedical paradigm: pain is primarily considered an indicator of bodily damage.[1–3] As a result, clinicians often engage in a quest for some biological root cause.[4] Structural changes observed on imaging — such as intervertebral disk degeneration, rotator cuff tears, or cartilage changes — are frequently identified as the underlying cause of pain, although they are also highly prevalent in pain-free populations.[5] Individuals end up interpreting their diagnosed condition as evidence that their body is damaged and broken.[6] They may fear and avoid movement and activity, and seek a series of guideline discordant interventions to correct the identified issues.[7,8]

In an effort to help patients, musculoskeletal clinicians employ treatments for conditions that may not exist or be reliably detected (such as sacral torsions, spine "instability") and have developed and sustained treatment paradigms (such as "correcting" posture, core training) that are not well-supported by scientific evidence.[5,9–12] The current approach to musculoskeletal pain, with its profusion of trademarked techniques and name-systems that have imbued physical and manual therapies, is failing.[4,5] Musculoskeletal pain care needs to move away from emphasis on a simplistic biomedical model.[13]

In this paper, we propose ways to better understand individuals experiencing chronic musculoskeletal pain so that they are treated less like a machine and more like an ecosystem.[4] We start by outlining three key issues with the biomedical model and identify important elements that the model is missing. We then discuss how the biopsychosocial (BPS) model is an important advancement yet has unfortunate shortcomings resulting in similar issues that we face with the biomedical model. We argue that an ecological-enactive framework[14,15] may serve to advance the understanding and treatment of people experiencing pain. The framework is grounded in the concept of *affordances*, i.e., opportunities for action offered by the environment. This framework does justice to the personal perspective of patients as well as their interactive relation to the environment which shapes the different ways pain is experienced. Our goal is to show the advantages of the ecological-enactive framework as a useful conceptual toolbox for pain management. We also intend to provide practical guidance to aid clinicians in managing and understanding the multiple and varied causal factors for pain, communicating, and building their reasoning in partnership with patients.

Three reasons the biomedical model is problematic and what it misses

The traditional biomedical perspective is problematic for at least three reasons. First, its proponents often inaccurately endorse a *linear* relationship between noxious stimuli and pain, while it is established that the relationship is highly variable.[16,17] Second, it is *reductionistic*, as it inaccurately assumes that "some underlying pathology is both a necessary and sufficient cause of the symptoms experienced."[18] This minimizes the role of psychological and environmental factors. Third, it is often *dualistic*: pain is considered *either* somatic *or* psychogenic.[18,19] When there is no objective evidence that the source of the pain is in the patient's body, the conclusion is that the pain experience must be in the patient's mind.[19] The pain experience is then deemed less real, and patients are often stigmatized as a result.[20,21] The biomedical view is anchored in an outdated view of pain that does not align with our current understanding that pain is *both* a sensory and emotional experience,[22] and always influenced by biological, psychological, and social factors.

Most persistent and disabling non-traumatic musculoskeletal pain disorders (e.g., chronic low back pain) cannot be explained by pathoanatomical processes alone. This has prompted the development of classifications that appreciate chronic pain as a condition *in its own right*, rather than a symptom of another underlying condition.[23,24] Chronic pain is a *multidimensional and multicausal* condition[5,25–28] and the many potential factors involved are time and context-sensitive, interacting with each other in a nonlinear fashion.[29]

The biomedical perspective misses the fact that psychosocial factors are important contributors to pain intensity and disability.[30–32] Paradoxically, exposure to health care can sometimes have harmful consequences.[33–36] Care that is inconsistent with evidence-based recommendations, for example, suggesting to avoid activity to prevent (further) damage to the body, can reinforce beliefs and behaviors which may further contribute to pain and disability.[37–42] Communicating that interventions "protect" the damaged body part or "correct" inadequate movement patterns can unintentionally reinforce patients' fear-avoidance and guarding behaviors.[8,40,43] These messages are more likely to come from clinicians who adhere to a biomedical understanding of pain, believing that pain signals the presence of a damaged body part that needs to be investigated, healed, or fixed.[37,38,41,44] While tissue damage and pathology can be an important contributor to pain, it is only one piece of the puzzle that we have historically overemphasized in people living with chronic pain.[17]

From biomedical to biopsychosocial: are we doing better?

Engel proposed his BPS model in 1977 to promote a broader, more humanistic perspective of healthcare by acknowledging psychological and social, in addition to biological, influences on health.[45] It later became the conceptual basis for the widely adopted International Classification of Functioning, Disability and Health.[46] The BPS model allows for recognition that musculoskeletal pain and disability are entwined with personal and cultural beliefs and inseparable from the social and economic context of people's lives.[47] It warrants a multidimensional assessment and management of musculoskeletal pain and is now widely recommended as the best approach for musculoskeletal pain management.[47–52] The model was an attempt to *avoid* the reductionism and dualism of the biomedical view. In principle, there should be no division between its three elements, for it's their combination and interaction, rather than the factors alone, that predict pain-related clinical outcomes.[53]

In practice, however, the BPS approach is rarely applied in the manner that Engel intended.[54,55] The main reason for its misapplication is that the model lacks theoretical depth – it postulates but does not provide a developed account of the dynamic interdependence between the three domains.[55] In educational and clinical settings, domains are approached separately, and the approach falls back to a primary focus on the biological factors and "objective" elements such as tissue damage, physical function, or biomarkers.[56–58] It often remains unclear for the clinician how different forms of assessment relate to the patient's lived experience, unique concerns, and subjective experience of pain.[55,59] In practice, therefore, the BPS approach has had limited theoretical efficacy to educate and influence clinicians about the complexities of pain.[60,61]

Another source of misapplication is 'neuromania'.[55,62] A recent critical review shows that the BPS approach to low back pain is frequently identified with a biomedical neuro- or brain-centric understanding of pain, with the individual pain experience reduced to a response of the nervous system.[58] To this reduction, patients may react by "believing that they are being told 'the pain is all in your head', which is a common pitfall of this approach."[63]

The review also indicates that psychological aspects are only narrowly defined and often fused with social aspects, if the latter are not entirely absent from BPS-based approaches. Pain is usually defined as an individual issue attributed to their beliefs, attitudes, behaviors, or mood. It is rarely deemed "social", that is, contextualized within the broader social environment in which someone is situated.[58] In clinical practice, psychological and social domains are often ignored, overly simplified, confused, or 'referred away' to other healthcare professionals.[64]

Because the interrelationship of the domains is not specified and understood, applications of the biopsychosocial model may "chop the patient into three neat packages."[65] Lacking a sufficiently developed theoretical base, the BPS model cannot resist being assimilated into the dominant paradigm and ends up being practiced in a *reductionist, fragmented*, and *linear* manner.[14] The pain experience is inappropriately considered separable into distinct parts while the involved factors are seen as only linearly connected. We believe that an ecological-enactive framing of musculoskeletal pain and (dys)function can enrich and complement the BPS model toward an approach where biological, psychological, and social factors are considered dynamic and interdependent, as Engel intended.[45]

An ecological-enactive approach to chronic musculoskeletal pain

"Ecological" and "enactivist" ways of thinking are both grounded in the idea that the central unit of analysis is the dynamic relation between person and environment.[66] Specifically, both suggest we experience the world and ourselves in terms of *what we can do* in the environment. To get at this idea the concept of *affordances* from James Gibson[67] is essential. We define this concept below and outline important theoretical developments.

What are affordances?

Affordances are *opportunities for action* (good or bad) that the environment offers an organism.[67] For example, the *sit-ability* of a chair or *climb-ability* of stairs (Fig. 1)[68] are typical affordances for adult humans due to their particular body shape (e.g., anatomical leg length), function (e.g., hip and knee flexion/extension), and sociocultural practices (e.g., convention to sit on chairs during meetings and climb stairs to enter buildings). The total set of affordances available to the members of a certain species or social group depends on their abilities and practices and the niche they live in.[69–71]

Action opportunities available to *a particular individual in a particular situation* not only depend on species-specific characteristics and sociocultural norms but are further shaped by the individual's abilities, personal history, long-term goals, and present preferences and concerns, including

Fig. 1 Affordances are opportunities for action that are specific to an individual's capabilities (from Vaz et al., 2017,[68] reproduced with permission).

the current physical condition and experience of the body.[69–73] The dynamic set of action opportunities constitute what is called a *field of affordances* that is *personally unique*. In the *field*, some action possibilities may seem positive or attractive because of personal needs or desires,[72,74] others may be viewed as negative and thus avoided. For example, lying on a bed may appear attractive to someone who is tired as it affords resting. When an individual is weighed down or fatigued, hills appear steeper[75,76] and therefore less climbable if one wants to preserve energy. Different situations might call out for different actions, and different people might be responsive to different aspects of a situation, shaping the particular decisions they make.

There are three main implications of these theoretical concepts. First, individuals do not perceive the world from a detached and neutral standpoint; rather, they are related and attuned to the world from a unique and personal point of view. Second, under *optimal conditions*, the diversity of action opportunities within the field of affordances allows individuals to *flexibly adapt to the world* in ways that are sensitive to their particular abilities, concerns, and circumstances. Finally, the field of affordances is dynamic and ever-changing as it emerges from the complex interplay of multiple idiosyncratic causal elements.

Chronic pain: a stuck field of affordances

In an ecological-enactive approach, pain is understood in terms of a person's perceived action possibilities (affordances) in their active engagement with their environment.[15] In *chronic pain*, people tend to experience themselves as trapped in a closed-off or hostile world: their *field of affordances* fundamentally *changes and shrinks* in terms of attractive and meaningful action opportunities. For example, the action possibilities of sitting on a chair or climbing stairs may change to be perceived as dangerous or unavailable for a person with severe back pain. Pain can also dilate subjective time[77] and distance perception[78] and alter subjective space to include "less room" and more restricted bodily motion.[79]

In chronic pain, the body becomes an obstacle, everyday tasks are harder, and it can become impossible to see how one can engage in certain actions now or in the future.[15] People can develop patterns where they stop believing in their bodily abilities, leading to a reduction in activity. They become "stuck" perceiving themselves and their environment in ways that may *no longer* be *adaptive*. This can become extremely frustrating to affected individuals as they often feel that others do not fully understand their experience or appreciate why they are acting in the ways they are (e.g., avoiding particular movements or tasks).

Embracing the "Es"

Frameworks grounded in ecological and enactive theory often make use of a family of concepts starting with "E", focusing for present purposes on *embodiment*, *embeddedness*, and *enaction*. Understanding these concepts helps further unpack the affordance-based approach to pain.

First, experience is *embodied*. We experience ourselves and our world with, through, and because of our bodies.[80,81] The body has a "dual" or "double" status: we (1) *experience* our body *subjectively* and (2) *objectively have* a physical body.[82,83] For example, we may experience our back from a private perspective as painful, while we also have a physical back that can be examined by others (e.g., physical therapist) and determined to be injured (or not). These two aspects of the body can become somewhat incongruent. For instance, a clinician's physical assessment of a patient's body may lead to the impression that the patient should be perfectly capable of engaging in a variety of actions. However, the patient's lived experience of their body may frame these actions, from their personal perspective, as impossible or something to be avoided: their field of affordances is restricted. This *lived experience* cannot be directly seen or observed by other people. However, as we unpack later, others (e.g., clinicians) can influence (intentionally or unintentionally) people's lived experience of their bodies and perceived action opportunities for better or worse.

Second, experience is *embedded*, that is, we are always situated in a physical and social *environment* that enables or constrains the types of experiences we have. To paraphrase a remarkable insight about ecological science, to consider embeddedness is to "ask not what's inside the patient's body (or brain), but what the body (and brain) is inside of".[84] How does the patient's environment shape their experience of pain? Embeddedness is a central element of affordance-based frameworks as affordances are essentially *relational*; the perception and actualization of action opportunities depend on an organism's characteristics *in relation to the environment's features*.[85] Together, embodiment and embeddedness highlight a bi-directional relation between person and environment mediated by the body. Much empirical work substantiates the relational nature of pain and pain-related disability,[14,15,86,87] including findings that messages of threat and danger, often conveyed by clinicians,[40,88] can amplify pain intensity[89] and lead to avoidance of activities (restricting the field of affordances) due to the patient's fear of (re) injury.[90,91]

Third, experience is *enacted*. Building on the previous Es, enaction — as the name suggests — focuses on *action*. Experience is enacted or brought forth through action and perceived action possibilities.[81] Enaction is a dynamic process between person and environment. Pain, therefore, cannot be understood in static terms or through an analysis of "root causes" isolated in the individual, let alone just their brain or other body parts.[92] Pain is generated and maintained in the dynamic interaction of a person (with a body and brain) and their physical and social context. Chronification of pain is an *active multicausal process* that evolves as a person actively shapes and is shaped by their environment. In particular, activity and inactivity play a central role.

Affordances are always biopsychosocial

The ecological-enactive approach to pain complements the BPS model and adds to its theoretical foundation, helping mitigate implementation issues that derive from its frail conceptual basis. Specifically, the relational nature of affordances makes it impossible to *only focus on one* of the three domains (biological, psychological, or social) or to consider them *in isolation* from each other, because it is not possible to coherently use the concept of affordances without consideration of both the individual and their environmental

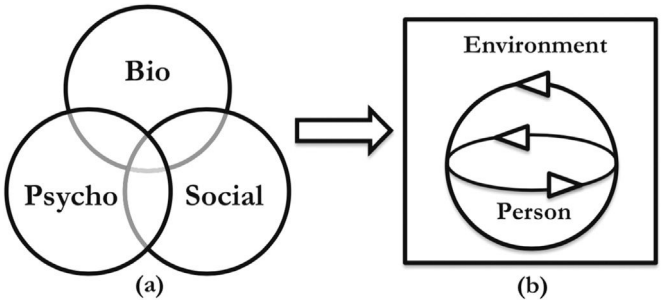

Fig. 2 Moving from (a) the biopsychosocial Venn diagram, to (b) a schematic of a dynamic person (the inner circle represents the organism's internal dynamics) coupled (outer circle) to a changing environment (from Stilwell & Harman, 2019,[14] reproduced with permission).

context.[85,93,94] Centralizing affordances in pain care theory and practice can provide safeguards against the fragmentation and the biomedical dualism and reductionism commonly seen in misapplications and misinterpretations of the BPS model.

Furthermore, embodiment, embeddedness, and enaction emphasize pain as the lived experience of acting in a dynamical relation to the environment. The 3 Es entail taking an ecosystemic view of the person and their physical/social environment (Fig. 2), as they place a fundamental emphasis on the fact that humans are always in a physical and social world, and that context and environment shape experience, meaning, and behavior.[4]

Finally, conceptualizing pain as a multicausal and dynamic process of change of the field of affordances requires innovative ways to reason in face of uncertainty and the absence of "root causes" for chronic musculoskeletal pain. The ecological-enactive perspective calls for clinical reasoning tools to take non-linearity and context-sensitive causation into account.

A novel clinical reasoning approach: reasoning about complex clinical problems in the face of uncertainty

In the ecological-enactive perspective, the disabling aspect of chronic pain is understood as the result of a dynamic multicausal process that restricts a person's perceived action possibilities as they engage with their environment. Put more simply, a person can become "stuck" in a closed-off field of affordances. Investigation of this field is important to identify ways to help the person "open it up." Because the field is unique for each individual and shaped by personal history, needs, desires, and fears, the patient's narrative provides clinicians a window of access into the idiosyncratic and complex interplay of causal elements contributing to their disabling pain.[14,15,53] This is illustrated in Box 1 (Carla's story). A collaborative investigation process that allows for causal complexity and uncertainty can help reframe beliefs, fears, and desires, opening perspectives for the future.[29]

Supportive context for meaningful connection

Creating a meaningful connection with people suffering with pain is essential for the exploration of their narrative. Connection requires careful, considerate, and curious forms of communication to establish trust and acknowledge the person within their unique circumstances.[95] It is widely recognized that people suffering with persistent pain are often stigmatized and marginalized[20] and as such, the creation of safe spaces to establish a therapeutic relationship is of the utmost importance. It is particularly important to not be dismissive or judgmental of "unhelpful" beliefs that the person may express and instead explicitly validate their lived experience. Well-established methods such as motivational interviewing can help establish a partnership, allow a space for acceptance of the other, facilitate compassion, and evoke a rich narrative[96,97] that brings into the open causally relevant information for their pain.[29]

Novel interactive clinical reasoning tools to move beyond linear causation

Clinical reasoning strategies have historically favored a "third-person perspective": the interpretation of the patient's situation is external to them, made *by the clinician*. For example, in hypothetico-deductive reasoning, clinicians generate hypotheses based upon signs, symptoms, and indices in an attempt to interpret the clinical presentation and formulate a diagnosis.[98] Alternatively, in inductive reasoning the clinician evaluating patterns of presentations matches them onto their previous experiences and diagnostic categories built over time.[98,99] In other approaches such as narrative, collaborative, and ethical reasoning[98] an interactive perspective is used to interpret the person's lived experience: the clinician involves the patients as an *active agent in the reasoning process*. Taking an ecological-enactive approach to pain encourages a shift from the historically favored third-person perspectives to an interactive perspective. *Reasoning together*, clinician and patient can get a co-constructed picture of how action/inaction and perceived action (im)possibilities shape the experience of pain, its personal meaning and related behavior, with a shared understanding of the situation that would not be available to each (clinician and patient) on their own. New tools that allow both patient and clinician to get more comfortable with causal complexity and uncertainty can add significant support to this process.

One practical tool for interactive reasoning is the *mind-map* (Fig. 3). It brings together the results of the physical examination, the clinician's expertise, and the patient's context, history, needs, desires, and fears in a shared

Box 1 Clinical scenario: an affordance-based approach to Carla's story.

Carla's background: Carla is a 45-year-old female with a history of low back pain and sciatica 18 years earlier. She had a disk protrusion at L4/5 and underwent a microdiscectomy. The sciatica returned within 3 months, and she underwent decompression and fusion at the L4/5 level, which resolved the pain. As a physical therapist, she felt vulnerable when engaging in manual handling activities and moved on to working as a Pilates teacher. After 15 years, her symptoms returned with no trauma or clear cause for onset. At this time, Carla had two young children and stopped working due to fear of exacerbating the back pain. Physical therapy, which included manual therapy, massage, postural exercises, and core exercises, helped ease the pain temporarily. However, over time, she became unable to sit, drive, or stand for any length of time. Movements of the trunk were, in general, associated with intense pain, which was exacerbated with any attempt to exercise. Her general practitioner prescribed nonsteroidal anti-inflammatories, opioids, and muscle relaxants. Magnetic resonance imaging and X-rays revealed nothing of note, other than the signs of surgical instrumentation. She was diagnosed with chronic nonspecific pain and referred to a community pain service, where she received education about pain, pacing her activities, and reducing her opioid medication. The clinic focused on mindfulness and psychological techniques for pain self-management. However, she became more frustrated, anxious, and fearful for the future. She developed poor sleep patterns and increased levels of anxiety and struggled to cope with everyday activities, becoming depressed. She decided to seek medical care, hoping to get injections or surgery, but she was referred to a physical therapist again.

Carla's narrative: The physical therapist invited her to tell her story. It became clear that because she had been given the label of "non-specific low back pain" and received treatment for so-called "psycho-social" elements of her problem, she felt that her pain was treated as primarily "psycho-social." The absence of any improvement in her symptoms reinforced her belief that something had been missed in the imaging exams. She expressed distrust in the medical doctor's diagnosis but was unwilling to question his expertise. She wondered whether the initial injury was the result of her not observing patient handling guidelines in her first job (i.e., keeping the spine straight). She also thought her symptoms might have been aggravated by not always observing correct postures during daily activities and felt guilty, thinking that as a physical therapist and Pilates teacher, she should have known better. She reported that a typical day was exhausting due to the anxiety of avoiding wrong movements that would exacerbate the pain. She dreaded sitting in a car and had stopped driving, becoming socially isolated. She recounted making elaborate excuses to avoid meeting friends. She felt guilty about her role as a friend, mother, and wife, as well as losing her professional identity. Carla became overcome with emotion while recounting her experiences.

Physical examination:

Normal gait pattern and balance
Tenderness between L2-L5 with muscle guarding
Pain restricted to the lumbar spine, no sensitivity to light touch or brushing the skin
Normal hip function
Normal tone, reflexes, power and sensation to light touch in the lower limbs
Negative pain provocation tests of the sacroiliac joints
Trunk rotation, extension and flexion limited either due to pain or the apprehension of pain.
Movement bracing with breath holding and a stiff trunk
Considerable effort to change positions (sitting to standing, lying or side-lying).

An ecological-enactive approach: Regarding the *field of affordances*, Carla's perceived opportunities for action had become restricted. The interaction of various personal and environmental factors had contributed to her being 'stuck' in a particular experience and interaction with the environment. The intervention aimed to open up her field of affordances via different routes, in a process of shared decision making. This process included re-establishing trust in the body (*embodiment)*, moving in a more fluid and relaxed manner (*enactment*), and re-establishing a meaningful relation with the environment (*embeddedness*).

An affordance-based intervention: Carla and the physical therapist collaborated to create a *mind map* (Fig. 3), outlining hypotheses of causal links between factors relevant to her complaints. This mind map informed the *vector model* (Fig. 4), which represented how much each causal factor was believed to contribute to or counteract her symptoms. These tools facilitated a discussion of *causation as a context-dependent and dynamic process that is unique to each person*. She understood that there is *no single explanation or 'fix'* for her pain. Instead, there are multiple entry points to promote positive change. She assisted in identifying the factors she found most amenable to change.

Initially, the physical therapist did not dismiss or challenge Carla's beliefs on manual handling and 'correct' movements and postures, as she had adhered to a rule-driven belief system rooted in idealized biomechanical reasoning. It seemed likely that she could reframe her perspective through *experiential learning*. At the outset, the priority was finding a safe starting point with reproducible postures and movements that helped manage symptoms to promote a positive experience during movement and reduce anxiety levels. With behavioral experiments involving lifting, carrying, and twisting of objects typically encountered in daily life, along with breathing and relaxation techniques, Carla began to realize that her symptoms could be altered. This provided her a sense of control and showed her that she could move in a variety of fluid, healthy, and relaxed ways. She was never instructed on how to move; instead, she was given the choice of how to move in a way that felt best to her during daily life tasks, practiced with the support of the physical therapist. This allowed her to view moving, sitting, and standing in an entirely different way, free from the constraint of one prescribed way or the best way. Through discussions about her circumstances, she also began to consider and work on other aspects of functional movements, including strength and load capacity, as well as recovery strategies, including sleep. Ultimately, with assistance from the physical therapist, she engaged in regular physical activity with social support, increasing her self-efficacy and autonomy to explore a wider range of action opportunities in her environment (*expanding her field of affordances*).

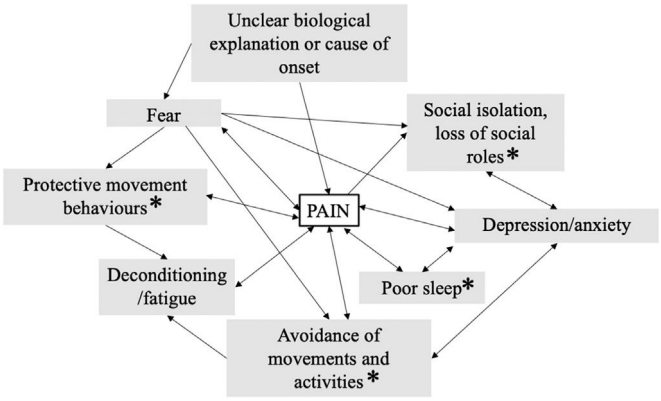

Fig. 3 Mind Map that brings together the results of the clinician's and patient's interactive reasoning, illuminating multiple causal loops among contributing factors. Asterisks indicate most easily changeable factors identified by therapist and patient; they are entry points to intervene in the loop. For simplicity, protective factors are not represented (please see them in the vector model in Fig. 4).

space.[29] The contents of the mind map should be discussed openly with permission given to patients to adjust and change their elements. The shared mind-map can illuminate complex and *circular causal connections* between biological, psychological, and social factors that may be perpetuating the pain experience. It can clarify how action possibilities are being blocked and indicate potential points of entrance to open up the field of affordances. This interpretative map is adapted and modified as the experience of expanding action possibilities evolves over time.

Another practical tool useful to reconceptualize causes of pain and identify factors amenable to change is the *vector model*[29] (Fig. 4). It can help both clinicians and patients overcome biomedical causal beliefs that have been found to be a barrier to recovery.[100] For example, when patients believe in a linear causal relationship between activity and pain and therefore choose to restrict their activities, but continue to experience pain, frustration ensues. This often feeds a self-fulfilling cycle of negative emotion, despondency, frustration, and anger that adds to the pain experience.[101] The vector model, derived collaboratively with the patient from the mind-map, helps clinicians and patients move away from the assumption of necessary and sufficient causes for pain as it promotes a *dispositional* perspective of causation.

In dispositional theories, causes are interpreted as a cluster of powers, or *dispositions*, orientated toward an effect.[102] For example, a glass has the disposition to shatter when struck. This disposition has to do with its *possible* shattering in *certain conditions*. Thus, the fact that the glass has been struck does not necessarily mean that it will break, because other causal powers may interrupt, counteract, or intervene. The effect (shattering) is only reached when a single or a combination of dispositions exceeds a threshold.

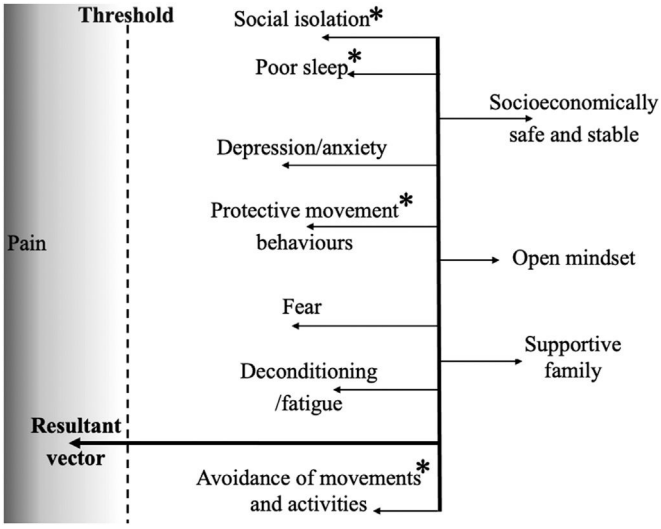

Fig. 4 Vector Model showing a set of potential causal influences that dispose toward or away from the generation of pain, summarizing the Mind Map and adding protective factors. The resultant vector conveys the concept of tendency instead of necessary and sufficient causes. The effect (pain and disability) is reached when a single or combination of dispositions exceeds a threshold as different causal powers may interrupt, counteract, or intervene. Asterisks indicate most easily changeable factors identified by therapist and patient.

The vector model, therefore, provides a visualization of a whole set of potential causal influences that dispose towards or away from the generation of pain. It helps show that *no single causal factor necessitates an effect on pain* for all patients, rather, effects are *context-dependent*, *dynamically interacting*, and *unique* to each person (please see Fig. 4 captions for further details). Confidence and optimism can be increased by using the concept of tendency rather than the concept of necessity or inevitability (e.g., avoiding the idea of inevitable pain due to processes of 'wear and tear' in osteoarthritis).[101] *Uncertainty can be reframed* in a positive light: multicausality implies that there are multiple options to reduce apprehension and pain. This is an innovative tool to reason in face of uncertainty and the absence of single 'root causes' for chronic musculoskeletal pain.[29]

Shared decision-making and planning

With a comprehensive viewpoint of a person's unique situation, an opportunity to facilitate a shared decision-making process can develop.[103,104] Seeing the bigger picture, a (mind)map alongside the causal terrain for pain (vector model), the patient and clinician together evaluate not only the most relevant factors that appear to be significant drivers of the situation but also which may be felt to be modifiable or open to change.[29] Interactive clinical reasoning aided by the mind map and the vector model allows for consideration of complex and dynamical causality while retaining and valuing the patient's narrative and lived experience, as originally intended by Engel's BPS model.

Based on this interactive investigation of the field of affordances and its causes, interventions will be chosen to create opportunities for patients to view and experience their body and world in positive ways, better adapting to their environments to reach their goals and aspirations.[14,15,55] Adaptability and autonomy are key components to achieve pain self-management.[105,106]

Affordance-based therapy for chronic musculoskeletal pain

The starting point for planning interventions is at the level of affordances — relations between the abilities of the individual and features of the environment.[85] Given the relational focus, the overarching goal of therapy should not be to fix 'originary' structural causes (they are not assumed) but rather to help patients to better adapt to their environments while equally considering all (biopsychosocial) domains of functioning and their dynamic causal interactions.[15,55] Intervention can be thought of as 'affordance-detection therapy' to enhance participation in life situations.[68] It aims to enlarge patients' fields of affordances by helping them perceive and enact opportunities for meaningful action based on self-identified goals.[15,55]

Various available routes to change may have mutually reinforcing effects on the field of affordances. Because perceiving affordances is seeing that the situation allows a certain activity,[85] interventions can include helping patients reconceptualize their situation, engaging the body to build ability and confidence, and changing the environment to make it supportive rather than restrictive of exploring activities.[15,55,107] Thus, the ecological-enactive approach calls for multidimensional, person-centered interventions. The concepts of embodiment, embeddedness, and enaction can once again help unpack the translation of the affordances-based approach to personalized treatment choices. Box 2 contains principles to aid in these choices; they are detailed in the next paragraphs.

Embodiment — build confidence, embrace versatility

First, *embodiment is the means* by which people interact with environments to perceive and enact possibilities to act. The lived experience of one's body and abilities are therefore determinants of the field of affordances. A very significant route for change is the active engagement of the body, affecting both actual and perceived abilities (self-efficacy) to function in life situations. Trust in the body's strength and adaptability can be enhanced with graded exercise. Exercise is a complex intervention with multiple potential biological and psychosocial benefits for chronic pain.[108—111] Because evidence showing that one form of exercise is clearly better than another is not available for common musculoskeletal conditions, such as low back pain, patient preferences should be taken into account in deciding the type of exercise.[47,110,112] However, because skill acquisition science disavows assuming that gains from traditional tissue-focused exercise generalize to functional activities,[113] the addition of person-specific graded skill building (focused on patient-chosen challenging activities) is likely needed to help improve functional ability.[68,114] Skill training can produce superior effects not only on function but also on pain when compared to strength and flexibility exercise.[114]

Box 2 Guides for affordance-based physical therapy: multidimensional person-centered intervention.

- Explore potential pain contributors and treatment options together with the patient
- Expand beyond physical exercise: support acquisition of skills to perform meaningful movement tasks based on patient-identified goals
- Allow for multiple movement solutions rather than ideal or 'correct' movement patterns or postures
- Be mindful of negative contextual messaging; provide messages that build confidence in the body and abilities
- Avoid reliance only on passive, impairment-based care; foster active patient participation
- Support experiential learning to reconceptualize understandings of pain by means of the body in action
- Co-develop personalized strategies to manage pain during activities of daily living

Another aspect of embodiment that should guide intervention choices is that behavioral flexibility and versatility should be fostered. Optimal variability of body movements and postures is linked to flexible, adaptive, healthy functional behavior,[115,116] that is, to enacting a rich set of action opportunities. Therefore, a priori defined, idealized (biomechanically 'correct') or prototypical movement patterns or postures are not a reasonable expectation. 'Incorrect' spine posture during sitting, standing, and lifting can neither predict nor prevent low back pain and disability.[117,118] 'Correction' or 'normalization' of movement patterns or postures, therefore, should not be a primary goal of intervention.[68] Instead, 'naturalization'— the adoption of varied and relaxed postures and ample, agile, and less protective movements — seems to be a better approach.[117–119] Therapy should aim for individual- and context-dependent fluid movement solutions, enhanced by creative practice variability built into skill acquisition programs, allowing for personalized optimal solutions.[68] 'One-size-fits-all' solutions cannot work; routes to improvement are highly individualized.[117,119,120]

Embeddedness — shape context, it always matters

Second, embeddedness directs attention to an often-neglected focus: psychological and social *contextual factors* can enable or constrain experiences.[121] For physical therapists, the context of exercise prescription is of special importance because, on the one hand, for many musculoskeletal conditions no form of exercise seems to be superior to another[47,110,112] and positive effects of exercise on pain and disability often do not seem to be attributable to any improvement in musculoskeletal impairments, muscle activity, or kinematic parameters.[122–125] Rather, successful outcomes after exercise may relate to building a sense of mastery or control over challenges, renewed expectations and attributions, and increased self-efficacy,[110] which can expand the field of affordances. On the other hand, the way exercise is prescribed can indeed constrain a patient's perceptions of action possibilities. When anatomical explanations, expressions like 'degeneration' and 'wear and tear', diagnostic labels such as spinal 'muscle imbalance', 'weakness', 'instability', 'incorrect' movement patterns or postures are used to explain the presence of pain and exercise recommendation, they may increase fear-avoidance.[126] Note that this is not to say that impairments should not be addressed in therapy but to say that the contextual effects of impairment-targeted interventions should be considered.

More generally, embeddedness is antithetical to narrow, unidimensional tissue-based approaches, that are exclusively or primarily focused on musculoskeletal or brain tissue. Again, this is not to say that unidimensional or linear causal reasoning is never useful; it is certainly accurate and necessary to diagnose and treat acute injuries, for instance. However, given the complexity of chronic musculoskeletal pain, problematic neurocentric pain explanations such as 'pain is in the brain' and 'retrain your brain' may result in patient frustration, confusion, or perceived stigmatization as they believe they are being told 'the pain is all in your head'.[14,55,58] Reductive approaches that ignore embeddedness can trivialize non-reducible factors beyond the body such as social context and culture,[127] neglecting the fact that situations can create a sense of threat or safety, worsening or dampening pain. Some therapeutic approaches may start from the question "what is inside this body/brain?" to define a treatment for pain, but ecological-enactive inspired therapy must also ask "what is this body/brain inside of?".[84] Therapy must therefore also aim to modify sources of threat and to create an environment where patients can freely express their concerns, be validated, and feel confident that they can move safely.[55] Clinical messages and interventions need to move away from an impairment focus that perpetuates 'body-as-(broken)-machine' views toward an empowering participatory discourse and practice to promote richer involvement in life situations,[128] enlarging the field of affordances.

Enaction — change perception through action

Lastly, enaction puts strong emphasis on conceiving pain as an experiential *process* that depends on our *active engagement* with the world.[14,15] Our primary perception (and understanding) of the world is and changes in terms of what we can do.[67,85,107] One powerful route for patients to change their understanding of pain and perception of action possibilities is by means of *experiential learning*. Traditional educational approaches assume knowledge can be 'transmitted' from the knowledgeable (therapist) to the unknowledgeable (patient) with prescription and explication (lecturing) to 'correct unhelpful beliefs'; 'filling' the patient with content to receive and memorize.[129] In this model, learners are spectators, not (re)creators of knowledge.[130,131] Experiential (learning by doing) approaches,[132,133] however, assume that knowledge and skills cannot be isolated from active, first-hand experience.[131] *To learn is to change what one can do, is to inhabit a richer field of affordances*.[134] Thus, guided active learning can be an effective means for patients to reduce the sense of threat and improve pain and activity limitation.[120,122,124,125,135] Ultimately, through experiential learning, autonomy and self-management[105,106] should be sought as an empowering culmination of an enactive-ecological approach to musculoskeletal pain care.[55]

Some current approaches like Cognitive Functional Therapy,[8,136,137] or Cognition-Targeted Functional Exercise[135] although not originally based on enactive-ecological theory, are multidimensional, person-centered interventions based on experiential learning. They foster positive experiences of safe completion of movement tasks that are functionally meaningful for the person but were previously perceived as dangerous or damaging. In consonance with favoring a functional focus for therapy,[68] patients are encouraged to focus on achieving personally relevant lifestyle goals.[7,136,138] Rather than being prescriptive, intervention is reflective: each individual is encouraged to find their unique strategies to respond to pain and perform valued activities with confidence and without hypervigilance. The new strategies are integrated into activities of daily living to generalize the learning and build self-efficacy, autonomy, and self-management.[136,138] As action-oriented approaches that promote *(re)learning* of (new) *action possibilities*, these therapeutic interventions may work by enlarging the *field of affordances*. These conceptual tools may guide future research on the mechanisms and effects of different interventions and guide their refinement.

Summary

Management of musculoskeletal pain needs to move beyond overly narrow biomedical approaches. Although the BPS approach is an important advancement to conceptualize and treat pain, it has a limited theoretical foundation that inadvertently leads to the perpetuation of linear, dualistic, and reductionist views concerning the relationship between the biological, psychological, and social processes involved in pain and its persistence. We presented an ecological-enactive approach, complementing and building on the BPS model. In this approach, disabling chronic pain is characterized as an embodied, embedded, and enactive process of experiencing a closed-off field of affordances (i.e., shutting down of action possibilities). Investigation of this dynamic, multicausal process requires communication skills and tools to reason about complex clinical problems in face of uncertainty and the absence of 'root causes' for pain.

A person-centered, narrative reasoning framework based on a dispositional view of causation can help clinicians and patients move beyond an understanding of pain based on single and linear causes. For planning interventions to open up the field of affordances, the relation of an individual with their environment needs to be the central focus. Validating a person lived experience, understanding their perceptions and beliefs about action possibilities, controlling contextual factors to create a safe environment for de-sensitization and graded exposure to feared activities, encouraging movement variability, building ability and confidence, and changing perceptions through action are all possible routes to help patients with chronic pain perceive and enact opportunities for action based on their self-identified goals.

The ecological-enactive concepts of *affordances, embodiment, embeddedness, and enaction* can allow for a more robust and coherent theoretical base to a biopsychosocial approach to musculoskeletal pain. They can help resist fragmented, oversimplified, and overly individualistic (neglecting the physical and social environment) approaches to musculoskeletal care. As a higher-level (big picture) approach, the ecological-enactive perspective may guide clinicians in choosing and combining practical tools that are consistent with each other and thus foster a true biopsychosocial approach to physical therapy care.

Conflicts of interest

Craig Liebenson delivers educational workshops for coaches and clinicians to promote self-management and independent functioning of patients and athletes.

Acknowledgements

This work was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

The work of Daniela V Vaz was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) — [Finance Code 001]. The work of Sabrina Coninx has been funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - project number GRK-2185/1 (DFG Research Training Group Situated Cognition)

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